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DEPARTMENT OF DEFENSE APPROPRIATIONS FOR 1970

24/60-2

HEARINGS

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS HOUSE OF REPRESENTATIVES

NINETY-FIRST CONGRESS

FIRST SESSION

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H.R. 15090

PART 4

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION

Department of the Air Force
Department of the Navy

Printed for the use of the Committee on Appropriations

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DEPARTMENT OF DEFENSE APPROPRIATIONS, FISCAL YEAR 1969

TUESDAY, JUNE 3, 1969.

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION, NAVY

WITNESSES

HON. ROBERT A. FROSCH, ASSISTANT SECRETARY OF THE NAVY (RESEARCH AND DEVELOPMENT)
REAR ADM. E. A. RUCKNER, DEPUTY CHIEF OF NAVAL OPERATIONS (DEVELOPMENT)
REAR ADM. L. P. SMITH, MANAGER, SPECIAL PROJECTS, NAVAL MATERIAL COMMAND
REAR ADM. T. B. OWEN, CHIEF OF NAVAL RESEARCH
REAR ADM. W. D. GADDIS, DIRECTOR, BUDGET AND REPORTS, OFFICE OF THE NAVY COMPTROLLER
COL. J. P. McNEIL, OFFICE OF DEPUTY CHIEF OF STAFF (R.D. & S.)
CAPT. G. E. JESSEN, SPECIAL ASSISTANT TO ASSISTANT SECRETARY OF THE NAVY (R. & D.)
R. C. WARSING, SPECIAL ASSISTANT TO ASSISTANT SECRETARY OF THE NAVY (R. & D.)
DR. J. S. LAWSON, DIRECTOR OF NAVY LABORATORIES
DR. W. P. RANEY, SPECIAL ASSISTANT TO ASSISTANT SECRETARY OF THE NAVY (R. & D.)

DEPARTMENT OF THE NAVY RESEARCH, DEVELOPMENT, TEST AND EVALUATION, NAVY PROGRAM AND FINANCING

[In thousands of dollars]

	Budget Plan (Amounts for procurement action programed)			Obligations		
	1968 actual	1969 estimate	1970 estimate	1968 actual	1969 estimate	1970 estimate
Program by activities—Direct:						
Military sciences	146,495	153,040	160,101	141,258	149,000	160,000
Aircraft and related equipment	217,301	395,799	577,221	283,564	385,000	580,000
Missiles and related equipment	769,443	713,456	564,648	776,345	702,000	564,000
Military astronautics and related equipment	15,452	17,827	23,959	14,863	18,000	23,000
Ships, small craft and related equipment	248,082	343,930	345,239	257,194	342,000	345,000
Ordnance, combat vehicles and related equipment	149,685	163,801	109,079	154,754	154,000	110,000
Other equipment	243,482	236,538	280,026	249,364	232,000	277,000
Programwide management and support	96,310	136,683	151,227	99,238	133,000	149,000
Total direct	1,886,250	2,161,074	2,211,500	1,976,580	2,115,000	2,208,000

DEPARTMENT OF THE NAVY RESEARCH, DEVELOPMENT, TEST AND EVALUATION, NAVY PROGRAM AND FINANCING—Continued

(In thousands of dollars)

	Budget Plan (Amounts for procurement action programed)			Obligations		
	1968 actual	1969 estimate	1970 estimate	1968 actual	1969 estimate	1970 estimate
Reimbursable:						
Military sciences	5,175	8,000	8,000	5,535	8,000	8,000
Aircraft and related equipment	125	200	200	127	200	200
Missiles and related equipment	23,830	28,000	28,000	15,519	34,000	28,000
Military astronautics and related equipment	333	400	400	371	400	400
Ships, small craft and related equipment	13,994	18,000	18,000	18,922	18,000	18,000
Ordnance, combat vehicles and related equipment	160	200	200	124	200	200
Other equipment	2,533	4,000	4,000	?,069	4,000	4,000
Programwide management and support	227,805	230,200	230,200	229,402	230,200	230,200
Total reimbursable	273,955	289,000	289,000	272,069	295,000	289,000
Subtotal	2,160,205	2,450,074	2,500,500	2,248,649	2,410,000	2,497,000
Intrafund obligations	−134,365	−135,000	−135,000	−134,108	−135,000	−135,000
Total	2,025,849	2,315,074	2,365,500	2,114,541	2,275,000	2,362,000
Financing—Receipts and reimbursements from:						
Federal funds	−138,428	−153,000	−153,000	−144,402	−153,000	−153,000
Trust funds				−294		
Non-Federal sources [1]	−1,170	−1,000	−1,000	−1,153	−1,000	−1,000
Unobligated balance available, start of year:						
For completion of prior year budget plans				−314,962	−210,275	−250,349
Available to finance new budget plans	−12,023	−19,735		−12,023	−19,735	
Reprograming from prior year budget plans	−22,247					
Unobligated balance available at end of year:						
For completion of prior year budget plans				210,275	250,349	253,849
Available to finance subsequent year budget plans	19,735			19,735		
Budget authority	1,871,716	2,141,339	2,211,500	1,871,716	2,141,339	2,211,500
Budget authority:						
Appropriation	1,816,400	2,141,339	2,211,500	1,871,716	2,141,339	2,211,500
Transferred from other accounts	55,316					
Appropriation (adjusted)	1,871,716	2,141,339	2,211,500	1,871,716	2,141,339	2,211,500
Relation of obligations to outlays:						
Obligations incurred, net				1,968,692	2,121,000	2,208,000
Obligated balance, start of year				1,009,053	975,118	1,026,118
Obligated balance, end of year				−975,118	−1,026,118	−1,081,118
Outlays				2,002,627	2,070,000	2,153,000

[1] Reimbursements from non-Federal sources are principally derived from provision of laboratory services to private organizations (10 U.S.C. 2481).

OBJECT CLASSIFICATION (IN THOUSANDS OF DOLLARS)

	1968 actual	1969 estimate	1970 estimate
Personnel compensation:			
Permanent positions	305,569	331,607	326,997
Positions other than permanent	3,728	4,175	3,334
Other personnel compensation	8,619	13,074	13,037
Total personnel compensation	317,916	348,856	343,368
Direct obligations:			
Personnel compensation	209,171	230,244	226,623
Personnel benefits: Civilian	16,347	17,737	17,368
Travel and transportation of persons	11,237	10,705	10,626
Transportation of things	2,491	2,724	2,916
Rent, communications, and utilities	5,851	5,790	5,951
Printing and reproduction	1,262	1,348	1,424
Other services	1,375,891	1,423,747	1,506,158
Supplies and materials	182,966	216,447	224,031
Equipment	169,338	203,910	210,902
Lands and structures	1,922	2,258	1,911
Grants, subsidies, and contributions	104	90	90
Total direct obligations	1,976,580	2,115,000	2,208,000
Reimbursable obligations:			
Personnel compensation	108,745	118,612	116,745
Personnel benefits: Civilian	8,406	9,137	8,948
Travel and transportation of persons	1,873	2,000	2,000
Transportation of things	176	200	200
Rent, communications, and utilities	4,492	5,000	5,000
Printing and reproduction	677	700	700
Other services	102,418	114,351	110,407
Supplies and materials	27,035	27,000	27,000
Equipment	18,247	18,000	18,000
Total reimbursable obligations	272,069	295,000	289,000
Subtotal	2,248,649	2,410,000	2,497,000
Intrafund obligations	−134,108	−135,000	−135,000
Total obligations	2,114,541	2,275,000	2,362,000

PERSONNEL SUMMARY

	1968 actual	1969 estimate	1970 estimate
Total number of permanent positions	34,785	33,505	33,610
Full-time equivalent of other positions	1,109	851	732
Average number of all employees	32,313	34,497	33,647
Average GS grade	9.1	9.1	9.1
Average GS salary	$10,422	$10,467	$10,472
Average salary of ungraded positions	$7,978	$8,280	$8,316

Mr. MAHON. We will now begin our hearing on research, development, test, and evaluation.

We will consider the fiscal year 1970 research, development, test and evaluation program of the Navy, which totals a tidy sum of $2,211,500,000. This proposed program is an increase of about $50.4 million over the fiscal year 1969 program amounting to $2,161,100,000.

Dr. Frosch, we are glad to have you before the committee again. You have quite a comprehensive statement and we will be glad to hear your presentation. Maybe you could capsule some of this for us.

DESTROYER "FRANK E. EVANS"

I was visiting with the staff a while ago and it seems a little bit ironic that when we schedule a major hearing with the Navy, the Navy makes the headlines worldwide. Here sometime ago we had a hearing and that was the day the Navy plane was shot down by the

North Koreans. Now we read about a destroyer being cut in two by an Australian carrier. Was this on a clear day?

Admiral RUCKNER. This was at night in a calm sea.

Mr. MAHON. I assume that both ships were equipped with modern communication devices?

Admiral RUCKNER. That is my understanding, sir.

Mr. MAHON. Admiral, you are a man of wide experience, is this easily explainable?

Admiral RUCKNER. It is very difficult to explain it, Mr. Mahon, until we know what the actual facts were. The ships were in a close formation. The destroyer was acting as part of the screen for the carrier and was ordered to take what we call plane guard station, which is astern of the carrier. The ships were zigzagging at the time. I would hesitate to try to explain the exact sequence of events except in a very broad generality, until we know more of the details of what happened.

Mr. MAHON. I understand very regrettably we lost many lives in this event.

Was the captain among those lost?

Admiral RUCKNER. No, sir. The captain was injured but is among the survivors. There is one known dead and at the present time 73 missing.

Mr. MAHON. That is what you would call a major disaster at sea more or less, I would think, for peacetime maneuvering.

Admiral RUCKNER. Yes, sir.

Mr. MAHON. Of course, you and I know that at a time when the military are under heavy attack from various unhappy groups in this country, things of this kind are not calculated to improve the image of the Navy, or the confidence of the people in the military management. I think you understand that.

Admiral RUCKNER. Yes, sir.

Mr. LIPSCOMB. Mr. Chairman.

Mr. MAHON. Mr. Lipscomb.

NAVY COMMUNICATIONS

Mr. LIPSCOMB. Admiral in accidents of this sort, and in previous serious events it appears a great deal of time elapses between the time of the event and when we get the information back. Today again the reports come back and they say that the information is spotty here in Washington. With our modern communications, and all that we have put into them, why at this hour should the information be spotty as to what happened?

Admiral RUCKNER. I wouldn't say it is spotty, Mr. Lipscomb.

Mr. LIPSCOMB. That is the way it has been characterized. Those are not my words.

Admiral RUCKNER. When you have a major accident such as that sort, there are a lot of people involved, and you get a preliminary report which gives you the broad outline of the event as it happened. You get this rather quickly.

But to sift through all of the information to reconstruct the event is like somewhat of a court. You have people seeing things different ways. We do not like to judge until we have all of the facts in our hands. I do not know what they meant by spotty. I think I could draw

you a sketch of what we believe happened from the traffic we have had. but I cannot tell you why. It will take some time to find out why this happened.

Mr. SIKES. What do you think actually happened?

Admiral RUCKNER. The ships were in formation, four destroyers up ahead of the carrier in a screen. They were on a base course of 220 degrees. They were zigzagging. The *Evans* was to the right of the base course. However, they were on a zig to the right, so she was slightly, as a result of that zig, temporarily on the port bow of the carrier. Here is the base course (sketching), there is the ship position. But actually, all of the ships were steaming on a course about like this. So you can see the base course was there, the ship was there, and they were steaming in this direction, putting her slightly on the port bow. She was then ordered to take station back in here and the ship turned in this direction. That much is quite clear. Sometime later the carrier, as you can see, headed over this way, announced to the destroyer that they were on a collision course. As you know, traveling at 18 knots these things happen quite rapidly, especially when you have come back in this direction. So after they announced they were on collision course they both took action and apparently what happened is that this ship turned this way and this one turned this way and they hit. Now the exact sequence of events in that area is what will take some time to straighten out.

I don't think any of us would like to make a judgment as to who was at fault or whether it was a personal error or a material error until we know more of the facts.

Mr. FROSCH. If I might come back to your question, Mr. Lipscomb, I think the point is that it is not a difficulty in communicating back to Washington from the site what they know. It is a difficulty that what they are sure they know on the site is what is described as spotty. There is plenty of communications to get back what they know when they sort it out, but it takes a good deal of time to sort it out. I think that the people on the site are probably more concerned with sorting out and taking care of survivors and so on than in trying to get a complete comprehensive tale to send back through the communications.

Mr. LIPSCOMB. It appears to the outside observer of some of these events that the information is not coming back in a timely way. With the *Liberty* tragedy, the *Pueblo*, and all, we have had too many examples over the past 2 years of not receiving messages in a timely way, or messages not being sent or received in a proper fashion. So we are becoming a little sensitive as to our communications. At least that is the way it affected me again when I read of this latest tragedy.

Those in charge of the information could at least say they would like time to evaluate the information available. That is understandable. That is different than an announcement that the information is spotty.

Admiral RUCKNER. Yes, sir.

Mr. LIPSCOMB. But if you indicate you don't have information then something is wrong.

Admiral RUCKNER. You recognize that the final information won't be in until we have had a chance to talk to, or the investigating group has had a chance to talk to people in charge on both ships at the time the incident happened, and to the other people who observed the sequence of events. I really have to agree with Dr. Frosch, the infor-

mation is fairly concise as to what did happen, and there is no delay in getting it back to Washington.

Mr. MAHON. I would think that the top officer in the area would immediately dispatch to the Secretary of the Navy or the Secretary of Defense a complete statement that was available as to the situation and keep them advised by the minute of everything transpiring insofar as was possible.

Admiral RUCKNER. Yes, sir. As the information is developed, it comes right into our operations center, and it is correlated and evaluated.

Mr. MAHON. I wouldn't charge you, Mr. Secretary, and you, Admiral, with being up to the minute in regard to all the information that is available, but I would like to think that the information is available at the Office of the Secretary of the Navy.

Admiral RUCKNER. I believe all the pertinent information is, with the exception of the exact sequence of events that happened in that one little time frame.

DAMAGE TO DESTROYER "EVANS"

Mr. MAHON. For the record, I wish you would place the names of the ships involved, the number of people aboard, the number of people lost insofar as you are able to ascertain it when you correct this record, the cost of the destroyer. In other words, what were our losses in lives—and that is the main loss—and what was the loss from the standpoint of the destroyer?

Admiral RUCKNER. I can give you some of it right now.

Mr. MAHON. Yes.

Admiral RUCKNER. The carrier was the H.M.A.S. *Melbourne*. The destroyer involved was the *Evans*. This is the *Frank E. Evans*, DD–754. It is commanded by Commander McLemore. There were other ships in the formation. There were four ships in the formation. I do not know the exact spots.

Mr. MAHON. Was this an old destroyer?

Admiral RUCKNER. This was a 2,200-ton destroyer that had been through the FRAM–II conversion.

Mr. SIKES. Would this destroyer be fitted with a new bow section or is it to be scrapped?

Admiral RUCKNER. I think it is too early to say. We would have to have a much better investigation of the damage. The ship was cut in half just aft of the bridge along about the forward fireroom bulkhead. The forward part of the ship sank in about 2 minutes. The after part is still afloat and should be at this point under tow. They have established a water tight boundary. The casualties involved, as I said, one known dead and 73 missing. The commanding officer, the executive officer, the officer of the deck and junior officer of the deck are among the survivors. There were six officers that I know of that were lost.

Mr. SIKES. What was the total crew?

Admiral GADDIS. 255 men and 18 officers, sir. There were 199 survivors.

Mr. MAHON. Were the top officers of the ship at the time of the collision in the portion of the destroyer which went to the bottom or in the other portion?

Admiral RUCKNER. The officer of the deck and junior officer of the deck were on the bridge. The captain was in his sea cabin. I don't know exactly where the executive officer was. The six officers that were lost that I know of were in the forward part of the ship. I believe two of them were in the combat information center, and four were in the officers quarters.

Mr. MAHON. When you get this record, in order to make it more complete, will you supply a more accurate and comprehensive statement about the loss?

Admiral RUCKNER. I certainly will, sir.

Mr. MAHON. You may proceed with your statement, Mr. Secretary.

STATEMENT OF ASSISTANT SECRETARY OF THE NAVY (R. & D)

Dr. FROSCH. Thank you, Mr. Chairman.

INTRODUCTION

Dr. FROSCH. Mr. Chairman, members of the committee, it is a pleasure for me to appear before you today to present the President's fiscal year 1970 Navy research, development, test, and evaluation budget.

With me again this year are the four officers who are my principal assistants in the day-to-day management of the Navy R.D.T. & E. programs.

Rear Adm. E. A. Ruckner, Deputy Chief of Naval Operations, Development, Rear Adm. T. B. Owen, Chief of Naval Research, Rear Adm. A. S. Goodfellow, Chief of Naval Development and Deputy Chief of Naval Material (Development), and Maj. Gen. L. Metzger, Deputy Chief of Staff—(Research, Development and Studies)—USMC.

I have provided for the committee record copies of my complete, printed statement. With the chairman's concurrence, at this time I propose to present selected parts drawn from that statement. The copies you have before you are suitably blue lined to enable you to follow along with me.

My statement this year is organized along lines similar to last year's and is outlined on this Vugraph. You will note that under the "Highlights of Navy R. & D." section, six of the topics shown were discussed last year and are included again because of their vital importance to the Navy and to the Congress. I have added two new topics to this section this year: "Behavioral and Social Science," "Navy Responsibilities Functional Analyses."

With your permission, throughout my presentation, I will illuminate the discussion with a series of vugraphs, and I have about 20 minutes of interesting film clips which I propose to show at the end of my statement presentation. We will respond to questions from the committee at any time during the testimony that you consider appropriate.

I mentioned a minute ago the new highlights section. I would now like to discuss the Navy responsibilities functional analysis portion in a little more detail. Over the past year, I have been concerned over our own internal Navy method of reviewing the R.D.T. & E., N program as it relates to the service peculiar overall Navy objectives and

tasks. Since the Secretary and the CNO must review the total Navy program on a mission or operational requirements basis, for example, force levels, contingencies, and so forth, I have for some time felt that our R. & D. program, which both leads as well as supports the mission requirements of the Navy, should give greater visibility to Navy managers responsible for review of our programs.

The DOD category method of review, and the budget activity method both serve a useful purpose in an accounting sense but are difficult to directly relate to operational requirements. Since the bulk of R. & D. requirements for system development originate along these operational lines and are promulgated in a series of documents known as general operational requirements (GOR's), it has become clear to me that for internal Navy review, structuring of our program patterned along those lines might give us a more meaningful examination when viewed from within the total Navy program. For that reason we adopted internally the functional analyses method in the systems areas, based on the mission responsibilities of the Navy. Research, exploratory development and management and support functions are not specifically oriented along operational requirement lines so remain in the original format. All other programs have been alined to the several mission responsibilities.

I hasten to point out that review of the entire R.D.T. & E., N program using this method provides precisely the same material now existing under the category/activity method with the advantage of examining programs in the functional areas where they will actually be used. Since it is purely an internal Navy review method, it is included this year for information of the committee only and does not represent a change in format in presenting the fiscal year 1970 budget.

I will now discuss our fiscal year 1970 program.

II. FISCAL YEAR 1970 R.D.T. & E., N FISCAL SUMMARY

For our fiscal year 1970 R.D.T. & E., N program the Navy is requesting new obligational authority in the amount of $2,211.5 million. The spread of this program by the eight budget activities is reflected in table I. Our fiscal year 1969 program is included for comparative purposes.

TABLE I.—FISCAL YEAR 1970 R.D.T. & E., N. PROGRAM BUDGET ACTIVITIES

[In millions of dollars]

	Fiscal year 1969	Fiscal year 1970
Military sciences	153.0	160.1
Aircraft and related equipment	395.8	577.2
Missiles and related equipment	713.5	564.7
Military astronautics	17.8	24.0
Ships, small craft and related equipment	343.9	345.2
Ordnance, combat vehicles, and related equipment	163.8	109.1
Other equipment	236.6	280.0
Programwide management and support	136.7	151.2
Total	2,161.1	2,211.5

The proposed program for fiscal year 1970 reflects an increase of about $50 million over the fiscal year 1969 program. The principal reasons for the major differences between fiscal year 1969 and fiscal year 1970 in budget activities 2, 3, 6, 7, and 8 are provided and will be presented at the beginning of each activity discussion under part IV if my statement along with details of the activity programs themselves.

In fiscal year 1970 all fleet support elements totaling $55 million have been transferred from R.D.T. & E., to O. & M.N. It is considered to be more appropriate to budget for this function of support of improvements and changes to inservice equipment in the operations Navy appropriation. This transfer like the transfer in R.D.T. & E. last year of management and support costs, is part of a continuing effort to refine and make more meaningful our budget structure.

We further divide our program into six DOD categories for our every day operations within the Department of Defense. Table II displays the same totals for the fiscal year 1969 and fiscal year 1970 programs by DOD category.

TABLE II.—R.D.T. & E., NAVY DOD CATEGORIES

[In millions of dollars]

	Fiscal year 1969	Fiscal year 1970
Research	130.5	136.5
Exploratory development	264.6	274.7
Advanced development	295.3	346.6
Engineering development	332.5	499.4
Management and support	223.2	236.3
Operational systems development	915.0	718.0
Total	2,161.1	2,211.5

III. HIGHLIGHTS OF NAVY RESEARCH AND DEVELOPMENT

Mr. Chairman, before I begin my activity-by-activity review of the Navy's proposed fiscal year 1970 R.D.T. & E. program, I would like to discuss in some detail several of the following subjects:

A. Fiscal management.
B. Navy R. & D. accomplishment.
C. SEASIA.
D. ASW.
E. Antishipping missiles.
F. Oceanography.
G. Social science studies.
H. Navy responsibilities functional analyses.

A. Fiscal management

I will now discuss the fiscal management of the R.D.T. & E., N appropriation. The first chart compares the fiscal year 1968 obligation plan in the fiscal year 1969 President's budget with the actual fiscal year 1968 executed plan shown in the fiscal year 1970 President's budget. The actual fiscal year 1968 performance in terms of obligations was 5.6 percent better than the estimate, and resulted in an unobligated carryover balance 13.2 percent below the estimate.

The second chart shows the fiscal performance for the past 5 years and projects the performance for fiscal year 1969 and fiscal year 1970.

The percent of unobligated balance at the end of fiscal year 1968 is below the unobligated balance at the end of any of the past 5 years: 3 percent below fiscal year 1964, 6 percent below fiscal year 1965, 10 percent below fiscal year 1966, and 4 percent below fiscal year 1967. It is anticipated that the unobligated balances at the end of fiscal year 1969 and fiscal year 1970 will approximate 9 percent. The reduction in unobligated balance has been accomplished with no relaxation of the care with which we obligate and use the funds appropriated for this work.

The next chart shows that in fiscal year 1968, the total funds available for obligations were increased during the year from $2,362.4 million to $2,478.7 million. This increase of $116.3 million, is comprised of a SEA supplemental appropriation totaling $35.7 million, emergency fund transfers of $19.6 million, and an increase of $61 million in reimbursements.

A number of factors influence the progress of the financial support of the R.D.T. & E., N programs. For example, availability of appropriations, emergency fund transfers, and supplemental appropriations. Programs are deferred by the Navy and D.D.R. & E. for a number of technical reasons, such as a need for more complete documentation of the technical development plans, more definitive program objectives, or completion of feasibility tests. Procedure for contacting for research and development are understandably complex; normally a 12-month period is required for program definition, negotiations, and contract definition.

This chart also compares the funds available for obligation with the actual obligations. Normally, funds available are obligated within a 12-month period. With additional or incremental funds being made available for obligation during the year, the average time for fiscal execution of a program may be 18 months. At the beginning of fiscal year 1968, the new obligational authority of $2,035 million plus the carryover balance of $327 million totaled $2,362.4 million. Twelve months later (June 30, 1968) $2,248.6 million was obligated. By the end of the first half of fiscal year 1968 (December 31, 1967), the total obligational authority plus carryover was $2,364.4 million with deferrals of $141.3 million, leaving $2.223 million available for obligation. Twelve months later (December 31, 1968), $2,352.1 million was obligated leaving a balance of $108.7 million in fiscal year 1968 and prior year availability.

The Navy maintains a constant review of its R.D.T. & E. program requirements, and, as necessary, redirects funds, with the assistance and approval of the Congress, matched to the needs of priority programs. Such actions are, of course, required to adjust to the changing technical and military requirements that take place between the time of budget preparation, appropriation, and obligation in support of the program(s).

FISCAL YEAR 1968 R.D.T & E., N OBLIGATION—PLAN COMPARED WITH JUNE 30, 1968 ACTUAL

[Dollar amounts in thousands]

	Fiscal year 1968 plan in fiscal year 1969 President's budget	Changes		Actual June 30, 1968
		Dollars	Percent	
Carryover July 1, 1967	$326,985			$326,985
Appropriation, fiscal year 1968	1,816,400			1,816,400
Supplemental for pay and postage increase	8,274	−$8,274		
Southeast Asia supplemental (OSD emergency fund)		+35,720		35,720
Transfers	22,577	−2,981		19,596
Reimbursements, fiscal year 1968	221,000	+58,958		279,958
Total, obligational authority	2,395,236	+83,423	+3.5	2,478,659
Actual obligations, fiscal year 1968	2,130,000	+118,349	+5.6	2,248,649
Actual fiscal year 1968 unobligated carryover balance	264,936	−34,926	−13.2	230,010

TREND IN "END YEAR" CARRYOVER BALANCES APPROPRIATION R.D.T. & E., N.

[Dollar amounts in millions]

	Availability			Carryover			Percentage carryover
	Service accounts	Reimbursements	Total	Service accounts	Reimbursements	Total	
Fiscal year:							
1964	$1,659.4	$152.2	$1,811.6	$167.3	$51.0	$218.3	12
1965	1,555.5	271.9	1,827.4	214.9	61.2	276.1	15
1966	1,788.4	294.0	2,082.4	326.7	66.9	393.6	19
1967	2,245.5	256.1	2,501.6	268.4	58.6	327.0	13
1968	2,140.3	338.4	2,478.7	163.7	66.3	230.0	9
1969 estimate	2,305.0	355.3	2,660.2	190.0	60.3	250.3	9
1970 estimate	2,401.5	349.3	2,750.8	193.5	60.3	253.8	9

SUMMARY, FINANCIAL HISTORY, FISCAL YEAR 1968 AND PRIOR YEAR PROGRAMS, R.D.T. & E., N. APPROPRIATION

[Dollar amounts in thousands]

	Status July 1, 1967	Status Dec. 31, 1967	Status June 30, 1968	Status Dec. 31, 1968
1. Unobligated balance start of year	326,985	326,985	326,985	326,985
2. New obligational authority	2,035,400	2,037,400	2,096,358	2,078,460
3. Emergency fund transfers			19,596	19,596
4. Transfers from emergency fund—SEA supplemental			35,720	35,720
5. Recoupment objective (nonadditional)	(112,000)	(96,977)		
6. Total new obligational authority (2+3+4)	2,035,400	2,037,400	2,151,674	2,133,776
7. Total availability (1+6)	2,362,385	2,364,385	2,478,659	2,460,761
8. Deferrals	[1] 269,201	[2] 141,336		
9. Available for obligation (7−8)	2,093,184	2,223,049	2,478,659	2,460,761
10. Obligations		1,238,692	2,248,649	2,352,068
11. Unobligated balance (8−9)		984,357	230,010	108,693

[1] Excludes deferrals for the recoupment objective since the amount included on line 2 for direct obligational authority is $1,816,400 (congressional program approval $1,928,400 less recoupment objective of $112,000).
[2] Excludes 96,977 in deferral status because of recoupment objective.

B. Navy R. & D. accomplishments

The deployment of successful weapons systems supportable under conflict conditions is the end result of a many-faceted program effort. It is not uncommon for specific systems to require 5 to 8 years of intensive research and development. The development cycle thus is often long compared to the fiscal support cycle.

The military systems which have been brought through this development cycle during the past few years are testimony to the effectiveness of the system.

In the 4 fiscal years prior to our current year of fiscal year 1969 there have emerged from the Navy R.D.T. & E. program many major weapons and weapons systems. For example in the field of missiles, the Standard missile was developed as a replacement for the missile in both the Terrier and Tartar systems. Further, we have adopted this same missile to the air launched antiradiation mode as Standard ARM.

The basic point defense surface missile system developed during this period provides our nonmissile ships with a degree of antiair defense not previously available.

Several air launched weapons completed the transition from R. & D. to product in this 4-year time frame. Most notable of course is the very accurate and highly successful Walleye.

Aircraft weapon systems developed by Navy in the period of discussion included the successful A–7A light attack aircraft and the OV–10A COIN aircraft both of which are now seeing service in Vietnam. A follow-on family of models of the A–7A have since been produced.

Our space program saw two very important developments, the satellite communications program and the Navy navigational satellite program reach operational status.

Any discussion of Navy development in the fiscal year 1964–68 period would be incomplete should I not mention the Navy tactical data system (NTDS). This tactical data processing system using digital computers, displays and transmission links provides the basis for modern command and control for our naval forces today. Naval air operations are linked via airborne tactical data systems (ATDS) and the U.S. Marine Corps has its counterpart the marine tactical data system (MTDS).

Our underseas program of investigation and development has produced several timely and important capabilities, for example the cable controlled unmanned recovery vehicle—CURV II with a 2,500-foot depth capability become operational. This was a replacement for CURV I which was used to recover the nuclear weapon lost off Palomares, Spain, in 1966.

Much has been accomplished which does not hold the outward excitement of Walleye or the fascinating complexity of NTDS. Many of the research and exploratory development achievements, individually exciting to the scientist and engineer, gain their recognition when several advances combine together to form a militarily useful system. Under exploratory development we developed HY 130 steel for specific application to submarine development under advanced development.

The present fiscal year of fiscal year 1969 promises to have a similar productivity. We have installed on our ships several equipments providing increased defense against antiship missiles. Notable among these are various decoys and threat detection devices to thwart the attacking missiles.

An electronic environment simulation range now in the grooming stage will permit establishment of a hostile EW climate for test and training purposes.

Ship surface weapon systems have been augmented by recent developments which include the 5-inch 38-rocket-assisted projectile

(RAP) which extends the range of unmodified guns providing improved gunfire support capacity.

The Briteye flare has progressed to the stage where we expect to approve it for service use by the end of fiscal year 1969. The Fireye improved firebomb has been approved for service use in an interim form. The helicopter trap weapon was introduced in November of last year.

The all-weather carrier landing system (ACLS) presently in fleet use allows carrier landings under all weather conditions in the manual, semiautomatic, or full automatic (hands off) mode.

Partially operational in fiscal year 1969 is the Omega VLF general-purpose electronic navigation system. When fully completed this system will provide worldwide continuous navigational information for military and civilian aircraft and ships. It is interesting to note that we have been able to provide navigation information to the U.S.S. *New Jersey* using this system.

This brings me to a prognosis for the 1970 fiscal year represented by the budget before you. Many of the programs which are expected to culminate during this year will be discussed in some greater detail in my review of the individual budget activities.

Among the ASW systems we expect to reach fruition during fiscal year 1970 is DIFAR. To be completed also is CASS or command activated sonobuoy system which also will enhance the accurate localization capability of our ASW aircraft. A major ASW development entering production in fiscal year 1970 is the MK–48 torpedo. A follow-on dual purpose version of the MK–48 will provide a vitally needed modern antiship torpedo.

The follow-on light attack aircraft A–7E will become operational during that year.

Along with these aircraft will emerge two air-launched weapons: (1) Walleye II an improved larger version of Walleye; and (2) ZAP.

Our underseas capability will be improved by the introduction of two deep submergence vehicles during the next fiscal year. CURV III, an advanced cable controlled unmanned vehicle with a test depth of 7,000 feet and the first deep submergence rescue vehicle (DSRV). This latter craft will provide an all-weather rescue capability operational to submarine collapse depths.

The Marine Corps will receive the amphibious vehicle LVTPX–12 for operations.

Not every program we undertake in Navy R.D.T. & E. reaches a successful culmination in an operational weapon or system. During the last 5 years, however, we have terminated several programs prior to completion, the most recent being the F–111B.

Earlier the TYPHON surface missile system was terminated as the result of recognition by the Navy of its evolving size and technical complexity coupled with obsolescence brought about by an overtaking technology base.

We have also terminated some ASW programs during the last 5 years because of the high cost and uncertain military utility.

Mr. Chairman, the foregoing highlighted our near past and projected future productivity. I will now address the problems and ac-

complishments provoked by the ongoing Southeast Asia conflict situation.

C. Southeast Asia conflict

The conflict in Southeast Asia has presented its own set of continuing problems and challenges to our research and development community's effort.

The Vietnam laboratory assistance program (VLAP), was initiated in November 1966 with the designation of the Naval Ordnance Laboratory, White Oak, and Naval Weapons Center, China Lake as east and west coast lead laboratories respectively, and with the purpose of quickly bringing the technological strength of the Naval laboratories to bear on the problems of the Naval operating forces in SEASIA as they are and were identified.

The laboratory assistance program consists of two main parts: (1) The sending of skilled laboratory scientists and engineers to the combat theater to provide technical expertise, act as communication links with the laboratories, assist in the identification of operational problems, as well as devise in-country "quick fixes," and (2) to insure that the best available laboratory capabilities are utilized to conduct projects which are of immediate importance to the in-country operating forces.

The projects which are included in the VLAP program have had their basic genesis in the field experience and emerging military needs. The solution to these needs is accomplished through application of currently available technology to the prototype development and test of modifications to old equipment or the generation of new devices which can be field tested within 6 months.

These projects do not alter or conflict with our longer range R.D.T & E. program objectives directly. There is, however, an important interaction, for example:

The engineers and scientists from the laboratory are diverted from longer term vital tasks to accomplish the short term VLAP objectives. This action would suggest that progress on our longer term program would be less than planned, and to a degree this is true, however, it has injected into the development effort important realities which portend to exhaust the military usefulness of the longer term programs.

To date there have been over 260 VLAP projects. Some of the projects that have already received or are receiving operational evaluation in country are:

1. The helo-pad for the armored troop carrier (ATC).—In-country design, fabrication, and installation of a lightweight helo-pad on the ATC to facilitate the medical evacuation of wounded MRF personnel.
2. A remote underwater detection device (RUDD).
3. An underwater dock illumination system.
4. A low light level television (LLLTV).

VLAP projects that will be, in the very near future, operationally evaluated are:

1. The helo trap weapon.

2. The hydraulic pump system.—This boat-borne high velocity water jet system will destroy and clear both natural and manmade barriers, bridge debris, and water hyacinth from canals and waterways.

3. Modular armor for riverine craft.—This alumina and glass reinforced plastic armor is expected to provide ballistic protection for threats equivalent to the .30 caliber AP projectile.

I will mention some of the other developments related to the conduct of the war in SEASIA which have recently emerged or will soon be released from our regular R. & D. program.

The new fire bomb mix and gelling unit have been tested.

Our tactical aircraft in SEASIA have been operating in the most sophisticated electronic environment ever encountered. We are continuing to update and modify our airborne countermeasures equipment in order to make them more effective. These improvements are contingent upon knowledge of enemy equipments. One key to this problem which portends to assure a continued weapons and tactical effectiveness, is found through the intercept and analysis of electronic emissions. We have several programs which will combine to enhance our operational effectiveness. These include: the big look improvement program. This program will provide our aircraft with a greatly improved capability. A related project of great potential is the joint services in-flight data transmission system. The principal features of this system are the near real time transmission of high resolution data from a sensor equipped aircraft to a land or sea surface terminal. The development program is multiservice, with the Navy as executive agent. A high degree of operational compatibility will result in that data can be transmitted by the aircraft of any service for reception by surface terminal equipment common to all.

Upon completion of development, we are planning to deploy the electronic emitter location system (EELS). This system, installed in carrier based aircraft, will greatly improve the accuracies with which we locate electronic emitters.

We continue to improve the weapons available to our ships operating off the coast of Vietnam. Rocket assisted projectiles provide significant increases in range over standard projectiles without degradation of accuracy. We are continuing to develop subcaliber projectiles for 8-inch guns.

The commitment of Marine Corps combat forces in Southeast Asia has necessitated a heavy orientation of Marine Corps R. & D. efforts toward projects with immediate applications to this conflict. To insure responsiveness to requirements generated in Vietnam, the Marine Corps is using a streamlined administrative process called special procedure for expediting equipment development (SPEED).

To date, III Marine Amphibious Forces has initiated several SPEED requirements covering a variety of operational needs including:

(1) Modifications to the MK–19 40-mm. gun for the UH–1E helo. Delivery of these guns is expected to commence shortly, following ground and flight testing.

(2) The A–6A forward air controller radar beacon which will provide an identifiable aim-point which the forward air controller can use to call in strikes on nonradar significant targets using the offset bombing capability inherent in the A–6A aircraft.

A significant boost to our visual observation capabilities was realized as the OV–10 aircraft was introduced in Southeast Asia in fiscal year 1969. This Marine Corps aircraft provides range, speed, survivability, and endurance greatly exceeding that of the O–1. The light armament package adds to the versatility of the aircraft. Work is presently underway on an improved target marking system. This system, by permitting target designation from greater standoff ranges, will further enhance the survivability of the OV–10.

The Navy R. & D. program will continue to respond where necessary and anticipate where possible the weapons and weapons systems requirements of our units in SEASIA.

D. ASW

The Soviets are now embarked on a priority construction program of second generation nuclear submarines, following a period of large-scale shipyard expansion. We believe that the speeds of new Soviet submarines compare faborably with those of our nuclear powered units. Metallurgy and related technologies are moving forward in the Soviet Union, thus submarine depth capabilities can increase commensurately. As to the older Soviet submarines, events of recent months have led us to increase the estimated endurance of these conventional boats, while the estimated maximum speed of the "N" class SSN also has been raised.

In the area of air ASW, the VSX (S–3A) aircraft system is the primary development. Contract definition is nearing completion and engineering development is planned to commence by July 1969. The first test flight is scheduled for July 1971 with fleet introduction several years later. The VSX development is supported by a concurrent laboratory simulation and aircraft test bed program.

A new sonobuoy system, DIFAR, is currently in production and will be introduced into the fleet as part of the P–3C ASW aircraft system shortly.

A command active sonobuoy system, CASS, will be ready for operational evaluation in the near future. This system will improve our target localization capability.

Development of the torpedo MK 48 continues to be the priority program for improving the ASW capability of our submarines. It is designed to outrun and go deeper than the new high performance Soviet SSN's. The system development has proceeded to the point that we expect to be able to begin procurement in 1969. Additional development is scheduled in order to produce a dual ASW/Anti-ship capability for this weapon.

We are studying a rapid reaction nonnuclear weapon with a short time of flight. This would be a new missile analogous to SUBROC and designed to be effective against surface ships or SSG/SSGN's.

Our submarine sonar R. & D. effort has been directed toward targets with a wide range of characteristics. A near term application from this project was approved and a line item BQS–13 DNA sonar is included in the fiscal year 1970 sub-sonar development element. This sonar makes use of recent developments to improve the active and passive performance of the sensors of our submarines. R. & D. efforts in submarine quieting will improve our basic capability by reducing radiated noise while increasing our sonar effectiveness.

We are continuing to seek improved target detection capabilities at longer ranges for our surface ship sonars. In addition to near term improvements to the SQS–26 series sonar, we are considering another hull-mounted sonar of improved performance. For the long term we are looking into alternatives to the active hull-mounted sonar as we know it today. We are providing limited technical support to the British planar array development in order to benefit from any technology that may be developed by that approach.

We have taken initial steps in fiscal year 1969 to overcome deficiencies in our ability to handle in a timely fashion ASW data in the ASW force command and control systems. Both ASWFORLANT and ASWFORPAC are being provided an interim, austere automated data processing capability this year. With the funds we have requested in fiscal year 1970 we expect to provide some urgently required additional capabilities to ASWFORLANT and commence development on the planned long range (1975) integrated system.

Other ASW R.D.T. & E. programs include:

The torpedo counter-countermeasures program.

The MK 46 lightweight torpedo for aircraft and surface ships.

SQS–23 surface ship sonar improvement.

BQQ–2 submarine sonar for SSN 637 building program.

The submarine improved sonar system (SISS) for updating the capabilities of SSBN's and pre-594/637 class SSN's.

ASW R.D.T. & E.

[In thousands of dollars]

	Fiscal year 1969	Fiscal year 1970
Total R.D.T. & E., N	2,161.1	2,211.5
ASW R.D.T. & E.	359.3	472.2
Percent	16.6	21.4

E. Antiship Missile Offense/Defense Program

The current concern over the survivability of surface ships when exposed to potential surface and air launched antiship missiles has been heightened by recent demonstrations of the effectiveness of some available weapons and delivery vehicles.

Operations in the several theaters where identification is difficult of potential belligerents, in terms of friend or foe, has highlighted the opportunities for effective attack against U.S. naval force elements.

Each operational theater presents a spectrum of requirements as well as constraints. Operations in the tension areas are fronted with thresholds which, at a first approximation, are threat controlled. These include factors such as time, location, tactic and political/military boundary conditions. Operational deployment and warfare response capability are related to the situations to be served, and the transition from one state to another. The continuing requirement to provide for positive target identification and command/destruct of errant missiles represents the primary action constraint. The most critical phase, where command intervention is required, is during the leading edge of war. The operational and technical system design must provide for

the essential rationalization associated with the requirements for decisionmaking—to launch or not to launch; to attack or abort; etc.

In order to respond to this complex problem a Ship Anti-Missile Integrated Defense (SAMID) program has been established.

Its initial function is to integrate equipments that are available in the fleet today into a total ship system to achieve improved capability and reduce reaction time through coordination of sensors and weapons. For example, simple internal ship data links are being developed to eliminate voice relayed information with easy to interpret display systems provided at the control stations to quickly exchange information and commands. The problem solving efforts under the SAMID program can be grouped into three basic phases. The predetection of hostile action, detection of hostile actions, and the engagement phases.

Two primary efforts to improve our defenses in the predetection phase are the development of devices for training purposes and the determination of means of reducing ships' inherent signature. Ship signature reduction developments have been evaluated at sea in a destroyer. Assuming successful results from the tests, techniques will be exploited to counter the antiship missiles.

There are several efforts ongoing in the detection field, both in active and passive sensors.

First, we have improvements to operational radars. A short pulse minimum range capability has been developed for air search radars. Use of these kits will provide short range coverage not possible with the standard long pulse versions of these equipments.

The point defense target acquisition system (TAS) development will provide detection of targets for our point defense surface missile system. The initial use of the TAS radar will be as the acquisition system for U.S. models of the NATO Sea Sparrow, now in development. There is advanced development work in an infrared electronic warfare (IREW) system.

A major effort, Shortstop, has been given increased emphasis. Shortstop is the most ambitious shipboard electronic warfare project yet undertaken. It will interface directly into the NTDS system, thus fully integrating our weapons and active sensor systems. It will provide automatic electronic countermeasures. Operational evaluation is expected to be completed in the near future.

The last of the three areas being addressed is the engagement phase. Work is ongoing in the weapon, electronic warfare as well as decoy areas.

An advanced point defense system has been defined through study. The technical requirements are such that achievement depends upon improved guidance technology which will become available in the late 70's. On this basis, an "improved" system using the powered director, smaller launcher, and control console defined for advanced point defense have been combined with the Sparrow missile for development under a NATO cooperative development program. The participating countries are Denmark, Italy, Norway, and the United States. A unilateral U.S. target acquisition system development will also be developed. These two programs will combine into an improved point defense system.

The advanced point defense system, when developed, will use the improved point defense system hardware.

We are planning to commence engineering development of the advanced surface missile system (ASMS) in fiscal year 1970. This fast reaction, high fire power system will have a built-in capability for antishipping missile defense. The system will begin to reach the fleet in substantial numbers in the latter 1970's.

The 5"/54 lightweight gun and fire control system is under development. It is an automated gun and GFCS. The system is designed to occupy minimum space aboard ship, offer improved surface, shore fire support, and limited AA capability. The weapon fires rapidly with less personnel required to man the system than the present systems.

The Navy is pursuing a program to develop an antiship missile that can be air launched from attack or ASW aircraft or surface launched. The surface-launched version will be primarily for ships that now have no missile capability, although it will be compatible with the "G" ships.

Other major efforts in the active ECM area are devoted to development of additional EW countermeasures equipments. As they are planned for, developed, and evaluated, they will be integrated into the Shortstop system as well as used in a separate installation.

We are continuing to research a near instantaneous means to deploy decoys in order to produce target selection confusion to an attacking enemy force.

A basic helo system is now available to the Fleet. Our effort today is to develop a pod mounted version of this system that can be applied to any helo.

We are conducting feasibility studies in utilizing other approaches. A proposed technical approach is under preparation in the material command. The studies will survey this entire field and allow us to select the route to follow for future developments. Several schemes are under consideration. The systems investigations are designed to provide the widest range of options consistent with the operational flexibility which is essential to the several concepts.

In summary, our efforts to improve our electronic warfare posture is focused on several time periods. The first of these is the integration of the total ship capability to use existing weapons and sensor systems. This is being done in the SAMID program.

The second is the longer term R. & D. program to provide improved and new capabilities. They will be integrated into the total ship system as they become available and in consonance with package concept assigned to meet the enemy threat.

Finally, continual investigation of new technology is proceeding as intelligence and operational experience expand our knowledge.

F. Fiscal year 1970—Navy oceanographic program

I should like now to address the Navy's program in an area which has been receiving a great deal of national attention, oceanography. The Navy oceanographic program supports a broad array of defense systems and is vital to our mission. Our program continues to represent over half of all Federal efforts in the marine sciences, and in many areas—ocean engineering and technology, hyperbaric biomedicine, environmental prediction, underwater acoustics, and others—Navy

leads the way for the Nation. We remain in close coordination with other agencies engaged in the Marine sciences, and diligently continue our efforts to make our data, competence, and facilities available to all who require them.

The funding here represents a compendium of efforts which appear in the budget as part of other line items. The funded effort, however, represent Navy's oceanographic program managed by the oceanographer of the Navy.

NAVY OCEANOGRAPHIC PROGRAM

For management purposes, the oceanographer divides the oceanography effort into three major functions: Ocean science, ocean engineering and development and oceanographic operations. The discussion that follows addresses these in that order. For information of the committee, the last page of this section of my statement contains a funding breakdown by appropriation and function.

OCEAN SCIENCE

The Navy ocean science program is responsible for developing a better understanding of the ocean environment in which the Navy operates and for the utilization of this understanding in support of the Navy's mission.

Antisubmarine warfare continues to be the single most urgent military problem supported by naval ocean science. Well over half of the ocean science program is devoted to underwater sound or directly related fields. Understanding of the relationship between sea generated sound and those produced by submarines is fundamental. The majority of acoustic research is now devoted to the study of the environmental constraints and new system concepts. The planned acoustic experiments in the Northern Pacific next summer and the long-range acoustic transmission predictive model being developed at the fleet numerical weather central at Monterey are key programs in this effort. Other investigations are planned in order to both optimize and estimate surveillance system performance in key oceanic basins.

Significant new research platforms have been emphasized this year. One such platform, called "Sea Spider," will enable us to make oceanographic and acoustic measurements from fixed sensors in midwater for the first time. Instrumentation of aircraft and spacecraft with sensors for oceanographic research are rapidly expanding our capabilities and at the same time increasing our efficiency. The research ship building schedule has been cut back, but two new AGOR's will be in service early in fiscal year 1970. The AGOR–16, a new catamaran type, is scheduled for delivery in 1971.

Many of the most important problems now addressed in oceanography, such as air-sea interaction and acoustic propagation, are so extensive and complex as to require the cooperation of several institutions and laboratories. The Navy portion of the Bomex air-sea interaction experiment in the Caribbean, the Parka II oceanographic-acoustic experiment in the Pacific, the Norpax experiment on temperature anomalies in the Pacific, and the Flip/Spar bearing accuracy experiment in the Atlantic are a few examples of this trend.

The Navy has a number of research projects in the Arctic in support of specific military requirements mainly focused in the central Arctic basin. Considerable effort has been devoted this year to reviewing arctic requirements and programs with a view toward developing a comprehensive plan for naval arctic research.

The Navy continues to take pride in its contribution to training oceanographers through its support of academic institutions, both through its contract research projects and through the more institutional approach of the oceanographically oriented Themis projects. The oceanographic training program at the Navy postgraduate school in Monterey also is constantly being upgraded.

OCEAN ENGINEERING AND DEVELOPMENT

The ocean engineering and development effort is directed toward the goal of permitting the Navy to operate effectively anywhere in the oceans, at any depth, and anytime. To this end, we have reorganized the deep submergence program in fiscal year 1970 for greater visibility and better management of our major projects. Subprojects within the deep submergence systems project now receive project status, and are regrouped with other deep submergence projects into either systems or technology oriented programs. In addition to improving Navy management, this reorganization will permit us to accept more readily any nationally oriented ocean engineering and development projects should we be asked to do so.

Under our ocean engineering systems development program the first deep submergence rescue vehicle (DSRV) should be completed and ready for test in late fiscal year 1969 and turned over to the Navy in late fiscal year 1970. The second DSRV is expected to be operational approximately 6 months later. These vehicles will provide us with the capability to rescue men from disabled submarines on the ocean floor and under ice to the collapse depth of the most modern combatant submarine. The DSRV's will also give us a secondary mission capability of search, location, and small object recovery to sufficient depth. A contractor was picked through competitive process in fiscal year 1969 to do a detailed design study for the 20,000-foot deep submergence search vehicle (DSSV). Long leadtime developments such as the DSSV's powerplant and pressure sphere material will be funded in fiscal year 1970 with vehicle construction commencing in fiscal year 1971. Although delivery of this first vehicle will not be available for a few years, a next step recovery device is undergoing concurrent development.

Under our ocean engineering technology development program, the major effort is in the deep ocean technology project (DOT). This project, initiated in fiscal year 1968, is a 10-year plan to generate, expand, and exploit the base of validated deep ocean technical knowledge in order that the Navy of the future can respond adequately to whatever needs arise. This effort remains the project in Navy's oceanographic program with the greatest promise of spinoff applicable to national nonmilitary goals. In fiscal year 1970 the DOT project will provide an operational 7,000-foot cable controlled unmanned recovery vehicle, a certified titanium hull for the Alvin-type submersible; design criteria for reliable electric drive systems, TV and acoustic imag-

ing systems; a variable ballast system usable to a 20,000-foot depth; high-electrical power wet connectors and transmission system; a sea floor rotary cutter, hydraulic earthmover and large hole driller; an in-situ large concrete pressure hull experiment; and we will undertake a program to provide certified glass pressure hulls.

Our technology oriented man-in-the-sea project is highlighted by a step-by-step progression toward SEALAB III off San Clemente Island. The unfortunate accident to Barry L. Cannon last February has caused us to undertake a close examination of all factors involved with man-in-the-sea. It is not certain whether SEALAB III will be undertaken in fiscal year 1970 or not. Fiscal year 1970 will see the development and testing of improved fleet-deliverable diver's hardware, the prototypes for which will be tested during SEALAB III. Our deep submergence biomedical project continues toward the development of medical techniques for improved performance and for the prevention and treatment of illness and injury among submariners, underwater swimmers, and divers. In fiscal year 1969 we initiated new developments in physiological and human performance efforts of prolonged exposures to pressure. In fiscal year 1970 the data obtained during SEALAB III and TEKTITE will be evaluated, a system for on-site treatment and evacuation of sick or injury divers will undergo development, and the physiology at depths below 1,000 feet will be explored using new hyperbaric facilities at the Submarine Medical Center, New London, the University of Pennsylvania, and Duke University.

In our instrumentation program, we are concentrating on systems to improve our capability to carry out coastal and deep ocean surveys and those efforts which support environmental prediction.

In exploratory development we are striving to improve our advanced sea-floor engineering by extrapolating terrestrial experience with soil mechanics into the ocean. We are also concentrating on exploratory programs in materials, power sources, navigation, biomedicine, swimmer-diver support, and environmental support.

During fiscal year 1970 we will accelerate the development of titanium (120/150 ksi) and a 30 pcf syntactic foam; sea-floor engineering will continue to identify and define parameters of interest in the siting of ocean bottom structures; and the fuel cell effort will shift emphasis from hydrogen/oxygen to hydrazine/hydrogen-peroxide under ambient pressure.

OCEANOGRAPHIC OPERATIONS

Oceanographic operations will continue in fiscal year 1970 to be devoted to support of fleet operations.

Our coastal hydrographic survey units completed charting in Vietnam early this fiscal year. Through fiscal year 1970 they will survey coasts and harbors in South Korea and the Pacific Trust Territories, and chart 12 special fleet operating areas in WESTPAC. Five new MSTS-manned survey ships will undergo shakedown and replace the present overage and wornout ships commencing in fiscal year 1970. Two helicopters are in the budget to support this fleet.

Deep ocean survey ships in support of Polaris/Poseidon will continue collecting precise bathymetry, magnetic, and gravity data along

hundreds of thousands of track miles. In addition, two specially configured gravity survey ships will complete efforts in the eastern and western missile test ranges in fiscal year 1970. Other deep ocean surveys will support project CAESAR.

ASW surveys will be carried out by our modern oceanographic survey ships. The *Silas Bent* will conduct acoustic/oceanographic operations with a contract ship in the South China and Philippine Seas, while her sister ship, *Elijah Kane*, will conduct similar acoustic surveys in the Caribbean. A third ship of the *Bent* class, the U.S.N.S. *Wilkes* (TAGS 33), will be delivered in late fiscal year 1970. Our support to Navy laboratories oceanographic projects also will be enhanced in fiscal year 1970 by the placing into full operational status of two new AGOR class ships. Though we have no survey ships in our fiscal year 1970 construction budget, we are requesting funds for a new aircraft to replace an aging C–54, in order to carry out global geomagnetic surveys in all areas of the world's oceans of importance to naval warfare.

NAVY OCEANOGRAPHIC PROGRAM

[In thousands]

	Fiscal year 1969	Fiscal year 1970
R.D.T. & E. (THEMIS included)	110.5 (3.0)	121.3 (3.5)
SCN	0	0
MILCON	7.0	3.8
OPN	40.6	34.2
O. & MN	81.1	97.8
MPN	13.3	10.8
PAMN	.2	10.7
Total	252.7	278.6

G. Behavioral and social sciences

The Navy and the Marine Corps carry on operations in widely differing media; under the water, on its surface, over the ground, and in the air. The forces are required to operate and maintain extremely sophisticated equipment in all parts of the globe, to cooperate effectively with allies, and to outmaneuver enemies deriving from a variety of ethnic, cultural, and environmental backgrounds who may employ against us techniques ranging from the very simple and unsophisticated to those that equal our own. It is of critical importance that naval manpower be optimally utilized if we are to meet these diverse requirements.

The objective of the Navy's behavioral sciences program is to contribute to the Navy's optimum utilization of its manpower: (1) through the development of fundamental knowledge needed for technological improvements; and (2) by interacting with all elements of the Navy—scientific and operational—to assist with the solutions of man-related problems arising in systems development and their utilization in the fleet.

The behavioral and social sciences research programs are fundamental to all work on personnel selection, training, proficiency maintenance, protection, motivation, morale, retention, and maximum utilization of naval manpower. Specific examples are: new techniques for maintaining the alertness of sonar operators, new procedures for im-

proving the pattern recognition capabilities of the operators of ASW sensor systems, new devices for coping with the "helium speech" of divers operating at depth, an exoskeletal system to augment man's strength and stamina, new techniques for training men to diagnose and repair malfunctioning electronic equipment, workable computerized techniques for forecasting personnel requirements and for making personnel assignments, improved techniques for selecting small crews for situations requiring isolation and confinement, and methods for evaluating performance impairment induced by fatigue and sleep deprivation.

In order to insure attention to high-priority Navy needs, the research program has been restructured into six major areas: (1) men in training, (2) men in weapons systems, (3) men under stress, (4) men in the sea, (5) men overseas, and (6) men in personnel systems. Examples of beneficial research outputs that are currently being produced can be identified for each of these research areas:

Men in training

A most important area of potential payoff for the Navy is improvement of training methods. This area is being revolutionized by new principles, techniques, and hardware. Among the most significant accomplishments are: (1) improved ASW signal detection and classification, (2) the development of techniques for training naval personnel to make cross-cultural contacts; and (3) the work on computer-assisted instruction for use both ashore and afloat (a field in which the Navy has led the way), and many others.

Men in weapons systems

With the increased sophistication of weapons systems it has become much more complicated to utilize available personnel resources in the most effective manner. The behavioral and social sciences program is developing many items for aiding and augmenting the performances of men who must operate and maintain our modern weapons systems. These include a number of guides and handbooks such as the revised Human Engineering Guide to Equipment Design, a revised U.S. Naval Flight Surgeon's Manual, and a revised Bioastronautics Data Book (prepared with NASA support). Several advances in display technology are being pursued. These include head-mounted display devices, new types of rotating displays, and luminescent displays. A troubleshooting aid is being evaluated in the field to determine its effectiveness in producing quicker and more accurate diagnoses of electronic equipment malfunctions. New techniques are being devised to assist in the composition of weapons system crews.

Men under stress

This area includes research on psychological, physiological, social, and environmental factors. The work is closely related to other scientific disciplines, but these projects represent unique stress problems. For example, research in this area includes work in: night carrier landings, human performance degradation resulting from such conditions as vibration, buffeting, heat, cold, noise, and panic; living in isolation; physical fitness; and behavioral biochemistry. As I mentioned earlier, a large volume of information is becoming available, including knowledge about appropriate protective equipment for pilots, tech-

niques for many men in the sea projects (salvage, rescue, UDT, underwater communication, et cetera), and techniques for operating under conditions of isolation and other environmental stress, et cetera. Stress resulting from combat and conflict involves environmental factors (for example, noise, darkness, humidity, temperature); physchological factors (for example, fear, confusion, time pressures); physiological factors (for example, hunger, fatigue); and a variety of social factors (for example, leadership).

Men in the sea

New developments in undersea warfare have given an impetus to research in this area; there will be many useful applications resulting from such effort. The range of work includes human factors research, human performance under varying pressures, diving, helium speech, survival techniques, swimmer guidance, search and rescue, salvage operations, and a whole area which may be termed behavioral oceanology, or man's performance in the sea.

Men overseas

Since 1946, when the Navy undertook social science studies relating to Micronesia and Japan, there has been a small foreign area social science research program relevant to the naval mission. This program has been approved in the Department of Defense and properly cleared with the Department of State Foreign Area Research Coordination Group. Current events in Vietnam indicate how necessary it is for the military to be prepared with the latest information for dealing with hostile elements in the most appropriate fashion. Whether the duties involve peace-keeping, special warfare or anti-Communist actions, the Navy is required to maintain a potentiality for providing its forces with necessary data and information for use overseas. In these efforts, the necessary social sciences information required does not exist in libraries, nor is it being produced by such Government organizations as NSF, NIH, or the State Department. Consequently, we maintain a small effort to provide essential and basic information for our forces.

As an example, in Southeast Asia our personnel are involved in a wide variety of activities ranging from pacification duties (performed, for example, by the Marine Corps and the Seabees) to counter-guerrilla efforts and other unconventional combat. Our social science research program has contributed directly to their capability to carry out such operations.

Men in personnel systems

Efficient procedures for selecting, classifying, and assigning personnel insure that each man is productively employed during his period of service and assigned in accordance with his capabilities. Research in this area has produced workable computer-assisted personnel assignment techniques which have proved superior to the manual methods previously employed. Job design efforts aim to tailor jobs to the capabilities and limitations of the available manpower supply. Continual progress is being made in improving personnel selection, classification, assignment, organization motivation, morale, job analysis, retention, and career planning methods.

To conclude—the Navy's research program in the behavioral and social sciences is subjected to intensive and continuous review. It has

recently been restructured into six Navy relevant areas. This program has produced and continues to produce a great deal that adds to the Navy's capability to make optimum use of its manpower resources.

II. Navy responsibilities functional analyses

When reviewed under the Navy's mission responsibility and functional breakdown, the fiscal year 1970 R.D.T. & E., N program consists of a level of effort grouping, eight broad operational objectives and 28 functional areas supporting those eight. Table III, at the end of this section, shows the breakdown including some of the major programs included in the fiscal year 1970 budget request.

You will note that some programs could well fit into more than one functional area or operational objective, such as the air launched/surface launched antishipping missile which can be included either under airborne attack or surface attack. Our principal effort to date has concentrated on an air-to-surface capability and we have thus determined the program better falls under its principal operational area, airborne attack. Other similar decisions on dual area programs have been made and agreed upon within the Navy.

Included in the following discussion is a brief description of a few of the mission objectives and functional areas to illustrate how we now orient our individual programs to fit this categorization.

I have chosen four, surface warfare, air warfare, underseas warfare, and strategic warfare as illustrations.

Surface warfare

We define surface warfare as that Navy mission objective encompassing all forms of offensive or defensive tactical warfare prosecuted from a surface ship at sea against surface or air targets and including supporting programs for the platform itself such as ship design and propulsion. We further define this objective into three functional areas of surface attack, surface antiair and ship support.

Since surface attack includes all aspects of tactical surface-to-surface capability, against both seaborne and land-based targets, all of our existing shipboard gun development and ammunition improvement elements are included here. The major caliber lightweight gun, bombardment rocket, the 5″/54LW gun are three examples of ongoing R.D.T. & E., N line items included.

The surface antiair functional area covers all aspects of shipboard tactical defense against manned or unmanned airborne weapon systems. Three major R.D.T. & E., N programs are included in this area, point defense missile system, ASMS, and the SAMID concept of total integration of all shipboard antimissile systems.

The third area under surface warfare is ship's support which encompasses those programs directly related to the concept and design of new ships and the equipment necessary to support the seaborne platforms. Major programs included here are the family of nuclear reactor plant developments, concept formulation/contract definition of ships, the surface effects ship, and the hydrofoil development programs.

Air warfare

We define air warfare as that Navy mission objective encompassing all forms of offensive or defensive tactical warfare prosecuted from airborne vehicles either carrier-based or land-based against surface,

subsurface, or other airborne targets and including supporting programs for the vehicles themselves. We have included four functional areas under this objective. Airborne attack, airborne-antiair, aviation support, and navigation and air traffic control.

Airborne attack encompasses development of aircraft and weapons for the air-to-surface missions.

Airborne antiair which encompasses development of airborne systems capable of countering the air threat to our forces at sea includes our major fighter aircraft developments as well as our air-to-air weapon systems.

The aviation support function is largely devoted to providing the basic tools for the successful accomplishment of the aircraft's mission and the pilot's survival. In this area we include programs such as catapult improvements, Avionics Development (VAST), Search and Rescue Systems, and A/C propulsion evaluation and improvements.

Navigation and air traffic control is a functional area devoted to the improvement and refinement of our submarine, shipborne, and airborne navigational accuracy. Because of its direct relationship, we include the safety of our aircraft as a key contributor to the Navy air missions and are continually striving to develop better air traffic control systems. Included under this operational area is the All Weather Carrier Landing System (AWCLS) program which provides for all-weather automatic or semiautomatic electronic approach and landing of high-performance carrier-based aircraft. OMEGA, which recently became operational, was another vital program included in this functional grouping.

Underseas warfare

We define underseas warfare as that Navy mission objective area encompassing all offensive or defensive warhead systems designed to counter those threats principally operating below the surface of the oceans as well as the exploration and exploitation of the world's oceans and ocean bottoms for both peacetime and military application. It is our largest single R.D.T. & E. Navy objective area and includes all ASW, oceanography and mine warfare programs. We divide this objective area into seven functions, namely ASW sensors, ASW weapons, ASW vehicles, ASW countermeasures, ASW command and control, ocean engineering, and mine countermeasures.

The first functional area, ASW sensors encompasses all subborne, shipborne, airborne and fixed systems required to detect, classify and localize hostile underwater vehicles and weapons. Some of our major programs include the undersea surveillance system, ASW surveillance, SSN sonar development and the new advanced ship/submarine sonar development program which will maximize commonality in the next generation sonars for these two platforms.

ASW weapons covers all developmental effort involved in the destruction of the underwater threat prosecuted from our ASW aircraft, ships, or submarines. Programs such as the MK 48 series, homing mine Captor and extended range ASROC are examples of R.D.T. & E. work ongoing here.

In our functional area of ASW vehicles we are principally devoting our energies to development of those mobile platforms which extend the locate and destroy capability of our ships and submarines. The major programs included in this area are the S–3A (VSX) ASW air-

craft and a new program in fiscal year 1970, the Destroyer Helo System (DHS), both of which are discussed in detail elsewhere in my statement.

ASW countermeasures covers those defensive systems necessary for the survival of our surface and submarine forces against hostile underwater-launched weapons. Major programs included here are submarine silencing and submarine acoustic torpedo countermeasures.

The final ASW functional area is titled ASW Command and Control Facilities. It encompasses all other ASW programs not otherwise covered but principally emphasizing the many supporting efforts required to insure a successful ASW program. Major programs included in this functional area are AUTEC, ASW system support, submarine integrated antenna, ASW force communication control system and ASW tactical and operations analyses.

Closely related and supporting our ASW effort but also recognizing the peacetime importance of the ocean environment, the Navy's function in ocean engineering is to provide a capability to utilize the total ocean environment in defense of national security as well as exploit its vast store of wealth for contributions to nonmilitary requirements.

The final function in underseas warfare is mine countermeasures. Thought not as heavily funded as our ASW or aircraft work, nevertheless, the six programs under development in this vital warfare area are allowing us to improve our capability to effectively counter hostile mines in navigable waterways of the world through better methods of location, sweep, neutralization and/or destruction. The major development program in this function is the navigation command and control system for mine countermeasures and amphibious assault (SEAGUIDE). This is a precise navigation system with semiautomatic steering and centralized realtime command and control system for location and destruction of hostile mines.

Strategic warfare

The Navy's mission objective in strategic warfare, for purposes of the R.D.T. & E., Navy effort, can be simply stated as providing sea-based offensive and defensive options to the total strategic force mix of the United States. We have only one functional area, sea-based strategic systems which includes all of the R.D.T. & E., N programs covering this mission objective.

In the foregoing paragraphs I have attempted to share with you a brief sample of how we now review our total programs within the Navy. Table III that follows outlines the full range of mission objectives, functional areas, and major R.D.T. & E., N fiscal year 1970 programs included thereunder.

TABLE III.—NAVY RESPONSIBILITIES FUNCTIONAL ANALYSES

Mission objectives	Functional areas	Major fiscal year 1970 R.D.T. & E., N programs
Level of effort	Research	
	Exploratory development	
	Management and support	
Surface warfare	Surface attack	Major caliber LW gun.
		Bombardment Rocket.
		5"/54 LW Gun system.
	Surface anti-air	Advanced surface missile system.
		SAMID.
		Point defense missile system.
	Ship support	Nuclear reactor plants development.
		Ships contract definition.
		Advanced surface craft.
Air warfare	Airborne attack	
	Airborne anti-air	
	Aviation support	SAR system.
		A/C propulsion evaluation and improvements.
	Navigation and air traffic control	All weather carrier landing system (ACLS).
Undersea warfare	ASW sensors	Undersea surveillance system.
		ASW surveillance.
		SSN sonar development.
		Advanced ship/submarine sonar development.
	ASW weapons	MK 48.
		Homing mine captor.
		Extended range ASROC.
	ASW vehicles	S-3A (VSX).
		Destroyer helo system.
	ASW countermeasures	Submarine silencing.
		Submarine acoustic torpedo CM.
	ASW command and control	AUTEC.
		ASW system support.
		ASW force communication control system.
	Ocean engineering	Ocean Engineering system development.
		Ocean engineering technology development.
		Ocean engineering instrumentation development.
	Mine countermeasures	MCS navigation command and control system.
Amphibious warfare	Amphibious assault	Heavy lift helo.
	Marine Corps programs	Landing force assault amphibian vehicle.
		Lightweight 3D ground control.
		Marine Corps operational electronic development.
Special systems	Special warfare	Swimmer support systems.
		Riverine warfare boats.
	Ordnance support	Target system development.
	Reconnaissance and intelligence	Surveillance equipment program.
	Environmental systems	Atmospheric applications.
	Naval communications	HARPY.
		Advanced communications.
	Command and control systems	Joint in-flight data transmission system.
		Advanced command data.
	Electronic warfare	Ship advanced electronic warfare.
		Airborne EW.
Navy space programs	Astronautics	Program 749.
		Satellite communications.
Supporting programs	Personnel	Education and training development.
	Medical	Advanced medical development.
	Logistics	Underway replenishment.
Strategic warfare	Sea-based strategic systems	FBM systems.
		FBM command and control.
		Advanced sea-based deterrence.

IV. Review of Fiscal Year 1970 R.D.T. & E., N Programs

I will now move to a detailed description of the individual budget activities.

Due to the large number of elements in each category, I have selected only the more significant ones for inclusion in this statement. These are shown in the statement before you. The totals shown in the upper right-hand corner of the summary pages represent the entire budget activity request and not a summation of the elements shown.

BUDGET ACTIVITY 1

Military sciences

Our total program for military sciences in fiscal year 1970 is $160.1 million. The greatest portion of this activity is devoted to our pro-

grams of research. Here we are requesting $136.5 million, an increase of approximately $6 million over our fiscal year 1969 request.

Research contains two elements, one providing for independent research conducted by our in-house Navy laboratories and defense research sciences, encompassing research programs conducted by both Navy laboratories and organizations outside the Navy, including colleges, universities, and commercial firms. The fiscal year 1970 request also includes funds in support of the Navy's oceanographic program (exclusive of THEMIS). Other areas are scheduled for nominal increases. However, in general, the fiscal year 1970 requested increase in defense research sciences approximates level funding because of increased costs of staffing and equipment.

Naval research has both long range and immediate basic problem areas under investigation. A very limited illustration of these areas includes optical radar and communications; surveillance, reconnaissance; missile guidance; nuclear, biological, and chemical detection; personnel training, selection, and retention; power generation and quality control in the manufacture of key naval materials. I would now like to note some of the principal features and examples drawn from the planned program.

The Navy in-house laboratory independent research is a level-of-effort program. The planned increase in fiscal year 1970 over fiscal year 1969 will return us to the level set in fiscal year 1968, a year in which funds in this element represented only a very modest fraction of the total in-house program in the major Navy laboratories.

A significant fraction of our general physics research is devoted to the laser, a program which has led the way for a host of important technological advances. Today, lasers are employed in all the professions. Examples include eye surgery, meteorology, rangefinding and holography—now acoustic as well as optical. Further research will be undertaken to improve power levels, efficiency, control of output wavelength, and the application to more advanced and sophisticated devices.

We have been extremely fortunate in bringing together at Stanford University the efforts of Nobel Laureate Robert Hofstadter's High Energy Physics Laboratory and National Academy of Sciences member William Fairbanks' Low Temperature Physics Laboratory for continued research and development in the field of superconductivity. Through their work, the Navy will soon have an important 500-foot cyrogenic testbed for a number of extremely exciting experiments.

The Navy supports this program with the objective of achieving major electronic advances through the use of cyrogenic technology. Examples of a cyrogenic or superconducting system might include low noise receivers, magnetometers, oscillators, gravity meters, accelerometers, Josephson junction infrared detectors and other superconducting circuit elements.

Our nuclear physics program is now focused on research in superconducting technology, shielding, and hardening against radiation effects, radiation detection and instrumentation, and application of nuclear techniques to analyses of surfaces, films, and oxides. The results will be applicable, in turn, to development in our environmental, medical, communications, and material programs.

Our chemistry research program has made significant progress and continues in the development of elastomers and plastics for high temperature applications. During the past year we have discovered how to vulcanize new fuel-resistant rubber-like materials, thus opening the way to developing improved sealants for use in aircraft. We have also learned how to vulcanize the carborane rubbers at 40° to 90° thus greatly simplifying the application of protective coatings to aircraft and to other large structures. We envision increasing the strength of the high temperature rubber, improving the processes of production, providing materials for quieting submarines, and synthesizing the polymeric compounds which have substituted carboranes containing metals.

In our mathematical science program, specific attention is being given to the research necessary for better man-computer interaction, including work in timesharing, graphics, pattern recognition, and management information system design. This research combines statistics, probability, linear programing and other decision sciences with the development of techniques to deal with military problems in the areas of inventory control, Navy readiness analysis, transportation planning, optimization procedures, and command and control. At the Naval Ship Research & Development Center, particular attention is being given to the development of numerical techniques for solving problems in fluid flow and through the development of specialized computer programs such as computer aided ship design.

Materials research is concentrated in areas where lack of suitable standards or materials present unconventional roadlocks of the technological progress of the Navy. Our materials research in metal fatigue has been instrumental in increasing the useful life of rotating machinery and vibrating structures. Similarly, superplasticity research portends great technological possibilities in metal forming operations. Research is being undertaken to understand the contribution of residual stresses in metals—a significant problem in welded structures. Research on the ceramics and glasses for functional and structural applications has been intensified. Goals here are related to applications in deep submergence, sonar transducers, and infrared optics. Improvements in such properties as fracture-toughness, resistance to environmental attack, and fabricability of such candidate materials as ultra-high strength metals, ceramics and glasses are sought.

Our work in mechanics is highly varied and involves extensive efforts in fluid dynamics and structures. Research on the dynamics of density stratified fluid flows has led to the conclusion that randomly oriented internal waves are generated in the wake found behind moving bodies. The implications of this phenomenon for the general problem of antisubmarine warfare are under investigation. Shock tube technology continues to be a very valuable experimental tool. It is now being applied in the generation of important chemical kinetic data. The back-fit redesign of submarine bulkheads for rescue purposes is being accomplished, in part, through our structural mechanics work. A general computer program has been instituted which will enable Navy architects to account directly and simply for structural shock specifications essential in ship designs. This will enable Navy program managers to concurrently assess acceptability of proposed designs. The

results of this one general purpose program may produce substantial saving in the acquisition cost of new ships.

In the field of terrestrial sciences, continued efforts are planned on identifying and understanding environmental processes effecting various coastal formations. This will include direct coastal observation, more detailed work in remote sensing, research on geographical information storage systems, and beach erosion processes. The information is important to the countering as well as the planning and execution of amphibious and mine-warware operations.

The increased funding in the Arctic program will support additions to the Naval Arctic Research Laboratory and the floating ice island, T–3. This action will bring to an acceptable level the equipment, instrumentation, and other facilities at this remote Laboratory. The current investigations and analysis of the internal stress of the ice-pack will be augmented through research in hydroacoustics. The stress field problem will be eliminated by a measurement of oceanographic and atmospheric variables and their induced stress in the ice. This work will be conducted from a three-station network of drifting pack ice stations initially disposed in a triangle of about 100 kilometers on a side.

The Navy's biomedical research program is directed toward understanding and modifying those biological factors which affect Navy and Marine Corps operations.

This research continues to make important contributions to the maintenance of health and performance capability of Navy and Marine Corps personnel, as well as improving the medical and surgical treatment of combat casualties. Our biochemistry program is pursuing an effort to isolate recently discovered biological substances which act as command and control regulators of the internal secretory glands of the human body. An understanding of the pharmacology of these substances will greatly enhance our efforts to maintain and improve the performance of personnel operating under the stress of combat. Another biochemical substance directly related to the hormone adrenalin has been isolated from blood. This intermediate metabolite of adrenalin appears to play a part in the mechanism of oxygen toxicity. Additional knowledge of this mechanism will enhance the development of safer and more efficient decompression schedules for divers, and reduce the hazards associated with prolonged excursions to the floor of the sea.

Rapid medical evacuation of the wounded by the helicopter, in the Southeast Asia combat zone, now brings to the casualty treatment facility critically injured patients who in previous conflicts would have died at the forward aid station. This opportunity to resuscitate and treat patients at the point of death has resulted in a complete reevaluation of methods of treating wound shock, and implementation of extensive studies of the mechanism of the shock syndrome. A better understanding of the entire process of human response to injury and treatment will increase the survivability chance of those persons who can be successfully resuscitated. Related to the treatment of shock is the use of blood elements preserved by freezing. A new cryogenic preservative agent, hydroxyethyl starch (HES) appears to be a most effective replacement for glycerol. This should reduce the processing time of frozen blood considerably.

Progress is being made with the use of human tissue transplants in the surgical treament of injuries. We are now investigating new techniques for the compatibility typing of human skin to be used for burn grafts, and for the collection, preservation, and use of nerve tissue.

The treatment of infectious disease, the scourge of tropical warfare and recruit centers, has benefited from the continued research program related to the genetics and biochemistry of bacteria and viruses. Navy medical scientists are currently developing candidate diagnostic antisera for the rapid identification of the causative agent in cerebrospinal meningitis which sporadically breaks out in recruit centers. Candidate vaccines for the prevention of meningitis are undergoing standardization prior to human test and evaluation.

In the psychological and social sciences, emphasis is placed on assuring maximum performance of man—the important link—in increasingly sophisticated weapons, vehicle, and support systems. Our efforts involve the impact of environmental factors including research on such problems as night carrier landings; human degradation resulting from vibration, heat, cold, noise, and other detriments to effective performance. This work has already netted knowledge which is crucial to developing appropriate protective equipment and techniques for pilots and for many man-in-the-sea projects (salvage, rescue, underwater demolition teams, and underwater communications).

Another research area is concerned with identification and understanding of the neural and perceptual processes as a basis for maintaining and enhancing personnel performance in a variety of environments.

There is one advanced development element under budget activityI—"Education and training development." The objective of this program is to apply new training techniques and concepts to existing and planned training and education programs in order to enhance their usefulness, feasibility, and economy. We will emphasize simulation and mathematical models for planning; proficiency and job training criteria; feedback and evaluation systems in training situations; and computer-aided instruction. In fiscal year 1969 we have undertaken projects in the use of programed instruction and computer-aided instruction. We are requesting funds in fiscal year 1970 to continue this evaluation and to broaden the scope of application of these teaching methods.

Moving on to "Management and support," we are requesting funds in fiscal year 1970 to support the center for naval analysis (CNA, Navy). The purpose of this group, administered under contract to the University of Rochester, is to conduct a continuing program of research, studies, and investigations which will assist the Chief of Naval Operations in making decisions in the application and development of naval capabilities and that will assist the operating forces of the Navy through operations research to improve our current capabilities.

This program provides a professional staff well versed in naval warfare that conducts studies and analyses emphasizing the long range, medium, and current time frames. The program provides for on-site analytical support to the operational fleet and force commanders.

Eight out of 14 analytical investigations were carried over from fiscal year 1968; 10 new studies were undertaken during fiscal year 1969 in personnel, tactical air, and logistic areas. The study program for fiscal year 1970 will emphasize strategic planning, logistictics concepts, operations, and the force structure areas. There is a separate and smaller program for CNA (Marine Corps) which deals with specific Marine Corps problems.

The final element under management and support in budget activity 1 is "Studies and analysis (Navy)." Under this element the Navy makes analyses of alternatives to be considered for major planning and policy decisions. Comprised of 10 individual projects, the work involves: (1) specific operations research and war gaming studies for force level, procurement, deployment, and R. & D. program planning effecting decisions by CNO and CNM; (2) studies of possible utilization of advanced systems and tactics pointing the way toward Navy exploitation of new concepts and translation of scientific results into needed fleet and Marine Corps capabilities; (3) work on future fleet data systems and analytical models needed to measure the actual at-sea performance of Navy ships and weapons systems; and (4) analyses to develop guidance for system development planning.

In fiscal year 1970 we plan to place particular emphasis on building better analytical models and data bases to derive capabilities and optimum force mixes for ship, aircraft, and associated weapons systems competing for development funding. We will continue with ongoing studies as to the implication of a possible war at sea; of surface-to-surface missiles; and of Naval Reserve Forces.

This completes my review of budget activity I. I will now move to budget activity II.

BUDGET ACTIVITY II—AIRCRAFT AND RELATED EQUIPMENT

Under budget activity II, "Aircraft and related equipment," we are requesting $577.2 million. This increase is about $181 million over fiscal year 1969 and essentially reflects sizable increases in three major aircraft programs.

We are requesting funds in the program for development of EW aircraft. Between 1972 and 1975, the Navy will need more early warning aircraft for their big deck carriers (CVA's). The shortages are caused by the combination of new carrier construction and normal attrition.

The development program during the past year has proceeded on schedule.

Funds requested for fiscal year 1970 will be utilized to continue the R. & D. effort and for preproduction configuration aircraft. TechEval/OpEval will be conducted at NMC, Point Mugu and NWC, China Lake.

We are requesting funds in the program to continue a new aircraft system development, the F–14A (formerly VFX–1). The F–14A is a high-performance fighter aircraft equipped with a long-range multiple shot air-to-air missile system and proposed for fleet introduction in the early 1970's. Simply described, the F–14A concept consists of a tandem two-place, variable sweep wing fighter incorporating: an AWG–9 missile system and two turbofan engines. It will be designed to operate from *Midway* or larger class carriers.

On October 1 of last year, proposals were received from five contractors for full-scale development. In January of this year, the contract was awarded to Grumman Aircraft Engineering Corp.

Since we met last year our exploratory development program has been restructured in order to effect an improvement in program management and provide a more lucid presentation of the program. We have reduced the number of program elements from 26 to 20. I will discuss a number of these elements. I will limit my description to the main objective of each element and enumerate, where appropriate, significant programs or projects in each.

The aircraft exploratory development program activity supports exploratory investigations of advanced aircraft system concepts and development of related technologies. Included is work in aerodynamics; structural design and test; aircraft instrumentation and control; electrical energy conversion and distribution; aircraft propulsion systems; auxiliary equipment; installed provisions for personnel protection and flight safety, acoustic, magnetic, and electromagnetic silencing; and aircraft handling and servicing.

In fiscal year 1970 requested funding will support the ongoing programs and new analyses of light attack aircraft, the impact of VTOL technology on ASW; wind tunnel experiments and flight tests of a new rotor concept for high-speed helicopters; and accelerated development of high-strength composite structures. We plan to continue protototype development of advanced aircraft propulsion systems for future Navy applications.

The largest advanced development element in this budget activity is airborne ASW detection system for which we have requested funds in fiscal year 1970. Effort under this element is directed toward providing ASW aircraft with advanced systems for detection and localization of high-speed, deep-diving submarines. I will briefly outline some of the work being done in the major projects.

A major effort and a new start in fiscal year 1970 will be in advanced acoustic search sensors in which conceptual studies will begin on the development of new sonobuoys. The sonobuoys under development will extend our capability into the future.

Two other projects are devoted to sonobuoys. The command active sonobuoy system (CASS) will provide ASW aircraft with an improved echo-ranging sonobuoy. Our fiscal year 1970 program will see the release to service use of CASS.

We are also developing an air-launched, long-life moored sonobuoy system (MSS).

The advanced ASW avionics system project is a continuing program currently devoted to development of an integrated advanced ASW avionics system for detecting, classifying, localizing, and attacking high performance submarines.

Developmental models of an airborne ASW radar capable of detecting submarine periscopes and snorkels in sea clutter will be tested beginning this year with flight tests scheduled for fiscal year 1970.

We are requesting funds in fiscal year 1970 for continued advanced development in the field of airborne electronic warfare equipment. Equipment developed under this program will provide protection to our tactical aircraft operating in a hostile environment. In fiscal year 1970 there will be several projects under this element.

Airborne jamming and deception, providing improved electronic countermeasures capabilities for Navy attack, fighter, and reconnaissance aircraft. These will be designed to increase the probability of our mission success and aircraft survivability in tactical operations. This project includes analysis and production of tactical intelligence, simulation, testing evaluation, component and equipment development, and maintenance of facilities for analysis, simulation, test, and evaluation.

Airborne electro-optical countermeasures is directed toward the development of integration of countermeasures systems to provide increased survivability of fighter, attack, reconnaissance, and rotary wing aircraft.

The development of airborne radio direction finding (DF) systems.

In fiscal year 1970 we plan to deploy, as I mentioned in my discussion of SEASIA, the first group of electronic emitter location system (EELS) aircraft aboard a CVA.

The last advanced development subactivity that I will address will be a new start in fiscal year 1970, the destroyer helicopter system. This program will result in a light airborne multipurpose system (LAMPS) capable of performing various missions off a destroyer. We have conducted a fleet operational investigation of the use of light manned helos aboard destroyers. In fiscal year 1969 we will conduct mission analyses of a "multimission" configured helicopter. The funds requested in fiscal year 1970 will permit the conduct of concept formulation for this system, initiate development of mission-oriented modules for use on these light helicopters, and fund first-year development contracts.

The first subactivity under the engineering development budget activity is the CVS ASW aircraft S–3A (VSX). The current S–2 aircraft was conceived in 1948, introduced into the fleet in 1954 and has undergone continuing updating since that time to counter advances in the submarine threat. The current model (S–2E) does not now possess the capability to cope with the projected submarine threat nor does it possess the potential for future upgrading. The S–3A system will be capable of greatly increased search speeds, tactical effectiveness, as well as have improved reliability and maintainability.

We are presently flight testing the postulated avionics system in a test bed aircraft. Development of the high bypass engine has progressed to the stage that the first full-scale run is scheduled for May 1969. In March of this year we will complete phase B of contract definition with the selection of one contractor to proceed with development of the airframe.

We are requesting funds in fiscal year 1970 to commence with engineering development of the S–3A airframe and continue development of the engine and avionics. Operational evaluation is planned for early fiscal year 1974.

The versatile avionics shop test (VAST) is a computer-controlled integrated system of testing avionics components. The system is being designed to test most electronics equipments independent from the airframe system from which the subsystem has been removed. The principal features of the VAST are functional versatility and adaptability to changing test requirements. This will produce a reduction in shop space, shop personnel, and training costs. Several "building blocks" of the system have been developed. The funds requested for

fiscal year 1970 will permit continued development of the building blocks, including those necessary to test particular functions of specific avionics package.

The next engineering development subactivity, target development, consists of three projects. Under the drone formation control projects we will continue in fiscal year 1970 the test and evaluation of a system which will allow the flight of these aerial targets in close formation. The seaborne target development project will be concerned in fiscal year 1970 with the development of a medium-sized high-speed drone target boat which will realistically simultate a current threat, the high-speed missile launching patrol boat. The largest portion of the funds requested in fiscal year 1970 will be used for the target systems development project. Here we expect to develop a full-sized supersonic target conversion and complete development of ground-based emitter targets.

In fiscal year 1970 we are requesting funds for continued development of the TRIM/combined sensor vehicle system. In my discussion last year the TRIM systems were described as installed in certain modified aircraft. We have been in the interim working on another aircraft for use under conditions of high antiair threat. In this fiscal year we will complete the design, development, and test of a new prototype incorporating additional sensors with increased integration into the airframe, and we will commence development of an aircraft modification program.

The funds requested for fiscal year 1970 will be used to conduct operational evaluation at a VX squadron and support a Navy technical evaluation. We will deploy some of these aircraft and will continue support and sensor improvement of them and other deployed aircraft.

The next budget subactivity under aircraft and related equipment is the F–14B/C aircraft. Both aircraft will use the same airframe as the F–14A. By following this concept not only is the development risk minimized but the improvements can be exploited operationally as soon as available.

A market improvement in the Navy/Marine Corps amphibious force capability can be achieved by the introduction of a crane helo/heavy lift. It appears that an improved version of an existing helicopter could be developed in about 24 months after program initiation. It would also be capable of recovering the largest assault helicopter the Marines currently employ. A majority of Navy/Marine tactical aircraft could be retrieved by a helicopter of this lift capability.

We have sufficient data in hand to believe that industry can supply this modest lift capability with minimum cost and risk.

This completes my review of budget activity 2. I will now turn to budget 3.

BUDGET ACTIVITY 3—MISSILES AND RELATED EQUIPMENT

Budget activity 3, missiles and related equipment, decreases $149 million from last year to a fiscal year 1970 total of $564.6 million largely as a result of a reduction in the FBM program; Phoenix and the surface missile system project. Other missile systems such as Standard Arm, and Sparrow have decreased budget demands in this

activity as they approach completion of the development phase. Partially compensating increases appear in other systems.

For fiscal year 1970 we are requesting R.D.T. & E. funds for support of Navy strategic systems development in this budget activity.

The fleet ballistic missile system with the Polaris missile has been operational since 1960. The Poseidon development program is continuing on schedule to support the initial deployment. The first Poseidon flight test vehicle was successfully flown from Cape Kennedy on August 16, 1968. A total of four successful flights and one unsuccessful flight have been conducted. The first shipboard flight test is planned from Observation Island in 1969. FBM system development costs are somewhat lower in fiscal year 1970.

Development of improvements in the ability of our FBM command and control communications network to survive nuclear attack and to function reliably in the face of enemy countermeasures continue. Construction of a Sanguine test facility in the northern part of the State of Wisconsin has begun. The first phase of this test facility, designed to demonstrate effective mitigation of the interference effects of the extremely low frequency (ELF) Sanguine system on psychological and biological effects will be completed early in fiscal year 1970. We are requesting funds in fiscal year 1970 to continue our work in FBM command and control.

The funds shown in fiscal year 1970 budget under the advanced sea-based deterrent element are to continue refinement of the SABMIS concept, a sea-based ballistic missile intercept system. SABMIS is a forward-based ABM system now in early stages of analyses.

In fiscal year 1970 for antiballistic missile support we are requesting funds for modification of excess of Polaris missiles to a target configuration in support of the Army Sentinel program.

At the end of fiscal year 1970 we expect to be ready to let the contract for pilot production of a new air-launched tactical missile. The Navy technical evaluation will be conducted with laboratory and flight tests. It is planned that the production contract will be awarded in calendar year 1970.

The Phoenix guided missile system as planned for installation in the F–14A aircraft consists of a pulse doppler radar and associated computer and displays which can acquire and track multiple targets at long ranges and make multiple near simultaneous attacks with long-range missiles against manned or unmanned enemy aircraft.

In fiscal year 1970, we are requesting funds to complete development of the basic Phoenix missile and conduct tests of the modified AMCS.

I mentioned last year that we have had successful guided Phoenix shots. Since that time we have fired more Phoenix missiles, all of which were successful.

We are requesting funds in fiscal year 1970 to continue the surface missile systems project. Prior to introduction of the advanced surface missile system, the Talos, Terrier, and Tartar systems must be capable of providing adequate defense to fleet units. Under this element we are supporting continued development of standard missile as the follow-on missile for the Terrier and Tartar systems. Development of improved surface-to-surface capabilities along with new weapon control system, Tartar D, is being developed for new guided missile ships.

We deployed the Standard Arm in March of last year. The AGM–78C has been designed for ease of production and lower cost.

The funds requested for this subactivity in fiscal year 1970 will be devoted to continuation of AGM–78D developments. Work will also begin on an integrated Standard Arm avionics system.

The first exploratory development element under this activity is missile propulsion. This element supports work on solid, liquid, hybrid, and air-breathing engines, propellants related thereto and gun propellants. Work is being conducted on quickly reacting, highly maneuverable, and more reliable rocket motors. Rocket fuel, nozzle materials, motor insulation, and bonding composition technology efforts will be supported. We will study the performance of air-breathing engines in a highly maneuvering trajectory; air-breathing engines for subsonic cruise missions; and trade offs of liquid/hybrid engines versus ballistic performance and versatility.

The second exploratory development element is strike warfare weaponry. Included is work on strategic and tactical weapon system components; guided and unguided missile structures, warheads and fuzes, aerodynamics and ballistics, guidance and control, explosive research, weapon launching and service technologies, and safety and vulnerability.

We plan to devote our efforts to studies of cluster warheads, ECM concepts, a short-range air-to-air weapon control system. We will also pursue work on a new coordinated guidance system, including terminal guidance, location, and target identification; lightweight antiair weapons system for small surface craft; and other aspects of airborne intercept weapons control, and fuzes and warheads.

The element air-launched/surface-launched antishipping missile was established in fiscal year 1969, studies have defined the requirements for an air-launched ship attack missile, ALSAM and the surface-to-surface missile, SSM. Advanced development work to meet this requirement is being conducted. In fiscal year 1970 funds are requested to complete the contract definition of this weapon.

The basic point defense surface missile system (BPDSMS) provides greatly improved self-defense against air attack over existing guns. The point defense systems development element is intended to provide improvements to basic point defense.

The first of the two projects in the element, NATO Sea-Sparrow, is a cooperative NATO program designed to provide a PDSMS to counter the air threat of the mid-1970's. The NATO Sea-Sparrow plus the target acquisition system (TAS) developed under the second project, point defense improvements, will constitute the U.S. Navy improved point defense surface missile system (IPDSMS).

By the end of fiscal year 1969 contract definition will have been completed in both projects and engineering development on hardware for all subsystems will have commenced. We are requesting funds in fiscal year 1970 to continue engineering development on both the NATO Sea-Sparrow and the TAS.

Engineering development for the surface missile systems is carried out in the 3T major development element. This was a new element created in fiscal year 1968. Fiscal year 1970 funds will be used to develop a new combined launcher capable of firing AAW and ASW missiles. This launcher is applicable to our new escort ship construction

programs. The new Talos replacement radar is derived from the Tartar D radar with accompanying savings in development cost. The advance ordnance package for Standard missiles is applicable to existing warheads with increased effectiveness.

By the end of fiscal year 1969 we will have completed CD and be ready to select a contractor for development of the advanced surface missile system (ASMS). We are requesting funds in fiscal year 1970 to proceed with engineering development of this system. The system will be fully evaluated with the standard missile and the new ASMS missile is planned for fleet introduction in the mid-1970's. This system is intended to counter the AAW threat of the mid and late 1970's with inherent growth capabilities to handle more advanced threats. ASMS is a second generation surface-to-air missile system with a capability for surface-to-surface use.

An important element under management and support is Pacific Missile Range (PMR). PMR is a national range under the management control of the Navy providing support for DOD and other designated government and civilian agencies engaged in missile, satellite, and space vehicle R.D.T. & E. programs.

PMR has highly sophisticated instrumentation and communication complexes located at Point Mugu, San Nicholas, Santa Crus, and San Miguel Islands along the southern California coast. PMR has facilities at Kaneohe Bay (Oahu) and Barking Sands (Kauai) in the Hawaiian area; Johnston Island; missile impact location systems sites at Wake/Midway Islands. Mobile instrumentation for downrange support includes vans and the range ship U.S.S. *Wheeling* (AGM–8). The Naval Air Station, Point Mugu, provides base support, maintenance and repair of real property, operation of utilities and other facilities for PMR operations for the Point Mugu area and offshore islands.

This concludes budget activity 3. I will now move on to budget activity 4.

BUDGET ACTIVITY 4—MILITARY ASTRONAUTICS

In budget activity 4, military astronautics, the Navy's fiscal year 1970 program is $24 million. The Navy is an active participant in the employment of space systems to support Naval and Marine Corps operations at sea. I anticipate an increase in the money required to support our space programs in future years primarily as a result of the advancing technologies capability to support our military requirements.

Our astronautics exploratory development program supports our technical and study projects for investigating new techniques which appear promising as future applications of space systems in support of naval operations.

We are expending exploratory development funds to further investigate Navy applications of communications satellites. We are looking at developmental concepts, techniques, and components peculiar to the Navy application that will provide a sound technology base for advance and engineering development in support of the Navy participation in the defense satellite communication program (DSCP) including triservice tactical satellite program. We are conducting investigations, tests, and analysis that will lead to the development of tactical

aircraft satellite communication equipment, including the aircraft antenna, compatible with communication satellites operating in both the UHF and SHF bands.

Another project area in exploratory development activity is navigation satellite experiments which include investigations to define systems which will meet requirements for future satellite navigation systems. Investigations include, among other, means to expand applications of the existing range-rate satellite navigation system (Transit) and to conduct experiments using a ranging technique (Timation) for determining the feasibility of providing satellite navigation on a continuous basis to operations units. Investigations will also be conducted using both the range and range-rate techniques to determine the feasibility of obtaining near instantaneous fixes from one satellite.

In the navigation satellite program, we are investigating advanced tactical applications of the Navy's navigation satellite (NAVSAT). We are developing (*a*) an aircraft user equipment compatible with the navigation satellite system; (*b*) an economical, lightweight, shipboard navigation receiver and (*c*) a man-pack field user equipment. The Transit navigation satellite system has been in operational use by a limited segment of users since 1964. Recent improvements in the current service of satellites as well as planned improvements, will now permit the sustained provision of a minimum of four operational satellites in orbit.

The other major area of our Navy space program effort is satellite communications. We have requested funds to continue development of advanced shipboard terminals that will be capable of utilizing all modes of satellite communications. Primary efforts are directed to the phase II of the DSCP (advanced satellite communication program) as well as updating existing terminals.

We are also participating in the triservice TACSATCOM program. This program will result in the development of a capability for tactical communications by means of satellite relay. All services are fully participating in this program with the Navy having the prime responsibility for all test planning connected with TACSATCOM.

Included in the astronautics budget in fiscal year 1970 is a new start under "Engineering development for tactical satellite communication equipment." This development effort will be conducted in the environment of a multiservice directed research and development program. The essence of this development is the determination of an economically feasible communication satellite system that will remedy a significant portion of the deficiencies in present Navy tactical communications. After the research and development phase and incorporation of the subsequent fixes, these terminals will be used to establish an initial operational capability. These terminals are designed to operate with synchronous UHF/SHF satellite repeaters.

BUDGET ACTIVITY 5—SHIPS, SMALL CRAFT, AND RELATED EQUIPMENTS

In this activity we have requested $345.2 million in fiscal year 1970. The largest part of this activity is related to our efforts in the field of submarine and antisubmarine warfare, discussed in detail earlier.

The AN/SQS–26 sonar has been under development since 1958 and

in production since 1960. In early fiscal year 1970 we will complete technical evaluation commenced in fiscal year 1968 and commence operational appraisal. We are working on an improved tracking capability and a rubber dome to reduce self-noise as well as reduce maintenance requirements. The funds requested for fiscal year 1970 will permit completion of operational appraisal and continuation of development system performance improvements.

We are requesting funds in fiscal year 1970 for submarine silencing. Our submarines are quiet; but not as quiet as we would want them to be.

In fiscal year 1970 we have requested funds to continue our efforts in cryptologic activities. This program, the details of which are of a classification higher than this statement, includes all Navy projects in the areas of communications and electronic intelligence and communication security development.

The first of the two exploratory development elements which I will mention under this budget activity is naval nuclear propulsion which comprises a comprehensive program of research and development directed toward the application of nuclear propulsion to naval ships ranging in size from small submarines to large combatant surface ships. This work is closely coordinated with that of the Atomic Energy Commission's Division of Naval Reactors concerning the development of improved reactor plants and nuclear cores. The nuclear propulsion exploratory development program includes work in: pressurized water technology, decontamination processes; powerplant materials/development and application; radiation shielding; component development; and submarine and surface ship nuclear plant development.

The second exploratory development element is "Ships, submarines and boats." Our effort under this element embraces investigation of advanced ship, submarine, and boat concepts; hydrodynamics; structural design and test; ship control; electrical energy conversion; propulsion systems; habitability; personnel protection and damage control; ship silencing; and vehicle handling and servicing.

In fiscal year 1969 our work included study of new hull design, propulsion machinery for small deep submersibles, propulsion plants, environmental improvements for submarine crews, ship silencing, and machinery noise. We will continue these efforts in fiscal year 1970. We will increase our emphasis on new approaches to small craft development for riverine warfare and superconducting machinery for propulsion applications. The VLAP program mentioned earlier is supported partially by this element.

To afford better visibility to this program, "Surface effect ships" is reflected as a separate subactivity for the first time in fiscal year 1970. In fiscal year 1969 and prior this program, funded jointly with the Commerce Department, was reflected as part of the advanced surface craft element.

The objective of this joint program is to determine the feasibility of building and operating large high-speed multithousand-ton surface effect ships of 80 knots or higher speed.

By the end of fiscal year 1969 we will have commenced construction of two 100-ton test craft (one propeller driven and one water-jet driven) and initiated conceptual design of a multihundred-ton test craft. We have requested funds in fiscal year 1970 to continue this

program of development of ships which hold a potential for revolutionizing naval warfare.

"Advanced ship/submarine sonar development" has as its objective the concurrent development of maximum effectiveness and commonality in sonar systems for new surface ships and submarines. The purpose is to ultimately decrease development production and support costs. Feasibility studies and analysis have been conducted. We request funds in fiscal year 1970 to continue our work and to enter into the competitive industrial portion of concept formulation.

We have requested funds in fiscal year 1970 for advanced development of reactor propulsion plants. This year there are five projects in this element for which funding is requested. Two projects have the objective of providing improved nuclear propulsion for surface ships and three projects will provide advances in submarine nuclear propulsion plants.

The first surface ship nuclear propulsion project is the two reactor aircraft carrier propulsion plant. The reactors of this plant will be the largest yet developed for naval nuclear propulsion. It is scheduled for fleet introduction in the *Nimitz* (CVAN 68) whose keel was laid June 22, 1968. The second surface ship reactor plant is being developed for small combatant ships. In fiscal year 1970, development efforts will be conducted to continue the plant evaluation studies and verify design parameters.

The first of the three projects associated with nuclear submarines is the natural circulation plant. The final two projects are aimed at providing higher propulsion power capabilities in nuclear attack submarines. The first project will adapt a reactor and associated reactor systems to provide a propulsion plant for installation in an attack submarine in the fiscal year 1970 shipbuilding program. The advanced design high-speed nuclear attack submarine propulsion plant project, commenced in November 1968, will provide a comprehensive program directed toward an improved higher performance submarine propulsion plant suitable for installation in a nuclear submarine in a future shipbuilding program.

The advanced submarine sonar subactivity supports the development of the U.S.S. *Dolphin* (AGSS) sonar and acoustic communications. The *Dolphin* project will investigate the tactical and technical significance of the deep diving combatant submarine sonar suit. Under acoustic communications we will continue in fiscal year 1970 with our development work on an integrated underwater communications and identification system for use between submarines and between submarines and surface ships. As part of this project, we are participating in a NATO project for establishment of the Azores fixed acoustic range (FAR) to be used for necessary acoustic measurements.

The funds requested in fiscal year 1970 for acoustic countermeasures is intended to provide surface ASW ships and submarines with an effective survivability and evasion capability against enemy acoustic weapons and sensors. The ultimate aim is a system which will detect, classify and track enemy acoustic emissions and passive acoustic homing weapons, evaluate the threat and determine the countermeasures to be used, either a device or a tactic, or both.

The goal of the marine gas turbines element is the development of gas turbine propulsion units which are economical, efficient, and will

withstand the salt air and high-impact shock inherent in a marine environment. Included within the scope of this program is the turbine powerplant along with auxiliary equipment for combat ships such as controllable and reversible pitch propeller (CRP) and an appropriate clutch. By the end of fiscal year 1969 we will have converted an aircraft jet engine to an operating marine engine (Pratt & Whitney) and installed this along with a converted GE gas turbine in a MSTS ship for comparison testing. We are requesting funds in fiscal year 1970 to continue with our efforts in this program.

New ship design is composed of two projects. The larger is advanced ship development, the objective of which is to conduct system and operational analyses for ship concepts leading to performance characteristics for new ships. These studies comprise concept formulation (CF) which meets the prerequisites for contract definition (CD) to be discussed later. During fiscal year 1969 CF for AGS and CVAN were initiated. In fiscal year 1970 it is planned to complete CF for DXG and commence this program for other selected types.

The second and smaller project is that of computer aided ship design and construction in which the computer is utilized to a large extent in the actual design of a ship and its components. We have developed a program where design of actual bulkheads, decks and shell are automated. In fiscal year 1970 we plan to commence a computer graphics system where information from a data bank on a specific ship can generate a graphic presentation of, for example, a ships compartment for study and possible modification (on the computer) by the architect. We are requesting funds in fiscal year 1970 for this element.

In fiscal year 1970 we ask for funds to support the two projects remaining in Advanced Surface Craft, the SES program now being funded separately. The first project, amphibious assault landing craft, is intended to define, develop, test, and evaluate a new set of amphibious assault craft including associated shipboard handling gear and beach equipment. In fiscal year 1969 we expect to review alternative designs, select the specific craft for development and continue detailed design. Funds planned for fiscal year 1970 will provide for completion of design and test craft.

The second project in this subactivity is hydrofoil craft. The purpose of this project is to develop, through test and evaluation of two hydrofoil craft, performance and reliability data on military effectiveness of this type of craft. By the end of fiscal year 1969 we will have completed tests on the 120-ton PCH–1 and developed modifications to provide increased reliability. In fiscal year 1970, we plan to make the modifications to PCH–1 and reevaluate this craft. The 320-ton AGEH delivered March 3 will undergo extensive trials for the next 2 years. At the same time we will collect data resulting from tests and evaluation of PGH–1 and PGH–2—two 72-foot hydrofoil craft constructed with SCN funds but with much benefit from R. & D. hydrofoil work.

The objective of the advanced communications element is to conduct advanced development which will lead to improved shipboard data handling, conventional message routing, communication equipment performance monitoring, and control and radio frequency facilities. It provides support for complete communication system test and evaluation facilities at the Naval Electronics Laboratory Center.

The funds requested in fiscal year 1970 will permit us to continue our efforts in all of these projects. The largest effort being in advanced shipboard communications where we will complete installation of certain *Nimitz* communication systems in the test and evaluation center and commence final evaluation prior to delivery to the shipyard.

While there are several smaller projects under shipboard electronic warfare, our major effort is now devoted to ship advanced electronic warfare. Phase I of this project, Shortstop, will provide for automated early warning and initiation of electronic countermeasures to defend against antiship missiles. Phase II will include followon development to adapt variants of Shortstop to smaller ships.

Our fiscal year 1969 program will see factory completion and component testing of the first prototype Shortstop. It is planned to install this prototypte at a selected station and conduct system acceptance tests in fiscal year 1970. The second prototype will be installed in a ship for at-sea evaluation. At the test station we will also install an environmental simulator which will provide the EW threat environment for the Shortstop system. Development of electro-optical countermeasures systems will continue in fiscal year 1970.

Subsystem reliability is a program to develop new techniques which will improve the reliability of selected electronic equipments which have had poor field maintenance and reliability history. The aim is to improve system availability and to reduce logistic and maintenance costs. Under our fiscal year 1969 program we will continue the development, fabrication, and testing of 20 battlefield surveillance radars. This development will be completed in fiscal year 1970. In fiscal year 1969 we will commence development of a highly reliable teleprinter. This development will be completed in fiscal year 1971.

An advanced development program recently emerged from exploratory development is the certification of HY–130 steel for use in SSN pressure hulls. In fiscal year 1969 we will procure steel and welding materials for use in qualifying shipyards in its use and for the construction of large scale representative hull sections at these shipyards suitable for training and performance tests. We will commence construction of the hull sections prior to the end of the fiscal year. We are requesting funds in fiscal year 1970 to complete construction of hull sections and fabrications of auxiliary hardware and structures for conduct of underwater explosive, fatigue and static tests. Actual testing is planned to commence late in fiscal year 1970. We will continue these tests and hope to construct a submarine hull in the near future.

In engineering development, under element submarine sonar development, there are four interrelated projects. The total result is to enhance the offensive and defensive capabilities of our submarine forces which operate for long periods of time completely submerged in waters under hostile surveillance and control.

The SSN sonar project will provide an advanced version of the AN/BQR–2 sonar which we call the AN/BQR–2 Dimus. The modifications provide increased track capability and improved signal processing. In fiscal year 1970 we plan to conduct engineering development and design for production sonars and commence development of the indicated submarines.

The FBM sonar, the second project, will result in an advanced type display for submarines.

Sub close contact sonar is a mine detection sonar for submarines. During fiscal year 1969 the service test model of this sonar will be fabricated for technical evaluation in fiscal year 1970.

The last project, AN/BQS–13 DNA sonar, is established to provide a signal processing improvement and increased search capability for the BQS–13 sonar. Studies will be conducted in fiscal year 1970.

The funds requested in fiscal year 1970 for river and shallow water warfare will be divided among several projects.

In fiscal year 1970 we will continue our development of advanced types of river warfare boats such as ATC, CCB, Monitor and ASPB. We will conduct operational evaluation of the riverine utility craft in fiscal year 1970.

We will proceed, in fiscal year 1970, with development of counter ambush and other weapons for coastal and riverine craft under the lightweight counterinsurgency weapon suit for small craft project.

Funded completely under R.D.T. & E., N for the first time in fiscal year 1969 is the ship contract definition program. Contract definition (CD) is the phase of development during which preliminary design and engineering evolving from concept formulation are verified and firm contract and management planning are performed. The following are accomplished goals during this phase:

(1) Definition of interfaces and responsibilities.

(2) Identification of high risk areas.

(3) Verification of technical approaches.

(4) Establishment of firm and realistic schedules and cost estimates for construction.

(5) Establishment of planning schedules and planning cost estimates for operation and maintenance.

In fiscal year 1969 we will carry out CD for the DXG(N). Funds requested for fiscal year 1970 will permit the conduct in that year of CD for the ships that complete CF and determined appropriate for CD such as DXG, major replenishment ship, LFS and MCS.

We ask for funds in fiscal year 1970 for our development work in the three projects composing the intelligence system subactivity. The first project, naval intelligence processing system, provides for automatic data processing systems on board CVA, AGC, and CVS types and numbered fleet flagships. These systems allow tactical commanders to rapidly process collected intelligence and provide a rapid, continuous updating of intelligence files. The NIPS was operational in the CVA (in SEASIA) in fiscal year 1968. In fiscal year 1969 emphasis is on AGC and numbered fleet flagship systems. Effort in this project will decline in fiscal year 1970 with the installation of these two systems for evaluation. A CVS system will be completed in fiscal year 1971 with operational evaluation of all four ship type systems expected to be completed by the end of fiscal year 1972.

The major effort in fiscal year 1970 will be in the development of the joint in-flight data transmission system (JIFDATS). The Navy is executive agent for this joint (Army, Navy, Air Force, and Marine Corps) project for development of a system capable of transmission (within minutes or less) of aerial reconnaissance data from the collecting aircraft to both land- and sea-based terminals for immediate

use by tactical commanders. In fiscal year 1970 we expect to make engineer designs for performance confirming tests and develop installation data.

The electronic warfare systems include work in several areas. We are continuing efforts to improve the basic system developed in fiscal year 1968. In fiscal year 1969 we will complete development of tactics and commence development of a pod mounted version. Our continued effort in fiscal year 1970 will apply techniques to reduce cost, weight, and improve performance of this system.

We will continue our work in improvement of present devices for jamming and deception of hostile radars and develop new capability in this field.

The last project under this element, electronic warfare environment simulation, has resulted in the Echo range at NWC, China Lake. During fiscal year 1970 we will continue to update the range in accordance with the latest intelligence available.

Ship antimissile integrated defense (SAMID) mentioned earlier in my discussion of antishipping missile will provide rapid incremental improvements in ship capabilities to defend against such threats by increased integration of the ships' defensive systems. Improvements are aimed at increasing ships' abilities to detect and identify antiship missiles, with reducing weapons reaction time, and improving engagement capabilities with missile, gun, and electronic warfare defensive systems. Performance capabilities of individual subsystems and systems will be optimized in unfavorable environments. Overall ships' defensive capability will be optimized by correlation of data from individual sensor subsystems and by mutual data transfer among weapon and EW systems. This data processing will be compatible with the Navy tactical data systems (NTDS).

In fiscal year 1970 we plan to complete refinement of the hardware improvements and procedures. These installations are planned to be consistent with regularly scheduled shipyard overhauls for additional classes of ships including CVA, CG/LG, LPD, LPH, AGC, and BB.

This completes my review of budget activity 5.

BUDGET ACTIVITY 6—ORDNANCE, COMBAT VEHICLE AND RELATED EQUIPMENT

Our fiscal year 1970 program for this budget activity, ordnance, combat vehicles and related equipment is $109.1 million. The decrease below fiscal year 1969 of $54.7 million results mainly from a reduction in MK–48 torpedo funding as this weapon nears production and the reduction due to the transfer out of R. & D. to O. & M.N. of fleet support elements discussed earlier.

We are requesting funds in fiscal year 1970 in support of the MK–48 torpedo program which provides for the concurrent development of the MK–48—Mod 1 dual purpose antisubmarine/antisurface ship torpedo. The MK–48—Mod-O torpedo, which is scheduled to commence operational evaluation in 1969, will provide our submarines with a long-range high-performance torpedo possessing a high-kill probability against the fast, highly maneuverable, deep-diving nuclear submarine. The MK–48—Mod-1 torpedo, a dual purpose version of the MK–48, utilizes a larger warhead, an improved acoustic homing system and

an exploder to provide a high-kill capability against surface ships as well as submarines.

I will now highlight our effort in exploratory development by discussing undersea warfare weaponry. This element supports investigations of advanced undersea warfare weapons and development of technologies related thereto. Its scope encompasses the means by which targets may be defeated by destructive measures. Included is work in structures, fluid dynamics and ballistics, propulsion, guidance and control, warheads and fuzes, launching, servicing technology for torpedoes, mines, and other undersea weapons.

In fiscal year 1970 we plan to continue our effort in many of these and other important projects. We will also conduct ordnance penetration studies of sea ice.

The first advanced development element is advanced mine development devoted to completion of the advanced development of the homing mine/Captor.

Unguided conventional air launched weapons is the largest engineering development element under this budget activity.

In fiscal year 1970 our emphasis will be on work on development of a high-speed delivery weapon for use by attack aircraft.

We will continue work on the Hart weapons, specifically the accelerated development version. This project was emergency funded for a maximum acceleration development effort, commencing in February of last year. We are now on schedule.

The subactivity conventional ordnance supports engineering development effort leading to improved gun systems and rockets for gunfire support and antiship protection. We have delivered to the fleet the 5″/38 rocket assisted projectile (RAP) which significantly increases the range over standard ammunition. The first recently developed bombardment rocket has been released to production and the 5″/54 lightweight gun (LWG) has been built and tests are underway. In fiscal year 1969 we expect to commence technical evaluation of the LWG and associated FCS onboard the USS *Norton Sound* test ship and complete technical and operational evaluation in fiscal year 1970. Our efforts on the longer range bombardment rocket (BOMROC) will continue in fiscal year 1969 as well as development effort in the 5″54 RAP. We expect, by the end of fiscal year 1970, to complete development effort on the basic 8″/55 fin-stabilized projectile as part of the long-range bombardment ammunition. This project utilizes subcaliber projectiles in unmodified guns as a means of extending range.

The major project in fiscal year 1970, and in fiscal year 1969 as well, will be the development of the major caliber lightweight gun (MCLWG). The MCLWG, when built for production, can be either 175 mm. or 8″. The prototype is being built as a 175 mm. gun. Should the fire mission not exceed the drum capacity, only one man will be required to operate the gun. The MCLWG will utilize the same MK–86 MCS as the 5″/54 LWG. In fiscal year 1970 we expect to complete fabrication of the prototype and commence testing of the gun and ammunition. A concrete penetrating projectile is being developed for this gun to provide increased gunfire support effectiveness. In fiscal year 1970 we will continue development effort in the 5″54 LWG, and BOMROC.

The element Marine Corps Ordnance/combat vehicle systems, consists of six major projects. Efforts for the landing force assault amphibian vehicle will be directed toward completion of engineering, service, environmental and troop testing of the retriever and command versions. Award of the production contract for the basic assault amphibian personnel carrier (LVTPX–12) and the command and retriever versions is also expected.

Continued system development of the lightweight air defense weapon will center around the combination of the seeker and motor development efforts.

Efforts on the improved hawk system will continue.

Development of night sights and maintenance equipment will be continued for the medium assault antitank weapon in fiscal year 1970 and a joint Marine Corps/Army engineer/service test of the system will be initiated.

For the multishot portable flame weapon project, effort will be underway to support configuration changes and modifications resulting from test and evaluation. Joint Marine Corps/Army engineer/service testing and the first full-scale production buy for force issue will be initiated.

Having completed my discussion of budget activity 6, I will now move to budget activity 7.

BUDGET ACTIVITY 7—OTHER EQUIPMENT

Budget activity 7 supports development effort in areas not specifically provided for under other budget activities. The Navy request for fiscal year 1970 in this BA is $280 million, an increase of $43.5 million over fiscal year 1969. This increase results primarily from increases for ocean engineering elements and undersea surveillance programs. Marine Corps programs in this activity contribute 6.6 million to the increase over fiscal year 1969.

Funds have been developed to support Marine Corps operational electronics development in fiscal year 1970. This is a continuing program for the investigation, design, construction, and evaluation of modifications of operational electronics equipment. Two major projects, the marine direct air-support system (MDASS), and the data transmission and switching system (DTAS), will have progressed into operational systems development and will be funded under this program. These two projects will require a substantial increase in effort over prior years.

The first exploratory development element is life sciences. This element consists of the exploratory effort directed toward protecting and improving the physical and mental effectiveness of man under all environments in which he must perform.

In fiscal year 1970 we plan to pursue such programs as determining the effect of chronic sleep loss on performance effectiveness; studies of performance under experimental threat stress; the physiology of submarine escape from operating depths continued development of bone and tissue transport techniques for treatment of combat injury, and determination of optimum cockpit arrangement of controls in displays as effected by tandem versus side-by-side seating configuration. This latter project bears on conversion of Phoenix system from F–111B to F–14A aircraft.

The second element is environmental support. The effort in this element consists of development of feasible solutions to the problems of measuring the undersea, air, space, and interface environment, predicting it and influencing it in direct support of naval operations.

The element supports deep ocean engineering and science effort using deep research vehicles at Woods Hole Oceanographic Institute and special laboratory support technology at the Naval Research Laboratory (NRL), the results of which were so effective in the searches for the (Polmares) A–Bomb and *Thresher*.

In fiscal year 1970 we are requesting funds to continue the effort which is directed toward the conduct of laboratory independent exploratory development. The objectives of this program are to encourage and exploit from within the laboratories fruitful new approaches to the solution of Navy problems, to give laboratory technical directors a degree of latitude, not otherwise available, in applying in-house technical resources to endeavors which appear most promising for achieving significant advances in technology, and to attract and retain highly talented and creative scientists and engineers in the Navy laboratories.

The element material support provides for exploratory effort directed toward providing improved technology for the development, engineering, distribution, storage, inventory control and maintenance of material not exclusively associated with vehicles, weaponry, surveillance, or command and control systems. Major technological areas include material control, distribution and storage, reliability engineering, value engineering, maintenance, servicing and salvaging support, electromagnetic compatibility, shore facilities, advanced base and amphibious support, and deep ocean engineering.

Exploratory effort in the materials and components element is directed toward attaining improved materials and individual components as well as the development of active and passive electronic parts and circuits. The area of materials includes the determination of engineering properties, corrosive tendencies, and methods of fabrication.

The electronic materials covers effort in both microelectronics and microminiaturization techniques. The electronic system effort includes technology for general purpose test equipment. The component area involves technologies concerning mechanical, pneumatic, electrical, electromechanical, electronic, microelectronic, pyrotechnic cartridge activated, and fluid mechanics devices.

Another exploratory development program is personnel support. This effort combines the broad areas of personnel management, training, and training devices. It encompasses qualitative and quantitative personnel requirements; retention; procurement and separation; selection in terms of aptitude and ability; distribution and assignment; promotion and advancement; proficiency evaluation; organizational analysis; training methods, content and evaluation; determination of training requirements and training curricula; and development of training device concepts and applications as well as simulation techniques.

Exploratory effort in undersea target surveillance is directed toward developments to detect, classify, localize, and identify objects which are submerged or substantially so, including surface ships when viewed by a submerged surveillance sensor, submarine, undersea platform or swimmer. Included are investigations of advanced undersea

surveillance system concepts and development of technology related to detection of undersea targets by acoustic, electromagnetic, magnetic and other means. The funding requested in fiscal year 1970 will permit continued effort in support of ongoing programs and the initiation of several new projects to include study of electro-optical assisted detection of submerged submarines and investigations of the predicted increase in detectability of a submarine after repeated deep dives.

We are requesting support in fiscal year 1970 for surface aerospace target surveillance. This element covers two major areas: (1) advanced radar technology for long-range surveillance and high resolution radar techniques for shorter range target detection and classification and (2) buildup of technology for advanced IFF systems.

Command and control exploratory development supports development to acquire, process and disseminate information required by a commander in planning, directing, and controlling military operations. This effort encompasses acoustic, electromagnetic, wire and other communications technology; radio frequency optical/IR/UV, inertial, and other navigation technology; and data processing including information transformation, storage, retrieval, and display technology.

In fiscal year 1969 we are continuing ongoing projects concerned with improvement of communication capabilities of submerged submarines, development of command displays for attack submarines, increased data transmission rates, navigation aids and new gyros for inertial navigation systems. We have begun work on developing a family of ultrareliable ground/amphibious communications equipment. We are requesting funds for our fiscal year 1970 program under this element.

Exploratory development in the countermeasures program element is directed toward defeating enemy vehicles, weapons, surveillance systems and command-control systems. Included are efforts related to acoustic and electromagnetic jamming and deception, special mine detection equipment, mine sweeping, and EOD equipment and techniques. In fiscal year 1970 we will continue this program of work with emphasis on new and improved jamming and deception equipments, torpedo countermeasures, mine sweeping and destruction equipments, and counters for enemy swimming detection systems.

The first three elements under advanced development, comprising our oceanographic engineering and development program have been discussed earlier under the oceanography section.

The funds we request in fiscal year 1970 for advanced undersea surveillance will be divided between two projects—ASW surveillance and long-range acoustic propagation (LRAP). Under the former we will conduct research, development, experiments and analyses in order to determine the optimum means of providing the Navy with an undersea surveillance capability against submarines in all modes of operation and under all environmental conditions. In fiscal year 1970 we plan to complete key studies in this area.

The project LRAP supports an advanced development program in long-range acoustic propagation in support of advanced ASW surveillance system developments and optimization of their use. The project emphasizes environmental factors. Our fiscal year 1970 funding will be used to implant the Seaspider (the deep water oceanographic struc-

ture mentioned earlier) as a platform from which we will make acoustic and oceanographic measurements.

We are requesting funds in fiscal year 1970 for advanced medical development. With these funds we plan to standardize the prototype mobile frozen blood banks which have worked out so well in Southeast Asia. We intend to further improve our combat casualty resuscitation and shock treatment capability. Full scale field test of mobile surgical facilities for support of amphibious assault and riverine warfare operations will be conducted. Expanded effort in the preservation and use of human tissues such as bone, skin, and nerve will improve our capability to restore the wounded to an acceptable functional status. A new meningitis vaccine is scheduled for test on humans, and the effort shows great promise of countering the ever-present threat of meningitis epidemics at recruit centers. An important new start will move the present joint Army-Navy research effort in impact injury prevention into advanced development. This effort is expected to give us the capability of predicting accurately the extent of human injury to be expected with specific impact forces. This reliable injury data will greatly increase our capability to include optimum safety in the structural design of aircraft and other vehicles. It also will provide the basis for much better design of safety and survival equipment attached to the individual.

Other Marine Corps advanced development systems, has a number of major projects within it in fiscal year 1970.

Tactical message distribution and voice communication equipment is expected to complete development effort for the terminal and switching equipment and the total system will be integrated. Man pack long-range transceiver service test models will be designed, fabricated and tested. The same effort is planned for the man pack tactical transceiver for fiscal year 1970.

Continued development and testing of improved ground terminals will be included in the tactical satellite communications equipment fiscal year 1970 effort and terminals will be procured to provide an interim operational capability. Development of the lightweight hostile mortar locator, the tactical electronic countermeasures system and the transportable communications countermeasures system will proceed.

The final element in this budget activity is other Marine Corps systems. These funds will support two major projects, Marine air/ground intelligence system (MAGIS) and lightweight 3-D ground controlled radar.

Funding for the lightweight 3-D radar has been provided by the Air Force in fiscal year 1968 and fiscal year 1969. In fiscal year 1970, the Marine Corps will participate financially with the Air Force as the construction phase on this radar commences.

This finishes my discussion of budget activity 7. I now turn to budget activity 8.

BUDGET ACTIVITY 8—PROGRAM-WIDE MANAGEMENT AND SUPPORT

Our request in fiscal year 1970 for this budget activity totals $151.2 million providing for the administration, operation and maintenance of those activities which support the Navy and Marine Corps R.D.T. & E. program.

In this budget activity the major factor contributing to the increase in fiscal year 1970 is an upswing in our facilities and installation support element and in the operation of AUTEC. Both of these increases result essentially from increased cost of station and facility operations. A new start in fiscal year 1970, international ocean exploration, also contributes to the overall increase. Minor changes in other programs for the remainder of the net increase in fiscal year 1970.

The first and by far the largest element under budget activity 8 is facilities and installation support which is a continuing program, funding recurring operation and maintenance, instrumentation and equipment costs, minor construction and alterations and other management costs for Navy R.D.T. & E. laboratories and facilities not directly identified with other programs. (Specifically excluded are PMR and AUTEC.) There are presently 49 activities supported by this subactivity, ranging from the Naval Weapons Center, China Lake, Calif., to the Naval Clothing and Textile Research Unit, Natick, Mass.

Some of the services performed under this element are maintenance of buildings and grounds; administration, supply and fiscal services; security and fire protection; utilities; communication; R7–D aircraft and ship support; and other programwide miscellaneous expenses not properly chargeable to individual projects in other elements.

Funds requested in fiscal year 1970 will provide for continuation of general support and will include replacement of general-purpose scientific equipment and machine tools and purchase of collateral equipment and instrumentation for initial outfitting of authorized military construction facilities projects; increased costs of personnel and materials; and higher costs of support of larger and higher performance R. & D. aircraft. This is a continuing program.

The Atlantic Undersea Test and Evaluation Center (AUTEC) is a deep-ocean, instrumented 3-dimensional R.D.T. & E. facility, consisting of three ranges (weapons, sonar, acoustic) with down-range tracking sites and main support base. It was built under a formal United States-United Kingdom agreement in the Bahamas to support R.D.T. & E. of Navy systems associated with the U.S. ASW effort.

During the past 2 years many important projects have been completed using the weapons range. In fiscal year 1969 and 1970 we will devote this range to testing of several types of weapons and systems.

The acoustic range was certified prior to the end of calendar year 1968 and sonar range development is underway with and expected completion date of fiscal year 1974.

The funds requested in fiscal year 1970 will permit operation of the AUTEC weapons and acoustic ranges and the development of the sonar range as necessary in order to meet the requirements for effective test and evaluation of new complex weapons and weapons systems.

The major effort under ASW management and technical support element is conducted under the project ASW systems support which provides for the implementation of the Naval Material Command centralized management and technical direction exercised by the man-

ager, antisubmarine warfare systems project. This is a continuing effort to ensure total system compatibility between sensors, fire control, launchers, weapons and their interconnecting equipments. In fiscal year 1970 we intend to continue with systems engineering and systems analysis for ASW platform systems, command and control, and surveillance. We will study the possible degree of commonality between surface ship and submarine sonars, and study total ASW combat systems.

Also under this element is support for ASW tactical and operational analysis. This program is devoted to rapid assessment of the changing ASW threat, the development of improved tactics and the design and conduct of exercises to obtain valid indicators of ASW force effectiveness and accurate data required for force structure decisions.

The third project, ASW intelligence support, provides support in the area of ASW intelligence collection and processing for the naval scientific and technical intelligence center (STIC). This effort has been recently expanded to include airborne acoustic intelligence gathering.

This continuing program for which we have requested funds in fiscal year 1970, provides centralized management and technical direction of the entire ASW effort under the cognizance of the Chief of Naval Material and under the direction of the Chief of Naval Operations.

The final element, and a new start in fiscal year 1970, is interagency support of international decade of ocean exploration (IDOE). This element consists of one project which will provide for establishment and operation of the national oceanographic instrumentation center to fulfill national needs in this area.

Conclusion

Mr. Chairman, this concludes my discussion of the elements of the Navy's proposed R.D.T. & E. program for fiscal year 1970. I have endeavored to recount to you something of the accomplishments of the Navy R. & D. community. I have also outlined those programs now underway and those which we would propose to undertake in the next year, all of which are directed at providing our naval force with equipment and weapons systems capable of meeting successfully the challenges confronting them.

Within the Navy and the Office of SecDef these programs have been carefully studied and weighed against our other urgent requirements. I feel that the budget before you today is an acceptable balance between these requirements and the resources available. It will provide not only for the Navy's immediate need but for those needs emerging in the near and not so near future. The President's fiscal year 1970 Navy R.D.T. & E. budget is a prudent budget and I solicit your support for it.

Mr. Sikes. Mr. Secretary, you have given us a very interesting and I think a valuable document on the Navy's R.D.T. & E. program. Obviously a great deal of work has gone into this. The committee is appreciative of your efforts and the efforts of your staff in preparing such a complete and comprehensive document.

Dr. Frosch. Thank you, Mr. Chairman.

EXPLANATION OF "BREADBOARD" AND "BRASSBOARD"

Mr. SIKES. In your statement you used the terms "breadboard" and "brassboard." What is the difference between the brassboard and the breadboard?

Dr. FROSCH. This is the difference between the kind of things the laboratory engineer might put together just to demonstrate that the principal works and the kind of thing that can be put together carefully enough so it can be flown in an airplane and demonstrate that it works in the flight environment. It is close enough to be a guide to the production engineer for design of things actually to be produced.

The names come out of a traditional sequence. Originally electronics equipment was built in laboratories on wooden boards and I suppose they started by going down to the corner store and buying a breadboard to do it and when a name was needed for the conversion from what you did on the wooden board to what you did on what you wanted to carry into the field, they called it the brassboard because that is where you stopped using a wooden base and went to the more expensive but more durable metal base, usually made out of brass.

While breadboards are now metal slabs, they are still called breadboards. It is engineering slang.

Mr. MINSHALL. How long does that go back?

Dr. FROSCH. The use of the breadboard probably goes back to the early days of radio experimentation and crystal sets when people would build them in homes or laboratories on little pieces of wood. I don't think I have seen a breadboard built on a piece of wood in quite a number of years.

CANCELLATION BY UNIVERSITIES OF MILITARY R. & D. WORK

Mr. SIKES. Accompanying the wave of student disorders which has disturbed our campuses and produced apprehension throughout the Nation, there has also been a number of cancellations or threatened cancellations by academic institutions of their scientific research which has been in progress at the behest of the Department of Defense.

I am curious to learn the effect of these cancellations or reductions in the Navy's research and development program. Are you prepared to give us an overall summary of the effects, if any, on the Navy's research and development program?

Dr. FROSCH. I think the bulk of those effects would be in the area of the Office of Naval Research. I would like Admiral Owen to comment on that aspect of it.

Admiral OWEN. Mr. Chairman, I am Admiral Owen, the Chief of Naval Research.

The effect of university unrest has been minimal as far as programs of the Office of Naval Research are concerned. We have had questions directed to us by Stanford University with regard to classified work sponsored at the applied electronics laboratory at that institution. As yet no final decision has been made by the university as to the cessation of that work. We are, however, engaging in studies related to where else we might put that work.

I might say parenthetically I was visited yesterday by the representative of the Stanford Research Institute, which is still part of the Stanford complex. The decision at Stanford has been made to

separate the research institute from the university. A considerable amount of classified work sponsored by my office and others in the Navy and the Marine Corps will continue at the Institute, I am sure, and we will be able to continue to operate effectively.

We have some modest classified contract activity at the Massachusetts Institute of Technology. That institution has not yet formally decided as to its future actions in connection with classified military research. Again we have surveyed our situation and are making our plans accordingly.

Mr. SIKES. Have any contracts actually been cancelled?

Dr. FROSCH. They have not been.

Mr. SIKES. Has the problem effected research programs now in operation to any serious degree?

Admiral OWEN. They have not, sir.

APPLIED PHYSICS LABORATORY

Mr. SIKES. The committee noted last fall that the University of Washington indicated it planned to relinquish its role as manager of the applied physics laboratory because of student criticism. What has happened in the interim period on that contract?

Mr. FROSCH. The contract continues. It came up for renewal in December. The contract was renewed pending further discussion. There have been a number of consultations between the Ordnance Systems Command and the university administration involving the laboratory. There have been some discussions involving the university, the laboratory and the university, with a committee of the State Legislature of the State of Washington. The university has suggested several alternative sponsors for the laboratory and no final decision has been made yet as to what will happen.

Mr. SIKES. This is a six-story laboratory building. Who owns the building?

Mr. FROSCH. The building is owned by the university.

Mr. SIKES. If the laboratory operations should be turned over to another institution, would it be necessary that it be relocated, moved out of the present building?

Mr. FROSCH. We believe from discussions with the university, so far, we believe in the long run that would have to be done, but the university has indicated that when we can agree on a resolution, if that resolution involves moving the laboratory, that they would be amendable to negotiating some reasonable period for the establishment of a new area for the laboratory to move into so we would not be faced with an immediate threat of having to move whether this was sensible or convenient at the time.

Mr. SIKES. What is the objection to the laboratory?

Mr. FROSCH. That is a little difficult for me to say because the statements of objection have not been completely precise.

Mr. SIKES. Isn't it just a nut fringe popping off?

Mr. FROSCH. From the newspaper articles I have seen that appears to be involved. The university administration is stating that they don't feel that the involvement of the laboratory in the university's affairs and vice versa is sufficiently entrenched so it is useful and proper for the university to continue the relationship.

We have been discussing whether, if this is the case, what they might propose as a different kind of relationship as one thing to be possibly discussed.

Mr. ANDREWS. Are you going to beg them to let you stay there?

Mr. FROSCH. No, I don't think we are going to beg them to stay there.

Mr. ANDREWS. How much are you giving them overall out of your budget?

Mr. FROSCH. We valued the laboratory very highly. It has been a major innovative organization in the torpedo business and things connected with torpedoes and torpedo countermeasures.

The amount for the laboratory in the fiscal 1970 budget would be $2.5 million.

Mr. SIKES. What would be the cost of moving?

Mr. FROSCH. We have not really looked into that in detail. I don't have precise figures for that, but usually the removal of a laboratory of that size just has a moving cost. If we assume it was moving to some place else in Seattle so there was not a great relocation of people, the moving cost would likely be several hundred thousand dollars.

Mr. SIKES. How disruptive would it be to the program?

Mr. FROSCH. It would depend on how it was done. If it was to another site in the Seattle area, and a new building became available and was prepared and before we had to move the laboratory from the old building so it could be done over a reasonable period of time, then it would not be too disruptive.

Mr. SIKES. Thank you very much.

I suggest that further questions on this subject be held first thing in the morning, after which we will have the film clip.

IMPACT OF CAMPUS DISTURBANCES ON RESEARCH WORK

Mr. LIPSCOMB. Mr. Secretary and Admiral, we have inquired about disruption of Naval Research activities for years, long before it received publicity anywhere near the degree it is now receiving. It has always appeared to me that not only the Navy, but others interested in this work have kind of pushed it under the rug and perhaps not realistically looked at the problem.

Now the Admiral answered that Navy research has not been seriously affected and the effect has been minimal. Certainly the disruptions at MIT, at Stanford, the Research Institute and all, must have caused some delay or retarded the efforts or will jeopardize the effective conduct of some work.

I think you ought to tell us all about it, exactly how you see it, so this committee can evaluate what needs to be done in the future.

We are concerned. But you can't just put it off as not being meaningful and a problem. MIT took some action yesterday which was in the paper today, about classified research. Tomorrow morning why not bring us up to date on just exactly what you see in this as a threat to Naval research in universities.

It is a problem, I believe also for the Army and for the Air Force. This has been developing over a period of years. It is worse today than it was in 1967.

The University of Pennsylvania took action 2 or 3 years ago in this regard. You have moved into Rochester, which is a new operation to you. So it has affected the Navy and there is no use just sloughing it off before the committee.

Admiral OWEN. I don't intend to slough it off.

Mr. LIPSCOMB. It appeared that way.

Admiral OWEN. I have asked my people to consider every piece of classified contract work that we have and to assess the impact of disturbance and what alternatives we might follow in the event a particular university makes a decision to close such work out.

Mr. FROSCH. We will be happy to discuss it in the morning.

WEDNESDAY, JUNE 4, 1969.

Mr. ANDREWS. The committee will come to order.

When we adjourned yesterday, the subject was Navy research contracts on campuses where we have had student unrest. The gentleman from California, who was interrogating the Secretary asked for information to be given to the committee this morning. The gentleman from California, Mr. Lipscomb.

AFFECT ON NAVY IF STUDENT UNREST INTERFERES WITH RESEARCH

Mr. LIPSCOMB. Mr. Chairman, when we closed yesterday, I believe that the witnesses indicated that the objection to military research on campuses had not affected them in any way. I think that was the substance of what was said.

Dr. FROSCH. I think the point is, if the question was asked what actual effects have we felt so far, then the effects are very small. If the question is, what worries do we have about what might happen, then I think we have a considerable number of worries about what might happen. So far the only place where there has been any real loss of work is at Stanford Applied Electronics Laboratory, which was closed down for a period of time.

There have been one or two other places where there have been days lost one way or another, but nothing very serious has yet happened. The question is, what is likely to happen or what may happen if the kind of thing that has been going on on some campuses continues. I think we have to divide the possibilities into several kinds of cases. One case is the case in which a university is operating under contract some special kind of organization which is principally or entirely Navy or DOD oriented. These are principally the Federal contract research centers. A second question is, aside from those organizations, with contractual work on campus in which individual faculty members or departments are involved. The third question of whether the work which is contracted for is in itself classified and requires security classification, or is unclassified. I think the situation is somewhat different in the three cases.

Of course, it varies a great deal among the campuses.

The situations in which we have had the most discussion and problem with regard to continuation, and where we have the most lively discussions now, are those that involved special laboratories or Federal contract research centers. The three that are under principal discussion now, and where there is some kind of problem, are Stanford, where we have a relationship with both the Stanford Research Institute and

the Stanford Applied Electronics Laboratory, the University of Washington, which was mentioned yesterday, where we have the applied physics laboratory of the university, and the Massachusetts Institute of Technology, involving some Navy work at Lincoln Laboratory, although that is principally Air Force, and more importantly, the work on the Poseidon guidance system which is being done at the instrumentation laboratory at MIT. Each of these cases is somewhat different and each appears to be handled differently by the university in question.

CONTRACT WITH MIT

MIT, for example, handled this by having the president of the university acknowledge that a number of questions had been raised about the conduct of such work at the university, which he felt were legitimate questions. So he appointed a committee which included faculty members, administrative people, trustees, and students, and asked them to lay out some recommendations for him. They spent a good deal of time looking into the subject, including coming to Washington to talk to myself and the Secretary of the Air Force and the other people in the DOD, and they have now, as you know from the newspapers, issued what is called an interim report in which they make some recommendations to the university.

I have scanned the report—it arrived in my office yesterday—and it takes a rather measured and even tone. It makes two recommendations, I think, that are of principal interest. One is that the university ought to try and do more of the kind of project work that it has done for Defense in other areas of general national and social interest. I think that is the best way to put that comment.

The other is that they feel that some aspects of the work being done at the instrumentation laboratory go beyond what a university ought to do. In particular, they are concerned about the fact that the instrumentation laboratory has taken responsibility for prototype preproduction hardware—that is, hardware that is actually to be flown and be the preproduction test material. This, they feel, goes too far.

I think this is at least a debatable point. I have some questions as to whether a university that won't carry hardware that far is in fact doing all of what it ought to do in engineering research and in teaching. They have some questions as to whether they should ever get that close to the production business.

At any rate, in that case Dr. Ruina, who is the vice president of MIT for the special laboratories, called me this morning and the principal burden of his comment was that the university takes both its contractual relationship with both the Navy and with the DO generally, viewed as a moral responsibility or requirement of the university, quite seriously. Certainly they will not respond to these suggestions on the part of their panel either unilaterally or rapidly.

They think the way to deal with this question of whether they should continue with all of the Poseidon work is for them and the Navy to sit down aid discuss the question of what is really involved, whether this is the best way to do it, and so on. I think that is a rather responsible way for them to respond.

Mr. ANDREWS. You do not know as yet whether you will have a contract with MIT next year.

Dr. FROSCH. They have said they do not propose to drop the contract. What they wish to do is merely to discuss whether some of the

past agreements on how far the work was pushed toward production are still appropriate and whether we ought to change them.

Mr. ANDREWS. What is the value of that contract, Mr. Secretary?

Dr. FROSCH. $18 million is the total R.D.T. & E., N portion of the work. That is all of the Navy work. The Poseidon part is about $9 to $10 million.

Mr. ANDREWS. But the school gets $18 million out of the Navy for research and development.

Dr. FROSCH. I would like to state that another way. I would like to state that there are contracts under which the school does $18 million worth of work for the Navy.

Mr. ANDREWS. That answers my question. They get $18 million of Navy money.

Dr. FROSCH. Yes.

Mr. ANDREWS. And it sounds like you are having to beg them to take it.

Dr. FROSCH. No. They have been delivering $18 million a year worth of work.

Mr. ANDREWS. I do not doubt that, but they are still getting $18 million of your money, and I have a little opinion you are having to beg them to take it. They have not decided whether or not they will continue to do that work.

Dr. FROSCH. Certainly.

Mr. LIPSCOMB. They will do it on their terms.

Dr. FROSCH. Mr. Lipscomb, we will do it on negotiated terms just as we do contractual work with any other entity in the United States with which we negotiate terms.

UNIVERSITIES AFFECTED BY STUDENT UNREST

Mr. ANDREWS. I wish you would have some of your men put in the record at this point a list of the universities holding Government contracts where there has been student unrest and expressed opposition to defense contracts and the amount of money involved in each contract—the total amount involved in each school.

Dr. FROSCH. I have this in front of me and we can supply it for the record. It is a long list.

Mr. ANDREWS. We would like to have it in the record at this point.

(The information follows:)

College and universities where student unrest has occurred for a variety of reasons not necessarily related to DOD involvement

University/college[1]	*R.D.T. & E.N. fiscal year 1968 obligations*
American University	42,915
Arizona State University	593,274
California State College at Los Angeles	33,792
University of California, Berkeley	2,376,648
University of California, Davis	22,851
University of California, Irvine	30,686
University of California, Los Angeles	537,977
University of California, Riverside	76,738
University of California, San Diego	1,285,000
University of California, Santa Barbara	121,617
University of California, Santa Cruz	48,423
Catholic University	1,044,185
University of Chicago	283,067

College and universities where student unrest has occurred for a variety of reasons not necessarily related to DOD involvement—Continued

University/college[1]	*R.D.T. & E.N. fiscal year 1968 obligations*
Cincinnati University	15,550
University of Colorado	1,706,484
Columbia University	2,744,938
Cornell University	327,744
Duke University	183,784
Florida State University	765,715
University of Florida	275,473
Georgetown University	12,963
George Washington University	1,026,779
University of Georgia	7,920
Harvard University	1,055,369
University of Houston	655,958
University of Illinois	1,422,166
University of Iowa	25,000
Johns Hopkins University	668,026
University of Kansas	108,083
Louisiana State University	202,247
Marquette University	5,000
University of Maryland	160,688
Massachusetts Institute of Technology	18,852,210
University of Miami	1,494,228
Michigan State University	96,155
University of Michigan	981,041
University of Minnesota	1,532,784
University of New Mexico	884,910
City University of New York	19,071
State University of New York at Buffalo	943,407
State University of New York at Stony Brook	22,622
New York University	1,195,963
North Carolina State University	25,000
University of North Carolina	52,183
Northwestern University	252,965
University of Notre Dame	685,200
Ohio State University	146,888
Oregon State University	1,888,127
University of Oregon	116,864
Pennsylvania State University	164,088
University of Pennsylvania	433,716
Pomona College	24,000
Princeton University	930,498
Purdue University	893,547
Rensselaer Polytechnic Institute	777,011
Rice University	125,000
University of Rochester	68,527
San Diego State College	4,300
University of Southern California	215,746
Stanford University	8,395,233
Temple University	53,214
University of Tennessee	490,282
Texas A. & M. University	1,469,069
Texas Christian University	33,092
University of Texas	2,925,159
Tulane University	1,207
University of Virginia	5,152
Washington State University	25,000
University of Washington	1,134,365
Wayne State University	65,000
Western Washington State College	31,325
University of Wisconsin	107,991
Yale University	208,915
Case-Western Reserve University	207,020

[1] Excludes support to Federal contract research centers.

CONCERN OVER RESEARCH BY SOME UNIVERSITIES

Mr. LIPSCOMB. Dr. Frosch, are you saying, then, that for the past year or more that the questions raised on university campuses in regards to military work, as far as the Navy is concerned, have not affected the work or the morale and attitude of the scientists and individuals doing your work?

Dr. FROSCH. As far as we can measure in terms of whether places are open and doing their work or closed, it has not affected the work directly. I think the principal way in which it has affected the morale of the scientists and engineers who are doing the work, judging from those with whom I have talked, is that it has annoyed them very greatly and in some cases they have gotten angry enough so I would not be surprised if they had worked harder and in a more annoyed way than they had before.

Mr. LIPSCOMB. As far as the Navy is concerned, you have had no difficulty whatsoever in the past year or two having universities accept classified work that may be of interest to the welfare and security of our country?

Dr. FROSCH. I cannot say we have had no difficulty whatever. I mentioned the three or four cases where we have had some discussions. We have had rumors and worries about problems at a number of universities, but I do not know any cases where work has been refused.

Mr. LIPSCOMB. Would you for the record place the names of the universities and colleges where you have concern or they have concern?

Dr. FROSCH. Yes, sir.

(The information follows:)

Stanford Research Institute.
Stanford Applied Electronics Laboratory.
Lincoln Laboratory, Massachusetts Institute of Technology.
Instrumentation Laboratory, Massachusetts Institute of Technology.
Center for Naval Analyses, University of Rochester.
Applied Physics Laboratory, University of Washington.

HUDSON LABORATORY

Mr. LIPSCOMB. What about the Hudson Laboratory at Columbia University?

Dr. FROSCH. As you know Hudson Laboratory is the place where I grew up technically. We decided to drop that laboratory entirely about a year and a half ago.

Mr. LIPSCOMB. Why?

Dr. FROSCH. For several reasons which, incidentally, antedated the actual trouble at Columbia University. It became apparent that laboratory top management wanted to change substantially the complex of the laboratory.

Mr. LIPSCOMB. What do you mean by complex?

Dr. FROSCH. There was a move to diversify in a number of directions other than those of Navy interest, and there appeared a growing reluctance to be involved in so much classified work. More important than either of these, there were changes in the general management concept of the Hudson operation which were of considerable concern to me.

The point is, that for a number of years the people in the laboratory, had wanted a much closer relationship with the university. In earlier days, the university essentially had acted as a kind of holding company for the laboratory. There was thus a long standing desire at the laboratories, to have closer integration with the university, and a long standing desire on the part of the Navy to do it. When we began to have this problem with the laboratory, I went up and discussed it with the president and the vice president of the university. It became clear to us that the university, at that point in time, had interests for the laboratory's future somewhat divergent from our need for an organization of continuing service to the Navy.

There was an additional complication, that the funding problems of keeping the lab going on that work were becoming more and more acute for the Office of Naval Research in the face of the competition from other jobs that we needed to have done. Moreover, it appeared possible for us to keep the work of greatest direct value to the Navy going in a Navy laboratory if we closed out Hudson and transferred the resources to a Navy activity.

Out of this complex of reasons we decided to drop the laboratory. I do not classify this as a case, which has been sparked by student unrest, largely because it happened before any of the real student unrest happened at the university. To what extent the university administration was concerned, about what they saw as the beginnings of possible student unrest there, I do not know.

Incidentally, when I say that there was a desire to move away from classified research, I do not mean to imply that this was at the expressed direction of the university administration. I think this was a matter of personal interests and desires.

STUDENT UNREST AFFECTS NAVY RESEARCH

Mr. LIPSCOMB. Dr. Frosch, at a place such as Hudson Laboratory at Columbia University, the question of doing governmental work and classified work is not new because of student unrest. Professors have been objecting to this for a period of 3 to 5 years. It has just been growing.

Dr. FROSCH. Some professors have been objecting for 25 years.

Mr. LIPSCOMB. It has become an issue as far as our Government work is concerned in the last 3 or 5 years.

I think you did the right thing at Hudson, but when we asked yesterday what the results were of the student unrest and other items, Hudson is a perfect example. Certainly you would not have had them doing Navy work if they had not been producing over the years.

Dr. FROSCH. That is correct.

Mr. LIPSCOMB. So when you had to close them off, you lost a certain expertise and a certain amount of work.

Dr. FROSCH. Certainly.

Mr. LIPSCOMB. Therefor it has affected you.

I think we should lay it out on the record.

I believe all of these labs have to be looked at with the same analytical viewpoint that you looked at the Hudson Laboratory at Columbia. That is why we are bringing these things up.

Student unrest, or whatever it may be called, is something that is happening and it is affecting defense research efforts. The fact is that even institutions such as the Institute of Defense Analysis is under reorganization; isn't that true, because of the objection of a university?

Dr. FROSCH. I believe it is.

Mr. LIPSCOMB. You have not mentioned this.

Dr. FROSCH. We do not have any direct Navy work with them.

Mr. LIPSCOMB. It is not something that can be swept under the rug. We have to look at it and the effects it has on R.D.T. & E. efforts. For instance, what did happen at the University of Pennsylvania? Why did you have to move the Institute of Naval Research up to Rochester?

Dr. FROSCH. This was not the University of Pennsylvania. This was the Franklin Institute in Philadelphia. That problem did not involve any students whatever. That was essentially a mutual agreement that it was not being done satisfactorily. That was a move away from a nonuniversity toward a university.

Mr. LIPSCOMB. When we lost the services of Hudson Laboratory did we lose something we have not replaced?

Dr. FROSCH. I think we have not replaced it completely. I think the principal and important pieces of work are being carried on at other Navy and Navy-associated facilities. We have probably lost some of the people from this field.

Mr. LIPSCOMB. That is all for now, Mr. Chairman.

Mr. ANDREWS. Mr. Davis, do you have any questions on this point?

Mr. DAVIS. No questions, Mr. Chairman.

CARRYOVER OF UNOBLIGATED BALANCES

Mr. ANDREWS. Mr. Secretary, the fiscal 1969 program is almost $20 million more than was appropriated for Navy R.D.T. & E. Does this mean you were able to recover almost $20 million from prior year balances?

Dr. FROSCH. I am not sure we understand that question.

(Discussion off the record.)

Mr. WARSING. We have received some transfers from the emergency fund.

Mr. ANDREWS. You can explain that in the record.

Dr. FROSCH. There are transfers from the emergency fund. There was a carryover from fiscal 1968 unobligated balances brought forward of $19.7 million available for new programs.

Mr. ANDREWS. That is what I had in mind. Do you anticipate recovering funds in fiscal 1970 in addition to those that have already been programed?

Dr. FROSCH. We would anticipate that there would be a small amount of funds recovered from the 1969 and prior years available for new programs in fiscal year 1970.

Mr. ANDREWS. I wish you would put in the record the amount you anticipate.

Dr. FORSCH. We will put in the record the predicted amount.

(The information follows:)

RECOVERIES

During the past 2 years, special effort has been directed toward recovering balances from prior year contracts to apply to the recoupment objective in fiscal year 1968 and to program deficiencies in fiscal year 1969. It is anticipated that recoveries during fiscal year 1970 will approximate $10 to $15 million.

RECOUPMENTS BY FISCAL YEAR

Mr. ANDREWS. What percent of your 1969 fiscal year program was involved in reprograming actions?

Admiral GADDIS. 4.8 percent in fiscal 1969 as of now; 6.8 in fiscal 1968, sir.

Mr. ANDREWS. Dr. Frosch, would you provide for the record the amount of recoupments by fiscal year since 1967, together with your recoupment objective, if any, for fiscal 1970.

(The information follows:)

The following table shows the amounts recovered or anticipated to be recovered from prior-year programs for application to current-year unforeseen deficiencies during the fiscal years listed.

Fiscal year:	Amount
1967	$28,468,000
1968	27,834,033
1969 (estimate)	19,735,000
1970 (estimate)	10,000,000 to 15,000,000

UNOBLIGATED BALANCES

Mr. ANDREWS. The committee notes that your unobligated balances are increasing each year. What is the explanation for this trend?

Admiral GADDIS. The unobligated balance, if I might, sir, was $230 million in 1968, $250 million in 1969 estimated, and $253 million in 1970 estimated. This actually adds up to essentially 9 percent for each year, of the total availability in the account. So I would class it as almost a stationary, stable, unobligated carryover.

Mr. ANDREWS. Does this mean the committee has been overfunding your program?

Dr. FROSCH. Mr. Andrews, this means that we are managing our prediction of obligation and the obligation management of our business to an accuracy such that we come out at the end of the year with something of the order of about 1 month's worth of funds for doing R.D.T. & E.

Mr. ANDREWS. About 9 percent over those 3 years.

Dr. FROSCH. No; each year was 9 percent of that year's availability.

Mr. ANDREWS. The committee is not complaining in the least, Mr. Secretary, about your having unexpended or unobligated balances. We want to commend you for it.

The question is, Are we overfunding your program?

Admiral RUCKNER. These are not cumulative, Mr. Andrews. This represents the length of time it takes to get the work out on the street and under contract, plus the late release of funds in some cases from the Department or Defense.

Admiral GADDIS. I would estimate that this is just about the irreducible minimum in this particular account and would note that the four years prior to the ones I noted, the carryover ranged from 12 to 19 percent. This represents a significant improvement in the unobligated carryover to what we feel is just about the irreducible minimum for this account.

UNEXPENDED BALANCES

Mr. ANDREWS. Will you provide for the record a table showing the unexpended balance at the end of each fiscal year since 1967.

(The information follows:)

Unexpended balance, end of year

Fiscal year:	*In thousands*
1967 actual	$1,336,038
1968 actual	1,205,128
1969 estimate	1,276,467
1970 estimate	1,334,967

Mr. ANDREWS. Also provide for the record the percent of now obligational authority expended in the same year it was appropriated, by fiscal year, since 1963.

(The information follows:)

Percent of new obligational authority expended in same year it was appropriated

Fiscal year:	*Percent expended*
1963	46
1964	52
1965	47
1966	46
1967	53
1968	59

Mr. ANDREWS. Will you also update the table appearing at the bottom of page 298 of last year's hearings?

(The information follows:)

ESTIMATED UNEXPENDED BALANCES, END OF YEAR

[In thousands]

Fiscal year in which funds were appropriated	Fiscal years—		
	1968	1969	1970
1962 and prior	$3,814		
1963	5,929		
1964	14,032		
1965	42,281		
1966	79,842	$28,236	
1967	260,030	70,892	$31,467
1968	799,200	226,200	85,000
1969		951,139	245,000
1970			973,500
Total	1,205,128	1,276,467	1,334,967

Mr. ANDREWS. The committee would also appreciate having for the record an update of the table appearing at the top of page 301 of last year's hearings relating to expenditures compared with budget estimates.

(The information follows:)

ACTUAL EXPENDITURES COMPARED WITH BUDGET ESTIMATES—R.D.T. & E.N. APPROPRIATION

[Dollar amounts in thousands]

Fiscal years	Total available for expenditure	Expenditures	Percent expended
1963:			
Budget estimate	$2,312,566	$1,395,000	60
Actual expenditures	2,393,030	1,429,341	60
1964:			
Budget estimate	2,552,786	1,500,000	59
Actual expenditures	2,524,664	1,577,846	63
1965:			
Budget estimate	2,468,402	1,458,000	59
Actual expenditures	2,335,071	1,293,639	55
1966:			
Budget estimate	2,321,733	1,395,000	60
Actual expenditures	2,614,992	1,406,832	54
1967:			
Budget estimate	2,955,731	1,565,000	53
Actual expenditures	3,127,138	1,791,101	57
1968:			
Budget estimate	3,320,196	1,840,000	55
Actual expenditures	3,207,754	2,002,627	62

1970 BUDGET INCREASES

Mr. ANDREWS. Dr. Frosch, you indicated at the outset of your prepared statement that the fiscal year 1970 program is an increase of about $50.4 million over the fiscal year 1969 program. You also pointed out that the Navy and OSD transferred $54.6 million of fiscal year 1970 R.D.T. & E. funds to the Navy operation and maintenance account. Does this mean your fiscal year 1970 program actually has increased $105 million over fiscal year 1969?

Dr. FROSCH. There is one additional figure that I have to check, and that is whether there were any budgetary transfers from 1969 to 1970 that went from other appropriations into R.D.T. & E. I think there were none in 1969 to 1970. If that is the case, then effectively for comparability we would be $100 million higher in 1969 terms.

Mr. ANDREWS. You can elaborate on that for the record.

(The information follows:)

INCREASE, FISCAL YEAR 1970 OVER FISCAL YEAR 1969

[In thousands of dollars]

	Fiscal year 1969	Fiscal year 1970	Difference, fiscal year 1970 over fiscal year 1969
Totals in budget document	2,161,074	2,211,500	+50,426
Less fleet support items funded in R.D.T. & E.N. in fiscal year 1969 and in O. & M. in fiscal year 1970	−57,361	.....	+57,361
Total, net of fleet support	2,103,713	2,211,500	+107,787

INCREASES RESULTING FROM INFLATION

Mr. ANDREWS. What R.D.T. & E. programs have been increased or initiated to fill the vacuum, so to speak, caused by the transfer of $54.6 million to O. & M., Navy?

Dr. FROSCH. Two comments need to be made: One, in 1970 the cost of doing 1969's amount of work will have increased in 1970 dollars because of inflation. So the increase has to be discounted by the inflationary amount.

Mr. ANDREWS. What rate of increase have you noted in your program due to inflation over the past few years?

Dr. FROSCH. This is a very difficult subject to get good statistics on. There are certainly areas in research where the inflation has been several times what the national average is. I guess my estimate would be that we are probably inflating in technical things at something like 6 percent or more.

I have seen estimates as high as 15 percent. I think those are probably exaggerated.

Mr. ANDREWS. In some areas of ship construction we were told that the rate of increase due to inflation was roughly 25 percent.

Dr. FROSCH. I was trying to give an overall average for everything. I am sure in some areas it is as high as that. In some, it is probably down with the national average or lower. I think it is clearly higher for technical things than the Bureau of Labor Statistics national average for inflation.

AWARDING OF CONTRACTS

Mr. ANDREWS. Are most of your contracts negotiated or made by competitive bidding?

Dr. FROSCH. I would have to look at detailed statistics. A very large number are made by competition among a selected list of bidders; that is, they are not open to anyone who wants to compete, but open to qualified bidders. A large number, particularly of the smaller contracts, and certainly contracts with universities and academic kinds of organizations are negotiated.

CIVILIAN EMPLOYMENT FUNDED IN R.D.T. & E. BUDGET

Mr. ANDREWS. What is the total number of civilian personnel funded directly from the Navy R.D.T. & E. budget? You can supply that for the record.

(The information follows:)

The total civilian employment (average number) reflected in the R.D.T. & E., N. personnel summary is estimated to be 33,647 for fiscal year 1970.

Mr. ANDREWS. Why are your permanent civilian employees increasing in fiscal 1970?

Mr. WARSING. Here we are speaking of the increase in the number of positions shown. This is a matter of reflecting in the personnel exhibits all positions occupied during the year. Actually, there is a reduction in the personnel of 850 man-years.

Mr. ANDREWS. In 1970 over 1969?

Mr. WARSING. Yes. There are 850 man-years less in 1970 than in 1969. But the positions listed show an increase because a position for each employee who has been on the rolls at sometime throughout the fiscal year. It must be reflected and displayed in this personnel exhibit.

Mr. ANDREWS. When you count the number on rolls it is increased but when you count man-years, it is decreased.

Mr. WARSING. That is right, sir.

Mr. ANDREWS. I wish you would put in the record a list of civilian employees for the last 5 years, the total number paid by the Navy R.D.T. & E. program.

(The information follows:)

CIVILIAN PERSONNEL (MAN-YEARS) PAID FROM THE R.D.T. & E.N. APPROPRIATION

	Fiscal year				
	1966 actual	1967 actual	1968 actual	1969 estimate	1970 estimate
Total civilian personnel at R.D.T. & E.N. installations paid from R.D.T. & E.N...	30,850	29,775	31,849	31,415	30,113
Plus personnel at R.D.T. & E.N. installations paid from reimbursements.....	+3,022	+5,677	+5,742	+9,180	+9,410
Plus personnel at other Navy facilities paid from R.D.T. & E.N.....				+1,932	+1,971
Total, direct and reimbursement paid through R.D.T. & E.N.....	33,872	35,452	37,591	42,527	41,494
Less personnel at R.D.T. & E.N installations paid from R.D.T. & E.N. via NIF...	−4,987	−4,996	−5,278	−8,030	−7,847
Total, civilian employment (average number) reflected in the R.D.T. & E.N. personnel summary.....	28,885	30,456	32,313	34,497	33,647
Comparability adjustment for transfer of personnel data between appropriations.	+2,349	+3,498	+3,486	.....	.....
Adjusted total, personnel summary.....	31,234	33,954	35,799	34,497	33,647

Mr. ANDREWS. Mr. Lipscomb.

Mr. LIPSCOMB. Do you happen to have such a list with you at the present time?

Dr. FROSCH. I have a list of 1969 and 1970, organization by organization, but not back through the years.

Mr. LIPSCOMB. What will you include in the chairman's request as civilian employees?

Dr. FROSCH. All of the civilian employees chargeable to R.D.T. & E., Navy.

Mr. ANDREWS. That was the question.

Dr. FROSCH. That would include the Office of Naval Research, and all of the R. & D. labs and the T. & E. field establishments. In the T. & E. field establishment, it would include only those personnel who are chargeable to R.D.T. & E., there being some in those establishments chargeable to other appropriations.

Mr. LIPSCOMB. You are going to include all of the civilian employees under R.D.T. & E., Government civilians paid out of R.D.T. & E. funds.

Dr. FROSCH. Yes.

CONTRACT EMPLOYEES

Mr. LIPSCOMB. Are you going to include all of the contract civilians?

Dr. FROSCH. No, I took the question as being civil service.

Mr. ANDREWS. Suppose we ask in addition to the other question that you supply for the record the total number of contract employees, if you can do it, who are employed by your contracts.

Dr. FROSCH. That I am not sure we have any way to get without a vast statistical search.

Mr. LIPSCOMB. You have most of them in your justification book for research, development, test, and evaluation.

Mrs. FERGUSON. The contract personnel are primarily those for the FCRC's only.

Dr. FROSCH. No employees paid by the commercial contractors are listed. Those are the ones we would find it most difficult to get any kind of accounting on.

Mr. LIPSCOMB. Maybe you can give us the contract civilians paid out of R.D.T. & E. Navy funds, and then you can footnote it with whatever qualifications you want.

Dr. FROSCH. The qualification is going to be that the only number we have deals with the Federal Contract Research Centers. I could conceive that we could get a number that would go with the university contracts, but I am not sure that there is any way to get a number that would go with the commercial contracts.

Mr. LIPSCOMB. You could footnote it and say this does not include——

Dr. FROSCH. We will do that, sir.

(The information follows:)

CONTRACT EMPLOYEES PAID FROM R.D.T. & E.N.[1]

	Fiscal year—				
	1966 actual	1967 actual	1968 actual	1969 estimate	1970 estimate
Contract civilians at Federal contract research centers	2,394	2,580	2,638	2,622	2,418
Contract technicians at Navy installations (primarily ranges and test facilities)	948	2,083	1,918	1,933	1,883
Total	3,342	4,663	4,556	4,555	4,301

[1] This schedule includes only those contract employees located at FCRC's and Navy installations. It does not include contract employment in colleges, universities, other nonprofit, and industrial organizations.

CONSULTANTS

Mr. LIPSCOMB. Do you have a list of persons that the Navy hires as consultants?

Dr. FROSCH. I do not have that with me now; and that is more than one list.

Many offices of the Navy will hire individual consultants for specific tasks or for a period of time. So we would have to get the lists and consolidate them.

The list I have most easily available is the list of consultants to the Secretary of the Navy and the members of the Secretariat. I do not have that with me, but I can get that.

Mr. LIPSCOMB. That would be a list of those consultants who are on a rather permanent on-call basis.

Dr. FROSCH. Yes.

These are normally people with whom there is a consulting arrangement for up to some number of days per year.

Mr. ANDREWS. Wouldn't they be included in the number of civilian employees funded by R.D.T. & E.?

Dr. FROSCH. They would be included in the average number (man-years) but not in the positions. There is a distinction apparently.

Mr. ANDREWS. But as a matter of fact, they are civilian.

Dr. FROSCH. They are employed by us, but they are not classified civil service employees nor are they employees through a contract with a commercial contractor.

They would not in any case change the number of civilian employees to an amount that would be measurable.

Mr. LIPSCOMB. Mr. Chairman, could we have a list of the consultants placed in the record at this point with the amount for fiscal year 1969?

Mr. ANDREWS. Without objection, Mr. Secretary, will you place such a list in the record?

(The information follows:)

Consultants at R. & D. activities paid from the appropriation "R.D.T. & E.N."

Ali, Abdul
Altar, William
Andreassl, John
Bageroer, Dr. Arthur
Belzer, Jack
Blementahl, Sol
Bliss, William
Bloom, Mortimer C.
Boehler, Gabriel
Bolle, Donald M.
Booth, Galt Buhler
Bozorth, Richard
Brown, Maurice V.
Brull, Maurice
Burstein, Elias
Callen, Earl
Childs, James Joseph
Cohen, Myron
Compton, W. Dale
Cortellessa, Robert
Costlaw, John D.
Culick, Fred
Daley, William J.
Daniels, Sarrington
Delani, John S.
dePain, Louis
Dickson, James
Dilliderto, Steve
Dorato, Peter
Duane, Thomas
DuBois, Arthur
Duechs, Diethelm F.
Ehrman, Joachin B.
Eisenhardt, George
Emmett, Paul Hugh
Estermann, Dr. Immannel
Evans, Robley
Farber, K. A.
Fowler, W. Beall
Gavis, Jerome
Genollo, Raymond
Glass, Alexandria
Golub, Morton
Griem, Hans R.
Gross, Fred
Guthrie, Albert N.
Hackman, Emery
Hardy, James
Hardy, James
Harris, Kent K.
Hayre, Harbbajan S.
Heckman, Harry H.
Heeger, Alan H.
Herbach, Leon
Herring, Robert A., Jr.
Hind, Alfred T., Jr.
Holt, Maurice
Hotz, Henry
Imbembo, Emil
Jackson, Clarence
Jarzynski, Jacek
Jorna, Siebe
Jen, Norman
Kaplan, Harvey
Kelly, Martin
Kern, Bernard
Klemens, Paul
Kuhel, David
Lee, Jhong S.
Lee, Richard S.
Lee, Thomas Shao-Chung
Levi, Leo
Lindgren, Allen G.
Litwin, Samuel
Livingston, Peter N.
Loeb, Leonard
Loferski, Joseph J.
Lampin, Lawrence
MacKenzie, John D.
Marsh, Dr. Henry W.
McGready, Leon J
Moeller, K.
Nash, Charles D.
Nathans, Robert
Newman, N. J.
Nicolaides, John
Nigrelli, Ross
Nowell, Peter
Noyes, Dr. Albert
Ogilvie, F. T.
Outwater, John
Page, Irving H.
Park, Robert
Pechacek, Robert E.
Penchina, Claude
Pride, Alfred
Raemer, Harold R.
Raphael, Robert B.
Reber, R. K.
Reynolds, Wallace
Richards, Paul B.
Rochester, Dudley
Rojas, Richard
Rose, Kenneth
Rosenthal, Louis
Rostoker, Norman
Rutelli, Giovanni
Sandler, Shelden S.
Sawyer, Ralph
Schade, Henry
Schilling, Donard

Schrock, Virgil E.
Schweitzer, Britt J.
Scottrum, V. E.
Seller, Kenneth
Shanny, Ramy A.
Shaw, William
Shen, Shan-Fu
Smyth, Dr. Charles P.
Snyder, Donald C.
Soules, Dr. Jack
Stakgold, Dr. Ivan
Stein, Dr. Seymour
Stevenson, James R.
Stewart, William
Stresau, Richard
Stronhagen, A. G.
Tanaka, Tomoyasu
Tang, Chung-Liang
Thomas, Donald
Tinklepaugh, James
Tschoegl, Nicholas
Tufts, Dr. Donald
Tyrees, S. Younf, Jr.
Uberall, Herbert
Upton, Morgan
VonHippel, Dr. Arthur R.
Wallace, Richard
Walsh, J. Paul
Webber, Joseph
Welden, Frederick
White, Dr. Frank M.
Williams, Arthur O., Jr.
Williams, Forman
Williams, Ross
Yodh, Gaurang Bhaskar
Zogor, Herbert

Total annual cost of 148 consultants, $247,000. The 148 individuals listed above have received appointments as consultants at Navy R.D.T. & E.. N. activities during fiscal year 1969. These appointments anticipate a period of employment ranging from 30 to as much as 130 days.

CONSULTANTS TO THE NAVY SECRETARIAT PAID FROM THE APPROPRIATION R.D.T. & E.N.

Dr. Fruno W. Augenstein
Dr. R. D. Bennett
Dr. W. R. Bennett, Jr.
Dr. Harvey Brooks
Dr. Keith A. Brueckner
Dr. Joseph Chadwick
Mr. W. J. Corcoran
Dr. E. P. Cronkite
Dr. Carl H. Eckart
Dr. Thomas G. Fox, Jr.
Dr. Martin Goland
Dr. LeVan Griffis
VADM J. T. Hayward, USN (retired)
Dr. David C. Hazen
Dr. Vrian T. Howard
Professor Vernon W. Hughes
Dr. Harry D. Huskey
Professor John D. Isaacs
Dr. A. H. Keil
Mr. Edwin Link
Professor Philip Mandel
RADM John H. McQuilkin, USN (retired)
Dr. Walter H. Munk
Professor John D. Nicolaides
Dr. W. A. Nierenberg
Dr. Jessee Orlansky
Mr. Robert Panoff
Dr. Carl Pfaffmann
Mr. Nathan E. Promisel
Dr. William R. Rambo
Dr. Joseph W. Rigney
Admiral J. S. Russell, USN (retired)
Professor Thomas C. Schelling
Dr. Frederick Seitz
Dr. W. G. Shepherd
Admiral John H. Sides, USN (retired)
Dr. Louis D. Smullin
Dean Robert D. Stout
VADM P. D. Stroop, USN (retired)
Professor Richard A. Swalin
Dr. Morris Tanenbaum
Dr. W. F. Whitmore
RADM F. S. Withington, USN (retired)

Total annual cost of 43 consultants, $35,000. Primarily these consultants serve on boards and panels of the Naval Research Advisory Committee which was established by Public Law 588, 79th Congress.

Mr. ANDREWS. Is that all?

Mr. LIPSCOMB. Yes, Mr. Chairman.

NAVY LABORATORIES

Mr. ANDREWS. How many in-house labs does the Navy have, and how may military and civilian employees are devoted to such in-house effort?

Dr. FROSCH. I want to get the precise numbers but I can give approximate numbers and we can correct them. Counting all of our laboratories and T. & E. establishments, we have 43, of which there are 15 major laboratories. The total number of personnel in R.D.T. & E. work is on the order of 37,000 people.

Mr. ANDREWS. All Navy?

Dr. FROSCH. All Navy, including 30,000 civil service and 7,000 military personnel.

Mr. ANDREWS. What is the total R.D.T. & E. effort managed by in-house laboratories, and of this amount, how much is actual in-house research work?

Dr. FROSCH. The total amount that goes to the Navy in-house R.D.T. & E. organizations for fiscal 1970 is estimated to be $784,194,000. We do not have here a breakdown of how much is spent in the organizations and how much is contracted out by them, but that I can supply for the record.

(The information follows:)

Of the $784.2 million requested for in-house organizations in fiscal year 1970, it is estimated that $164.9 million will be used for contracts in support of onstation work.

IN-HOUSE COMPARED TO TOTAL R.D.T. & E. EFFORT

Mr. ANDREWS. For the record, will you provide a table showing the trend of R.D.T. & E. in-house effort, by fiscal year, indicating the number of military and civilian personnel involved, as well as the total amount of the program for each of the last 3 fiscal years. Also show your proposed program for fiscal year 1970.

(The information follows:)

R.D.T. & E.N. TOTAL VERSUS IN-HOUSE EFFORT

[In thousands]

	Fiscal year—				
	1966 actual	1967 actual	1968 actual	1969 estimate	1970 estimate
Total R.D.T. & E.N. program	$1,582,457	$1,947,422	$1,886,250	$2,161,074	$2,211,500
Total R.D.T. & E.N. program performed by Navy installations	682,096	725,673	731,933	784,397	784,194
AVERAGE NUMBER OF PERSONNEL					
Total civilian personnel at R.D.T. & E.N. installations paid from R.D.T. & E.N.	30,850	29,775	31,849	31,415	30,113
Military personnel in R.D.T. & E.N. work	7,345	8,375	7,477	7,215	7,401

CONSOLIDATION OF NAVY LABORATORIES

Mr. ANDREWS. Last year you discussed the realignment of Navy laboratories into centers. Has there been any attempt to physically consolidate several laboratories during the past year?

Dr. FROSCH. We have announced our intention to take three Navy labs, the Navy Radiological Defense Laboratory, the Corona Laboratories of the Naval Weapons Center and the Navy Applied Science

Laboratory, and essentially put them out of existence as such. In each case this involves taking certain portions of the laboratory and transferring them to other labs, and in each case it also involves abolishing certain laboratory functions with an attendant reduction in personnel and function.

Mr. ANDREWS. You will reduce the total number of labs you have.

Dr. FROSCH. That is correct.

NAVAL RESEARCH LABORATORIES

Mr. LIPSCOMB. Mr. Chairman, I would like to ask a few questions about laboratories at this point.

Mr. ANDREWS. Mr. Lipscomb.

Mr. LIPSCOMB. Mr. Secretary, you have already discussed the Hudson Laboratory. There is no funding for the Hudson Laboratory in fiscal year 1970.

Dr. FROSCH. That is correct.

LAKEHURST NAVAL AIR TEST FACILITY

Mr. LIPSCOMB. On the Naval Air Test Facility in Lakehurst, N.J., there is a significant reduction in personnel from fiscal year 1969 to fiscal year 1970 from 400 to 254. Is there a phaseout of R.D.T. & E. taking place at Lakehurst?

That is Government civilian.

Dr. FROSCH. I was not aware of this and I would have to check back into the reason why.

(The information follows:)

The reduction in civilian personnel funded by R.D.T. & N. is due primarily to a transfer of certain fleet support items from R.D.T. & E., N to O. & M., N, The following is a summary of civilian personnel at Lakehurst.

NAVAL AIR TEST FACILITY, LAKEHURST, N.J.

	Fiscal year 1969	Fiscal year 1970	Change
R.D.T. & E.N	400	254	−146
Other appropriations	83	199	+116

Note: The net change is −30 which was a reduction required by sec. 201 of Public Law 90-364.

Mr. LIPSCOMB. There is a significant reduction in the funding also from $4.1 million in fiscal year 1969 to fiscal year 1970 funding of $1.3 million.

Dr. LAWSON. I do not have detailed analysis, but looking at the change in numbers I suspect that represents the change from carrying fleet support as an R.D.T. & E. item into the O. & M. appropriation.

Dr. FROSCH. That must be what it is.

Dr. LAWSON. This is going to wind up meaning that people may be doing the same work physically, but they will be paid out of another appropriation.

Dr. FROSCH. This is a result of the $50 million transfer from R.D.T. & E. to O. & M.

The assumption, and we can check that, is that the number of people and the work does not change, but the people who vanished from R.D.T. & E. are picked up and paid from O. & M.

Mr. LIPSCOMB. Would you explain that further for the record?

Dr. FROSCH. Yes, sir.

Mr. LIPSCOMB. Perhaps as I ask the questions about other labs the same explanation will fit in.

Admiral GADDIS. I can amplify that a little because Lakehurst is the primary station for launch and recovery tests of modifications to catapult and arresting gear aboard carriers. That specific item, the entire program, has been transferred to O. & M. funding within the Air Systems Command, sir.

Mr. LIPSCOMB. The Government civilian personnel went down. The military personnel remain the same.

Dr. FROSCH. Mr. Lipscomb, we have the data here now. Of the civil service people there, 254 at Lakehurst are paid from R.D.T. & E. from Navy and 199 are paid from other appropriations. The military personnel are all paid from the appropriation, military personnel, Navy and so we can only state how many we believe to be in R.D.T. & E. work and how many are in other work there. They do not appear as a dollar amount in this appropriation.

Mr. ANDREWS. Are all those employees engaged in research work—the civilians?

Dr. FROSCH. The work of that installation lies right on the boundary between research and development and operations; that is, they do test and evaluation work and they do work which is connected with following things that are in the fleet: Repair, maintenance, study, analysis, and recommendations for better maintenance procedures. We always have a question whether work like that should be chargeable as development or should be chargeable as operations and maintenance. Originally, a lot of that was carried in O. & M. Some years ago it was transferred over with a feeling that it ought to be carried as research and development. Now, in the course of looking again at the financing arrangements for various appropriations, the people who are responsible for making those kinds of divisions feel that some of this has to be transferred back to O. & M. because it is more properly an O. & M. charge. As far as I can tell, it is a case in which the work could be classified as either, and it is a matter of sensible budgetary arrangement.

Mr. ANDREWS. All those civilian employees work together, on the same project and in the same laboratory.

Dr. FROSCH. They work in the same installation. They may not be working on the same projects.

Admiral GADDIS. I could amplify a bit, sir. The decision relative to this transfer between the R.D.T. & E., Navy appropriation and the O. & M., Navy appropriation was a decision of the Office of Secretary of Defense to insure that the same categorization of work was applied in all three services equally. In the past few years the prior decision to carry a larger amount of this kind of support of operational programs in the research and development account has grown, contrary to the situation in other services.

The coordinated review developed a set of guidelines applicable to all services, and this functional transfer of funding support resulted.

Mr. LIPSCOMB. Mr. Secretary, if you follow your explanation this means that there has been an increase in personnel at this Naval air test facility, because you gave us 199 transferred, you have 254 programed for fiscal 1970 which is an increase of 53 over the 400 for fiscal year 1969.

Dr. FROSCH. No, the 400 you are quoting for 1969 were those chargeable to R.D.T. & E. There were an additional 83 that were chargeable to other appropriations but do not show in the R.D.T. & E. book. So the total for fiscal 1969 was 483. So there has been a transfer of whatever 199 minus 83 is between 1969 and 1970. The net total employment has gone down by 30 people because of the requirements of section 201 of Public Law 90-364.

Mr. LIPSCOMB. What would be the total comparable figures, then?

Dr. FROSCH. The totals for the entire organization in 1969 are 483 and in 1970, 453.

NAVAL MEDICAL NEUROPSYCHIATRIC UNIT

Mr. LIPSCOMB. At the Naval medical neuropsychiatric unit there is an increase of a little less than $400,000, I believe, and an increase in employees. Is this an increase in workload?

Dr. FROSCH. Yes, I think it is. That group does research work in areas having to do with, among other things, personnel psychological classification.

That is the only way I can describe it conveniently. For example, in working with the San Diego recruit training facility, they have examined the question of what kinds of incoming examinations actually act as a predictor for whether a recruit is likely to be successful on a problem, or successful in a particular class of work. One consequence of this work several years ago was a recommendation on their part that the incoming psychiatric interview be dropped on the ground that it was not as effective in predicting whether there were psychiatric problems coming in the future as some other techniques.

I believe that was carried out. They have also more recently done some work on the question of how to fit recruits in jobs not only in which they will develop the right skills but in which they are likely to be successful and happy. This is an area in which, like all manpower areas, there is a great deal of money to be made for the Navy in efficiency in the use of people.

TAIPEI NAVAL MEDICAL RESEARCH UNIT NO. 2

Mr. LIPSCOMB. Could you explain the type of work done by the Naval Medical Research Unit No. 2 in Taipei, Taiwan?

Dr. FROSCH. I can generally. It is mostly epidemiology and the study of diseases that occur in that East Asia part of the world. That is true of all of our overseas medical research units. They concentrate on disease problems that the Navy or the military in general might face in the part of the world in which they are operating.

Mr. LIPSCOMB. And the reasons for the increase; $500,000 in money, one civilian employee and 22 military personnel.

Admiral RUCKNER. At the request of the State Department we were asked to put a unit into Indonesia which is part of this particular group. It is an offshoot of this group to study an outbreak of the plague which is in the hill country around there. This is an opportunity to help the State Department in their international relations. It is also a golden opportunity for us to study the plague. They are providing the facilities and we are providing the people to study this.

Dr. FROSCH. The only comment I would add is——

Mr. LIPSCOMB. By "they" you mean the Government?

Admiral RUCKNER. The Indonesians are providing the facilities and we are providing the people.

Dr. FROSCH. One of the diseases we are having continual concern about is plague in Southeast Asia, which does crop out in that area.

CAIRO NAVAL MEDICAL RESEARCH UNIT NO. 3

Mr. LIPSCOMB. Would you explain the operations of the Naval Medical Research Unit No. 3 in Cairo, Egypt?

Dr. FROSCH. It is the same kind of operation. They have been studying Near Eastern diseases for quite a number of years. They are there again with State Department concurrence and at the invitation of the Egyptians. A useful statistic to keep in mind about why this is a good and useful operation is that during the Lebanon landing, after the first several days it is my understanding that approximately 50 percent of the troops who were landed were partly or totally incapacitated by illnesses they contracted locally. In many of these areas where we expect we might have to have a military operation there are local medical situations which we need to study. This is a relatively simple and easy way to study them.

The only other comment about the group in Cairo is that they are sufficiently acceptable to the Egyptian Government that during the last hostilities in the Near East although they left, as all American military groups left, they were invited back by the request of the local government almost immediately after the end of the hostilities. When they returned they discovered that in contradistinction to what happened to much other American property in Cairo, the Egyptian employees of the medical unit had taken extremely good care of all of the good instruments and facilities left behind, with the assistance of the Egyptian Government. So this is a case in which we are getting some important military medicine with high acceptability to the local country and with the encouragement of the State Department.

Mr. LIPSCOMB. The justification sheets indicate 86 government civilian employees paid out of R.D.T. & E. funds. Are these local nationals?

Dr. FROSCH. I do not know the precise number, but many or some of them would be local nationals.

Dr. RANEY. A very large fraction of employees in Cairo are Egyptian nationals paid with counterpart funds.

Mr. LIPSCOMB. The 86 are all U.S. employees.

Dr. RANEY. I am not sure whether they are all U.S. employees.

Dr. FROSCH. They are not all U.S. citizens. They are employees of the U.S. Government. Most are Egyptian nationals.

Dr. RANEY. In all of these units the bulk of the personnel requirement is medical technicians, people who take care of cultures and simple lab work. There is not such a heavy requirement for highly trained specialists as you might expect.

Mr. LIPSCOMB. For the record, would you put in a breakdown of the military personnel at Cairo, Egypt?

Dr. FROSCH. Certainly.

(The information follows:)

Military personnel assigned to Naval Medical Unit, Cairo, Egypt, and detachment at Adis Ababa, Ethiopia.

	Cairo	Adis Ababa
Officers	9	5
Enlisted	12	6
Total	21	11

WASHINGTON AND SAN DIEGO NAVAL LABORATORY

Mr. LIPSCOMB. The Naval Personnel, R.D.T. & E. Laboratory in Washington, D.C., shows a significant increase both in operational support and Government civilians.

Dr. FROSCH. That is the result of an organizational realignment. There was a small unit that had that title and a larger unit which was a portion of the headquarters of the Bureau of Personnel administratively. During the past year there was recommended, and I approved, a change in the status of a portion of the headquarters organization, to become a designated laboratory. In addition, due to the administrative shift there is a planned increase in the studies and work on more effective utilization of personnel.

Mr. LIPSCOMB. Is the same explanation true of the naval personnel research activity in San Diego?

Dr. FROSCH. No, the administrative portion does not apply. We are purposely trying to increase the amount of work those organizations are doing because it looks as though there is a tremendous economic payoff for the Navy in understanding how to use the people we have much better. This is an area of research that we are trying to build up.

Mr. LIPSCOMB. For the record, would you insert the activities of both of these laboratories?

Dr. FROSCH. Yes.

(The information follows:)

Naval Personnel Research and Development Laboratory, Washington, D.C.:

Mission: Plan and conduct appropriate research and exploratory development in personnel operations and related behavioral sciences for the purpose of investigating and developing new concepts and improved methods, techniques, and procedures for administration and management of personnel to enhance the utility of available manpower and potential of human factors.

Past significant accomplishments:

- Accelerated AIM equipment training procedure for SEASIA Naval Units.
- DDG protoype digital ship simulation model.
- Ship manning documents for five ship types.

Current significant programs:

- Shore manning predictive techniques.
- Programed instruction shipboard package evaluation.
- Personnel reactions to inventives, naval conditions and experiences.

Planned programs:
Evaluation of applicability of DDG prototype model to other classes.
Degredation of personnel performance due to cross assignment.
Personnel training implications of DX/DXG alternatives.
Naval personnel research actiivty, San Diego, Calif.:
Mission.—Plans and conducts research and development is personnel operations and behavioral sciences to develop new concepts and improved methods for acquiring, classifying, training, distributing, and retaining personnel and for maximizing the utilization of Navy manpower resoures.
Past significant accomplishments: Development and evaluation of:
Classification strategies using computer simulation methods.
A scale for use with strong vocational interest blank in predicting NROTC officer retention.
Performance oriented electronics technician training program.
Current significant programs:
Advancements, strength, training and attribution projection model.
Computer assisted instruction in enlisted training.
Screening, selection, classification instruments and procedures for marginal personnel.
Planned programs:
Projecting optimized personnel force structure.
Methods for training sonarmen to discriminate and use clues to classify passive sonar contacts.
Prediction of on-the-job performance.

CARDEROCK NAVAL SHIPS R. & D. CENTER

Mr. LIPSCOMB. For the Naval Ships Research and Development Center in Carderock, Md., there was a significant reduction in civilian personnel and also a $1 million reduction in operating cost. Is that a change in the work level or a reduced mission?

Dr. LAWSON. It is partly a reflection of accounting procedures.

Dr. FROSCH. It is part of the effect of cuts in personnel due to Public Law 90–364, which affected our whole personnel ceilings, and resulted in reductions that were distributed among a number of laboratories. This is also a change which comes because part of this laboratory was project funded and is now shifting to the Navy industrial fund accounting system which changes the way the people and dollars appear somewhat.

Mr. LIPSCOMB. It is hard to keep up with these things.

Dr. FROSCH. We have been trying to improve our accounting and management procedures and that calls for changes and the changes produce visible effects.

Mr. ANDREWS. Isn't that still considered a research project?

Dr. FROSCH. Yes.

Mr. ANDREWS Why shouldn't those people who work out there be paid from R.D.T. & E. funds?

Dr. FROSCH. They are

Mr. ANDREWS. I thought you said some were paid out of industrial funds.

Dr. FROSCH. Let me make a distinction. One, there have always been people there who were paid from appropriations other than R.T.D. & E. because there is work done by that installation for the ship construction appropriation and for others, so that while it is basically an R.D.T. & E. establishment, some of the people are paid by projects from other appropriations, and do not show in the installation analysis. Navy industrial fund refers to an accounting system, not an appropriation.

Mr. ANDREWS. Do you still have as much activity out there as you did 10 years ago?

Dr. FROSCH. Probably more.

Dr. LAWSON. In this area I can separate out some of the problem because I control the ceiling, the total number of onboard full-time employees. That number has changed by 15 or 20. I don't have a recent head count, but our estimated present onboard number is 3,544 and it will be in June 1970, by our present estimate, 3,503. I expect that number may actually be changed upward slightly. This does not include part-time employees not subject to ceiling counts. This is the number of people who go through the gate in the morning, no matter how they are paid.

Mr. LIPSCOMB. This justification book says for fiscal 1969 you have 2,654 Government civilians paid out of R.D.T. & E. funds. Yet you say you have roughly 3,544 onboard which makes a difference of 890.

Dr. FROSCH. You have only partial figures. That is the significance of Dr. Lawson's statement that that is the total number of people in the organization. The number you have, and in the justification books, represents the civil service personnel paid from R.T.D. & E., Navy.

Mr. LIPSCOMB. That is all I am talking about.

Dr. LAWSON. Part of the difference here is that a man may be working on a method of quieting submarine engines. He is paid from R. & D. for several years. We build the submarine. He and his group get on that program and they help build it. At that point he may very well, while doing the same work, show up in the SCN budget because he is now doing a particular thing which is funded differently. This is the reason I stress this. I can count the people going through the gate and the number may not agree with the number paid from the R.D.T. & E., Navy appropriation.

Mr. LIPSCOMB. I am sorry to take so much time on this, but laboratories are of great interest at the moment.

My question was, there are 358 fewer employees shown on the justification sheets from 1968 down to 1970 and yet if you compare 1968 to 1970, the cost for operation of those Navy installations goes up.

There is a significant increase in personnel between 1969 and 1970 and yet there is a very small increase in operating cost. I was looking for an explanation for those facts and figures that are before us. If you want to do it for the record, fine.

Dr. FROSCH. Well, let me make a comment now. There is not necessarily a direct relationship between the number of people and total dollars. The personnel costs are, of course, a portion of the work done there but they have material costs and this increase could easily be an indication that some of the material costs and some of the purchases of equipment to go with it were more expensive in the later years than in the earlier 2 years. We can give a precise reasoning for this particular case in the record.

(The information follows:)

NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER, CARDEROCK, MD.

[In thousands of dollars]

	Fiscal year 1969 estimate	Fiscal year 1970 estimate
Personnel costs paid out of R.D.T. & E.N.	32,317	31,543
Material costs paid out of R.D.T. & E.N.	17,960	17,658
Subtotal	50,277	49,201
Personnel costs paid out of other than R.D.T. & E.N. (excluding military personnel)	9,872	10,514
Material costs paid out of other than R.D.T. & E.N.	6,583	6,657
Subtotal	16,455	17,171
Military personnel appropriation	1,792	1,792
Total	68,524	68,164

PERSONNEL COST AS A PERCENT OF TOTAL BUDGET

Mr. LIPSCOMB. What would you estimate as the percentage costs for personnel in this operation?

Dr. FROSCH. In most laboratories it runs——

Mr. LIPSCOMB. Eighty-five percent?

Dr. FROSCH. Well, that's high. I was going to say something more like 65 or 70 percent, depending on what the laboratory is doing.

Now, the ships research and development center has been engaged in things which have some fairly heavy equipment purchase problems. They have been going into deep-diving submarine areas and they have had to buy some rather heavy high-pressure tanks to do almost full-scale testing with and so on. So in those cases one expects the annual expenditures to go up.

Mr. ANDREWS. Don't you have a terrific utility bill out there?

Dr. FROSCH. I would expect so.

Admiral GADDIS. On the basis of average salaries, sir, in this particular case on the record the civilian personnel costs are about half the total R. & D. costs of this laboratory.

NAVAL UNDERSEA RESEARCH AND DEVELOPMENT CENTER

Mr. LIPSCOMB. Mr. Secretary, does this justification on the Naval Undersea Warfare Center in San Diego, Calif., also include the Naval Undersea Warfare Laboratory in Pasadena?

Dr. FROSCH. I believe that includes both of the laboratories under the center. That is, it would be both the San Diego Laboratory and the Pasadena Laboratory and a couple of field installations.

Mr. LIPSCOMB. For the record, would you set out how this was determined? Indicate the division between San Diego, Pasadena and any other laboratories, so it will show how the organization is set up.

Dr. FROSCH. Yes; we will be happy to.

(The information follows:)

NAVAL UNDERSEA RESEARCH AND DEVELOPMENT CENTER—FORMERLY NAVAL UNDERSEA WARFARE CENTER, SAN DIEGO, CALIF.

	Fiscal year 1970	
	Civil service	Funds, all sources
San Diego	516	
Hawaii	38	
Point Mugu	14	
San Clemente Island	74	
Total, San Diego Laboratory	642	$22,755,000
Pasadena	628	
Long Beach	29	
Morris Dam	32	
Total, Pasadena Laboratory	689	24,455,000
Grand total, NURDC	[1] 1,331	47,210,000

[1] Civil service people paid out of R.D.T. & E.N. only: 1,148.

Mr. LIPSCOMB. Is it set up this way in the justification book, because San Diego is the command center?

Dr. FROSCH. Precisely. It is set up to cover a whole center rather than breaking down all the laboratories. The home address of the center is San Diego, as is the headquarters.

Mr. LIPSCOMB. The organization of these two laboratories is still as we have been working out for the past year?

Dr. FROSCH. Yes.

Mr. LIPSCOMB. Can you separate that out for the record?

Dr. FROSCH. We will do so.

NAVAL WEATHER RESEARCH FACILITY

Mr. LIPSCOMB. You can explain this one for the record: Naval Weather Research Facility. The funding operations go up and the personnel down again. Funding operations for fiscal year 1970 are significantly greater than 1969.

(The information follows:)

Personnel: Reduction in manpower in accordance with section 201 of Public Law 90-364 (reduction of civilian manpower to 1966 level).

Funding: Programs increased from fiscal year 1969 to fiscal year 1970:

(*a*) Lease of a larger scale computer during fiscal year 1969 have an impact on fiscal year 1970 costs.

(*b*) Category II funds were issued to Norfolk in the latter part of fiscal year 1969 for commercial procurement of studies for the "Critical characteristics of air environment," funds for this program are being increased in fiscal year 1970.

(*c*) Both of the above programs are not related to personnel support.

NOTE.—Subsequent to the congressional submission, an additional $201,000 fiscal year 1969 R. & D. funds (to support the above requirements) have been granted to Naval Weather Research Facility. These additional funds bring the total R. & D. funds for fiscal year 1969 to $761,000 in lieu of the $560,000 estimated in the congressional budget.

LOS ANGELES NAVAL SPACE SYSTEM ACTIVITY

The Navy space system activity in Los Angeles, Calif., has a one-quarter of a million dollars increase in the operation. The civilian employees remain the same. Is there a change in the mission?

Dr. FROSCH. This is essentially a Navy office attached to an Air Force installation. The funds are transferred to the Navy office to cover work the Air Force installation does for us; the Navy office is essentially a liaison office that stays the same size, roughly, no matter how much work we buy from the Air Force installation. In a sense, this is a Navy installation that handles the transfer of funds to the Air Force, and the control of those funds.

Mr. LIPSCOMB. What requires a quarter of a million dollars increase?

Dr. FROSCH. Because we have just begun to work on a program I mentioned in my statement. That is, the development of a ——— which is eventually to turn into, we hope ———. We have just gotten to the status where hardware work is to be begun.

Mr. LIPSCOMB. Thank you, Mr. Chairman.

QUESTIONABLE LEASING OF AIRCRAFT

Mr. ANDREWS. Mr. Secretary, the committee understands that the Office of Naval Research is seeking firms capable of supplying air support for so-called air-sea interaction projects. Reportedly, ONR is looking for a small, twin-engine aircraft to be available at Hyde Field, Clinton, Md. What is the background of this requirement and what is the estimated cost per year for this effort?

Admiral OWEN. The Office of Naval Research advertised to determine interest for providing that capability. The Office of Naval Research is carrying out a program of studying the sea surface ———. We are hunting for a small aircraft that can carry instrumentation at a reasonable cost to allow us to make studies that are pertinent to oceanography and antisubmarine warfare. The estimated cost if we choose to go ahead with this work, is about $10,000 a year, sir, and this would provide approximately 200 hours of flight time.

Mr. ANDREWS. How much leasing have you done of aircraft in the last few years?

Admiral OWEN. Very little, sir. We figure that an economy can be realized by leasing in this case because an expensive large Navy aircraft is not required.

Mr. ANDREWS. Why is it that the Navy does not have an aircraft in the inventory to meet this mission?

Admiral OWEN. Sir, there are aircraft in the inventory that will carry the instrumentation. However, we felt it would be an overall economy to the Government in flight hours by using a small aircraft where extreme long-range and load-carrying capability are not required.

Mr. ANDREWS. How many planes do you have in mind?

Admiral OWEN. One plane, sir. I am sorry. We have expressions of interest from about 10 companies. We have not made a decision, first of all, to go ahead with the work, nor have we made any selection of contractor.

Mr. ANDREWS. What do you plan to do, just lease a small plane?

Admiral OWEN. Yes, sir.

Mr. ANDREWS. Would you work on the plane?

Admiral OWEN. We would install simple equipment. We estimate the cost would be about $55 a flight hour. At 200 hours, roughly, $10,000 or $11,000 for the total experiments that we wish to conduct.

Mr. ANDREWS. Who would man the plane?

Admiral OWEN. A civilian pilot, sir. We would have naval civilian personnel riding in the aircraft to watch over the instrumentation.

Mr. ANDREWS. And you still think it would be better to lease it?

Admiral OWEN. For this small task we feel so, sir.

Mr. LIPSCOMB. What kind of an aircraft?

Admiral OWEN. A single-engine light airplane, a Cessna-type, a Piper type, that will reach out over Chesapeake Bay and reach out over the immediate areas of the Atlantic, sir.

Mr. LIPSCOMB. The justification said a small twin-engine aircraft.

Admiral OWEN. Yes, sir. We are hunting for a light aircraft and, as I recall, our requirements are for a single-engine aircraft or a small twin-engine aircraft. The main thing we want to make sure is that it has durability enough to fly out and fly back.

Mr. ANDREWS. Has the Navy ever leased any planes before?

Admiral OWEN. Yes, sir.

Mr. ANDREWS. For naval work?

Admiral OWEN. Yes, sir. The Naval Research Laboratory for similar work some years ago, to study phenomena associated with the water surface ——— has leased small aircraft carrying somewhat similar instrumentation.

Admiral GADDIS. In 1968, sir, we also leased three Sabreliners for jet transport service in the Pacific with option to buy in 1969. This is known as the VT–39 Echo aircraft.

Mr. ANDREWS. Would you plan this lease for a long length of time?

Admiral OWEN. 200 hours of flight time.

Mr. ANDREWS. Over what period?

Admiral OWEN. Probably a year, sir.

Mr. ANDREWS. And you would have no further need for it?

Admiral OWEN. No, sir.

Sir, we are buying flight hours, sir, of a small airplane.

Mr. ANDREWS. But the ownership of the plane will remain with the contractor?

Admiral OWEN. Yes, sir.

Mr. ANDREWS. Now, you will put some expensive electronic gadgets on that plane. What happens to those instruments you put on that plane at the end of your lease?

Admiral OWEN. We will take them off, sir.

Mr. RHODES. Mr. Chairman, it is too small an item to spend this much time on, I guess, but doesn't the Army and the Air Force have planes like this just literally coming out of their ears? Isn't it possible to get a loan from one of the other services if the Navy doesn't have this type aircraft?

Dr. FROSCH. It is not just getting the airplane; it is an airplane and a pilot so we don't use a military pilot to carry a few experiments over the bay.

Mr. RHODES. There are a lot of Reserve pilots around, but also the Army has all sorts of pilots who are somewhat skilled in this type of

flying. We pay their salaries anyway. I just don't understand the rationale of it.

Admiral OWEN. There is a requirement that we fly under certain stated conditions of the sea, sunlight, and so forth, so the flight has to be performed at our option rather than at the convenience of another organization or another man.

Mr. RHODES. That statement really throws me. It seems that a few years ago the Congress passed a bill to unify the armed services and now you are saying it isn't possible for you to get an airplane and a pilot from the Army that will fly at the times and in the ways you want them to fly because of an inflexibility of command. Is this what you are telling us?

Mr. ANDREWS. And to fly the smallest, simplest plane.

Mr. RHODES. I never heard of such a thing.

Dr. FROSCH. I believe if we look in detail at the cost we will find that the cost to the Government there would be greater than the cost of the Government to go to a commercial outfit for that kind of flight hours. It is also the case that I am not——

Mr. RHODES. Maybe we better junk the Navy Air Force and the Army Air Force and go to civilians.

Dr. FROSCH. The point is, the Army is not set up to be an occasional charter service for 0–1 aircraft and I am not sure whether they, in fact, have the surplus that you refer to, the surplus of 0–1 aircraft in this area, considering that they are used as FAC in Vietnam, or in training for that.

Mr. ANDREWS. You need one plane and one pilot?

Dr. FROSCH. Part time.

Mr. ANDREWS. You are telling the committee you can't find that plane and that pilot for part-time duty?

Dr. FROSCH. No; I think we are not telling the committee that.

Mr. ANDREWS. That is what I gather.

Dr. FROSCH. What we are telling the committee is something much simpler, that for 200 flight-hours for a total cost of $10,000, the estimate indicates that it is as cheap or cheaper to go outside and, for an item of that amount, it doesn't seem sensible for us to generate a tremendous administrative problem which it would be to make arrangements to have a pilot and a military operational plane available whenever we want it. This is a service we can more easily buy for a few hours on the commercial market.

Mr. ANDREWS. Now, if you follow this thought on through, you might wind up with a lot of contracted services; contracts to fly officers to make speeches, and so forth.

Dr. FROSCH. I think not. This is a peculiar requirement for one airplane for a short period of time. It is not a requirement which can be efficiently melded in with a lot of other similar requirements to become a service matter. The transportation of people in the military is a case in which there is a large number of similar requirements that come up every day. That case is amenable to owning a force of pilots and airplanes to do this so as to schedule the results; this case is singular.

VIETNAM LABORATORY ASSISTANCE PROGRAM

Mr. ANDREWS. You mentioned initiation in November 1966 of the Vietnam laboratory assistance program to meet immediate Southeast Asia needs. How much have we devoted to this program by fiscal year?

You can put that in the record.

(The information follows:)

VLAP funding

[In thousands]

Fiscal year 1967	$402
Fiscal year 1968	5,731
Fiscal year 1969	6,282

Mr. ANDREWS. How much is in the fiscal year 1970 budget for the program?

Dr. LAWSON. The fiscal year 1970 budget includes $4,810,000 for the VLAP program.

Mr. ANDREWS. Do you believe the accomplishments to date have been worth the cost of the program?

Dr. LAWSON. Yes.

Mr. ANDREWS. Tell us briefly what you have accomplished.

Dr. LAWSON. The program has accomplished two somewhat different things. I will talk about them separately. It has accomplished quick fixes of equipment in the field, which were recognized by the operators, but not of sufficient magnitude to cause a major perturbation in the Navy's system.

Mr. ANDREWS. Such as what?

Dr. LAWSON. There was a question of protecting the operators of small boats from the effect of a mine detonated under the boat. The bottom of the boat comes up at them very fast and breaks their legs. To do this properly, one would design the hull of the boat somewhat differently. The VLAP people were able to find first a ——— material and later an ——— material and have it in the field within a matter of a month or two. It provided enough cushioning to save a man's leg.

Mr. ANDREWS. You don't think that could have been done without your laboratory?

Dr. FROSCH. It wasn't.

Dr. LAWSON. It wasn't, sir.

Dr. FROSCH. The problem existed for a period of time and there were messages going back and forth. When we got the laboratory people on it, they were able to do something about it instantly.

Dr. LAWSON. One difficulty is that the operator in the field may be too close to the problem.

Mr. SIKES. This is a matter of the objectivity of the people. The laboratory technicians knew what they were trying to do but presumably this is something that any smart repairman or mechanic could have done if he had thought about it. Is that about the size of it?

Admiral GADDIS. Yes, sir.

Dr. FROSCH. I think that is roughly right and what we are providing are technically trained laboratory people who can get assistance directly from their laboratories when they need it and when they see a problem. It seems to work very satisfactorily.

Mr. SIKES. It sounds like a good thought. How many people are involved and for what period of time are they in Vietnam, at whatever location they are assigned?

Dr. LAWSON. We keep about 11 out there. There are normally about 11 out there, nine with the Commander Naval Forces Vietnam, and two up at Da Nang with the Marines.

We have sent about 60-odd people through there on 4-month tours.

Mr. ANDREWS. Are they civilians?

Dr. LAWSON. Yes, sir.

Mr. SIKES. You only gave us one example. I think it would be well to have more for the record.

Dr. FROSCH. I can give several now.

A rather simple technical problem to someone who understood what was required and solved the problem suitably was simply to make an underwater detection device which could be used to keep track of areas in the rivers where Vietcong were expected to cross and the solution was a simple hydrophone, wire, and detector arrangement.

It is the kind of thing that can most easily be done by somebody who is an engineer and understands the accoustics. It was done that way.

There was a problem of producing quickly an illumination system for the underside and underwater portions around docks. That is really a kind of fancy electrician's job or electrical engineering job where you want a technical man who understands the problem who can assemble the things quickly and do it.

We have been able to provide that kind of thing.

Another example, which is a little more elaborate, is the provision, on a rapid basis, of some low light level television capabilities for particular use in a ———. There was a kind of a field experiment in which the TV was ——— so that we could very rapidly provide the ——— capability for special purposes.

We can give many other examples for the record.

Mr. ANDREWS. Put them in the record, Doctor.

(The information follows:)

Other accomplishments of the VLAP program are:

(*a*) Computer systems were constructed and software was developed for rapid computation of ballistic corrections and calculation necessary to establish real-time, accurate, continuous navigation fixes for U.S.S. *New Jersey* (BB 62).

(*b*) Fuzes to improve foliage penetration were developed.

(*c*) Modifications were designed and tested to improve small craft mobility in weed-infested waters.

(*d*) A quiet gasoline outboard motor has been developed and evaluated for use on PBR's for auxiliary power and propulsion during quiet patrol.

(*e*) A sensor system for remote detection of clandestine river crossings by small boats has been developed.

(*f*) A jungle trail surveillance device to detect armed personnel and alert a remote monitoring station has been developed.

R. & D. RELATED TO VIETNAM WAR

Mr. ANDREWS. Now, will you provide for the record a table showing by fiscal year since 1964 the trend in research and development directly related to the war in Vietnam. Also show the percentage of the R.D.T. & E. budget and include the estimate for fiscal year 1970.

Dr. FROSCH. Yes, sir.

(The information follows:)

Year	Total R.D.T. & E.N.	Southeast Asia	Percent
1964	$1,565.2	$38.0	2.4
1965	1,423.4	88.0	6.2
1966	1,582 5	177.7	11.2
1967	1,947.4	251.7	12.9
1968	1,886.2	325.2	17.3
1969	2,161.1	298.9	13.8
1970	2,211.5	193.8	8.7

FILM ON NEW R. & D. DEVELOPMENTS

Mr. ANDREWS. Now, I believe you have a film you want to show the committee.

Dr. FROSCH. We have a collection of film clips.

Mr. ANDREWS. You may proceed with the film at this time.

Dr. FROSCH. This shows the weapon I mentioned cleaning jungle growth for, among other things, helicopter landing zones.

That shows how it is used and the results in cleaning brush.

It clears a landing zone. It also makes sure the area is cleared of mines.

This is a riverboat mounted fire weapon which makes it possible for the boat to force the Vietcong along the banks of the rivers to stay much further back than they were normally accustomed to doing.

This was partly an improvisation that later turned into a real weapon in the field. It pushes the Vietcong back and forces them to fire from a longer range and use much more ammunition. It has been very useful in that kind of an operation.

This is a shot of the Helo-Trap Weapon. ———.

This is the EA–6B, showing the first simplified mockup that was made by modifying an A–6A.

Here is another view of it. You can see where the modification was made to turn it into a four-place version so there can be three electronic countermeasures electronic warfare operators.

By using pods for the equipment, we can change the various equipment.

This is part of a testing program to see what the operating factors of a light helicopter might be on destroyer-size ships. We are considering the use, as I mentioned in the statement, of a light helicopter for many purposes, including replenishment, ASW and so on, on small ships. This is an experiment with an available type of helicopter to see what the operator requirements and problems might be.

There are some special problems in operating them on these ships, both because of the deck motion and the size of the obstructions. We have known for years we can land helicopters and take them off as an occasional matter. The question is whether we can really produce a helicopter to do this:

Mr. SIKES. This is not new, is it, the question of landing helicopters?

Dr. FROSCH. The question is whether we could make it a continual type of operation.

This is a simulator for the ———. We are using a standard U.S. drone flown from a small boat which is mocked up for radar simula-

tion, using both the boat and the drone as targets for our 3T and Standard Missiles

That is a drone being dropped from an aircraft. It will be used as a simulator.

This is the surface launch of the same kind of missile with a supersonic profile.

This is a gunnery target which is used for the same purpose.

Here is a launcher for the Phoenix missile. We have had a very good success rate in the launch of this missile.

This is from the target viewpoint. This is a photo taken out of the wing of the target.

This is a standard missile firing against a ——— simulation boat. Here is the Standard Missile being fired.

Mr. SIKES. What is the range of the Standard Missile?

Dr. FROSCH. There are two versions. One is ——— miles and one has an extra boost, which is ——— miles.

This is the camera on the target and you see the missiles coming right through.

Admiral RUCKER. You can only do that within the radar horizon.

Dr. FROSCH. This is a drop of the Condor without the motor. As I mentioned, we are having some motor problems, but we have solved all of the problems associated with the ——— and so on.

This is what the Condor operator in the aircraft sees: and he is now scanning around. He has found the road and he is running the Condor's optical viewer up the road and he sees the target—you can see the white dot, which is the target complex—and as he moves the tracking dot to the desired aim point the Condor flies into the target and you see he is now attempting to keep the target centered right in the middle of the tracking gate cross-hatching.

If I remember correctly, this was from ——— feet at ——— miles range, the plane has now turned from its launch position and it is going away; the operator in the plane is watching his Condor go all the way into the target. Now, he has ———.

Now he has found the aim point he desires. ———.

As you can see, it continues locked on. So this is essentially like a ——— in the automatic tracking phase. However, and of great importance, Condor ———.

Now, the target complex has resolved into a collection of trailers and it appears that in this lock-on he is locked on the end trailer and, as you see, it takes the corner off the trailer. This shows it coming in in slow motion and knocking the corner off that trailer.

In a later shot, of which I don't think we have a film clip here, at the last minute the operator moved the aim for the second trailer in and it went right into the lower left corner of the trailer in the same target complex.

So we now have a weapon which, when we have fixed the motor problem, will have a ——— mile range with that kind of controllable accuracy.

This is a launch of the basic point defense Sea Sparrow missile which we are developing for short-range protection of ships of various sizes.

Now, this is part of a new launching mechanism arrangement which enables us to package the missiles for a long period of time in the

launcher without worrying about weather. The missile simply breaks the door on the way-out and we don't need a door-opening mechanism.

This is a Shrike launch and that is its effectiveness against a target which ———.

This is a stop-action picture of the same thing. The missile is fuzed so that when it reaches the optimum position relative to the ———.

Now, the Shrike, of course ———.

This is Standard Arm, which has such a capability to a limited extent.

To launch Shrike, ———.

The Standard ARM, can be launched and ———.

This is the world's largest hydrofoil. It is now hullborne. It is 310 tons and now this is a picture of it flying, which it can do at 40 knots. I am happy to say I have been out and have flown this vessel. The main thing I can report from that is that, at any rate in relatively calm water, it is remarkably easy to fly. There was no hesitation to have a complete amateur like me in the pilot seat.

This is one that is operationally assigned to the First Fleet for operational test and evaluation.

I have been on this boat doing 40 knots in a sea state such that the swells were up to 10 and 12 feet and it makes a remarkably smooth and fast ride.

This is a new firefighting system which is a mix of chemical materials with water for fighting gasoline fires. This is now deployed, at least in an interim arrangement, on board our carriers.

Mr. ANDREWS. What is that chemical?

Dr. FROSCH. It is a mixture of two chemicals. Potassium bicarbonate and a special polymer dissolved in water.

This will be a demonstration of what is called light water which is designed for gasoline fires. It is an additive to the water so that the water doesn't just float the gasoline up and away with the flame, but the water actually floats on top of the gasoline and cools the flame down. It is lighter than the gasoline, thus "light water."

This is for getting at a fire in a hurry. As you see, it makes it possible to pull a pilot out or to get at the inside of an aircraft under situations where we would have no such capability.

This is the lightweight gun firing test. There are no personnel in the mount. There are a couple of loaders below the mount. We have reduced the number of men required for this type of gun ——— which could require in the past up to 16. This will go probably on the DD963-class. It also has a smaller silhouette and it is lighter in deckload.

This is the 5-inch 54, which is firing.

This is a demonstration of the effect of ZAP ———.

This has to fly at something over ——— and these were initial burning experiments.

This is Deneye ———.

This is a full-sized warhead of the same mine in a test space.

This is TOW, a heavy assault antitank weapon, which is included here because it is a weapon in which the Marine Corps is interested. It is Army-developed.

Mr. ANDREWS. Is that an antitank gun?

Dr. FROSCH. It is basically antitank-antimaterial. This is a shot against simulated bunkers. It is a small rocket.

Admiral GADDIS. It is around a 6-inch missile.

Dr. FROSCH. This is the LVTPX-12, the Marine amphibian personnel carrier.

Mr. LIPSCOMB. Didn't you show that picture last year?

Dr. FROSCH. It is possible but I don't think so. I think we showed a test of the marginal terrain vehicle (MTV).

Mr. LIPSCOMB. It was something in Florida.

Admiral RUCKNER. That was the one on the air rollers that we showed last year.

Dr. FROSCH. This is a simulation of what the operation of the deep submergence rescue vehicle would be like. It would come from a mother sub, go down, make a landing and connect to a hatch on the downed sub. Then the people would transfer through a sealed hatch arrangement. This is a simulation of how it would put a cable down, grasp the hatch, winch itself down, do a mating operation and then equalize pressure. The people climb up into it and then it can go back and mate with a submarine or a surface ship.

Mr. ANDREWS. That is something you have needed for years.

Dr. FROSCH. These are some things that have been done on electronics systems for self-destruct. We have been using them in aircraft that fly over enemy territory. They are now being used for some of the kinds of intelligence equipment that presented a problem with the Pueblo. Simple detonation arrangements completely destroy the insides of the electronics. We are looking at the best present assortment of devices.

This is a circuit board which is in itself a pyrotechnic so when you ignite the board it destroys itself. It is not too easy to light off. You can't do it with a match. You need a proper igniter.

Here is a proposed arrangement in which a safe is a destruction container for its contents. It takes about 15 or 20 minutes to do it. It does evolve some smoke, but no flame comes out. It could be used on shipboard in place where it could be vented.

As you see, it does a thorough job on whatever was inside.

That is the end of the film clip.

DEEP-SUBMERGENCE RESCUE VEHICLE

Mr. ANDREWS. I wanted to ask you a question about that deep-submergence rescue vehicle. How are you progressing with that?

Dr. FROSCH. We now have under construction the first actual one. The portions of it, the pressure chambers, and so on, have been tested and it is now being assembled and coming along very satisfactorily.

Mr. SIKES. When will it be operational?

Admiral GADDIS. It goes into operational test this fall, sir. The second one, DSRV-2, is also under construction as a procurement operation; the first one is purely research and development.

Mr. SIKES. It is intended to give rescue capability at what depth?

Dr. FROSCH. Up to 3,500 feet.

Mr. SIKES. That compares with what present rescue capability?

Admiral GADDIS. 850 feet has been given by some of the experts.

Dr. FROSCH. There is a self-escape capability.

MARGINAL TERRAIN VEHICLE

Mr. LIPSCOMB. Mr. Secretary, that vehicle you showed last year was a marginal terrain vehicle. Is this the same one?

Dr. FROSCH. No, this is not the same one. The one we just showed is the amphibious assault vehicle, the LVTPX–12.

Mr. LIPSCOMB. What happened to the MTV?

Dr. FROSCH. It is still in development.

Mr. LIPSCOMB. Do they have a different mission? What is the difference?

Admiral GADDIS. The amphibian vehicle (LVTPX–12), sir, for the Marines, is their primary assault landing vehicle. It is a replacement for their LVTP–5, which is the standard vehicle now, and the first procurement is requested in the 1970 budget in procurement, Marine Corps, sir. The marginal terrain vehicle you saw last year is a logistic support vehicle.

Dr. FROSCH. The MTV is in an earlier stage of development not ready for production.

Mr. LIPSCOMB. Would you put the specifications in the record for the vehicle shown, the LVTPX–12?

Dr. FROSCH. Yes; I will also include the characteristics for the LVTP–5, which the LVTPX–12 will replace, and the MTV.

Mr. LIPSCOMB. The vehicle shown goes on land and water both, I take it?

Admiral GADDIS. Yes.

(The information follows:)

	LVTP-5	LVTP-12	MTV
Length	29 ft. 8 in	26 ft	20 ft. 1 in.
Width	11 ft. 8 in	10 ft. 6 in. maximum	9 ft. 2 in.
Height	9 ft. 7 in	9 ft. 9 in. maximum	7 ft. 3 in.
Gross weight	81,780 lbs	48,500 lbs	11,700 lbs.
Power	810-horsepower gasoline	400-horsepower diesel	160 horsepower gas.
Troops	34 (2.2 sq. ft. per man)	25 (3.55 sq. ft. per man)	14.
Cargo	12,000 lbs	10,000 lbs	3,000 lbs.
Speed:			
Water (miles per hour)	6.8	8.4	7.
Land (miles per hour)	30	40	35.
Water	Track	Water jet	Wide track tire.

Dr. LIPSCOMB. The one you showed us last year was 7 miles per hour in water and 35 miles per hour on land.

Mr. FROSCH. That is the MTV. It is a lighter vehicle in the sense of weight of armor and ammunition load and one we are not as sure of and are not ready to put into production. It is a marginal terrain vehicle for use on shore, if we adopt it.

Mr. LIPSCOMB. If you adopt the MTV?

Dr. FROSCH. If we adopt the MTV.

Mr. LIPSCOMB. You didn't go into production in 1969?

Dr. FROSCH. No.

Mr. LIPSCOMB. You said last year that in 1969 deliveries of a unique amphibious vehicle will come in.

Dr. FROSCH. That is the LVTPX–12.

Mr. LIPSCOMB. MTV. I am reading from your testimony last year. "Through otherwise impassible terrain such as the swamps of Viet-

nam. It has a watertight hull and utilizes the air roll principle in the track system."

Dr. FROSCH. It is not intended to be part of an amphibious landing group coming ashore from a ship, but is intended to be used in marginal terrain ashore.

Mr. LIPSCOMB. Did deliveries come in for 1969?

Colonel MCNEIL. No deliveries. There has been some difficulty in the development of the MTV; engineering difficulties.

Mr. LIPSCOMB. Is there money in the budget for that one this year?

Dr. FROSCH. There are no R. & D. funds for it.

Mr. LIPSCOMB Production funds?

Colonel MCNEIL There are Marine Corps production funds available had the development of the vehicle proceeded on schedule.

Mr. LIPSCOMB. Why isn't there any R.D.T. & E. money if you have problems?

Colonel MCNEIL. All the money required for the R.D.T. & E. though the current year is in the program. It is not known at this time if additional R.D.T. & E. funds will be required.

Mr. LIPSCOMB. Is it out for bid or anything like that?

Colonel MCNEIL. The Pacific Car & Foundry has it if we intend to go into production. We haven't decided it is a successful vehicle.

Mr. LIPSCOMB. There is a request for production funds?

Colonel MCNEIL. There is money set aside for production.

Mr. LIPSCOMB. Do you happen to know offhand how many and what amounts?

Colonel MCNEIL. Marginal terrain vehicle.

I would have to supply that for the record. I don't know it offhand.

Mr. LIPSCOMB. If you would, please.

(The information follows:)

Colonel MCNEIL. $9.9 million in fiscal year 1967 PMC funds were committed to procure a quantity of 200 marginal terrain vehicles (XM759's). Mechanical and structural failure resulted in delays in the development program, however, and the requirement to continue to support SEA with a marginal terrain vehicle led to the withdrawal of production moneys from the XM759 program. These funds were then utilized to provide modification kits and purchase ——— M116's and ——— M733's which will give the Marine Corps an interim MTV capability. At this time there are no production dollars in the PMC budget for the marginal terrain vehicle (XM759).

Mr. ANDREWS. The committee will stand adjourned until 2 o'clock.

(AFTERNOON SESSION)

Mr. ANDREWS. The committee will come to order.

Now we will discuss Federal contract research centers.

FEDERAL CONTRACT RESEARCH CENTERS

Mr. ANDREWS. As you know, the committee has been vitally interested in past years with your Federal contract research centers. Will you provide for the record a table showing FCRC support, by appropriation, for the past 3 fiscal years?

(The information follows:)

FEDERAL CONTRACT RESEARCH CENTERS

[in thousands of dollars]

Appropriation	Fiscal year 1967	Fiscal year 1968	Fiscal year 1969
Research, development, test and evaluation, Navy	51,109	49,215	57,452
Ship construction, Navy	4,530	4,277	632
Procurement of aircraft and missiles, Navy	4,100	1,306	1,456
Operation and maintenance, Navy	7,475	10,968	10,020
Other procurement, Navy	58	1,972	2,100
Total	67,272	67,738	71,660

Mr. ANDREWS. How much is in the fiscal year 1970 Navy budget, by appropriation, for FCRC support?

(The information follows:)

Federal contract research centers

[In thousands of dollars]

Appropriation	*Fiscal year 1970*
Research, development, test and evaluation, Navy	$55,851
Ship construction, Navy	350
Procurement of aircraft and missiles, Navy	150
Operation and maintenance, Navy	12,215
Other procurement, Navy	3,180
Total	71,746

UNIVERSITY OF ROCHESTER CONTRACT

Mr. ANDREWS. After termination of the Center for Naval Analyses contract with the Franklin Institute, you turned to the University of Rochester. It would appear that because of the change, the University of Rochester would have to make an austere start; however, the fiscal year 1969 program actually increased over 1968, and in fiscal year 1970 it amounts to $8.5 million, an increase over fiscal year 1969. What is the explanation for this?

Dr. FROSCH. What we were able to arrange was to take the existing Center for Naval Analyses organization, which, when it was under the Franklin Institute, was in fact a separate entity with quarters in Rosslyn and a separate staff, and transfer that as an existing organization to the University of Rochester. Rochester assumed the leases of all of the property and the payroll, and took it over as an operating organization. They were thus able to begin work with it immediately, and over the course of the ensuing year they have gradually made the changes in personnel and operation and organization which we hoped they would make. But there was no destruction of organization and the beginnings of construction of a new organization. That was part of the arrangement, a three-way arrangement, that we worked out among Franklin, the Navy, and the University of Rochester.

Mr. ANDREWS. Were all of the personnel with the Center for Naval Analyses in Philadelphia transferred to Rochester or did the University of Rochester have to recruit?

Dr. FROSCH. The personnel were not in Philadelphia. They were in fact in Washington. Most of them transferred. Some left immediately

and there was some immediate recruiting by Rochester. There has been some turnover, particularly in the senior personnel, and this was purposeful. We had hoped for some turnover there that has taken place and we are very satisfied with the new people we have.

Mr. ANDREWS. How does the number of personnel staffing in the new CNA compare with the Philadelphia staffing?

Dr. FROSCH. The staffing under Rochester is about the same as the staffing was under Philadelphia.

Mr. ANDREWS. Put the numbers in the record, if you will, at this point.

Dr. FROSCH. The total number is 463 as of December 1968. I believe that is about the same as it was previously. We will put the precise numbers in the record.

(The information follows:)

A comparison of the personnel numbers at the time CNA was under the Franklin Institute in fiscal year 1967 with the current level follows:

Average number:

Fiscal year 1967	447
Fiscal year 1968	458
Fiscal year 1969	454

Mr. ANDREWS. How has the new relationship worked out?

Dr. FROSCH. It has worked out very well.

As you know, we made the change because we were concerned, and the Office of the Chief of Naval Operations was concerned, about the way the quality and nature of the work seemed to be going.

Since the change in management there has been, I think, a great improvement in the quality of the work and a very much greater degree of satisfaction expressed to me by the officers in OPNAV who deal directly with them and use the output of their work.

PROJECT THEMIS

Mr. ANDREWS. Will you provide a table showing the Project Themis program by fiscal year since its inception, including the fiscal 1970 estimate.

(The information follows:)

Project Themis Funded From R.D.T. & E.N.

Fiscal year:	*Dollars in millions*
1967	$7.0
1968	10.5
1969	11.2
1970	12.7

Mr. ANDREWS. Has this program been affected in any way by student unrest and rioting at universities?

Dr. FROSCH. No, there has been no effect at any of the Themis contracts with colleges.

FUNDS FOR STUDIES AND ANALYSES

Mr. ANDREWS. Will you provide a table showing by fiscal year and appropriation the amount of funds programed for studies and analyses? In this connection, show the amounts for fiscal years 1967, 1968, and 1969 and the estimate for 1970.

(The information follows:)

FUNDS PROGRAMED FOR STUDIES AND ANALYSES

[In thousands of dollars]

	Fiscal year 1967	Fiscal year 1968	Fiscal year 1969	Fiscal year 1970
Studies and analyses, Navy	9,304	10,067	9,215	9,800
Studies and analyses, Marine Corps	1,060	1,168	1,170	1,300
Total, studies and analyses	10,364	11,235	10,385	11,100

Mr. ANDREWS. Mr. Lipscomb.

INCREASE FOR PROJECT THEMIS

Mr. LIPSCOMB. There is an expansion proposed for Project Themis in the Navy I observe, is that correct?

Admiral OWEN. May I respond to that, sir?

Mr. LIPSCOMB. Yes.

Admiral OWEN. Yes, sir; there is. The fiscal year 1970 funding for Themis we are asking for is $12.7 million.

Mr. LIPSCOMB. How much of an increase is that?

Admiral OWEN. This is an increase of $1.5 million from the 11.2 appropriated in fiscal year 1969.

Mr. LIPSCOMB. Have you any recent accomplishments of the Themis program since it went into effect in fiscal 1967?

Admiral OWEN. May I say, sir, that I have personally visited several Themis universities. I can point to no outstanding accomplishments if you are talking of results that would lead to immediate hardware. I do feel that the universities are organized properly and are engaging in a good research program related to the defense interests. For example, at Iowa State University I visited Prof. Grover Brown, and he is working on a project related to navigation and is working with the APL, Johns Hopkins University, in connection with a system for improving navigational accuracy of our satellite navigational system. I visited the work going on at Lehigh University in connection with fracture mechanics. This is related to heavy steel specimens and the reasons why they fail, knowledge of which will be applicable to our submarine and ship construction program.

I visited the State University of New York at Buffalo. They are just getting underway on developing a capability for further study in the School of Medicine of Man in the Sea and problems associated therewith. We feel that the University of Massachusetts and Notre Dame, both having Themis contracts in the area of deep ocean technology and deep ocean submersibles are working very well and providing information that will benefit the Navy.

My representatives have recently visited all Themis universities and have an indication that they are indeed doing good research that we feel is related to the interests of the Navy. Out of the first year's contractors, there were two universities that were slow to get started but they have since come on the line and are doing very well.

Mr. LIPSCOMB. You have invested in the Navy Themis program as of the close of fiscal year 1969, $28,707,000.

Admiral OWEN. Yes, sir.

The Themis colleges, which really got started on a calendar basis at the close of fiscal year 1967 or the beginning of fiscal year 1968, have been productive in that research reports have been submitted, published, and there is an indication of good activity.

Dr. FROSCH. I think a couple of general comments have to be made on the matter of investment and payout in this kind of a research enterprise: One, the time that it takes to begin to get something out of a brand new research project or research group starting on a new problem is likely to be almost anything—it can be almost zero if somebody has a good idea that can pay off immediately—it is much more likely to be on the order of 5 years or longer.

Mr. LIPSCOMB. Will you clarify any difference between a project and the issuance of a report?

Dr. FROSCH. The purpose of any of these research projects is to understand the problem and produce new knowledge. The report is the tangible evidence either of the new knowledge or of the progress they are making in the work they are doing.

All of these projects, I believe, have issued reports, some of them with new knowledge in them. Whether the new knowledge is of tremendous significance or has solved a major problem is another question. That frequently takes many years even to find out.

VALUE OF PROJECT THEMIS

Mr. ANDREWS. I think what the gentlemen wants to know, and certainly I would like to know, is that you have spent roughly $22 million on this Project Themis in the last few years, and what have you gotten in return for the money spent?

Dr. FROSCH. The most significant thing we have gotten is that we have gotten started a number of research groups in universities that had not previously had any extensive research contact with any Defense Department problems.

Mr. ANDREWS. That is no contribution to the Navy, is it?

Dr. FROSCH. This is essentially seed money to get new people interested in research problems that are of interest and importance to Defense needs and Navy needs.

Mr. ANDREWS. What are you hoping to get out of this program that can be used in the Navy?

Dr. FROSCH. What we are hoping to get from some of them at least in the long run is new knowledge that will make a real difference in how we do naval missions, or in new ways to do them, or in new missions. For example, Admiral Owen mentioned someone who is working on the fracture mechanics of heavy-metal materials. The limitation on the kind of submarine we can build is essentially based on how various kinds of steels and materials behave under pressure and stress. The final limitation is usually the manner in which they crack. What we are doing is investing money with somebody who seems to have some ideas on these problems different from other people's, and if he solves some of those problems, then it can make a major difference in the amount of steel and the kind of steel we need to build the submarine. It could make a major difference in the weight

or depth capability of the submarine. I cannot guarantee and he cannot guarantee that such a result will come out of it.

Mr. ANDREWS. You are getting up to the big league now where it comes to money. Is that $28 million already expended or does that include the $12 million you are asking for this year?

Dr. FROSCH. I don't know. Mr. Lipscomb quoted the number.

Mr. ANDREWS. Does that include the request for 1970?

Admiral OWEN. No.

Mr. ANDREWS. You have $12 million requested before the committee. You will be pushing $40 million.

Admiral OWEN. That is correct, sir.

Mr. LIPSCOMB. That is just in the Navy program.

Mr. ANDREWS. And nothing that you can put your teeth into as far as help to the Navy is concerned.

Admiral OWEN. There are reports that contribute to the knowledge of the Navy.

Mr. LIPSCOMB. Would you place in the record those reports?

Admiral OWEN. Do you want the reports or the title?

Mr. LIPSCOMB. No; just place the title and the amount involved and the contribution to the Navy.

Admiral OWEN. Yes, sir.

(The information follows:)

PROJECT THEMIS

CONTRACT FUNDING, LIST OF REPORTS AND CONTRIBUTIONS

THEMIS CONTRACT FUNDING, LIST OF REPORTS AND CONTRIBUTIONS

Funding information for Navy THEMIS contracts is presented below, followed by a listing of reports generated, publications supported, and contributions to the Navy from each contract. The contract starting date is included with these data. New starts with fiscal year 1967 funds begin in fiscal year 1968; similarly new starts with fiscal year 1968 funds began in early fiscal year 1969. No contract is as yet 2 years old. Step funding is incorporated in Project THEMIS whereby initial funding provides full funding for the first year, two-thirds funding for the second and one-third funding for the third year. Subsequent renewals provide one-third funding for each of the 3 successive years. At this time, therefore, the allocated funds from which research results could be expected do not exceed $10.5 million; the funds available to the contractors for the first 2 years of THEMIS operation.

THEMIS CONTRACT FUNDING, LIST OF REPORTS AND CONTRIBUTIONS

[In thousands of dollars]

Contractor and State	Short title	Programmed funds Fiscal year 1967	Fiscal year 1968
Arizona State University, Tempe, Ariz	Human Performance in Unusual Environments.	380	190
Case Western Reserve University, Cleveland, Ohio	R. & D. Management	100	50
Florida State University, Tallahassee, Fla	Fluid Dynamics Center	600	300
Do	Computer-Based Instrumentation		460
Hawaii, University of, Honolulu, Hawaii	Solar and Other Astronomy	350	175
Houston, University of, Houston, Tex	Information Processing Systems	380	190
Iowa State University, Ames, Iowa	Automatic Navigation and Control	400	200
Iowa, University of, Iowa City, Iowa	Automata Theory		400
Massachusetts, University of, Amherst, Mass	Deep Sea Submersibles	360	180
Minnesota, University of, Minneapolis, Minn	Gas Turbine Research	400	200
Do	Optical Technology	380	190
New Mexico, University of Albuquerque, N.Mex	Radiation and Semiconductors	370	185
New Mexico, Institute of Mining & Technology Socorro, N. Mex.	Thunderstorm Environments	406	203
New York at Buffalo, State University of	Environmental Physiology	600	300
Notre Dame, University of, Notre Dame, Ind	Technology of Military Vehicles	400	200
Oregon State University, Corvallis, Oreg	Computer Oceanography	580	290
South Dakota School of Mines, Rapid City, S. Dak	Modification of Convective Clouds	260	130
Stevens Institute of Technology, Hoboken, N.J	Nonlinear Physics of Polymers	324	162
Tennessee, University of, Knoxville, Tenn	Dynamic Sealing	300	150
Texas A. & M. University, College Station, Tex	Optimization Research	400	200
Catholic University, Washington, D.C	Dynamics of Cable Systems		402
Do	Vitreous State Basics		386
Colorado State University, Fort Collins, Colo	Tropical Weather		500
Do	Prediction of Wind Flows		430
Jefferson Medical College of Philadelphia, Pa	Diarrheal Disease		390
Kansas State University, Manhattan, Kans	Radiation and Electronics		577
Lehigh University, Bethlehem, Pa	Low-Cycle Fatigue		400
Missouri, University of, Rolla, Mo	Aqueous Aerosols		400
North Dakota, University of, Grand Forks, N. Dak	High Pressure Physiology		527
Oklahoma, University of, Norman, Okla	Shock Mechanisms and Therapy		405
Rensselaer Polytechnic Institute, Troy, N.Y	Radiation Effects on Electronic Materials.		430
Rice University, Houston, Tex	Coherent and Incoherent EM Radiation.		350
Southern Methodist University, Dallas, Tex	Statistics in Calibration Methods		502
West Virginia University, Morgantown, W. Va	V/STOL Aerodynamics		416
Travel costs		10	30
Total		7,000	10,500

[1] Triservice supported, Army contract.

University.—Arizona State University.
Title.—"Human Performance in Unusual Environments."
Contract No.—N00014-68-A-0150.
Start date.—September 1, 1967.

REPORTS RECEIVED TO DATE

Bachrach, Arthur J., "Man in the Sea," Interplay, August 1968.
Falk, John L., "The Behavioral Measurement of Five Motor Control Effects of Pharmacological Agents," Readings in Behavioral Pharmacology, edited by Thompson and Pickens, August 1968.

CONTRIBUTIONS TO THE NAVY

Knowledge and experience gained through this contract has contributed to the principal investigator D. Bachrach's service as a consultant to the sealabs III program. As a consultant, he reviewed the habitat design from a human factors viewpoint and made specific recommendations to the Deep Submergence Systems Project Office.

University.—Case Western Reserve University.
Title.—"R. & D. Management."
Contract No.—DA HC 19-68-C-0007.
Contracting Office.—Department of the Army, Office of the Chief of Research and Development.
Start date.—September 1967.

REPORTS RECEIVED TO DATE

Bushnell, Jon. "Use of Queuing Theory in Study on R. & D. Project Flow," technical memorandum No. 125, Department of Operations Research, Case Western Reserve University, Cleveland, Ohio, October 1968.

Chidambaram, T. S., "Optimality of Full Funding Strategies in R. & D. Allocation Problems," technical memorandum No. 102, Department of Operations Research, Case Western Reserve University, Cleveland, Ohio, August 1968.

Dean, Burton V., "Evaluating, Selecting, and Controlling R. & D. Projects," research study 89, American Management Association, 1968.

Dean, Burton V.; Matel, Samuel J.; Brown, Melvin; Friedel, Donald; and Heuttner, David; "Allocation of Resources for Basic Research in a Mission Oriented Governmental Agency," technical memorandum No. 128, Department of Operations Research, Case Western Reserve University, Cleveland, Ohio, August 1968.

CONTRIBUTION TO THE NAVY

Principles and techniques are being established which will provide R. & D. managers with procedures for improving program effectiveness. An important study has been completed on the methods and procedures used by industrial R. & D. organizations which may have implications for the Navy.

University.—Florida State University.

Title.—Fluid Dynamics Center.

Contract No.—N00014-68-A-0159.

Start date.—September 1, 1967.

REPORTS RECEIVED TO DATE

Brand, S. "Bernard Cell Convection in the Laboratory and the Atmosphere" TR 1, 1967.

Mathur, M. "On the Role of Eddy Transport of Angular Momentum During Intensification and Maintenance of Tropical Storms" TR 2, 1967.

Pfeffer, R. L. "Available Potential Energy in a Quasi-Geostrophic Atmosphere" TR 3, 1967.

Dietrich, D. "The Spectral Approach Toward the Investigation of Rotating Basin Experiments" TR 4, 1967.

Buckley, J. "Wave Dispersion and Amplitude Vacillation in a Differentially Heated Cylindrical Annulus of Fluid" TR 5, 1968.

Pfeffer, R. L., Fowlis, W.W. "Wave Dispersion in a Rotating Differentially Heated Cylindrical Annulus of Fluid" TR 6, 1968.

Fowlis, W. W., Pfeffer, R. L. "Characteristics of Amplitude Vacillation in a Rotating Differentially Heated Fluid Determined by a Multi-Probe Technique" TR 7, 1968.

Fein, J. "Guest Lectures at the Geophysical Fluid Dynamics Institute, Part I" TR 8, 1968 (issued in three parts).

Niedoroda, A. "Preliminary Study of Transverse Bars" TR 9, 1968.

Fowlis, W. W. "Techniques for the Fast and Precise Measurement of Fluid Temperatures and Flow Speeds Using Multi-Probe Thermistor Assemblies" TR 10, 1968.

Brindley, J. "Symmetric Flow in a Differentially Heated, Rotating Annulus of Fluid" TR 11, 1968.

Hseuh, Y. "A Buoyant Ekman Layer" TR 12, 1968.

Krishnamurti, R. "On the Transition to Turbulent Convection—Part I—Transition From Two to Three-Dimensional Flow" TR 14, 1968.

Drazin, P. G. "Kelvin-Helmholtz Instability of Finite Amplitude" TR 17, 1969.

Barcilon, A. "Convection in a Nearly Isothermal Atmosphere" TR 18, 1969.

Lau, J. "On Surface Gravity Waves in Heterogeneous Shear Flows" TR 20, 1969.

Hsueh, Y. "A Contribution to the Dynamic Method" TR 22, 1969.

Pfeffer, R. L., Fowlis, W. W. "Wave Dispersion in a Rotating Differentially Heated Cylindrical Annulus of Fluid" Journal of Atmospheric Sciences, 25, No. 3, May 1968.

CONTRIBUTION TO THE NAVY

This program of theoretical and experimental studies of natural environmental phenomena in the oceans and the atmosphere should meet some critical fleet requirements. Advanced techniques now under development may permit modeling of clouds in their entire complexity and lead to greater effectiveness in fleet

meteorology. For example: (1) hurricanes and other storms can be studied for their genesis and for techniques for the modification, (2) large scale atmospheric circulations can be realistically simulated from which development of long-range weather forecast techniques are possible.

University.—Florida State University.
Title.—Computer-Based Instruction.
Contract No.—N00014-68-A-0494.
Start date.—July 1, 1968.

REPORTS RECEIVED TO DATE

Dick, W., "Implementation of Computer Assisted Instruction," technical memo 1, May 1, 1969.

Hansen, D., "Current Issues in Computer Assisted Instruction," technical memo 2, June 1, 1969.

Hansen, D., "Computer Application in Psychology," technical memo 3, June 1, 1969.

Ehlers, W., "Computer Assisted Instruction in Social Work," technical memo 4, June 1, 1969.

O'Neill, J. Spielberger, C., and Hansen D., "Effects of State Anxiety and Task Difficulty on Computer assisted Learning," Journal of Educational Psychology (in press).

O'Neill, J., Hansen, D., and Spielberger, C., "Errors and Latency of Response as a Function of Anxiety and Task Difficulty" (in press).

Hansen, D., Dick, W., and Lippert, H., "THEMIS Project Progress," January 1, 1969.

CONTRIBUTION TO THE NAVY

Direct tie has been established between the Computer Assisted Instruction Center of Florida State University and two Navy installations: Navy Training Device Center, Orlando, Fla.; and Naval Reserve Training Center, Tallahassee, Fla. In the latter facility, equipment is being set up for individualized computer assisted instruction of naval reservists on an experimental basis with the aim of improving the efficiency of Navy training.

University.—University of Hawaii.
Title.—Solar and Other Astronomy.
Contract No.—N00014-68-A-0149.
Start date.—September 1, 1967.

REPORTS RECEIVED TO DATE

Finn, G. D. and J. T. Jefferies, "Studies in Spectral Line. I. Formulation and Simple Application," J. Quant. Spec. and Rad. Transfer 8, 1675, 1968.

Fischer, R. R., "P-I-N Diodes as Detectors for Astronomical Photometry," Appl. Opt. 7, 1079, 1968.

Jefferies, J. T. and O. R. White, "The Analysis of Spectral Profiles. I. A generalized Theory," Ap. J. 150, 1051, 1967.

Jefferies, J. T. and G. W. Curtis, "The Analysis of Spectral Line Profiles. II. An Application to the Solar Sodium D. Lines," Ap. J. 150, 1061, 1967.

Sinton, W. M., "Stellar Spectra," Infrared Astronomy, A.G.W. Cameron, ed., Gordon and Breach, New York, 1968.

Wolff, Sidney Carne, "The Incident of Ap Stars," Publi. Astr. Soc. Pac. 80, 281, 1968.

Zirker, J. B., "The Solar H and K lines of Ionized Calcium," Solar Physics 3, 164, 1968.

Jefferies, J. T., "Spectral Line Formation," Blaisdell Publishing Co., Massachusetts, 1968.

CONTRIBUTION TO THE NAVY

This work is attempting to determine the origin of high-energy particles responsible for certain solar flares, which have important effects on weather, and the performance of radar and communication systems. For infrared work a highly sensitive detector has been completed.

University.—University of Houston.
Title.—Info. Processing System.
Contract No.—N00014-68-A-0151.
Start date.—September 1967.

REPORTS RECEIVED TO DATE

Childs, S. B., "Identification of Systems," Project THEMIS report RE 2-68, University of Houston, August 1968.

Luckenbill, Dennis L., and Childs, S. B., "Inverse Problems in Partial Differential Equations," Project THEMIS report RE 1-68, University of Houston, August 1968.

Motard, R. L., Lee, H. M., and Barkley, R. W., "CHESS—Chemical Engineering Simulation System, User's Guide," October 1968, TECH Publishing Co., Houston, Texas.

Newhouse, Albert, and Sibley, Robert A. Jr. "On the Use of Very Low Cost Terminals," Project THEMIS report RE 3-69, University of Houston, March 1969.

Project THEMIS information processing systems, proceedings of Review Conference, University of Houston, April 24, 1969.

CONTRIBUTIONS TO THE NAVY

New computer languages are being developed oriented toward application in areas of engineering and science of naval interest. To date such languages have been written for chemical engineering process control and electrical engineering circuit design.

University.—Iowa State University of Science and Technology, Ames, Iowa.

Title.—Automatic Navigation and Control.

Contract No.—N00014-68-A-0162.

Start date.—September 1, 1967.

REPORTS RECEIVED TO DATE

R. E. Horton and R. G. Brown, "Use of Continuous Measurements in a Discrete Kalman Filter," proceedings of the National Electronics Conference, Vol. 23, pp. 141-143, October 1967.

A. N. Michel and S. H. Wu, "Stability of Systems with Respect to Parameter Variations," proceedings of the 11th Widwest Symposium on Circuit Theory, pp. 281-289, May 1968.

R. G. Brown and L. L. Hagerman, "An Optimum Inertial/Doppler-Satellite Navigation System," proceedings of the 24th Annual Meeting of the Institute of Navigation, June 1968.

A. N. Michel, "Stability Analysis of Pulse Width Modulated and Delta Modulated Feedback Systems." Proceedings of the Second Asilomar Conference on Circuits and Systems, Monterey, California, November 1968.

A. N. Michel, "Practical Stability of Dynamical Systems," proceedings of the Sixth Annual Allerton Conference on Circuit and System Theory, Urbana, Ill., October 1968.

R. G. Brown and G. L. Hartmann, "Kalman Filter with Delayed States as Observables," proceedings of the National Electronics Conference, December 1968.

J. A. Heinen, A. N. Michel, and S. H. Wu, "On the Linear Pursuit Problem," proceedings of the National Electronics Conference, December 1968.

CONTRIBUTIONS TO THE NAVY

A number of contributions are being made toward improved navigation and control systems. These include:

(1) Work on an integrated inertial doppler satellite navigation system, with special interest for aircraft application.

(2) Attempted development of improved ring lasers for gyro technology.

University.—University of Iowa.

Title.—Automata Theory.

Contract No.—N00014-68-A-0500.

Start date.—July 1968.

REPORTS RECEIVED TO DATE

"Bounds on Memory Requirements of Multiprocessor Systems," by Donald Epley, October 1968.

"A Decoding Algorithm for Some Convolutional Codes Constructed from Block Codes, Information, and Control," by John Robinson (with S. M. Reddy), September 1968.

TR No. 1—"A Note on Computable Real Fields," by E. W. Madison, December 1968.
TR No. 2—"Structures Elementarily Closed Relative to the Natural Numbers," by E. W. Madison, December 1968.
TR No. 3—"On Classes of Graphs Defined by Special Cutsets of Lines," by S. Hedetniemi, January 1969.
TR No. 4—"On the Complexity of Grammars," by A. C. Fleck, February 1969.
TR No. 5—"Memory Requirements of Two-Way Versus One-Way Automata," by B. H. Barnes, February 1969.
TR No. 6—"S-Semigroups of Automata," by S. T. Hedetniemi and A. C. Fleck, March 1969.
TR No. 7—"Real Ordered Fields with Characterization of the Natural Numbers," by E. W. Madison, March 1969.

CONTRIBUTIONS TO THE NAVY

This is the first large-scale interdisciplinary attack on automata theory by techniques of mathematics, linguistics, computer science, and engineering. Results obtained to date are fundamental to the design and development of possible automatic mechanical devices needed for future applications. These include devices for naval intelligence (automatic translation machines and cryptographic coding and decoding) and robots for manipulation in inaccessible or dangerous regions (such as ocean-bottom retrieval or handling of radioactive materials).
University.—University of Massachusetts-Amherst.
Title.—Deep-Sea Submersibles.
Contract No.—N00014-68-A-0146.
Start date.—September 1, 1967.

REPORTS RECEIVED TO DATE

Hwang, H. U., McGowan, J. G., and Murthy, S. N. B. "Motion of Colloid Particles in a Fluid Flow due to an Applied Magnetic Field," University of Massachusetts, Project Themis, Report No. Themis-UN-68-1, May 1969.
Hutchinson, C. E. and Wondergen, H. M., "An Error Analysis Technique for Inertial Navigation Systems and Kalman Filters," University of Massachusetts, Project Themis, Report No. Themis-UM-68-2, September 1968.
Hutchinson, C. E. and De Sousa, A. E., "Optimum Alinement of Inertial Navigation Systems," University of Massachusetts, Project Themis, Report No. Themis-UM-68-3, November 1968.
Hutchinson, C. E. and Metrick, A. J., "A Statistical Error Analysis of the Gyrocompass," University of Massachusetts, Project Themis, Report No. Themis-UM-69-3, March 1969.
Ritter, J. E. and Vrooman, D. L., "Static Fatigue of Acid-Etched, Soda-Lime-Silica Glass Rods," University of Massachusetts, Project Themis, Report No. Themis-UM-69-4, April 1969.
Kalagian, E. H., Bemben, S. M., "The Vertical Pullout Capacity of Marine Anchors in Sand," University of Massachusetts, Project Themis, Report No. Themis-UN-69-5 April 1969.
Ritter, J. S., Jr., "Glass Materials for Deep Seat Submersible Vehicles," Glass Industry, 49, pp. 603-608 (1968).

CONTRIBUTION TO THE NAVY

1. A study of system responses to random input errors using the latest statistical error analysis techniques may provide answers to command and control problems such as elimination of error from inertial navigation systems.
2. Studies of the behavior of glasses under stress and their failure mechanisms have potential application to the design of pressure hulls for deep submersibles.
University.—University of Minnesota.
Title.—Gas Turbine Research.
Contract No.—N00014-68-A-0141.
Start date.—September 1967.

REPORTS RECEIVED TO DATE

Scott, C. J., "Transient Temperature Response of a Thin-Walled Transpiration-Cooled Porous Surface," Journal of Heat Transfer, 90, 1, 77-83, February 1968.

Metzger, D. E., Carper, H. J., Swank, L. R., "Heat Transfer with Film Cooling Near Non-Tangential Slots," Journal of Engineering for Power, 90, 2, 162–163 (1968).

Raithby, G. D., Eckert, E. R. G., "The Effect of Support Position and Turbulence Intensity on the Flow Near the Surface of a Sphere, "Warmound Stoffubertragung, 1, 2, 87–94 (1968).

Briggs, D. G., Goldstein, R. J., Ibele, W. E., "Precision Measurement of the Thermal Conductivity of Gases in a Transient Hot-Wire Cell," pages 452–461 in Proceedings of the Fourth Symposium on Thermophysical Properties, New York: The Americal Society of Mechanical Engineers (1968).

Beavers, Gordon S., Amberker, Mohan, N., "An Investigation of the Reflection of a Plane Shock Wave from Porour Wall," AHL Research Report 194, August 1968.

Brannon, R. R., Jr., "The Variation of Total Normal Emittance and Total Directional Emittance as a Function of Dielectric Film Thickness on a Metal Substrate," M. S. Thesis, University of Minnesota, July 1968.

Desmond, R. M., "Measurement of the Thermal Conductivity of Gases at High Temperatures with a Hot Wire Cell," Ph. D. thesis, University of Minnesota, March 1968.

Wyatt, W. G., "Determination of Thermal Diffusion Factors in Binary Gas Systems," Ph. D. thesis, University of Minnesota, July 1968.

Kammin, M. R., "Impingement Cooling on the Interior Surface of a Sphere," M. S. thesis, University of Minnesota, March 1969.

CONTRIBUTION TO THE NAVY

This program is generating information for more effective cooling of components like combustion chambers, nozzles, and buckets of aircraft gas turbines. Some of these data are being used by a major aircraft engine manufacturer in a film cooling system design.

University.—University of Minnesota.
Title.—Optical Technology.
Contract No.—N00014–68–A–0141–002.
Start date.—September 1, 1967.

REPORTS RECEIVED TO DATE

1. H. Risken and K. Nummedal, "Instability of Off-Resonance Modes in Lasers," Physics Letters 26A, 275 (1968).
2. H. Risken and K. Nummedal, "Pulse Formation in Lasers," Physics Letters, 1968.
3. H. Risken and K. Nummedal, "Self Pulsing in Lasers," Journal of Applied Physics (in press).
4. R. J. Collins and D. L. Franzen, "CW Mixing of 10.6 and 0.6328 Lasers," Journal of Quantum Electronics (in press).
5. D. M. Thymian and J. A. Carruthers, "Second Harmonic Enhancement Using a Self-Locked 0.6328 He-Ne Laser," Journal of Quantum Electronics (in press).
6. D. M. Thymian and J. A. Carruthers,"Second Harmonic Enhancement Using a Self-Locked 0.633 He-Ne Laser," Themis Technical Report No. 1, August 1968.
7. H. Risken and K. Nummedal, "Pulse Formation and Mode Instabilities in Laser," Themis Technical Report No. 2, August 1968.

CONTRIBUTIONS TO THE NAVY

Contributions have been made in the following areas:
(1) Methods of superheterodyne receiver detection of infrared laser energy.
(2) Techniques for improving gyroscopes using lasers, and
(3) Improvements in photodetectors of the kind found in night vision and surveillance gear of the Navy and Marine Corps.

University.—University of New Mexico.
Title.—Radiation and Semiconductors.
Contract No.—N00014–A–0158.
Start Date.—September 1, 1967.

REPORTS RECEIVED TO DATE

Gwyn, C. W.; "An Analysis of the Effects of Ionizing Radiation in One-Dimensional Metal-Oxide-Semiconductor Structures," Journal of Applied Physics, Vol. 40, No. 1, January 1969.

Schnurr, R. H., and H. D. Southward; "Radiation Effects on Gallium Arsenide Devices," IEEE Transactions on Nuclear Science, Vol. NS-15, No. 6, December 1968.

Allen, R. C., Jr., and G. M. Wing; "Transport in Periodic Systems." Submitted to the Journal of Mathematical Analysis and Applications.

Allen, R. C., Jr., M. Scott, and G. M. Wing; "Numerical Solution of a Certain Class of Nonlinear Two-Point Boundary Value Problems," submitted to the Journal of Computational Physics.

Boatwright, L. T., Goebel Davis, Jr., and W. W. Grannemann; "Applications of Junction Compensation Techniques in Reducing Transient Gamma Radiation Effects in Transistor Circuits," submitted to the IEEE Transactions on Nuclear Science.

CONTRIBUTIONS TO THE NAVY

(1) Experiments to develop electronic circuits and components which will operate in high level nuclear radiation fields have been conducted with some success.

(2) Detailed studies of the motion of charges in semiconductor devices due to the effects of X-radiation, have led to evolution of a theory potentially useful in the design of future hardened electronic devices.

University.—New Mexico Institute of Mining and Technology.

Title.—Thunderstorm Environments.

Contract No.—N00014-68-A-0157.

Start Date.—September 1, 1967.

REPORTS RECEIVED TO DATE

"A study of Atmospheric Pressure Variations from Lightening Discharges" McCrory, R. A., and C. R. Holmes comment of a paper by Bhartendu, Canadian Journal of Physics, *46*, 20, 1333-34, 1968.

"Fluctuating Radar Echo: Modulation by Vibrating Drops" (Letter) Brook, M., and D. J. Latham, Journal of Geophysical Research, *73*, 22, 7137-7144.

"Radon-Daughter Ions, Measurement of Activity and Mobility" Jonassen, N., New Mexico Tech, 23 pp., August 1968.

CONTRIBUTION TO THE NAVY

These studies should lead to improvements in thunderstorm forecasting of particular interest to Naval aviation operations at sea.

University.—State University of New York at Buffalo.

Title.—Environmental Physiology.

Contract No.—N00014-68-A-0216.

Start date.—September 1, 1967.

REPORTS RECEIVED TO DATE

Van Liew, H. D., and Hlastala, M. P.: "Influence of Bubble Size and Blood Perfusion on Absorption of Gas Bubbles in Tissues," accepted by Resp. Physiol.

Van Liew, H. D.: "Variation of Tissue P_{CO_2} in Synchrony with the Sexual Cycle in Rats," In Press.

Gurtner, G. H., Song, S. H., and Farhi, L. E.: "Alveolar to Mixed Venous P_{CO_2} Difference Under Conditions of No Gas Exchange," In Press.

Van Liew, H. D.: "Dissolved Gas Washout and Bubble Absorption in Routine Decompression," In Press.

Van Liew, H. D.: "Oxygen and Carbon Dioxide Tensions in Tissue and Blood of Normal and Acidotic Rats," J. Appl. Physiol. 25(5) :575-580, 1968.

Olszowka, A. J., and Farhi, L. E.: "A Digital Computer Program for Constructing Ventilation-Perfusion Lines," J. Appl. Physiol., In Press.

Farhi, L. E.: "A Laboratory of Environmental Physiology," 1967 Annual Progress Report.

Farhi, L. E.: "A Laboratory of Environmental Physiology," 1968 Annual Progress Report.

Farhi, L. E.: "A Laboratory of Environmental Physiology," 1969 Annual Progress Report.

Van Liew, H. D.: "Coupling of Diffusion and Perfusion in Gas Exit from Subcutaneous Pockets in Rats," Am. J. Physiol., 214:1176–1185, 1968.

Van Liew, H. D., Schoenfish, W. H., and Goldberg, M. H.: "Diffusion of Oxygen From Gas Pockets to Capillaries," accepted by Microvascular Research.

Van Liew, H. D., Schoenfish, W. H., and Olszowka, A.: "Exchange of N_2 Between a Gas Pocket and Tissue in a Hyperbaric Environment," accepted by Resp. Physiol.

Farhi, L. E.: "Convective and Diffusive Gas Transport in the Lung," The Ciba Foundation, London.

CONTRIBUTION TO THE NAVY

Potential contributions include:

(1) Increased knowledge of the physiological effects of breathing various gas mixtures during diving operations.

(2) Increased understanding of the effects of pressure on divers.

(3) Development of rapid methods for the determination of minute quantities of rare gases in breathing mixtures for use in constructing decompression schedules.

University.—University of Notre Dame.

Title.—Technology of Military Vehicles.

Contract No.—N00014–68–A–0152.

Start Date.—September 1, 1967.

REPORTS RECEIVED TO DATE

Lynch. R. D., Kelsey, S. and Saxe, H. C., "The Application of Dynamic Relaxation to the Finite Element Method of Structural Analysis," Technical Report No. THEMIS-UND–68–1, September 1968.

Ariman, T., Lee, L. H. N., and Hoffman, R. E., "Thermal Stresses in Open Cylindrical Shells with Circular Cutouts," Technical Report No. THEMIS-UND–68–2, December 1968.

Hoffman, R. E. and Ariman, T., "The Application of Micropolar Mechanics to Composites," Technical Report No. THEMIS-UND–68–3, December 1968.

Yang, K. T., Nee, V. W., "Structure of Turbulent Free-Convection Boundary Layers along a Vertical Plate," Technical Report No. THEMIS-UND–69–1, April 1969.

Roache, P. J., Mueller, T. J., "Numerical Solutions of Compressible and Incompressible Laminar Flows," Proceedings, AIAA Fluid and Plasma Dynamics Conference, Los Angeles, California Paper No. 68–741, June 1968.

Lui, R. W., "Convergent Systems," IEEE Trans. Automatic Control, AC–13, pp. 384–391, 1968.

Weaver, H. J., Leake, R. J., "Canonical (Phase-Variable) Form by Signal Flow Graph," Electronics Letters, 4 pp. 351–352, 1968.

CONTRIBUTION TO THE NAVY

1. Submersible shell studies using the most recently developed analytical techniques may be of importance in future deep research vehicle design.

2. The development of new magnetostrictive materials offers promise of eventual application in sonar.

3. Analysis of the sensitivity of nonlinear systems may have important application in the optimization of navigation and fire control systems.

University.—Oregon State University.

Title.—Computer Oceanography.

Contract No.—N00014–68–A–0148.

Start Date.—September 1967.

REPORTS RECEIVED TO DATE

Baughman, J. A., C. D. Pielstick, "Using the Plotter: Documentation and Examples," OSU Computer Center, TECH Report, August 1968.

Neshyba, S., G. F. Beardsley, V. T. Neal, and K. Carder, "Optical Structure of Arctic Waters," Science, fall 1968.

CONTRIBUTIONS TO THE NAVY

This program which seeks improved numerical models of air-sea interaction processes should contribute directly to the Navy's efforts to develop environmental prediction systems for ASW and other naval operations.

University.—South Dakota School of Mines and Technology.
Title.—Modification of Convective Clouds.
Contract No.—N00014-68-A-0160.
Start Date.—1 September 1967.

REPORTS RECEIVED TO DATE

"Effects of Second Order Advection Scheme on a Numerical Cloud Model," H. R. Orville, submitted to Monthly Weather Review.

"Precipitation Effects on the Growth of Cumulus Over Mountains—A Numerical Experiment," Orville, H. D. and Liu, J., submitted to Journal of Atmospheric Sciences.

CONTRIBUTIONS TO THE NAVY

It is anticipated that this research will contribute to both weather modifications studies and the forecasting of cumulus cloud development.

Contractor.—Stevens Institute of Technology.
Title.—Non-Linear Physics of Polymers.
Contract No.—N00014-68-A-0131.
Start Date.—September 1967.

REPORTS RECEIVED TO DATE

Andrews, R. D., and Okuyama, H., "Rheo-Optical Behavior of Polyacrylonitrile Creep and Creep Recovery," Technical Report No. 1, August 1968.

Reich, L., and Stivala, S. S., "Molecular-Weight Changes During Autoxidation of Atactic Polypropylene in Solution," Technical Report No. 2, August 1968 (accepted for publication in J. Appl. Polymer Sci.).

Reich, L., and Stivala, S. S., "Estimation of Rate Constants During Polypropylene Autoxidation," Technical Report No. 3, June 1968 (accepted for publication in the J. Appl. Polymer Sci.).

Reich, L., and Stivala, S. S., "Autoxidation of Poly (Alkylene Glycols) in Solution," Technical Report No. 4, November 1968 (accepted by J. Appl. Polymer Sci.).

Volpe, A. A., Kaufman, L. G., and Dondero, R. G., "Isomeric and Substituent Effects in Some Dibenzoylbenzene-Diamine Polymers," Technical Report No. 5, October 1968 (accepted for publication in J. Macromol. Sci.-Chemistry).

Koo, G. P., and Andrews, R. D., "Mechanical Behavior of Polytetrafluoroethylene around the Room Temperature First Order Transition," Technical Report No. 6, March 1969.

Duyderani, I. J., Biesenberger, J. A., and Gogos, C. G., "Thermomechanical Studies of Polymer Deformation I. A New Deformation Calorimeter," Technical Report No. 7, April 1969.

CONTRIBUTIONS TO THE NAVY

Polymeric materials such as plastics, rubbers, and composites are widely used by the Navy including special materials for adhesives, sealants, and structural components for aircraft. Definite patterns of behavior for plastics under ordinary conditions are known. This program is developing data for the correlation of mechanical properties with chemical composition and molecular structure under conditions of severe stress.

University.—University of Tennessee.
Title.—Dynamic Sealing.
Contract No.—N00014-68-A-0144.
Start date.—September 1967.

REPORTS RECEIVED TO DATE

Stair, William K., "Effect of Groove Geometry on Viscoseal Performance," J. Engr. for Power, ASME Trans., Series A, 89, 605-614, October 1967.

Milligan, Mancil W., "Rarefied Gas Flow Through Passages With Static Boundaries," ASLE Trans., 11, 228-234 (1968).

Fisher, Charles F,. Jr., Stair, William K., "On Gas Ingestion and Fluid Inertia Effects in Viscoseals," ASLE Trans. 11 (1968).
Hodgson, Jeffery W., Milligan, Mancil W., "Visco-Type Gas Sealing," ASLE Trans. (1968).
Headrick, Michael R., "The Design and Construction of a Facility To Determine the Dynamics of a Face Seal," University of Tennessee, M.S. Thesis, 120 pages, December 1968.
Tsai, Ming S., "Laminar Flow in Plane Channel and Annulus with One Wall Porous," University of Tennessee, M.S. Thesis, 125 pages, December 1968.
Stair, W. K. "Introduction to Dynamic Sealing," ASLE Conference, Kingsport, Tenn. October 17, 1968.
Chandrakaut, Khumaji Shah, "An Experimental Study of the Viscoseal Bearing" February 1969.
Vreeburg, Jan P. B., "Investigation of Laminar Flow Patterns and Pressure Generation in a Viscoseal," Geometry, March 1969.
Fisher, Charles F. and W. K. Stair, "On Gas Ingestion and Fluid Inertia Effects in Viscoseals, Fourth Int. Conf. on Fluid Sealing, Philadelphia, May 6-9, 1968.
Hodgson, J. W. and M. W. Milligan. "Visco-Type Gas Sealing," Fourth Int. Conf. on Fluid Sealing, Philadelphia, May 6-9, 1969.

CONTRIBUTIONS TO THE NAVY

(1) This project is contributing to the develop t of dynamic seal technology. This area is important for main propellor shaft seals for surface ships and submarines, main shaft and interstage seals in advanced air-breathing engines, pumps, and torpedoes.
Contractor.—Texas A & M University.
Title.—Optimization Research.
Contract No.—N00014-68-A-0140.
Start date.—September 1967.

REPORTS RECEIVED TO DATE

R. R. Hocking, P. L. Claypool, C. G. Ohlendorf, "Nonlinear Programing in Multiple Response Optimization Problems," Technical Report No. 1, May 1968.
L. R. Lamberson, R. R. Hocking, "Optimum Time Compression in Project Scheduling Technical Report No. 2, May 1968.
L. R. Lamberson, "The Development of Optimization Procedures for a Class of Multiple Constraint Inventory Problems," Technical Report No. 3, May 1968.
A. W. Wortham, R. H. Gibson, "System Cost Analysis," Technical Report No. 4, July 1968.
S. W. McGuire, R. R. Hocking, H. O. Hartley, "Spherical Programing: A Convex Programing Algorithm," Technical Report No. 5, October 1968.
H. O. Hartley, R. R. Hocking, "Non-Convex Programing," Technical Report No. 6. November 1968.
T. J. Kozik, R. E. Martin, H. O. Hartley, "Optimization of Orientations for Multi-Layered Anistropic Shells of Revolution," Technical Report No. 7, December 1968.
R. E. Martin, "Theory of Sandwich Shells with Laminated Anistropic Facings," Technical Report No. 8, March 1969.
R. E. Martin, "Free Vibrations of Anistropic Conical Shells," Techanical Report No. 9, March 1969.
R. E. Martin, D. D. Drew, "A Bardorf Type Modified Equation for the Stability Analysis of Anistropic Cylindrical Shells," Technical Report No. 10, March 1969.

CONTRIBUTIONS TO THE NAVY

New mathematical programing methods have been developed with application to the design of proximity fuses, and to the analysis and control of military petroleum inventories.
University.—Catholic University.
Title.—Dynamics of Cable Systems.
Contract No.—N00014-68-A0506.
Start date.—July 15, 1968.

REPORTS RECEIVED TO DATE

Laura, P. A., Casarella, M. J.; Discussion of the paper "A Three-Dimensional Dynamic Analysis of a Towed System" (Vol. 2, No. 4, by Schram and Reyle), Journal of Hydronautics, Jan. 3, 1969.

Laura, P. A., H. Vandervelt. Gaffney, P.: "Acoustic-Detection of Structural Failure of Mechanical Cables," Journal of the Acoustical Society of America, February 1969.

Laura, P. A., Casarella, M. J.; "A Survey of Publications on Mechanical Cables and Cable Systems," Themis Report 68-1, The Institute of Ocean Engineering, The Catholic University of America.

CONTRIBUTIONS TO THE NAVY

Potential contributions include:

(1) Acoustic detection of incipient mechanical failure of cables.

(2) Understanding of the conditions leading to excess cable stresses in buoy-and-cable systems.

(3) Development of shock-absorbing devices for cables.

University.—The Catholic University of America.

Title.—Vitreous State Basics.

Contract No.—N00014-68-A-0506.

Start date.—July 15, 1968.

REPORTS RECEIVED TO DATE

Status Report for the period of July 15-December 31, 1968.

CONTRIBUTIONS TO THE NAVY

Potential Naval interest relates to (a) infrared transmitting materials capable of withstanding high temperatures, (b) chemically strengthened glasses of concern in underwater structures, and (c) controlled modulus glasses for structural components in ships and deep submergence structures.

University.—Colorado State University.

Title.—Tropical Weather.

Contract No.—N00014-68-A-0493-0002.

Start date.—July 15, 1968.

Reports.—None to date. Effort has been devoted to the establishment of the field observation program.

CONTRIBUTION TO THE NAVY

As improved ability to forecast weather, stream runoff, and soil trafficability in the tropics should result from this work and would be of direct interest to Naval and Marine Corps operations.

Contractor.—Colorado State University.

Title.—Prediction of Wind Flows.

Contract No.—N00014-68-A-0493-0001.

Start date.—July 1, 1968.

REPORTS RECEIVED TO DATE

J. T. Lin, S. Panchev, J. E. Cermak, "Turbulence Spectra in the Bouyancy Subrange of Thermally Stratified Shear Flows," TR1, February 1969.

S. P. S. Arya and J. E. Cermak, "Measurement of Turbulence in Three-Dimensional Mean Flow," TR 2, April 1969.

CONTRIBUTIONS TO THE NAVY

This work is concerned with the prediction of winds in the lower atmosphere, a subject bearing on a number of naval interests, including communications, ship and aircraft operation.

University.—Jefferson Medical College.

Title.—Diarrheal Disease.

Contract No.—N00014-68-A-0516.

Start Date.—July 15, 1968.

REPORTS RECEIVED TO DATE

Goldstein, F., C. W. Wirts, G. Salen, and R. J. Mandle, "Diverticulosis of Small Intestine, Clinical, Bacteriological, Metabolic and Biopsy Observations in a Group of Seven Patients." American J. of Digestive Diseases, December 1968.

Wirts, C. W., "Mechanisms of Malabsorption in Diverticulosis of the Small Intestine." International Congress of Gastroenterology, Prague, Czechoslovakia, July 1968.

Schaeder, R. W., "Lesions and Defense Mechanisms in Germ-free Hosts," Infectious Disease Society of America, New York, October 1968.

Goldstein, F., "Relation of Small Intestinal Bacterial Flora to Malabsorption," Second Central American Congress of Microbiology, Panama City, Panama, December 1968.

Schaeder, R. W., "The Establishment of the Gastro-Intestinal Flora," Second Central American Congress of Microbiology, Panama City, Panama, December 1968.

Kowlessar, O. D., "Jejunal Loop in Uremic Patients—Evidence for Secretary IgA in Its Secretions," Philadelphia Gastrointestinal Research Forum, Philadelphia, Pa., December 1968.

Schaeder, R. W., "The Gastrointestinal Flora," Philadelphia Gastrointestinal Flora, Philadelphia, Pa., December 1968.

CONTRIBUTIONS TO THE NAVY

Acute and chronic diarrheal disease is a principal cause of man-hours lost from duty by Marine Corps personnel on duty in Southeast Asia. Findings from this contract should provide means for improving prevention and treatment of these conditions.

University.—Kansas State University.

Title.—Radiation and Electronics.

Contract No.—N00014-68-A-0504.

Start Date.—July 15, 1968.

REPORTS RECEIVED TO DATE

N. O. Folland, "Electron-Phonon Matrix Elements in N-Type Silicon," Phys. Letters A27, 708-709 (1968).

W. Meyer, G. G. Simons, R. K. Smith, and G. E. Hansen, "Measured N. E. -213 Fast-Neutron Spectrometer (With Gamma-Ray Discriminator) Response Functions and Absolute Efficiency," Trans. Am. Nucl. Soc. 11, 704-705 (1968).

W. Meyer, G. G. Simons, and W. R. Kimel, "Measured Fast-Neutron Spectra after Reflection of Fission-Source Neutrons from a 9-Inch Thick Concrete Slab." Trans. Am. Nucl. Soc., Vol. 11, 705-707 (1968).

G. L. Stuckey, J. L. Lambert, and R. D. Dragsdorf, "The Hydrates of Sodium Hyponitrite," submitted to J. Inorg. Nucl. Chem.

R. T. Johnson, Jr., and R. D. Dragsdorf, "On the Detection of Axial Screw Dislocations in $BaTiO_3$ Whiskers Using Ka X-Radiation," submitted to J. Appl. Phys.

F. E. Haskin and R. E. Faw, "Approximate Solutions to the Diffusion-Kinetics Equations," submitted to Nucl. Appl.

W. Meyer, G. G. Simons, and H. J. Donnert, "Comments on a Combination Neutron and Gamma-Ray Spectrometer," submitted to Nucl. Instrum. Methods.

CONTRIBUTIONS TO THE NAVY

This work should lead to the development of new, improved radiation dosimetry techniques for use in very high intensity radiation environments, for which reliable dosimetry is not now available. Further, this work should lead to the development of electronic components for reactors, satellites, and missiles which will increase the lifetime of the devices, their reliability and greatly improve their ability to withstand high levels of nuclear or space radiation.

University.—Lehigh University.

Title.—Low-Cycle Fatigue Behavior of Joined Structures.

Contract No.—N00014-68-A-0514.

Start Date.—July 15, 1968.

REPORTS RECEIVED TO DATE

Sih, G. C. and Loeber, J. F., "A Class of Wave Diffraction Problems Involving Geometrically-Induced Singularities," J. Math., and Mech., in press.
Sih, G. C., "Torsional Vibration of an Elastic Solid Weakened by a Penny-shaped Crack, "J. Acoustical Soc. of America, in press.
Sih, G. C. and Loeber, J. F., "Normal Compression and Radia Shear Waves Scattering at a Penny-Shaped Crack in an Elastic Solid," J. Acoustical Soc. of America, in press.

CONTRIBUTIONS TO THE NAVY

A new mathematical technique has been developed concerning the behavior with time of structures containing flaws. The technique is of broad potential interest in structural design and particularly for weapon systems.
University.—University of Missouri—Rolla.
Title.—Aqueous Aerosols.
Contract No.—N00014-68-A-0497.
Start Date.—July 15, 1968.

REPORTS RECEIVED TO DATE

"Cluster Structure of the Anomalous Liquid Water," R. W. Bolander, J. L. Kassner, Jr., and J. T. Zung, Journal of Chemical Physics, vol. 50 (1969).
"A Semi-Empirical Determination of the Water Dimer Bond Energy in the Vapor Phase," R. W. Bolander, J. L. Kassner, Jr., and J. T. Zung, Journal of Chemical Physics, vol. 51 (1969).

CONTRIBUTIONS TO THE NAVY

Promises improved understanding of the nucleation processes in the atmosphere by which water vapor form cloud droplets and ice particles. This should contribute to efforts in weather prediction and modification.
University.—University of North Dakota.
Title.—High Pressure Physiology.
Contract No.—N00014-68-A-0499.
Start Date.—July 1, 1968.

REPORTS RECEIVED TO DATE

Wilson, R. H., "Gamma Aminobutyric Levels in Brains of Mice Exposed to 20, 40, and 60 Atm He-O_2 for 24 Hours." In press.
Wilson, R. H., and Dowell, H. L., "High-Pressure Physiological Research Man in the Sea," 1968 Annual Progress Report.
Wilson, R. H., "High-Pressure Physiological Research—Man in the Sea," 1969 Annual Progress Report.
Ackers, T. K., and Thompson, R. E., "Double High-Pressure Chamber for Chronic Exposure of Small Animals," J. Appl. Physiol. 197-199, 1968.

CONTRIBUTIONS TO THE NAVY

This work should increase knowledge of the physiological effects of long-term submergence, remote monitoring of physiological and biochemical changes which occur in saturation diving, and temperature regulation in divers operating in cold water.
University.—University of Oklahoma.
Title.—Mechanism and therapy of shock.
Contract No.—N00014-68-A-0496.
Start Date.—July 15, 1968.

REPORTS RECEIVED TO DATE

Barkett, V. M., J. J. Coalson, and L. J. Greenfield. Protective Effects of Pulmonary Denervation in Hemorrhagic Shock. *Surgical Forum.* 19: 38-39, 1968.
Harrison, L., J. Beller, C. Gill, L. Hinshaw, J. Coalson, and L. Greenfield. Effects of Endotoxin on Pulmonary Capillary Permeability and Surfactant. *Surgical Forum.* 19: 250-251, 1968.
Guenter, C. A. and L. B. Hinshaw. Endotoxin and Septic shock in the Rhesus Monkey, *Circulation.* 38 (Suppl. 6) : 90, 1968.

Jacobson, E. D., L. Solomon, J. Blaschke, and W. E. Price. Effects of Ouabain on Mesenteric Hemodynamics. *J. Lab. Clin. Med.* 72: 886, 1968.

Barkett, V. M., Coalson, J. J., and Greenfield, L. J. Early Effects of Hemorrhagic Shock on Surface Tension Properties and Ultrastructure of Canine Lungs. *Johns Hopkins Med. J.* (In press.)

Gunn, C. G., Wolf, S. G., and Block, R. T. Psychophysiology of Cardiovascular System. In *Handbook of Psychophysiology.* (In Press.)

Gunn, C. G. Neurophysiological Factors in Atherosclerosis, Psychopharmacological Factors, Implications and Perspectives. *Psychotropic Drugs in Internal Medicine.* L. Donnatelli and A. Marino, eds., Naples, Italy, 1969. (To be published in monograph.)

Dietzel, W., Hinshaw, L. B., Samuelson, S. A., Massion, W. H., and Guenter, C. A. Arterial PCO_2 and Capillary Permeability. *Clin. Res.*, 1969.

Hinshaw, L. B., Shires, T. K., and Parry, W. L. Autoregulation and Response to Ischemia in Canine and Primate Kidneys. *Clin. Res.*, 1969.

Shanbour, L. L., and Hinshaw, L. B. Effects of Dopamine Infusion in Endotoxin Shock in the Dog. *Fed. Proc.*, March 1969.

Solomon, L., Blaschke, J., Phillips, R., Price, W. E., and Jacobson, E. D. Splanchnic Hemodynamic Responses to Ouabain in the Dog. *Clin. Res.*, January 1969.

CONTRIBUTIONS TO THE NAVY

This work aims at devising and validating more effective therapeutic procedures to control shock and prevent lung complications following severe injuries. It should contribute directly to the care of casualties from combat operation.

University.—Rensselaer Poly. Institute Troy, N.Y.

Title.—Radiation Effects on Electronic Materials.

Contract No.—N00014-68-A-0495.

Start date.—July 15, 1968.

Reports.—None to date.

CONTRIBUTIONS TO THE NAVY

Results of this work should make possible the development of materials which improve the radiation resistance and reliability of electronic devices for missile applications and satellite systems; of materials for use in and around reactors and isotopic power supplies with improved high temperature capabilities and increased life times; and improved radiation detectors.

University.—William Marsh Rice University, Houston, Tex.

Title.—Coherent and Noncoherent Electromagnetic Radiation. Contract No.—NOOO14-68-A.

Start date.—15 July 1968.

REPORTS RECEIVED TO DATE

1. "Test of Time-Reversal Variance of Long Interactions Utilizing the Mossbauer Effect," Hannond, J. P. and Trammel, G. T. Physics Review Letters 21, 726, 1968.
2. "A Cascade Image Intermediate Camera Beam-Foil Spectroscopy", Proc. of the Fourth Symposium on Photo-Electronic Image Devices—McGee, J. D., Editor.
3. "Interference of Electronic and Nuclear Resonance Absorption for Mossbauer Gamma Rays", Trammel, G. J. and Hannon, J. P., Physics Review Letters, November 1968.
4. PhD Thesis, "A Quantum Theory of Occurrence and Polarization of Light," Pann, K.: September 1968.
5. "Infra-red Astrophysics," Low, F. J., *Science*, May 2, 1969.
6. "Infra-red Astronomy Applications," Low, F. J., Detection and Cryogenics, Frankfurt, April 1969.
7. "Infra-red Astronomy," Low, F. J. American Astronomical Society Spring Meeting, February 1969.

CONTRIBUTIONS TO THE NAVY

(1) An airborne far infrared system with very low noise has been developed.

(2) Consultation with DOD on the infrared brightness of the sky, has resulted.

Contractor.—Southern Methodist University.
Title.—Statistics in Celebration Methods.
Contract No.—N00014-68-A-0515.
Start date.—July 1968.

REPORTS RECEIVED TO DATE

D. B. Owen, "Summary of Recent Work on Variables Acceptance Sampling with Emphasis on Non-Normality',, Technical Report No. 1, September 1968.

John E. Walsh, "Probability of Locating a Submarine Within a Stated Distance by Use of a Range-Bearing Sensor," Technical Report 2, September 1968.

John E. Walsh, "Sample Sizes for Approximate Independence of Largest and Smallest Order Statistics," Technical Report No. 3, September 1968.

John E. Walsh, G. J. Kelleher, "Extended Uses of Linearized Non-Linear Regression for Random-Nature Simulations," Technical Report No. 4, September 1968.

R. L. Thomasson, C. H. Kapadia, "On Estimating the Parameter of a Truncated Geometric Distribution," Technical Report No. 5, September 1968.

John E. Walsh, "Exact Existence of Every Possible Distribution for Any Sample Order Statistic," Technical Report No. 6, September 1968.

John E. Walsh, "Sample Sizes for Approximate Independence Between Sample Median and Largest (or Smallest) Order Statistics," Technical Report No. 7, September 1968.

John E. Walsh, "Approximate Joint Probabilities for Largest and Smallest of a Set of Independent Observations," Technical Report No. 8, September 1968.

John E. Walsh, "Change of All Success for Independent Binomial Events with Large Success Probabilities," Technical Report No. 9, September 1968.

John E. Walsh, "Approximate Distribution for Largest and for Smallest of a Set of Independent Observations," Technical Report No. 10, September 1968.

John E. Walsh, "Recent Probability Results for Extreme Ages," Technical Report No. 11, September 1968.

G. H. Kapadia, "On the Analysis of Triangular Designs," Technical Report No. 12, September 1968.

R. E. Kromer, C. H. Kapadia, "Sample Size Required to Estimate a Parameter in the Power Functions Distribution," Technical Report 13, September 1968.

John E. Walsh, "Probability of Locating a Submarine Within a Stated Distance on the Basis of Two Directional Sensors," Technical Report No. 14, September 1968.

J. T. Webster, "A Note on the Evaluation of a Multivariate Normal Integral by the Method of Das," Technical Report No. 15, December 1968.

John E. Walsh, "Generalization of Ratio Estimate for Population Total," Technical Report No. 16, October 1968.

John E. Walsh, "Asymptotic Independence Between Largest and Smallest of a Set of Independent Observations," Technical Report No 17, October 1968.

John E. Walsh, "Sample-Like Distribution of an Order Statistic Under General Nonsample Conditions and Some Asymptotic Implications," Technical Report No. 18, October 1968.

John E. Walsh, "Development and Analysis of Modified Paired Comparisons by Use of Linearized Nonlinear Regression," Technical Report No. 19, October 1968.

G. M. Jones, C. H. Kapadia, D. B. Owen, and R. Bland, "On the Distributions of the Quasi-Range and Midrange for Samples From a Normal Population," Technical Report No. 20, October 1968.

Hal Watson, Jr., "Dynamic Testing and Wave Propagation in a Strain Rate Sensitive Material," Technical Report No. 21, December 1968.

Danny R. Dixon and C. W. Tittle, "Stress-Wave Propagation in a Three-Region Cylindrical Composite Medium," Technical Report No. 22, November 1968.

Paula Carter Davis, D. H. Kapadia, and J. T. Webster, "Distribution of Quadratic Forms in the Multirvariate Singular Normal Distribution," Technical Report No. 23, January 1969.

A. M. Kshirsagar, "Goodness of Fit of an Assigned Set of Scores for the Analysis of Association in a Contingency Table," Technical Report No. 24, February 1969.

John E. Walsh and G. J. Kelleher, "Approximations to Large Probabilities of All Successes for General Case and Some Operations Research Implications," Technical Report No. 25, February 1969.

A. M. Kshirsagar, "Correlation Between Two Vector Variables," Technical Report No. 26, March 1969.
John E. Walsh, "Discrete Two-Person Game Theory With Median Payoff Criterion," Technical Report No. 27, March 1969.

CONTRIBUTIONS TO THE NAVY

This study of signal detection and analysis is expected to contribute improved processing methods applicable to a wide range of detection and classification problems particularly in the radar and sonar fields.
University.—West Virginia University.
Title.—"V/STOL Aerodynamics."
Contract No.—N00014-68-A-0512.
Start date.—July 15, 1968.

REPORTS RECEIVED TO DATE

Fanucci, J. B. and Walters, R. W., "Analysis of the Rotor Downwash in Ground Effect in the Presence of a Step," AIAA/AHS VTOL Systems Conference, Atlanta, Ga., February 19, 1969.
Migliore, Paul G., "Rotor-Induced Flow Fields, Ground Effect in the Vicinity of Vertical Step," Department of Aerospace Engineering, Technical Report No. 13, April 1969.

CONTRIBUTIONS TO THE NAVY

The work is contributing to the development of composite lift/cruise aircraft systems, including higher lift and speed, and improved control and response. The work applies directly to investigations of aerodynamic circulation, augmentation, and control techniques for rigid and stoppable rotors, and to the feasibility of heavy-lift helicopters.

EXPANSION OF PROJECT THEMIS

Mr. LIPSCOMB. Secretary Frosch, you mentioned that you are setting up these centers of excellence in universities or colleges that have not participated before. This is true in some cases but in other cases you are establishing further centers in universities that already participate in one way or another, such as the University of Notre Dame. That is not a new center for the Navy. Likewise, the University of Minnesota.

Dr. FROSCH. The ground rules for the program were centered in all DOD programs by the Office of the Director of Defense Research and Engineering, and the criteria, which I can read for the record, are:

A college or university that expended more than $8 million during fiscal 1968 from DOD grants and contracts is not encouraged to submit proposals.

All of the proposals that do come in, in response to the information that the program exists, are sent to a D.D.R. & E. group which has representatives from all the services, which goes over the proposals. The D.D.R. & E. committee decides which programs ought to be considered, and then the group essentially decides which are of particular interest to each service, and each individual service then has the job of going out and making final decisions and determinations and negotiations, and running the program.

So it is a process in which we participate with the other services and the Office of the Director of Defense Research and Engineering.

TYPE OF RESEARCH CARRIED ON UNDER PROJECT THEMIS

Mr. LIPSCOMB. Do we tell the universities what we need or do they tell us what they would like to do?

Dr. FROSCH. The brochure that goes out contains a list of scientific areas and programs that we think are interesting. Perhaps I might read a couple of samples.

The section of the brochure is headed "Relevant Research Problem Areas." The first category is "Detection and Surveillance." The first subcategory under that is "Detectors" and there is a long paragraph that describes the kind of detectors that interest us for night and all-weather purposes and some discussion of the kind of technology we think we would like to have. Then it goes on to another set of items which I can read the titles of: "Superconductive Technology Aimed at Electronic Devices," "Image Intensification Techniques," "Certain Areas of Quantum Electronics and Underwater Acoustics." The next category is "Energy and Power" and that discusses certain things of military interest. We go on through "Computer Science," "Material Science," and so on. This is a long list of fairly reasonably specific areas that we know are of interest to us to have new knowledge and information. Based on this they can either make proposals that are drawn from this set of requests, or they can make other proposals, and we can decide.

Mr. LIPSCOMB. Are most of these studies of an unclassified nature?

Dr. FROSCH. They are all unclassified.

Mr. LIPSCOMB. Does the recipient of the grant have complete authority and permission to publish the results of the study?

Dr. FROSCH. Yes.

TRANSFER OF PROJECT THEMIS TO NATIONAL SCIENCE FOUNDATION

Mr. LIPSCOMB. Why wouldn't it be possible for the Department of Defense, including all the branches of the service, to lay their requirements on the National Science Foundation where I believe it belongs and let them administer it and carry it through their regular program? In fact, they are doing some of this right now.

Dr. FROSCH. I can think only of one major problem in doing that, and that is I believe their charter and statute makes them responsible for science that does not have somebody's specific mission requirement attached to it, and whether we could in fact get that much mission flavor into it, I don't know. The Navy has not discussed that possibility with NSF. I don't know whether the OSD has.

Mr. LIPSCOMB. This committee in two reports has suggested that the Department of Defense turn this over to the appropriate agency that has capability for administering it. You do not know whether any effort has been made to work out something?

Dr. FROSCH. I do not know either way.

Mr. LIPSCOMB. You just happen to be our first witness on Themis.

Dr. FROSCH. I am afraid that is so. I do not know what has been done in that regard.

Mr. LIPSCOMB. I wish we could get some resolution of this because of the time and effort that is spent on it by DOD and each of the services.

Dr. FROSCH. We believe, and we think that the record of Navy-sponsored scientific research over the years demonstrates, that it is important for the services to sponsor quite basic research in areas that they think will be important to future missions of the service.

We have quite a large number of items which came out of Navy-sponsored research and have been important to the Navy. Probably the strongest example of an area in which we sponsor basic research is oceanography, where we sponsor it because we know that the basic knowledge about the ocean has been important to an understanding of how to do Navy missions and we expect that it will continue to be important in that way.

RESEARCH ON RESEARCH

Mr. LIPSCOMB. Last year, Admiral Owen, we had a little discussion about the project which was entitled, I think by you, "Research on Research."

Admiral OWEN. At Case-Western Reserve.

Mr. LIPSCOMB. Have you had any substantial research papers produced from this study on research on research?

Admiral OWEN. There have been reports from the project. I personally have not read them, sir. I can provide the reports for the record.

Mr. LIPSCOMB. This particular project, "Research on Research," is a joint effort.

Admiral OWEN. That is correct.

Mr. LIPSCOMB. With an investment of $300,000 for last year.

Admiral OWEN. Our contribution initially was $100,000, as I recall, I do not believe we had responsibility for funding it in successive years.

Mr. LIPSCOMB. Are you aware of any helpful consultation that has taken place by the participants on "Research on Research" and with the personnel of the military departments?

Admiral OWEN. I believe my people who have interests in this area have visited Case-Western Reserve and have talked to the people. To my knowledge there has been no consultancy in my office itself.

Mr. LIPSCOMB. If there have, could you provide the dates and place and a description of such consultation?

Admiral OWEN. Yes, sir.

(The information follows:)

There has been no direct consultation in my office. A representative of my office, however, visited Case-Western Reserve on September 20, 1967, March 6, 1968, December 5 and 6, 1968, and February 12, 1969, to discuss the status of their work on research management.

Mr. LIPSCOMB. Also, for the record, provide any substantial research papers that have been produced.

Admiral OWEN. Yes, sir.

(The information follows:)

Contractor.—Case-Western Reserve University.
Title.—Research in R. & D. management.
Contract No.—DA HC 19-68-CX0007.
Contracting office.—Department of the Army Office of the Chief of Research and Development.
Start date.—September 1967.

SIGNIFICANCE REPORTS

Bushnell, Jon, "Use of Queuing Theory in Study on R. & D. Project Flow," Technical Memorandum No. 125, Department of Operations Research, Case-Western Reserve University, Cleveland, Ohio, October 1968.

Chidambaram, T. S., "Optimality of Full Funding Strategies in R. & D. Allocation Problems," Technical Memorandum No. 102, Department of Operations Research, Case-Western Reserve University, Cleveland, Ohio, May 1968.

Dean, Burton V., Mantel, Samuel J., Brown, Melvin, Friedel, Donald, and Heuttner, David, "Allocation of Resources for Basic Research in a Mission Oriented governmental agency," technical memorandum No. 128, Department of Operations Research, Case-Western Reserve University, Cleveland, Ohio, August 1968.

Dean, Burton V., "Evaluating, selecting, and controlling R. & D. projects," research study 89, American Management Association, 1968.

Mr. LIPSCOMB. Last year, in explaining the program in the record, you said:

The program is currently being sharpened to focus more directly on the specific needs of military R. & D. The actual research is to be performed by about 10 graduate students. It is anticipated that within the next year several substantial research papers will be produced and some helpful consultation to military departments will have taken place.

That was a year ago.

EXPLANATION OF PROJECT THEMIS

Mr. ANDREWS. Mr. Secretary, on this Project Themis, I believe you said the Navy has already spent about $27 million. You are asking for $12 million, plus, now. Therefore, the Navy will have spent, if this request is granted, approximately $40 million on this project. Can you tell us how much the other services have spent on this project?

Dr. FROSCH. I believe we have that. I would like to make one comment on characterizing it as a project.

Mr. ANDREWS. May I have this total figure on Themis?

Admiral OWEN. I am sorry, I do not have the 1967 figure.

Mr. ANDREWS. You say it is not a project. What do you refer to it as?

Dr. FROSCH. It is referred to as Project Themis. A project normally implies that a single piece of work is being done on a single piece of equipment. This is a collection of projects. The Navy list includes—I haven't time to count them—two pages of universities involved.

Mr. ANDREWS. Is it correct to say this Themis project is just a research program farmed out to the colleges by the Navy, or contracted out?

Dr. FROSCH. Yes, it is a set of research projects.

Mr. ANDREWS. In the hope that something useful will come back to the Navy and the other services.

Dr. FROSCH. There is more to it than that. This was devised in response to considerable criticism, a good deal of it in the Congress, to the effect that the Defense Department, and the Government generally, was depending for its research principally on a few universities in particular parts of the country. The suggestion was made that this really ought to be broadened. The problem that we faced then was that we were going to the institutions that had the greatest capability for the research. The suggestion was that with an expenditure of Federal money and DOD money, we could assist universities in other parts of the country to build up a capability to assist the Defense Department, thereby broadening the base of places in the United States that the Department could go to and building up new expertise that would be useful.

Mr. ANDREWS. Broadening the program?

Dr. FROSCH. Yes.

Mr. ANDREWS. Taking in more beneficiaries.

Dr. FROSCH. The additional important point is that we are only interested in contracting for this research if the research is of interest to us for our purposes.

Mr. ANDREWS. I understand. It is a research program conducted by whatever universities you do business with and financed by the Defense Department through the Navy, Army, and Air Force.

Dr. FROSCH. That is correct.

Mr. ANDREWS. If this budget request is granted, the Navy's part will have been at the end of fiscal 1970 roughly $40 million.

Dr. FROSCH. That is correct.

Mr. ANDREWS. I would like to have placed in this record what the other services have contributed to the program so we can find out how much this type of research, which so far as the Navy is concerned has made no contribution that you can put your teeth in at this time.

Dr. FROSCH. I would say again at this point, in a program of this kind that is 3 years old, we would expect lots of small pieces of knowledge to have come out, but I am not surprised that we do not have major significant things to report.

(Discussion off the record.)

SERVICEWIDE COST OF PROJECT THEMIS

Dr. FROSCH. Mr. Chairman, if you like, I have the overall Department of Defense figures.

Mr. ANDREWS. What is it?

Dr. FROSCH. For fiscal year 1967, DOD overall, $17.8 million. For fiscal year 1968, $26.8 million; for fiscal 1969, $28.5 million. The total fiscal 1970 budget request for Themis for the DOD overall is $33 million.

Admiral RUCKNER. A little over $140 million including fiscal 1970.

Mr. LIPSCOMB. Actually you have not allocated your 1969 money yet.

Admiral OWEN. Sir, it depends on what you mean by allocated. We have our contractors lined up. We are in the process of negotiating with them. I am hopeful we will have our fiscal 1969 money obligated prior to the 1st of July.

Mr. LIPSCOMB. I am sure you will. But the thing is that you allocate and spend the money a year after we appropriate it, is that right?

Dr. FROSCH. That has been the case. The process of getting the proposals and putting them in the overall DOD mechanism and coming to a conclusion has taken about that period of time.

Mr. LIPSCOMB. And the universities want to work this way so the program is always on-going.

Dr. FROSCH. No, I think this cannot be put on the universities. This is more a matter of administrative processes inside the DOD. In this case, at any rate.

PURCHASE OF EQUIPMENT FOR PROJECT THEMIS

Mr. LIPSCOMB. Would you put a listing in the record of Themis expenditures for 1967, 1968, and 1969, for any brick and mortar construction that was programed or equipment which was purchased?

Dr. FROSCH. I am sure we can do the brick and mortar. In order to do the equipment, do you mean a list of equipment items or a total of dollars spent for equipment? If it is a list of equipment items, I would suggest that we say something about the size of the item or the list can be very long because there may be a large number of small instruments in some cases.

Mr. LIPSCOMB. I do not believe there was any indication of this committee that Themis funds should go for substantial equipment investment.

Dr. FROSCH. I do not know whether the investment would be substantial but there might be a fair number of small items.

Mr. LIPSCOMB. It is primarily a studies and analysis program, is it not?

Dr. FROSCH. No, it is not.

Mr. LIPSCOMB. They are going to produce.

Dr. FROSCH. It is in large measure experimental work.

Mr. ANDREWS. I can see why you would have to have equipment to do a project.

Mr. LIPSCOMB. I am talking about equipment that is built into the university.

Dr. FROSCH. That we can break out if there is any such.

(The information follows:)

MAJOR EQUIPMENT ITEMS FOR THEMIS CONTRACTS

The following table provides a listing of major items of equipment for the Themis contracts:

Contractor/State.—Arizona State University, Tempe, Ariz.
Contract No.—N00014-68-A-0150.
Short title.—Human Performance in Unusual Environments.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Line 8 computer	$53,800	
Pressure chamber	34,500	
Extended life support system for chamber		$21,750

Contractor/State.—Catholic University, Washington, D.C.
Contract No.—N00014-68-A-0506-0002.
Short title.—Vitreous State Basics.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Electron microscope		$50,000

Contractor/State.—Florida State University, Tallahassee, Fla.
Contract No.—N00014-68-A-0494.
Short title.—Computer Based Instruction.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Interface system computer	$16,000	

Contractor/State.—Iowa State University, Ames, Iowa.
Contract No.—N00014-68-A-0162.
Short title.—Automatic Navigation and Control.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Computer components		$34,277

Contractor/State.—Kansas State University, Manhattan, Kans.
Contract No.—N00014-68-A-0504.
Short title.—Radiation and Electronics.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Recording spectrophotometer		$15,000
Dual monochromator		12,000

Contractor/State.—Lehigh University, Bethlehem, Pa.
Contract No.—N00014-68-A-5014.
Short title.—Low Cycle Fatigue.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Amsler slow cycling unit and associated equipment		$23,000

Contractor/State.—Missouri, University of Rolla, Mo.
Contract No.—N00014-68-A-0497.
Short title.—Aqueous Aerosols.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Vertical atmospheric wind tunnel	$38,500	.....

Contractor/State.—New Mexico, University of Albuquerque, N. Mex.
Contract No.—N00014-68-A-0158.
Short title.—Radiation and Semiconductors.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Vacuum system	$10,000	.....

Contractor/State.—New York at Buffalo, State University.
Contract No.—N00014-68-A-0126.
Short title.—Environmental Physiology.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Submergence tank	$30,000	.....
Rotating arm equipment	50,000	.....
Monitoring, recording, and data processing equipment	19,000	$10,000
Mass spectrometer	30,000	25,000
Centrifuge	.....	40,000

Contractor/State.—North Dakota, University of, Grand Forks, N. Dak.
Contract No.—N00014-68-A-0499.
Short title.—High Pressure Physiology.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Process control computer	.....	$40,000

Contractor/State.—Notre Dame, University of, Notre Dame, Ind.
Contract No.—N00014-68-A-0152.
Short title.—Technology of Military Vehicles.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Environmental pressure tank	.....	$10,397

Contractor/State.—Oklahoma, University of, Norman, Okla.
Contract No.—N0004-68-A-0469.
Short title.—Shock Mechanisms and Therapy.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Fluoroscope	$22,350	.....

Contractor/State.—Oregon State University, Corvallis, Oreg.
Contract No.—N000-14-68-A-0148.
Short title.—Computer Oceanography.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
3 oceanographic buoy and sensor systems	$120,000	.....
1 oceanographic buoy and sensor system	.....	$43,000
Meterological sensor and buoy system	.....	12,000

Contractor/State.—Rensselaer Polytechnic Institute, Troy, N.Y.
Contract No.—N00014-68-A-495.
Short title.—Radiation Effects on EM Materials.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
High-power magnet system	$29,400	
Positive ion conversion unit		$22,000

Contractor/State.—Stevens Institute of Technology, Hoboken, N.J.
Contract No.—N00014-68-A-0131.
Short title.—Nonlinear Physics of Polymers.

PLANNED EXPENDITURES

Major equipment	Fiscal year 1968	Fiscal year 1969
Thermal gravimetric analyzer	$11,000	
X-ray diffraction unit	19,000	
Deformation colorimeter components	12,000	
Instron mechanical test unit		$22,300

(Clerks note: There were no equipment expenditures during fiscal year 1967. There were no construction expenditures during fiscal year 1967, 1968 or 1969.)

RESEARCH AT CASE-WESTERN RESERVE

Mr. MINSHALL. Mr. Frosch, you previously answered that student riots and unrest has had no effect on your Project Themis or university programs. But you have had student unrest at certain of these universities and colleges where you have Themis funds; have you not?

Admiral OWEN. Yes, sir; there has been student unrest at one or more of the schools which are Themis funded.

Mr. MINSHALL. Was this in any way connected with the Federal programs at these colleges or universities, in protest of them?

Admiral OWEN. There was a question with regard to pursuit of defense-related research at the State University of Buffalo. The situation was satisfactorily resolved within the university. There was a question. I cannot say there was interference with the work, sir.

Mr. MINSHALL. We had some unrest, as you call it, at Case-Western Reserve.

Admiral OWEN. Yes; I am familiar with that. The business administration office was closed for one day that I know of.

Mr. MINSHALL. This was in no way connected with any of the Government-funded projects at Case-Western Reserve?

Admiral OWEN. To my knowledge, no, sir.

I queried my branch office representative with regard to universities in the Midwest and he has indicated there has been no interference with Navy contracts at universities in the Midwest, including Case-Western Reserve.

Mr. MINSHALL. Will you please supply for the record, after you have consulted with DOD, what other Federal funds in support of defense projects are going to Case-Western Reserve?

Admiral OWEN. Yes, sir.

(The information follows:)

DOD CONTRACTS AT CASE-WESTERN RESERVE

The following tabulation lists DOD contract funds placed in support of defense projects at Case-Western Reserve during fiscal year 1968:

	Fiscal year 1967	Fiscal year 1968	Fiscal year 1969
Department of the Army	$703,638	$784,725	$793,338
Department of the Air Force	319,063	432,180	685,124
Department of the Navy	309,670	307,020	194,486

ADMINISTRATION OF PROJECT THEMIS

Mr. LIPSCOMB. Admiral, you bring up an interesting point here. How many personnel, officers, civilian, enlisted personnel, do you have working on the Themis program? You mentioned your midwestern representative.

Admiral OWEN. I am sorry, sir. I was speaking of my branch offices that I have for contract administration of all Navy and certain NASA, Army, and Air Force contracts at civilian universities.

Mr. LIPSCOMB. How many people do you have administering Themis in the Navy?

Admiral OWEN. Administering Themis per se?

Mr. LIPSCOMB. Yes.

Admiral OWEN. This would be a part-time assignment for a variety of my people both at headquarters and in the field.

Mr. LIPSCOMB. You have nobody in charge?

Admiral OWEN. Yes, sir. At headquarters my director of research, Dr. Trumbull and his deputy, Mr. Pryce, are responsible for the pursuit of the Themis programs and the contract administration aspects are taken care of in the field by my representatives.

Mr. LIPSCOMB. For the record, maybe you could list the administrative personnel associated with Themis, plus the administrative costs, because the cost of DOD administration is not included in the Themis request before the committee. That is correct; isn't it?

Dr. FROSCH. I think cost of administering an additional $12 million worth of research in an office that operates $178 million worth of direct contract research annually would effectively disappear into the overall administrative cost.

Mr. LIPSCOMB. I thought Admiral Owen just said he had somebody administering Themis.

Dr. FROSCH. There are people who are responsible for administration of contract areas who also administer the Themis contracts when appropriate for those areas.

Mr. LIPSCOMB. With all the accounting systems in the Department of Defense, maybe we could figure out what the administrative cost of Themis is, literature, folders, mailing expense.

Dr. FROSCH. We would have to work with the other services in the D.D.R. & E. to get such an estimate.

Mr. ANDREWS. Put that in the record.

(The information follows:)

Cost of administering Themis program—DOD-wide in fiscal year 1969

DOD	$33,800
Army	128,500
Navy	139,850
Air Force	138,800
	440,950

OPERATION OF THEMIS CONTRACTS

Mr. ANDREWS. I want to ask you one other question about Themis contracts.

Admiral Owen, let us assume that you make a contract with a college for $500,000 under your Themis program. Tell us how the mechanics of the program operate. What becomes of the $500,000? Do you have a contract that big?

Admiral OWEN. No, sir.

Mr. ANDREWS Let us make it $100,000.

Admiral OWEN. They average $200,000 a year.

Mr. ANDREWS. Take a $200,000 contract then.

Admiral OWEN. The university will have proposed a program of work related to Navy interest, and we will have approved that research. The proposal will outline the job to be done, the number of people, their salaries, and other expenses associated with the contract. That contract will be negotiated by my contract people with the university. When the contract has been consummated, the university manager and his staff will commence work. Normally you will find that the staff addressing itself to the program consists of members of the faculty and graduate students who are working in this field of interest to the Navy.

Mr. ANDREWS. How many people would be involved in the $200,000 contract at the college level?

Admiral OWEN. This may vary. One can roughly say perhaps 15 to 20 people.

Mr. ANDREWS. Let us say 20.

Admiral OWEN. It would vary, sir, depending on who was particularly involved.

Mr. ANDREWS. So the $200,000 would pay for personal services of those 20 people?

Admiral OWEN. Plus the material associated or necessary for conduct of the project, plus the necessary service support that the university must provide in the way of utilities, janitorial services, stenographic service, and so forth.

Mr. ANDREWS. Does the college charge a fee for any part of the $200,000 for administrative costs of the college?

Admiral OWEN. Not a fee, sir.

Mr. ANDREWS. Does the college charge any administrative fee?

Admiral OWEN. There is an overhead applicable to all Federal contracts at that particular university.

Mr. ANDREWS. Tell us something about the overhead.

Admiral OWEN. The overhead charges at colleges and universities, that is the allowable overhead charges are based upon the principles set forth in Bureau of the Budget Circular A-21. It provides for

those support charges such as we mentioned, utilities, janitorial service, administrative service provided by the university in support of the particular Government contract.

They would range on an average between 55 and 60 percent of what they call the direct labor hours associated with the contract. These are the terms generally used in the assignment of overhead.

Mr. ANDREWS. Fifty percent.

Admiral OWEN. Of the direct labor hours. I believe the GAO has made a study of overhead charges at colleges and universities, sir, and I believe that has been submitted by now to the Congress. This is an average figure I quoted.

Mr. ANDREWS. In the record, when you correct your remarks I wish you would break down a hypothetical typical $200,000 contract, the number of employees, salaries, overhead, fees, everything. In other words, tell us how the $200,000 is spent.

Admiral OWEN. Yes, sir.

(The information follows:)

An example of a Themis contract which has a first year budget of $200,000 is as follows:

PERIOD: JULY 15, 1968, TO JULY 14, 1969

	University cost sharing	Contract budgeted costs
Salaries:		
Scientist, 50-percent time, $20,000, 11 months	$5 000	$5,000
Scientist, 25-percent time, $17,000, 11 months	2,125	2,125
Scientist, 50-percent time, $17,000, 11 months	4,250	4,250
Scientist, 50-percent time, $15,000, 11 months	3,750	3,750
Scientist, 50-percent time, $13,500, 9 months	3,375	3,375
Scientist, 50-percent time, $12,000, 9 months	3,000	3,000
Scientist, 50-percent time, $12,000, 9 months	3,000	3,000
Postdoctorals (2), 100-percent time, $11,000, 11 months		22,000
Graduate students (14), 50-percent time academic year, 100-percent time, summer		49,600
Total, salaries	24,500	96,100
OASI, 4.8-percent, 1968-70; 5.2-percent, 1970-71	1,176	4,613
Indirect costs, 54.33 percent of salaries	(13,311)	(52,211)
Permanent equipment (This includes a vertical, atmospheric wind tunnel.)	10,000	38,500
Machine shop, supplies, and miscellaneous		5,000
Travel to meetings and conferences		800
Publication, report reproduction, page charges, reprints		776
Computer charges		2,000
Total, direct costs	35,676	147,789
Total, indirect costs	13,311	52,211
Grand total	48,987	200,000

BEHAVIORAL AND SOCIAL SCIENCE RESEARCH

Mr. ANDREWS. Mr. Secretary, will you provide a table showing the amount of funds made available and programed for behavioral and social science research by fiscal year since 1967?

(The information follows:)

BEHAVIORAL AND SOCIAL SCIENCES RESEARCH

[In thousands]

Appropriation	Fiscal years— 1967	1968	1969	1970
Research, development, test and evaluation, Navy	$3,873	$3,620	$4,007	$4,119

RESEARCH IN FOREIGN COUNTRIES

Mr. ANDREWS. Provide a list for the record showing the amount of the Navy R.D.T. & E. budget that will be used to fund research in foreign countries, by country, and compare this with each fiscal year since fiscal year 1967.

(The information follows:)

FUNDING OF FOREIGN PERFORMERS APPROPRIATION, "RESEARCH, DEVELOPMENT, TEST AND EVALUATION, NAVY," FISCAL YEARS 1967, 1968, 1969, AND 1970

[In thousands]

	Fiscal year—			
	1967	1968	1969 (estimate)	1970 (estimate)
Argentina	$11	$25		
Australia	13	10	$15	
Belgium		9		
Bermuda	29			
Brazil	15	44	25	
Canada	2,273	1,772	358	
Denmark	6	6		
France	43	86	67	
West Germany	28	9	150	
Iceland	714	25		
Ireland	4		50	
Israel	126	86	76	
Italy	44	42	14	
Japan	3	35	56	
Netherlands	30	20	20	
Norway	181	161	122	
Spain	3			
Sweden	41	28		
Switzerland	2			
Trinidad	40			
United Kingdom	137	193	323	
Urguay	5			
West Indies	62			
Total	3,810	2,541	1,276	824

SACLANT ASW RESEARCH CENTER

Mr. LIPSCOMB. There is an activity which appears in the justification sheet for the first time, to my knowledge, that is called SACLANT ASW Research Center.

Dr. FROSCH. Yes.

Mr. LIPSCOMB. It was previously funded under military assistance. Is this a new program to your foreign research?

Dr. FROSCH. This is a NATO laboratory that has been in existence for at least a decade to my knowledge.

Admiral GADDIS. Since the late 1950's.

Dr. FROSCH. It was funded in MAP, I think, essentially as an administrative matter. The decision was rather than funding it under MAP it ought to be funded under R.D.T. & E.

Mr. LIPSCOMB. How much is included for that?

Dr. FROSCH. $249,000 in fiscal 1970.

Mr. LIPSCOMB. Is that just the Navy share or is that the total?

Dr. FROSCH. That is the total U.S. share. It is entirely a Navy associated ASW laboratory.

Admiral GADDIS. This is a similar situation, Mr. Lipscomb, to our inclusion in the "Shipbuilding and conversion, Navy," of the frigate

for ——— where those projects of direct military application are now funded in the regular appropriation rather than under the MAP appropriation.

Mr. LIPSCOMB. Are you putting this NATO appropriation in the same category as emergency funds for Southeast Asia which includes ———. Is that what you meant?

Admiral GADDIS. No, sir. If you recall, sir, under the SCN appropriation we had two line items, one was the partial funding with ——— of the subchaser or patrol vessel, and support for Vietnam in building a frigate.

Mr. LIPSCOMB. We are handling in the Defense appropriation budget Southeast Asia expenditures, but this happens to be a NATO program.

Dr. FROSCH. I think Admiral Gaddis meant this was analogous to a case that was discussed under SCN.

Mr. LIPSCOMB. We could draw the same conclusion with all military assistance programs and then put them all in this budget, couldn't we?

Admiral GADDIS. This, like other military assistance, comes under its proper appropriation which in this case is R. & D.

Admiral RUCKNER. This is administered by a U.S. officer with his SACLANT hat. This is the money that funds our share of the total laboratory.

Mr. LIPSCOMB. Do you have any idea what other NATO countries are placing into the operation of the lab?

Dr. FROSCH. I don't know precisely, but it must be very much more in toto than our contribution, because our contribution would amount to paying for about four or five scientists and their technicians and the number of people there is closer to something like a total of 200. Fifty of these are scientists. I can find the precise numbers for the record.

(The information follows:)

NATO financial support for SACLANT ASW Research Center, La Spezia, Italy

[Percentages by nations on cost-sharing basis for calendar year 1969]

	Percent share
Belgium	8.56
Canada	6.99
Denmark	2.10
Germany	19.42
Greece	.47
Iceland	.06
Italy	7.38
Luxembourg	.11
Netherlands	8.55
Norway	1.45
Portugal	.78
Turkey	1.99
United Kingdom	21.98
United States	30.16

Mr. LIPSCOMB. Do you consider this as part of your foreign research now?

Dr. FROSCH. I do not believe it is classified that way, no. It appears as foreign research but it is a special item in that it is a contribution to a NATO laboratory and is not the support of an individual investigator someplace overseas.

Dr. RANEY. A large fraction of the money we contribute goes to the salaries of U.S. scientists stationed at SACLANT center.

Mr. LIPSCOMB. If you have four or five scientists there and you are paying $249,000, you are contributing something besides salaries.

Dr. RANEY. We are contributing small sums in addition to the salaries of the scientists, but the Italian Government provides the facilities, other NATO nations provide scientists, and in some cases facilities. For instance, they have a small ship which they operate for oceanographic missions. Part of the moneys go into the support of the operation of that ship. But the bulk of the money we put in goes to the support of U.S. personnel at the center.

Mr. LIPSCOMB. You can put an analysis of this in the record.

Dr. FROSCH. Yes, sir.

(The information follows:)

U.S. SUPPORT OF SACLANT ASW RESEARCH CENTER, LA SPEZIA, ITALY

The Navy was assigned administrative responsibility for the SACLANT ASW Research Center. In March 1963 the Chief of Naval Research was authorized to:

(a) Assume the U.S. Navy responsibility pertaining to personnel and administrative matters affecting U.S. employees assigned to the center;

(b) provide U.S. liaison support as described in the SACLANT ASW Research Center Charter; and

(c) assist the director of the center, as feasible, to obtain additional scientists on loan and equipment on request.

The following chart shows the budget estimate, military assistance program obligations by object classification, Navy:

Description	Fiscal year 1968, actual total cost	Fiscal year 1969, estimated total cost	Fiscal year 1970, estimated total cost
Personnel compensation	134,000	153,000	153,000
Personnel benefits	31,000	34,000	34,000
Travel and transportation of persons	12,000	19,000	19,000
Transportation of things	7,000	15,000	15,000
Other services	1,000	12,000	12,000
Total obligations	185,000	233,000	233,000

Fiscal year 1969 estimate for "Other services" reflects anticipated increased activity in providing additional U.S. scientists on loan to assist the Director.

MILITARY ASSISTANCE PROGRAM OBLIGATIONS BY OBJECT CLASS (11-12) DETAIL OF PERSONNEL SERVICES

	Grade and title of position	1968 actual[1]	1969 estimate[2]	1970 estimate[3]
	Civilian Personnel			
FD-2	Deputy director	$22,308	$24,614	$24,614
FD-3	Operations research analyst	21,602	23,868	23,868
FD-3	Operatons research analyst	21,602	23,868	23,868
FD-4	Operations research analyst	15,307	16,329	16,329
FD-4	Oceanographer	13,957	15,369	15,369
FD-4	Electronic engineer	13,957	15,369	15,369
FD-5	Electronic engineer	12,957	13,722	13,722
FD-5	Oceanographer	12,233	12,938	12,938
FD-7	Oceanographer	8,907	9,300	9,300
	Total authorized permanent U.S. civilian personnel positions (9)			
	Total	142,848	155,377	155,377

[1] Project No. 4.
[2] Project title—International military sales.
[3] Activity—London branch office (La Spezia, Italy).

ANTISUBMARINE WARFARE PROGRAM

Mr. ANDREWS. We will now discuss the antisubmarine warfare program.

FUNDING

Will you provide for the record the dollar amount and percent of R.D.T. & E. funds directed to your ASW program by fiscal year since 1964?

(The information follows:)

ASW PORTION OF TOTAL R.D.T. & E., N. SINCE FISCAL YEAR 1964

[Dollar amounts in millions]

Fiscal year	Total R.D.T. & E., N.	ASW R.D.T. & E., N.	ASW percent of total R.D.T. & E., N.
1964	$1,565.2	$283.9	18.1
1965	1,423.4	315.0	22.1
1966	1,582.5	357.0	22.6
1967	1,947.4	360.5	18.5
1968	1,886.2	306.1	16.2
1969	2,161.1	359.3	16.6
1970	2,211.5	472.3	21.4

Mr. ANDREWS. Will you also compare the ASW program for those fiscal years with the amount appropriated by Congress for the purpose?

(The information follows:)

ASW R.D.T. & E, N. COMPARED WITH AMOUNT APPROPRIATED BY CONGRESS

[In millions of dollars]

Fiscal year	Navy program	Appropriated by Congress
1964 [1]	283.9	296.9
1965 [1]	315.0	295.7
1966	357.0	383.1
1967	360.5	362.9
1968	306.1	353.6
1969	359.3	386.3
1970	472.3	.....

[1] Adjusted for comparability with ASW program purification effected in fiscal year 1966.

INTERIM DATA PROCESSING

Mr. ANDREWS. Why are ASWFORLANT and ASWFORPAC being provided with an "interim" austere automated data processing capability this year?

Dr. FROSCH. I am not sure I understand in what sense you mean why. Do you mean why it is interim instead of final?

Mr. ANDREWS. Yes; interim austere and what does it do?

Dr. FROSCH. Interim austere because we are not yet prepared to provide them with what we think would be a final complete total system. This kind of data processing system is to take care of the fact that an ASW campaign or even a single action against a submarine is based from the point of view of ASW forces in a particular fleet center on a variety of different kinds of data. For example, there may

be acoustic data ———. There may be sightings over a previous period of time by an aircraft.

There may be some kinds of radar information. There may be high frequency direction finding information on submarine communications. There may be a record of some intelligence data. There may be information coming back from an ASW task group at sea. So the commander who is trying to direct the forces for ASW is faced with the problem of a large quantity of data coming from different sources with different degrees of accuracy and time characteristics. He needs a data processing system to help him to coordinate all this data and present it to him in a form so that he can use it for controlling the attacks and controlling his campaign. So this is essentially to collect a lot of different kinds of data, bring it to him, display it to him and give him an opportunity to look back at the previous history of campaigns. He can also use it to help with managing his communications out to his units.

NEED FOR ADDITIONAL RESEARCH

Mr. ANDREWS. As you know, this committee has been extremely interested in ASW activity for a number of years. Are you doing all that your capability will permit in the field of R. & D., ASW?

Dr. FROSCH. I think we are doing everything we can within the assortment of priorities of various naval missions within the funding available.

Mr. ANDREWS. The information the committee has had about Russian submarine activity is frightening.

Dr. FROSCH. There is no question about the submarines they are building.

Mr. ANDREWS. I think the time is now as never before when we should concentrate to the very limit on ASW.

Are you suffering from a lack of funds? Could you do more if you had a higher priority, if you had more funds?

Dr. FROSCH. There are certainly additional projects that are worthwhile that could be carried out with additional funds.

Mr. ANDREWS. Such as what?

Dr. FROSCH. In a number of areas. There are some things that we would like to pursue a little harder in the undersea surveillance area, particularly understanding how to build better ——— and to begin to make faster progress into ———. There are some questions as to whether in the long run when we have a large number of ships equipped with the ———. We need to do some work to keep up with that problem. We could pursue the advances in submarine sonar that we are working on at a somewhat faster pace than we are now. In that area, I think, we are probably with some of the things somewhat money limited more than idea-limited.

ASW is an extremely high priority. It shares about the same kind of priority with the problem of anticruise missile defense which is also an area in which the Soviets have been building up. In those areas and looking at other areas, we had to make choices as to what were the most important things to do.

Mr. ANDREWS. Admiral Owen, do you want to comment on this subject?

Admiral OWEN. Sir, my responsibilities lie principally in the field of oceanography and basic research, but I do say we have attempted

to increase our support in fiscal 1970 of both basic research and in the general oceanographic field that relate very strongly to the ASW program.

RECENT DEVELOPMENTS IN ASW

Mr. ANDREWS. What has Navy research come up with in the last few years in ASW?

Dr. FROSCH. Let us see.

Mr. ANDREWS. Something that is brand new and is now operational.

Dr. FROSCH. I would say that the closest thing to being operational is the Difar sonobuoy which is brand new in that it has ——— sensing properties.

Mr. ANDREWS. How will that be helpful in the ASW program?

Dr. FROSCH. We believe it will make a major difference in the speed and capability of an aircraft to locate a submarine that it has detected.

Mr. ANDREWS. When will that be in use by the fleet?

Admiral GADDIS. ———.

(Discussion off the record.)

Admiral GADDIS. Particularly noteworthy, Mr. Andrews, is the combination of the Difar locating technique with A-new, the avionics in the P–3 aircraft which is now just coming into the fleet. The collection of information from this aircraft is an order of magnitude improvement of anything we have had in patrol aircraft in the past.

(Discussion off the record.)

ARTIC RESEARCH PROGRAM

Mr. DAVIS. We have a few questions relating to arctic research that we would like to talk about. On page 41 of your statement, Dr. Frosch, you make mention of the arctic research program. How much of the budget for fiscal year 1970 is devoted to the arctic research program?

Admiral OWEN. It is approximately $2.8 million, sir, for arctic research.

I beg your pardon, this is arctic research that is conducted under my aegis.

Mr. DAVIS. Is what?

Admiral OWEN. $2.8 million for arctic research.

Mr. DAVIS. How would you classify that research as to military and nonmilitary requirements?

Admiral OWEN. Sir, we consider that all of our arctic research is military related.

Undoubtedly there is information deriving from that program, a whole host of it, related to weather and environment that is applicable to other interests having operations or planned operations in the arctic area. We consider our program as entirely military related but there is a spinoff of information and data related to the nonmilitary community.

Dr. FROSCH. There is one complication which arises from the way in which we conduct some of the research. One of the things we did a few years ago to make it possible to conduct some kind of oceanographic research in the Arctic Basin was to set up by contract with the University of Alaska an arctic research laboratory which performs the job of being a base for people working in the Arctic. Since that base has existed, it has become very useful for people with other interests

in the Arctic. So we give some support, generally reimbursed, to other research work in the Arctic.

Mr. DAVIS. Will you provide for the record a table showing the Arctic research program by appropriation and by fiscal year for the years 1967, 1968, 1969, and 1970.

(The information follows:)

ARCTIC RESEARCH PROGRAM

[In thousands of dollars]

	Fiscal year 1967	Fiscal year 1968	Fiscal year 1969	Fiscal year 1970
Research, development, test, and evaluation, Navy	$2,360	$1,894	$3,558	$2,835
Military construction, Navy	3,000	.....	1,985	.....
Total	5,360	1,894	5,543	2,835

(Discussion off the record.)

NEW RESEARCH PROJECTS

Mr. ANDREWS. How many new starts will you have in fiscal year 1970? Will you discuss briefly the most important ones?

Mr. FROSCH. May we come back to that question?

Mr. ANDREWS. You can supply it for the record.

(The information follows:)

In fiscal year 1970 we plan to start work on 38 new projects. Among the more important ones are:

Destroyer Helo system.—This project will result in a light airborne multipurpose system (LAMPS). It is the intent to develop a light helicopter for operation off of a destroyer and capable of performing tasks in the areas of antiair warfare, antisurface warfare, antisubmarine warfare, and utility missions. Some preliminary work has been performed such as fleet operational investigation of use of a light manned Helo off of a destroyer. In fiscal year 1970 we will conduct concept formulation and commence the first year of development.

The marine tactical command/control system (MTACCS).—This project is directed toward the development of an air/ground tactical command and control system, integrated to the maximum extent possible and pointed toward the amphibious environment to meet the unique requirements of the landing force commander in the 1975–85 era.

The fiscal year 1970 planned program includes implementation of a test bed plan; coordinating and cooperating with the Army tactical operations system (TOS) project; contracting for a study of the requirements and interfaces for an integrated fire and air support system. This integration includes Tacfire, semiautomatic DASC, naval gunfire; tactical position location, and naval amphibious force command, and control systems; and development of functional area descriptions for the amphibious operation, to be followed by feasibility and cost effectiveness analyses to determine the applicability for ADP.

Advanced medical development (aircraft impact injury prevention).—This is a joint program with the U.S. Army in the study of injury and its prevention. We hope to be able, as a result of this research to accurately predict the extent of injury resulting from a given impact force. This data will greatly enhance our capability to design improved structural design of vehicles (including aircraft) and safety equipment.

Tactical satellite communications equipment.—This program is intended to provide improvements modifications, including those necessary for installations in various platforms, and engineering fixes to the advanced TACSATCOMM terminals to insure optimum operation. In fiscal year 1970 we will test these terminals in conjunction with Lincoln Experimental Satellite 6 and the TACSATCOMM I

satellite. We will also assist in contract definition for the follow-on TACSAT system with the Army and U.S. Air Force.

SSBN defense.—The purpose of this project is to conduct analyses of existing and potential threats to our SSBN's, to weigh this threat against our capabilities and to develop defensive systems which will preclude or reduce the possibility of detection of the SSBN. These systems will also enhance the ability of our SSBN's to evade or defend against attack.

Submarine sonar developments (AN/BQS-13) SONAR. This program is intended to develop the AN/BQS-13 DNA sonar———.

Sea tests in support of AN/BQS-13 DNA development were conducted in January/February 1969 establishing feasibility and magnitude of achievable ———. Competitive industrial concept formulation is scheduled to commence in July 1969 following detailed Navy studies.

Mr. ANDREWS. How does this compare with the past 3 years? You may supply that for the record.

Dr. FROSCH. We will have to supply that for the record.

(The information follows:)

In fiscal year 1969 we have 98 new starts and in fiscal year 1968 there were 66. We show 70 new projects in fiscal year 1967. It should be noted that these figures are higher than fiscal year 1970 because they reflect projects started during the course of each fiscal year. The fiscal year 1970 figure of 38 indicated only those which are now planned for commencement in fiscal year 1970. Others will unquestionably be added during the course of the fiscal year as the need arises.

COMPLETED RESEARCH PROJECTS

Mr. ANDREWS. Will you discuss the number of projects completed by fiscal year and describe some of the most interesting projects. Can you do that now?

Dr. FROSCH. Yes. I covered some of them in my statement, I believe, and I can go back to a few of them. What period of time would you like me to speak to?

Mr. ANDREWS. In the last year or two?

Dr. FROSCH. We made the statement up in terms of a 4-fiscal-year period prior to the current one. Among the projects completed have been the standard missile as a replacement for Terrier and Tartar. The basic point defense missile which has come into the fleet and which provides nonmissile ships with antiair defense which they had not previously available. We brought the Walleye TV guided glide bomb into actual operation over North Vietnam during the past 7 years. We had the A-7A and OV-10—an aircraft, both now operational in the fleet. We had the satellite communications program in conjunction with the other services which we are now actually using on a quasi-operational basis from Southeast Asia back to the United States. We have the Navy transit navigational satellite program which is in operational use by the Polaris submarines and by other naval ships, and in fact by non-Navy users. We have the Navy tactical data system which is a system capable of collecting data from radars on the ship, radars on other ships, and information from aircraft in flight, and integrated this data together into a battle picture for the commander.

We have developed what is called the cable-controlled unmanned recovery vehicle, CURV-II, which can pick objects up from 2,500 feet in depth. Those are some highlights. We can add quite a long list, if you like.

(The information follows:)

In fiscal year 1968 we completed 21 more projects under R.D.T. & E., N. and in fiscal year 1969 we expect to complete 23 more.

The more significant weapons and systems completing R. & D. since fiscal year 1964 are as follows:

Navy tactical data system
Marine tactical data system
Satellite communication program
CURV II
Mines MK 52, 55, and 56
Destructor MK-115A
Destructor modification MK-75
60-millimeter mortar MK-4
Grenade machinegun MK-19 and MK-20
Asroc
Subroc
Torpedo MK-46
Basic point defense surface missile system
Standard missile
Snakeye
Sadeye
Weteye
Walleye
OV-10A aircraft
SPS-48 radar
Standard Arm
Bullpup
Sparrow III
C-2A COD aircraft
Sidewinder IC
Navy navigational satellite
A-7A aircraft
Deep dive system MK-I and II
Sea Spider
5"/38 rocket assist projectile
Talos Arm
Briteye
Fireye
Helo trap weapon
Rockeye II
Chaffroc
Threat reactive EW system
Echo range (phase I)
5"/38 ——— Fuse
Automatic carrier landing system
AIMS-MK XII—IFF system
OMEGA navigational system
TRIM (AP2H aircraft)
Helo decoy system
Exploratory development:
Over the horizon radar
HY-130 steel
Solrad satellite
Dextor torpedo
Bikini ——— drone

STATUS OF RESEARCH COMPLETED SINCE 1968

Mr. ANDREWS. Will you provide for the record a list of projects, completed since 1968. In other words, give us an accounting of what you have accomplished in the last 12 months.

Dr. FROSCH. Yes, sir.

(The information follows:)

The following projects have completed research and development since March 1968:

AN/SPS-54 Radar
AN/SPS-55 Radar
AIMS MK-X11 IFF
ANEW ASW Avionics system
ASW ship command and control system
Automatic carrier landing system
Briteye flare

Echo range phase I (EW (simulation range)
Fireye (fire bomb)
5''38 rocket assisted projectile
5''38 fuze
Helo decoy
Helo trap weapon
Navigational satellite system
Omega navigation system
Rockeye II
Seaspider (interim)
Standard arm
Talos arm
Threat reactive EW system
TRIM (AP-2H)

CANCELLED RESEARCH PROJECTS

Mr. ANDREWS. You briefly discussed in your statement a number of projects which were canceled. Will you provide a list of the projects canceled in fiscal years 1968 and 1969, and also let us know what those cancellations cost.

Dr. FROSCH. Yes, sir.

Mr. ANDREWS. Project A, canceled, and what it cost.

Dr. FROSCH. Yes, sir.

Mr. ANDREWS. We are getting a lot of criticism on Capitol Hill, as you know, for canceled contracts, some of which run into millions upon millions of dollars.

(The information follows:)

The following projects have been canceled:

[Millions of dollars]

Project	Total cost
Fiscal year 1968:	
Air transportable sonar	$8.1
Periscope detection radar	10.1
600 HP regenative gas turbine	1.4
F-111B aircraft	[1] 55.4
ILAAS	46.5
FDL ships	17.7
Fiscal year 1969:	
Offensive acoustic warfare	.8
Passive active location	.1
Sub-Launched antiship torpedo	13.8

[1] Percent estimate of F-111B R. and D. lost cost for which R. and D. programs derive no benefit.

Mr. ANDREWS. Now I want to ask you this: In view of the tremendous strides being made by the Russians not only in research and development, but in the actual deployment of new weapons. Are you doing enough to counteract what they are doing in the field of research and development? Members of this committee ———.

Dr. FROSCH. I do not believe we are doing as much research and development or putting enough possible kinds of weapons systems capabilities on the shelf or in the fleet to do that.

Mr. ANDREWS. Have you seen that ——— we referred to?

Dr. FROSCH. Yes; I have.

Mr. ANDREWS. Their amphibious weapons, do we have anything in our arsenal comparable to what they have?

You saw those tanks.

Dr. FROSCH. I don't know enough about the Army tank structure to know, although I have certainly seen movies of U.S. amphibious vehicles that look somewhat like the Soviet ones.

I cannot speak for the details.

Mr. LIPSCOMB. The one we discussed this morning looked something like the Soviet one.

Dr. FROSCH. I can come back to that.

There are two vehicles in fact, the LVTPX–12 is an armored vehicle intended to be an amphibious assault vehicle in a landing. It has capabilities to go through the surf. It is of an advanced design of a conventional sort in that it has ordinary tracks and is intended to go in the water, through the surf, and in land. Development and test is almost complete and it is ready to go into production. The marginal terrain vehicle is intended to be a vehicle that does not participate in the landing in the sense of going through the surf under its own power. It is not intended to have surf capabilities. But it is intended to be brought ashore in situations where there is not hard terrain ashore but a mixture of soft terrain, water, and hard terrain. For that we are trying to develop a different principle than the other track principle for passage over a mixture of soft, hard, and water terrain. We have not tried, and I do not think it would be terribly successful at this stage to try to make an all-terrain vehicle with a surf, ocean, and hardroad capability. I think we are stuck with two kinds of vehicles for the two purposes.

Mr. LIPSCOMB. The one we were discussing this morning and the reason why it was interesting, Mr. Secretary, is that it had been stated as one of the accomplishments of new equipment for Vietnam. That is why it was developed.

Dr. FROSCH. At that point at which we were discussing it we thought we had come to the end of the development and were in fact going to put it into production and get it into Vietnam but we subsequently ran into some troubles with the engineering that we had not anticipated.

Mr. LIPSCOMB. That is understandable.

(Discussion off the record.)

BROOKLYN NAVAL APPLIED SCIENCE LABORATORY

Mr. ANDREWS. Mr. Addabbo?

Mr. ADDABBO. Thank you, Mr. Chairman.

In the Department of the Navy justifications for 1969, on page 31, you show the Naval Applied Science Laboratory, Brooklyn, N.Y., 1970 estimate, $13 million, man-hours 749. Can I gather from this, Mr. Secretary, that the Naval Applied Science Laboratory will continue in that same status and strength?

Dr. FROSCH. No: I think you can gather from that that the justification book was made up when the 1970 budget was being made up prior to the decision to change the status of the Naval Applied Science Laboratory.

Mr. ADDABBO. What is that decision?

PLAN TO CLOSE LAB

Dr. FROSCH. The decision is to take the Laboratory and, with the exception of the navigation work being done at the Laboratory as a backup to the Poseidon project, to phase out portions of the Laboratory and transfer work from other portions of the Laboratory, possibly with the people involved, if they wish to move to some other activities. In particular the navigation work would remain at that site.

The sonar reliability work is expected to go to the Naval Underwater Sound Laboratory at New London; the electronics work to the Naval Electronic Center in San Diego. The material sciences and the electrical work will go to the Naval Ship Research and Development Center at Carderock and the chemical effort to the Naval Weapons Laboratory at Dahlgren.

Mr. ADDABBO. With this spreading to the four winds, do you actually expect these men who are specialized and have been working at the Naval Applied Science Laboratory to go to the four winds?

Dr. FROSCH. We would hope that some of them would move.

Mr. ADDABBO. In your experience of closing down the Brooklyn Navy Yard, isn't it a fact that you lost many experienced men?

Dr. FROSCH. Yes. We will probably lose many experienced men here.

HIGHER COST IN LONG RUN

Mr ADDABBO. We heard testimony only last week by members of the Navy Department where they now rue the day they lost those men because it is costing us more in dollars. Isn't the same thing going to happen by closing down this installation?

Dr. FROSCH. I doubt it.

Mr. ADDABBO. Why not?

Dr. FROSCH. I doubt it because we have looked very carefully over all our laboratories. We have tried to find better arrangements, better consolidations of the work, so that we can essentially package up pieces of work in laboratories that can do them in a more competent way because of the size of the organization and the kind of mission that it has.

The decision has been, and I think quite rightly, that while we will lose some experienced people in this change, we will in the long run have a more effective and efficient organizational operation.

Mr. ADDABBO. These are the exact same words and speeches we heard when we closed the Brooklyn Navy Yard and because of certain changes having to be made it has cost us more dollars. I have not seen to date $1 saved, and as I said before, possibly it is costing us more by moving the work out of the Brooklyn Navy Yard into these other Navy yards.

Can you show me one place where you are going to save us $1? Is there any place in this budget where you show me that we have reductions? I looked through here and I see increases, increases, increases, and I don't see a reduction. Here you are closing a facility and we still do not see a reduction. Where are reductions other than depriving New York of needed military work, destroying work of qualified experienced men, and losing those men to the Government effort?

Dr. FROSCH. Mr. Addabbo, if we were to keep the Applied Science Laboratory as it is, I believe that over the next few years that we would have to ask for a greater increase in Navy R. & D. than we are now asking for because there are higher priority jobs elsewhere and other jobs that would need to be done.

Mr. ADDABBO. This belies the fact because all you have asked for in the last 3 fiscal years, 1968, 1969, and 1970—in 1969 you decreased it from $13 million to $12.9 million and in 1970 you increased it by only $100,000, from $12.9 million to $13 million. I daresay if I go through this request there will be more than a dozen requests of over $100,000 increases in 1 or 2 or 3 years.

NEED TO REDUCE CIVILIAN PERSONNEL

Dr. FROSCH. Mr. Addabbo, over the past several years this committee of the Congress and other committees of the Congress and the Office of the Secretary of Defense has, each year, I believe—and I can provide some references—stated that we had more civilian personnel than the committee or the DOD believed were proper for us to have, and has asked us quite specifically to cut down on our laboratories and on our civilian personnel, to rearrange them so they are more efficient. We have tried to be responsive to that. What we have done is looked among our laboratories for the best way to do it. There are essentially two ways to do it. One way is what I would refer to the "death of a thousand cuts"; namely, you go through the entire laboratory system and slip a little bit off here and there. When we have done that in the past it has clearly had a very deleterious effect on the entire laboratory structure, and has made situations which were very important to us, very difficult to keep operating in a healthy way. So we have looked for another way to do it.

The way we have looked to do it is to find those organizations that we believe are least efficient from the point of view of the overall Navy laboratory organization structure and the work being done by the Navy, of work in them which can be dropped completely, and of jobs in them that really are properly assignable to other organizations that are doing larger pieces of Navy work into which these

would fit. The result of our attempt to do this has simply come out that one of the organizations we feel we need to take apart this way is the Naval Applied Science Laboratory.

PERSONNEL TO INCREASE AT OTHER LABS

Mr. ADDABBO. In these other four or five that you mentioned that are going to take up the work of the now concentrated Naval Applied Science Laboratory in Brooklyn, is there going to be any increase of personnel in those offices?

Dr. FROSCH. There will be some increase of personnel in those places. But the total of transferred personnel to those places does not add up to the total of personnel at the Applied Science Laboratory.

Mr. ADDABBO. Don't you take into effect the separation salaries and transportation costs?

Dr. FROSCH. I think I said earlier it is certainly true that in order to accomplish the move, we will have to use funds that would have been used at Applied Science Lab or elsewhere to get the move. But this is in order to accomplish something that over a long period of time we have a a more efficient, and I think a lower cost, and I hope lower personnel operation.

Mr. ADDABBO. The Naval Applied Science Laboratory at Brooklyn is Government owned.

Dr. FROSCH. Yes, it is.

Mr. ADDABBO. We pay no rental or anything else.

Dr. FROSCH. We have the problem of keeping up the property and so on.

Mr. ADDABBO. You will keep the property open by your own testimony.

Dr. FROSCH. We will keep a small piece of it there and we do not know how long that will continue. We are going to keep it there because we need that direct support to the Poseidon program for the next several years.

We contemplated moving it and the only reason for not moving it and closing the property down completely was the immediate disruptive effect on that work.

ANTICIPATED SAVINGS

Mr. ADDABBO. Next year when you come before us you are going to show us $13 million of savings, aren't you?

Dr. FROSCH. No, I expect not. We will show you that the Naval Applied Science Lab does not appear as a line item for $13 million. It appears for something else.

Mr. ADDABBO. But your overall budget should be decreased by $13 million or thereabouts.

Dr. FROSCH. By something less than $13 million.

Mr. ADDABBO. $6 million.

Dr. FROSCH. By the amount required for moving.

Mr. ADDABBO. It should be decreased by $6 million.

Dr. FROSCH. It should be decreased by some number. I do not know what the estimate for the moving is.

Mr. LAWSON. By next year there will be no saving.

Mr. ADDABBO. No saving in 2 years. By 1971 we should begin to see a saving.

Dr. FROSCH. Yes.

Mr. ADDABBO. About $6 million?

Dr. FROSCH. Probably more than that.

Mr. ADDABBO. In other words, if my good people send me back here in 1972 I can see at least a cut, all things being equal other than the Vietnam war cuts, in this research angle a cut of at least $6 million, if not better.

Dr. FROSCH. Not necesarily. It depends on what other problems the Navy has to do research and development in that year.

Mr. ADDABBO. There could not be a possibility that these same problems could not be worked at the Naval Applied Laboratory where you have a going Government facility, where you do not have to spend money to send these people to the four winds, is that correct?

Dr. FROSCH. If we continue to support all of the laboratories——

Mr. ADDABBO. You are supporting all these colleges. You are asking for $30 or $40 million here where kids are throwing us out of colleges. Here are dedicated men and women who have given their lives to the Government for 20 years.

Dr. FROSCH. The work being done in the colleges and universities is an entirely different kind of work. I do not believe it could be done at the Applied Science Laboratory by the people who are there.

Mr. ADDABBO. Do you want to bet? I think you better take another careful look at this particular feature because I will be taking a very careful look at your budget.

Thank you, Mr. Chairman.

OCEANOGRAPHY

MISSION

Mr. ANDREWS. How much of your oceanography program is in direct support of the Navy ASW and other naval warfare efforts and how much is related to the nonmilitary general field of oceanography? In other words, are all the funds committed to the Navy oceanography program purely military-mission oriented?

Dr. FROSCH. The entire Navy oceanography program—with the exception of $500,000, which I can speak to in a moment—in the 1970 request is in support of the military missions of the Navy. That is how we decide what oceanography we want to do. Of the R.D.T. & E. in the 1970 request, $62 million we consider to be in direct support of antisubmarine warfare. All of it is in support of the accomplishment of the Navy missions. A good deal of it also turns out to be general oceanography. But it is the oceanography that supports the Navy's missions that interests us and we support.

FUNDING

Mr. ANDREWS. On page 38 of your statement you indicated that the funding for the Navy oceanographic program represents a compendium of efforts in other line items of the budget. Does the $286.6 million represent the entire oceanographic program of the Navy during fiscal year 1970?

Dr. FROSCH. The correct number I have is $278.6. This represents the budget, as amended. The answer is yes, that the $278.6, which is the correct figure, is the total Navy oceanographic program, not all of which is in R.D.T. & E. As I mentioned, when I read the statement for completeness in the statement I have described and discussed all of the Navy's oceanography, only part of which is in this appropriation.

Mr. ANDREWS. How does this compare with previous fiscal years? I note it was $252.7 million in fiscal 1969.

Dr. FROSCH. Yes. And $231 million in 1968.

(Discussion off the record.)

Mr. ANDREWS. Provide a table for the record showing the Navy oceanography program by appropriation and by fiscal year since 1967, including your 1970 estimate.

(The information follows:)

NAVY OCEANOGRAPHIC PROGRAM BY CONGRESSIONAL APPROPRIATION

[In millions of dollars]

	1967	1968	1969	1970
R.D.T. & E.	$93.3	$107.3	$110.5	$121.3
O. & M.N.	79.7	78.9	81.0	97.8
MPN	12.4	12.6	13.3	10.8
OPN	16.5	25.8	40.7	34.2
MILCON	3.0	1.7	7.0	3.8
SCN	62.5	4.7	0	0
PAMN	.9	.1	.2	10.7
Total	268.3	231.1	252.7	278.6

ACCOMPLISHMENTS

Mr. MINSHALL. Dr. Frosch, the June 1966 report of the Panel on Oceanography, the President's Science Advisory Committee, indicated $196.9 million was spent in fiscal year 1965 on the national oceanographic program. This total included efforts by the Departments of Defense, Commerce, Interior, HEW, Treasury, State, the AEC, Smithsonian Institution, and National Science Foundation.

The estimated budget for fiscal years 1966 and 1967 was $178.3 million and $219.9 million, respectively. The oceanographic program for the Navy alone for fiscal year 1970 totals $278.6 million. Can you point to significant accomplishment in the way of justification for this large expenditure of funds in recent years?

Dr. FROSCH. Yes, I can. I would like to make a comment about those figures before I do so and that is that the definition of what they called oceanography at that time that the PSAC committee used is not, if I recall correctly, the same as the definition of oceanography we are using here. They were restricting, if I remember correctly, their definition much more to purely scientific efforts so it would be more related to our definition of research rather than what we define as all of oceanography, which includes oceanographic operations and some engineering things which go beyond their definition.

There are several kinds of examples I can think of to give of oceanographic accomplishments. In a scientific way, we have, for a number of years, been trying to understand what are the oceanographic factors that make sound in the ocean behave in the way that it does. This

has been a long scientific effort. We have gained much more understanding than we have ever had before. We are continuing this effort.

For example, several years ago it became very clear that we were getting ——— and we had no way of knowing whether we could depend on them or at that time what kind of systems we could build to capitalize on them.

Over the past few years we have begun to understand in considerable detail how that happens and what oceanographic conditions could prevent it. As a result, we have a much better understanding of how ———. That is a scientific example.

In the course of doing that science, the oceanographers have devised some general engineering techniques ———.

You saw earlier some movie animation of what the deep submergence rescue vehicle will be like. That we consider to be one of the engineering products of what we call overall the oceanographic program.

You are familiar with the finding and photographing of the lost submarine *Scorpion*. The equipment and the techniques that were used to do the final search and take the photographs of the submarine were in fact research equipments developed in the Navy's oceanographic program.

The bathyscaph *Trieste* is now on its way to the site to go down to the bottom and investigate in detail what can be found out about what happened to the submarine. That is classified as part of our oceanographic program.

I might say, parenthetically, that if the bathyscaph can find out precisely what happened to the submarine, then we might have a very large payout economically in being able to prevent future accidents and know precisely what happened to that submarine so that we can decide precisely how to prevent them.

You may recall that after the *Thresher* went down we were able to get photographs of the *Thresher*, but we had at that time no equipment which could give us enough detail so we could be absolutely certain we knew what happened. We then had to take all of the things we found out about the submarine and use that to improve our other submarines and we had to improve all the things we could find out. That was an exepnsive and important effort. If we then had the capability to understand in detail what the problem is, we might have been able to save some of that effort.

Another example which I mentioned in the same statement, was the CURV II, which is a vehicle which can pick up objects from as deep as 2,500 feet, unmanned. Some of that technology has already begun to have a major payout in the recovery of torpedoes lost on the ranges not previously recoverable; also out of the parts of the oceanographic program have come our capabilities to build better ranges and kinds of ranges.

We include under oceanographic operations, incidentally, as I mentioned in my statement, the charting efforts. These are not under R.D.T. & E., but under the "Operations" appropriation. The charting effort has improved our capability to navigate around Vietnam and the charting effort that is now going into the area off ——— is of immediate interest.

SUBMARINE "SCORPION"

Mr. ANDREWS. Would it be possible to raise the *Scorpion?* Would it be impractical?

Dr. FROSCH. I think with the present technology it would be possible for us to raise the *Scorpion*, but the expense of doing so, for raising the whole submarine, I think would not be warranted.

Mr. ANDREWS. You have no plans for doing that?

Dr. FROSCH. We have no plans to do so.

We are considering, depending entirely upon what the *Trieste* finds when she looks at the submarine, the possibility of trying to pick up selected pieces of the submarine, or even to break it apart so that we can pick up selected pieces for further study. Whether that makes sense will depend entirely on what *Trieste* finds.

NATIONAL OCEANOGRAPHIC PROGRAM

Mr. ANDREWS. Do you have any idea how much will be budgeted in fiscal year 1970 for the national oceanographic program?

Dr. FROSCH. $514 million including all of the agencies.

You will recall I mentioned a $500,000 item that was not included under "Navy mission." That is mentioned in the statement and I should state that that was put into the Navy budget at the request of the National Council on Marine Resources and Engineering Development as part of Navy support for the National Oceanographic Instrumentation Center.

Mr. MINSHALL. How much of this total for the national oceanographic program is for the Defense Department?

Dr. FROSCH. Essentially the $278.6 million is the Defense Department total. There is an additional portion which is very much smaller. I can get the figure for the record. I do not have it, which is the portion of the Army Corps of Engineers program.

Mr. MINSHALL. Dr. Frosch, how is this program coordinated in order to avoid duplication of effort?

Dr. FROSCH. The Navy program or the national program?

Mr. MINSHALL. The national program.

Dr. FROSCH. The national program is coordinated by the National Council on Marine Resources and Engineering Development, which is chaired by the Vice President and has representatives, or observers, from all of the agencies that have major interest in the oceanographic program. There is a staff of that council which carries out the coordinated work. There have also been committees appointed by that council to carry out coordination in particular areas. The committee structure is now undergoing some review and may be changed to keep pace with changes in the nature of the program.

Mr. MINSHALL. Mr. Secretary, how much of the Navy oceanographic program for the past 3 fiscal years has been provided to institutions of learning and to industry for your oceanographic program support?

Dr. FROSCH. I will have to break the list out and provide it for the record. It is a rather comprehensive list of where it has gone.

(The information follows:)

NAVY OCEANOGRAPHIC PROGRAM DOLLARS TO INDUSTRY AND INSTITUTIONS OF LEARNING

[In millions]

	Industry	Institutions
Fiscal year:		
1967	$43.4	$32.1
1968	62.3	42.3
1969	69.2	50.0

Mr. ANDREWS. Are there any questions on oceanography?

AIRCRAFT AND RELATED EQUIPMENT

REASON FOR BUDGET INCREASE

Mr. ANDREWS. The fiscal year 1970 program for "Aircraft and related equipment" totals $577.2 million, an increase of $181.4 million over fiscal year 1969 program.

Mr. Secretary, generally what are the principal reasons for the increases in this budget activity during the last 2 fiscal years?

Dr. FROSCH. The principal areas of increase between 1969 and 1970 have been an increase in the aircraft E-2C, which is an increase that comes just from the way in which that program of aircraft improvement is phased over several budget years.

As you will recall, that is the early warning and air control aircraft. We are using basically the E-2A airframe. The program is to improve the radar and electronics and have capability ——— and higher reliability.

The F-14A will have an increase between fiscal 1969 and fiscal 1970. This is again for the phasing of the development of that aircraft which has been begun in 1969 and will have major development work and the construction of the research and development aircraft during fiscal year 1970.

The third major item is the beginning of the S-3A, the carrier-based antisubmarine warfare aircraft. This has had funding in fiscal year 1969 which has been spent so far on contract definition. We are now, as you know, evaluating the proposals and coming to a final decision on that aircraft, and actual work, cutting metal on the development of the aircraft, would come in fiscal 1970 and that is the third major increase.

Mr. ANDREWS. Do you fund the first F-14 production?

Dr. FROSCH. In the F-14A program, there are, as I recall, 12 aircraft that are used at some point in their life for development, test, and evaluation. Of the 12 aircraft, six of these aircraft are funded in R.D.T. & E. because they will be used for development purposes and will be models that will be early enough in the development so that they will never be useful for fleet use. The other six are paid for out of "Procurement, aircraft, and missiles," because we expect in the end they will go into fleet training uses.

Mr. ANDREWS. Are you requesting money here for any aircraft?

Dr. FROSCH. Yes. This money includes partial funding of the first six F-14A aircraft.

Mr. ANDREWS. When do you expect to get them?

Dr. FROSCH. We expect delivery in 1971.

Admiral GADDIS. First delivery is January 1971 and then ——— a month.

Mr. ANDREWS. You will pay for it with your 1970 funds?

Admiral RUCKNER. Incrementally.

Dr. FROSCH. Increments for three aircraft in fiscal year 1969 and the principal amount in fiscal 1970.

Mr. ANDREWS. I wish you would elaborate in the record some of the other reasons for your increased request.

Dr. FROSCH. Certainly.

(The information follows:)

[In millions]

	F-14A, fiscal year 1969	R. & D., fiscal year 1970
Airframe	$43	$108
Avionics	38	23
Engine	10	9
GFE and support	15	35
Contract definition	24	.....
Total	130	175

As noted in the table above, the major increase in fiscal year 1970 is for airframe development. The contract for airframe engineering development was signed on February 3, 1969, so that contract was in effect for only 5 months as compared with 12 months in fiscal year 1970, requiring a much larger amount of money. GFE and Support, the other area requiring added funds, was assigned limited funding in fiscal year 1969 because of overall program funding limits. It is necessary that this area be funded at a higher level in fiscal year 1970 in order to have the required GFE and Support equipment available by first flight in January 1971. The avionics and engines will require less funds in 1970 and contract definition, of course, was completed when the engineering development contract was signed in February 1969.

F–14A AIRCRAFT

Mr. ANDREWS. You were funded $130 million in fiscal year 1969 for F–14A aircraft, and the request for fiscal year 1970 is $175 million. How were the fiscal year 1969 funds spent?

Dr. FROSCH. They have been spent on the beginning work and the beginning construction of some of the first six aircraft. They have been spent on work on the electronic systems, the avionics that will go into the aircraft. They have been spent on much early development work, including wind tunnel work, design work, and so on. We can provide a detailed breakout if you like.

Mr. ANDREWS. Provide a table showing how the fiscal year 1970 request for funds will be utilized.

Dr. FROSCH. We can do that.

(The information follows:)

Airframe design and development	$108,000,000
Avionics—including AWG–9 reconfiguration	23,000,000
Engine testing. Nozzle design, inlet tests	9,000,000
GFE and support	35,000,000
Total	175,000,000

TF-30-P-12 ENGINE

Mr. ANDREWS. What has been the cost of developing the TF-30-P-12 engine, which was originally scheduled for the F-111B and will now be used in the F-14A aircraft?

Dr. FROSCH. $33 million, Mr. Chairman.

Mr. ANDREWS. How much of the cost of improving and modifying the TF-30-P-12 engine is funded under the F-14A program?

Dr. FROSCH. This is an amount——

Captain JESSEN. Actually the engine is changing designation. TF-30-P-412, as it goes into the F-14 aircraft. There will be money spent adapting the nozzle, an iris-type nozzle. Basic development was carried out, however, under the F-111B moneys we had in previous years.

Mr. ANDREWS. How much?

Captain JESSEN. The basic aircraft cost, the basic cost is $33 million. There was a family of TF-30 engines which started with the P-1 and that is the increment, for the P-12. The nozzle itself, and the design effort we are doing, is about $5 million. We don't have a precise input.

Mr. ANDREWS. Is that all you are spending under the F-14 program for improving and modifying the engine?

Dr. FROSCH. That is $5 million for the nozzle design effort and $6.2 million for nozzle engineering development. There is additional work, about $4.2 million for full military qualification of the TF-30-P-412 equipped with that nozzle. There is additional cost involved in engine/inlet compatibility work and propulsion associated testing. By fiscal years this effort amounts in total to about $12 million in fiscal year 1969, $9 million in fiscal year 1970, and $7 million in fiscal year 1971.

Mr. MINSHALL. Is the engine manufacturer doing this nozzle work or who is doing it?

Dr. FROSCH. The engine manufacturer in coordination with the airframe manufacturer. The engine manufacturer is responsible for the nozzle.

Mr. MINSHALL. Who is doing it?

Dr. FROSCH. Pratt & Whitney, the engine manufacturer.

Mr. MINSHALL. They didn't farm that out?

Dr. FROSCH. No. As far as I know, they are doing it themselves. Grumman was the prime air frame contractor and they farmed the engine out to Pratt & Whitney.

Mr. ANDREWS. Your justification book indicates the total estimated cost of the F-14A program is $680 million. Does this include any of the costs attributable to the advanced technology engine?

Dr. FROSCH. The F-14A line does not. The advance technology engine is included under the line item labeled F14-B/C.

PHOENIX MISSILE

Mr. ANDREWS. Mr. Secretary, what are the pacing items in the development of this aircraft? I suppose the AWG-9 fire control system would be one?

Dr. FROSCH. Yes. The completion of the Phoenix and its fire control system and the alterations that are required to change it from

the configuration and characteristics as it was designed for, the F-111B. To change it to be suitable for the F-14A is one pacing item.

Mr. ANDREWS. How long have you been working on this system?

Admiral GADDIS. This was started in 1962.

Mr. ANDREWS. Are you still doing R. & D. work?

Dr. FROSCH. We are still doing development work. We are now in the stage of test flying actual missiles.

Mr. ANDREWS. Do the tests come under your jurisdiction?

Mr. FROSCH. Yes, as a part of the research and development test and evaluation.

Mr. ANDREWS. Bring us up to date on the test results for the record.

(The information was provided to the committee and is classified.)

Dr. FROSCH. There have been ——— tests, of which ——— have been successful. Of the ——— which are unsuccessful, ——— which the launch enabled us to understand and has now been corrected.

Mr. ANDREWS. Do you consider that good?

Dr. FROSCH. We consider that very good for a highly complicated missile system.

FUNDING OF F-14A AIRCRAFT

Mr. ANDREWS. As you know, the contract for the F-14 aircraft provides for six prototype aircraft to be funded in fiscal years 1969 and 1970 with R.D.T. & E. funds and six with fiscal year 1970 procurement funds, all 12 of which will be used in the R.D.T. & E. program. Was budgetary considerations the principal reason for funding these 12 aircraft in this manner?

Dr. FROSCH. Well, this is a complicated question. There is always a problem of whether a particular aircraft which is connected with development should be funded as development or as procurement. The rule that was used in this case was that any aircraft that was to be used for development only and would never have any chance of going into the fleet would be funded under development, but the later aircraft for the test and evaluation program which are very likely to come out of the program in a configuration where they will go into the fleet at least for training uses, would be funded under procurement, aircraft and missiles.

There is always a problem of splitting funds between PAMN and R.D.T. & E., and certainly that is a consideration.

Mr. ANDREWS. There is no question that you need the first six F-14's for testing purposes?

Dr. FROSCH. We need the first 12 for testing purposes.

Mr. ANDREWS. I was going to say you might need the next six.

Dr. FROSCH. We clearly need all 12 to do a full test program.

Mr. ANDREWS. But you hope that the last six of the 12 can be operational?

Dr. FROSCH. Will be operational in the fleet after the test program is completed, principally as training aircraft.

Admiral RUCKNER. The R. & D. aircraft are not lost completely either because they go into the R. & D. inventory and are used at the R. & D. centers to correct problems that are found years later in operation of the aircraft at sea.

Mr. ANDREWS. Under the contract, the Grumman Co. will deliver the aircraft ——— a month beginning January 1971, is that correct?

Admiral RUCKNER. That is correct.

PROCUREMENT PRIOR TO COMPLETING DEVELOPMENT

Mr. ANDREWS. The first flight of aircraft No. 1 will be January 1971. However, 4 months prior to that time, in September 1970, the Navy must decide whether to accept lot III of 30 production aircraft or lose all production options. Isn't the telescoping of development and production one of the reasons for the problems we have been experiencing in weapon system procurement?

Dr. FROSCH. Several comments on that. One, in lot III the 30 aircraft is the nominal number. The number of aircraft that we are obligated to buy in lot III is as low as ———, so it might be ——— aircraft, or up to, in fact, ——— aircraft. We thus have flexibility in lot size at predetermined ceiling prices.

The question of whether to make a schedule so that we need to exercise an option before we are fully completed with development is a rather difficult one that always puts us in a dilemma. If we make a schedule and try to separate development entirely from production, then we find ourselves in a position where we are likely to have to negotiate for production in a sole-source position with the developer of the aircraft at a later time. We then face the possibility of having to negotiate with someone who is a sole-source contractor, and face the difficulties in doing that.

If we negotiate at the beginning for a program including an option at the beginning of production, then we can usually negotiate a ceiling price for the production aircraft which appears to be a price which is worth while and we can hold, and we do that negotiation before we are completed with the competition. So we get prices—ceiling prices, at any rate, for the early production aircraft that are based on a competitive process rather than later having to go into a sole-source process. This has seemed to us to be a better procedure than having to face the sole-source problem later.

There are other versions of contracts that can be made. For example, in the S–3 case, we are examining a contract which has built into it a clause which makes it possible to delay the options depending on what happens in the process of meeting particular development milestones during the development of the aircraft. Then, in order to have such a clause, we have to negotiate some possible increase in the ceiling price that has to do with the risk that the contractor faces if the Government unilaterally decides to slip the option date.

GRUMMAN CONTRACT

Mr. ANDREWS. Under the contract as of today, how many F–14's is the Navy obligated to buy from Grumman?

Dr. FROSCH. We are obligated, I believe, to buy only the first 12. That is, the ones required for R.D.T. & E.

Admiral GADDIS. We are only obligated absolutely through the three; the 1969 funding.

Dr. FROSCH. Admiral Gaddis corrects me quite properly. We are only obligated for those funded in the 1969 appropriation, and that is

the first three. Each of these contracts is such that we are only obligated for the year's money as appropriated. We can't obligate it and the contract can't tie us down.

Mr. ANDREWS. I wondered whether you went to competition for this F-14.

Dr. FROSCH. The competition was completed when we selected the manufacturer.

Mr. ANDREWS. So it is Grumman from now on with the F-14, regardless of the number of planes the Navy purchases?

Dr. FROSCH. I think that is correct, unless and until we get to a point in production where we would be deciding to buy a sufficient number of aircraft so that it would make sense to go to a competition for a further follow-on buy. Usually we have not been able to either see far enough ahead into the future or, in fact, to be in a position to come to the Congress for authorization and appropriation for a large enough buy to take an aircraft which is in production and then put it out to competition. It isn't economical to do so.

Mr. ANRDEWS. How many of the F-14's do you have in mind at this time, Admiral Gaddis?

Admiral GADDIS. The total program contemplated at this time is 463 aircraft. The total number of aircraft that are in the 5-year defense program as approved line items in the program is 287 aircraft, sir. Obviously, the total package program extends beyond the period of the 5-year defense program.

EXTENDED DEVELOPMENT PRIOR TO PRODUCTION

Mr. ANDREWS. Is it not possible to obtain, during the competitive phase of a negotiation, contract proposals which will permit a 2- or 3-year development program, before the Government must commit itself for production aircraft?

Dr. FROSCH. Yes, it is possible to do that. As I mentioned earlier, one of the options is to contract for development only and not for any production, and then, at the end of development, or at the appropriate time in development, to negotiate with the contractor to build production aircraft. And, as I pointed out, when we do that we then face a sole-source contractor, because it never appears to us, or has never that I know of, appeared to be sensible to take an aircraft that has been developed completely by one manufacturer and then put it out to competitive bid, because normally a second manufacturer has a very great amount of difficulty and we pay for these in trouble in trying to build an aircraft that was designed and developed by somebody else.

Admiral RUCKNER. I think you will find it a very expensive program, because to build a modern, high-performance airplane today you really have to build them on hard tooling or you don't really have a prototype of the one you are going to produce.

Mr. ANDREWS. Isn't it possible to competitively negotiate the contract at the outset which provides you 2 or 3 years of development? A "fly before buying," so to speak, development program, with the option to enter production at a specific option price, and negotiate this at one time in the beginning where you have all of your contractors together rather than facing essentially a sole-source negotiation, as you indicated? In this way you will get competition and also get an option price for your production model.

Dr. FROSCH. Essentially, that was done with the F–14, except that the contracts we negotiated in that way must have something about the option dates in them as well as the option prices.

In the case of the F–14, there are these specific option dates. At the time we made the source selection on the F–14, we had in our hands, signed by two contractors, signed contracts between which we could choose; so, in fact, we did do a competitive negotiation.

In the S–3 we had the same thing, and then went back to negotiate what I might describe as this sliding-date arrangement between development and production, and in each case we negotiated with both contracts; so, again, we now have in hand a signed contract by each competitor which states precisely the dates, the prices, the ceiling prices, and all the lot arrangements which that contractor would sign.

In order to get this sliding arrangement so that we can delay a production-lot option by as much as a year from the time it is now scheduled to fit with the development program, we had to negotiate a scale of possible changes to the ceiling prices for the various lots so that the ceiling prices would go up in accordance with the amount of delay that we built in between development milestone and production. The schedules for those increases in the S–3A case are slightly different between the two contractors, but not sufficiently different to have a real impact in price.

The reason for this was that, in asking a contractor to accept a split in a production option program, we are asking him to put himself in a position where the program is going along on a certain schedule and he has hired people and developed a production capability to build aircraft on a certain schedule; then, we will decide that the aircraft is not ready for production, and want to slip his production, so that that risk has to be taken account of in the negotiations.

We wanted them to do it for no change in ceiling price. They came into the negotiation wanting some considerable change in negotiated price for that ceiling, and out of the negotiation came what I think is a fairly nominal increase in ceiling price which would apply to the S–3A contract.

The difference between target and ceiling for the nominal prices is about 180 percent. That is the nominal price—the target price for the aircraft is some number, and then the ceiling price which the Government is not obligated to pay beyond is 180 percent of that price. In order to get this sliding arrangement between production options and development milestones, we negotiated a table which I believe goes up as ——— percent of target for ceiling. You will understand these are ceilings above which the Government does not obligate itself.

CEILING PRICE

Mr. ANDREWS. Then, as I understand it in the S–3A case, you do have an idea of how much you will have to pay for production aircraft without further negotiation of price, is that correct?

Dr. FROSCH. We have a target price for each—well, we have a target price for the first lot. We have a ceiling price which is the total amount we do not have to go beyond for each lot, but that ceiling price is an absolute ceiling. When we come to negotiate for that lot, we negotiate a new ceiling price which can only be lower than the absolute

ceiling that was set now. So that the price to the Government can only go lower than the ceiling now.

Mr. ANDREWS. In other words, that ceiling means what it says. You can't go above it?

Dr. FROSCH. The ceiling means what it says. Let me add one footnote to that. With the later lot there is a clause that adjusts that ceiling in accordance with the Bureau of Labor Statistics' Index of Labor Costs for Escalation.

If the Index of Labor Statistics goes up, then automatically the ceiling price for those lots goes up to adjust for inflation. If it goes down, the ceiling price automatically goes down.

Mr. ANDREWS. But neither the Navy nor the contractor will have to go into that second phase.

Dr. FROSCH. That is correct. And, furthermore, neither the Navy nor the contractor has control over that inflationary escalation or de-escalation. That is automatic with the Bureau of Labor Statistics figure.

F-14A CONTRACT

Mr. ANDREWS. Now, would you briefly discuss for the record the type of contract for the F-14 aircraft, including the target cost, target price, and ceiling price, as well as the incentive features of the contract? You have given us most of it, but you can elaborate.

(The information follows:)

The F-14A engineering development (R. & D.) contract with Grumman Aircraft Engineering Corp. includes six R. & D. aircraft. This contract was let as a result of competition between five firms: Grumman, McDonnell Aircraft, Ling-Temco-Vought, General Dynamics, and North American Rockwell.

———. At the conclusion of the contract, the appropriate share to be applied will be determined by the aircraft performance achieved. . . . This sharing percentage will be applied to the difference between the actual cost and the target cost. The resultant amount is then added to or subtracted from the target profit, as the case may be, to determine the contractor's acual profit earned. The present ceiling price is the maximum amount the Government will pay for the contract scope of work. Costs incurred beyond the ceiling price are borne solely by the contractor.

The R. & D. contract penalties and awards are based on performance by the contractor and are implemented by use of an interrelated cost and performance incentive structure. The structure is designed to influence the contractor to produce a target performance aircraft at target cost. This aim is effected by the use of the different contractor-sharing percentages. As actual aircraft performance exceeds target performance, the contractor's cost share gradually increases to the maximum ——— thus making it more costly to the contractor to increase the aircraft performance by incurring additional cost. Conversely, as actual performance falls below target performance, the contractor's sharing percentage gradually decreases to a minimum ——— making it less costly to the contractor to incur cost to improve the aircraft's performance. At any actual cost within the ceiling price ———. The amount of profit earned will be maximized by the realization of best performance, coupled with lowest actual cost and, conversely, minimized by lowest acceptable performance and high cost. Also, high actual cost will reduce profit earned for maximum performance, while low actual cost will increase profit earned for a minimum performance aircraft. This is what is meant by an interrelationship of cost and performance. Attachment 1 hereto is a graphic representation of the incentive structure.

The Government has no obligation to accept the aircraft if any of the minimum performance levels are not achieved. At this point the Government can either require the contractor to correct the aircraft to meet the minimum requirement or agree to an equitable reduction in contract price.

The contract requires the contractor to maintain a management and reporting system which meets the criteria of Department of Defense Instruction 7000.2. In addition, the reports are stipulated as a substantive product of the contract, and the Government contracting officer can reduce or suspend progress payments under the contract if the contractor fails to submit the reports on time.

The R. & D. contract contains options for the follow-on ——— production lots, with ceiling prices stipulated for the F-14A aircraft base quantity of aircraft in each lot as shown in Attachment 2 hereto. A variable quantity formula is also included which will adjust the ceiling price for increases or decreases in aircraft quantities up to ——— of the lot base quantity. For example, the ceiling price of the base quantity of ———. It should be noted that exercise of the maximum quantity option decreases unit price and the minimum option increases unit price. Further, this effect is carried over into subsequent lots of production through the variable quantity formula. The impact of exercising the reduced option provision in Lot II would, for example increase Lot III, ———. This variable-quantity pricing formula is important, because it protects the ceiling prices achieved during the completed competitive stage of the procurement in the event of a quantity change. However, to keep this protection, the Government must order within the quantity limitations and before expiration of the respective option date for each lot ———. Failure to exercise any given lot option negates the ceiling prices for all subsequent lots.

There is no pricing formula in the contract which ties the price of a subsequent lot to the actual cost of any prior lot. However lots ——— include provision for adjusting the lot ceiling prices either upward or downward on a prospective basis (that is, before the aircraft are produced) depending on abnormal fluctuations in the national economy. Adjustments will be determined by comparison of predicted Bureau of Labor Statistics indices set forth in the contract with the actual level of these indices as of ———. The ceiling prices associated with production aircraft lots II-VIII are shown in attachment (2).

The procurement of the production lots will be handled in the normal manner in each successive fiscal year. For instance, in the case of lot 2, a request for proposal will be sent by the Government to the contractor indicating the quantity of aircraft and delivery schedule desired. The contractor will then submit a comprehensive price proposal which will be subjected to cost analysis by Government personnel. After the necessary negotiation approval has been received, negotiations will be conducted and either a firm fixed price or fixed price incentive contract will be executed within the applicable ceiling price specified for lot 2. It should be noted that the Government will have the unilateral right to determine which of these two types of contract is used for all the production lot contracts.

Although it is difficult to foresee at this time other specific items on which lot II negotiations will be based, the following are typical considerations:

———.

Mr. ANDREWS. When will this aircraft become available to the fleet?

Admiral GADDIS. ——— 1973.

PROVISION FOR CONTRACT TERMINATION

Mr. LIPSCOMB. I would just like to review for a moment the aircraft and the contract. As I understood you to say previously, Dr. Frosch, the Government is committed for three research and development aircraft at the present time?

Dr. FROSCH. Using fiscal 1969 appropriated funds.

Mr. LIPSCOMB. How many R. & D. aircraft are proposed, total?

Dr. FROSCH. Six.

Mr. LIPSCOMB. Are the three which the Government is committed to buy included in the contract that is now in existence?

Dr. FROSCH. Yes.

Mr. LIPSCOMB. We understand that if it is felt we should not go into the production aircraft at this time and not appropriate for them that the contract is null and void. Is that the way you understand it?

Dr. FROSCH. My understanding is that if at any time we were to decide not to go further with the contract there is a provision for, I believe, an equitable adjustment for what the actual costs to that point are, and any costs of terminating and closing the contract at that point. We can unilaterally determine we do not wish to go further, but we are obligated to pay the actual cost to that point and costs that are arrived at in negotiation as being those required to terminate the contract equitably.

Mr. LIPSCOMB. In this fiscal year 1970 budget, you are only asking for funds for three R. & D. aircraft?

Dr. FROSCH. The three R. & D. aircraft—I am not sure that the funds in 1969 were sufficient for all of the first three. They were sufficient for the beginning of the first three. The funds in 1970 are for the completion of the first three and partial on the next three, and for the testing program and the electronics that goes with the aircraft and for the beginning of the flight tests.

SUCCESSFUL DEVELOPMENT PRIOR TO PRODUCTION

Mr. LIPSCOMB. This committee recognizes the value of the F-14 program; the needs of the Navy and our Government, but we feel that we would like to appropriate for the six R. & D. aircraft and wait and watch the program before we decide to go and appropriate money for production. What happened?

Dr. FROSCH. There was no appropriation of funds for the first six aircraft funded in PAMN.

Mr. LIPSCOMB For production?

Dr. FROSCH. Well, they are productive aircraft, but I was going to say all 12 aircraft are essential for the flight test program, so what we would then be doing is producing aircraft which would be sufficient only for part of the flight test program. If one waited until that were the case, then the next increment would have to be aircraft for the rest of the flight test program, and that would still not get us to the point where we would have completed the flight test program, be ready for the board of inspection and survey, and be ready for production.

The crucial point about the second six aircraft, they are funded in PAMN. They are funded for the tests and evaluation program but they are funded in PAMN because after that program we expect they will be useful fleet aircraft, whereas the first six will only be useful for R.D.T. & E.

Mr. LIPSCOMB. What reason makes it necessary to appropriate in fiscal year 1970? Why can't it be put in the fiscal year 1971 budget?

Dr. FROSCH. Because then we would not have the second six aircraft in time to fit into the test and evaluation program in an engineering-sensible way. That is the only phrase I can use to describe it. The flight test program for such an aircraft is a carefully constructed and integrated test program and various aircraft are allocated to different tasks in that program. The latter aircraft, the more advanced task building on the earlier aircraft, if we put a year's delay in the later aircraft, that would break the flight test program and put a large hiatus into it.

Mr. LIPSCOMB. What you are telling us then is that by the contracting procedures in the Department of Defense you have put the Congress in the position that it must go ahead with a six aircraft R. & D. program and a six-production aircraft program.

Dr. FROSCH. If we are to carry out a well-phased and integrated test program on this aircraft.

Mr. LIPSCOMB. Inasmuch as the Congress has responsibility for not only raising but appropriating funds, isn't it necessary to get the congressional authorization and appropriation before you commit the Governmnet to such a contract?

Dr. FROSCH. If we were to do that, we would then have to ask the Congress to appropriate funds sufficient for several years' worth of purchase and R.D.T. & E. and for the production aircraft that fit into the T. & E. and also into the fleet, all at one time, and that would be asking the Congress to authorize and appropriate funds in 1 year which we knew absolutely certainly need not be obligated or expended until one or two or several years later, so I think that conflicts with other congressional desires.

Mr. LIPSCOMB. This is exactly the same problem that you had with the F-111B program in which you got into an R. & D. aircraft program and at the same time tried to keep getting money for production aircraft. You weren't ready. The Congress looks upon this with great concern.

You are going into a new, sophisticated aircraft. We know the necessity for it but we don't want to get burned again.

Dr. FROSCH. I would like to make a couple of comments if I might. One, I believe that this plan that we are discussing came before this committee in January. I just make the remark.

Mr. LIPSCOMB. We took no action in such planning.

Dr. FROSCH. My understanding was it was approved.

Mr. LIPSCOMB. The first time this committee was informed of the commitment to a 12-aircraft program in this fiscal year 1970 budget was when we started discussing this, Admiral Gaddis, some weeks ago.

Admiral GADDIS. There was a presentation made, sir, for each of the four concerned committees of the Congress, separately and individually.

Mr. ANDREWS. By Admiral Connolly.

Admiral GADDIS. Made by Admiral Connolly and the program manager. The chairman was consulted by the Secretary of Defense before the Navy was allowed to make the selection between the two final contract definition finalists.

Mr. LIPSCOMB. What you are saying is, members of the committee were fully aware and informed and knowledgeable——

Admiral GADDIS. The program was outlined, sir.

Mr. LIPSCOMB (continuing.) And knowledgeable of the intimate details of the contract and the fact that we were committed to six production aircraft in this fiscal year 1970 budget?

Dr. FROSCH. This committee required that last year and I believe we have carried out that requirement.

Let me make a further comment on this.

Mr. LIPSCOMB. You feel now we have an obligation?

Dr. FROSCH. I simply state that as a matter of information.

You have referred several times to production aircraft.

Mr. LIPSCOMB. That is what they are listed as in these budget documents.

Dr. FROSCH. Those aircraft are listed under "Procurement aircraft and missiles" and in that sense they are production aircraft. However, they are aircraft that are essential for the test and evaluation program. There is an arbitrary decision—and I believe it really is arbitrary—that has to be made in each such case. We could have in principle asked for all 12 in R.D.T. & E., or we could have done as we did, ask for six in R.D.T. & E. and six in procurement funds. The reason we did the latter was essentially an OSD opinion, that, inasmuch as the final end use of the six that were to be used in R.D.T. & E. but funded under procurement funds was to be used as aircraft in the fleet for fleet training and other operational uses, it was proper and correct to ask for them to be funded under procurement, even though one could make a logical case that they be funded under development.

All of these aircraft are required before we can go to the board of inspection and survey. True, full-rate production of the aircraft will occur with, I believe it is lot IV.

Captain JESSEN. We build up very slowly. We buy ——— airplanes a month for ——— months, which is very different from what we were doing in the F-111B program. The flexibility is built into the ceiling prices that Dr. Frosch referred to and is all part of the master plan. We tried to get low prices and fixed ceilings in the total negotiation with both finalists. We have some flexibility. I don't know if we have discussed that flexibility in the quantities that we buy each year. We have that flexibility and we haven't discussed it so far.

Mr. LIPSCOMB. The reason that the production aircraft and the research and development aircraft are entirely different is because this committee didn't permit the Navy or the DOD to go ahead as they wanted to. Do you recall that? We kept cutting it back.

Captain JESSEN. In the F-111B program that you are referring to now?

Mr. LIPSCOMB. That is what I am referring to.

Captain JESSEN. We did not have the terms or the prices or where we were going in the production buy, except each year as we tried to put together the budget sheets for next year and we worked under a letter contract in trying to determine what the next year's buy was going to be. It shows that we deferred those buys from year to year, but the difference that I am trying to emphasize, sir, is that in this program we have laid out the total lots—lots I, II, III, IV, V, VI, and we had prices attached to those. Because we have prices attached to those through competitive negotiation, we are in a much better possition to utilize the slow buildup rate of ——— per month for ——— months as the most economical way to enter production and work in evaluation.

Mr. LIPSCOMB. If the committee decided to go for the first 12 aircraft but decided that we wait before taking up the options for the 30 production aircraft until completion of the test program, what would this do to the contract?

Dr. FROSCH. I think we would have two options. One would be to do nothing to the contract now, but before that option was due to be

taken up we would know either that the committee wished to appropriate and the Congress wished to authorize and appropriate funds for that next lot, in which case we would simply pick up the option. Or we would know that the Congress did not wish to appropriate funds for us to pick up the option, at which point we could then do one of two things: Either cancel the contract and pay whatever accrued costs and termination charges there were, or we could go into a renegotiation of the product options in the contract.

The other major thing we could do is, now, if we know that the committee doesn't wish to do that, renegotiate the entire contract to change the production options. I would think the former would be a wiser procedure for us. But we would have to look at a prediction of what the actual cost situations would be under those situations before we knew.

Mr. LIPSCOMB. To the best of my recollection, I don't recall the committee having been briefed on the details of the contract to be signed. The Navy discussed delivery schedules, but we were not informed of options for production aircraft and when they were to be exercised.

Dr. FROSCH. I don't recall exactly what was in the briefing, but it is possible we can find out.

Admiral GADDIS. I am sure the briefing can be reconstructed, sir.

(CLERK'S NOTE.—The specific details of the F-14 aircraft contract, the contract options, when they were to be exercised, and total number of aircraft in each option were not discussed during the F-14 briefing of January 29, 1969.)

S-3A (VSX) AIRCRAFT

Mr. LIPSCOMB. From what I understand you have said about the proposed VSX aircraft development and the reevaluation of the proposed method of contracting, I just want to commend the Navy and the Department of Defense—whoever is responsible for reevaluating the contract procedures—on that new approach.

Dr. FROSCH. Mr. Packard was principally responsible for deciding it should be done.

Mr. LIPSCOMB. I think under present conditions we can afford to go a little slower with our contracting procedures based on what we know today that we didn't know a year ago.

Dr. FROSCH. I think this looks like a promising contract and procedure. It is possible to find some things to worry about and we will do our best to carry that contract out if we go ahead with the S-3A, to get those benefits.

Mr. LIPSCOMB. Neither the Navy nor this committee can stand any more Cheyennes or F-111B's.

Thank you, Mr. Chairman.

Mr. ANDREWS. Ten o'clock tomorrow.

THURSDAY, JUNE 5, 1969.

AWG-9 PHOENIX FIRE CONTROL SYSTEM

VEDA, INC. CONTRACTS

Mr. MAHON. It has been reported that Veda, Inc., would perform an analysis of the Hughes AWG-9 Phoenix missile control system in support of a revised technical development plan under terms of a contract to be negotiated with the Naval Air Systems Command. What is the cost and reason for awarding this contract?

Dr. FROSCH. I am not familiar with that contract. We will have to supply that for the record. I don't know what that particular contract is.

Captain JESSEN. I believe it is a standard sort of contract where they review our technical development plans but we will have to provide the precise data for the record, sir.

(The information follows:)

The contract is in the amount of $20,000 (R. & D.) to prepare a smooth draft revision to the Phoenix missile system technical development plan (TDP).

Mr. MAHON. Is this a routine way of doing business in this kind of an operation?

Captain JESSEN. We select a small research organization of some kind and have them put together the facts and put together the data that we have supporting our major programs and submit it to the Navy for review and I believe this is the sort of contract we are talking about, sir.

Mr. MAHON. In September 1968 the Veda firm received a $50,000 contract for the Naval Air Systems Command for preparation of a Phoenix missile system research and development program completion analysis. What brought about the requirement for this study? Does anybody know?

Dr. FROSCH. I don't know precisely. We will supply that for the record.

(The information follows:)

The purpose of the contract is to:

a. Present a conceptual technique for measuring and determining the completion of the research and development portion of a weapon system program.

b. Review the objectives, functional, and hardware requirements of the F-14/Phoenix system integration laboratory and laboratory integrated system.

c. Reevaluate Phoenix missile system training devices requirements in light of the changes from the F-111B to the F-14 aircraft.

RESOURCES MANAGEMENT CORPORATION CONTRACT

Mr. MAHON. In about September 1968, the Resources Management Corp. was awarded a $42,000 contract to investigate the methodology used by Hughes Aircraft Corp. to arrive at the price estimate histories submitted to the Navy on the AWG-9 Phoenix fire control system. Why is this type information not already available to Government auditors and contracting personnel?

Dr. FROSCH. I think the normal kinds of auditing information are available but I think this must be a case where there was a feeling that we would like a much deeper review of how they arrived at the numbers than we get from ordinary auditing, and hence the attempt to get outside assistance to make such a deeper review, but I am sure in this case I would have to also get the precise details on the reasoning behind the contract.

(The information follows:)

A contract from Naval Air Systems Command was negotiated with Resources Management Corp. (RMC) of Bethesda, Md., to investigate the methodology used by Hughes Aircraft Corp. to arrive at the price estimate histories submitted to the Navy on the AWG/9 Phoenix system. The study lasted for a period of 8 months at a cost of $42,000.

The Naval Air Systems Command provided its own pricing estimates for the AWG/9 Phoenix; however, the purpose of the RMC effort was to furnish the Navy an independent validation of certain R. & D. cost elements.

Mr. MAHON. Does this indicate that Government contracting and auditor personnel are ill equipped to determine the reasonableness of cost when negotiating large weapons systems?

Dr. FROSCH. I think it sometimes indicates they feel they could use additional assistance beyond the capability they have in-house and they wisely go out and contract for additional help. We don't always have enough people to do all of the things we would like to do in-house and rather than build up a continually larger in-house establishment, when we get special jobs or get overloaded, we go out to industry for assistance.

AWG-9 DELIVERIES

Mr. MAHON. The committee understands that the original December 1962 contract for the Phoenix missile system called for——— AWG-9 systems and———missiles. All the missiles were delivered but only———AWG-9 missile control systems were delivered. Does this mean that there was a slippage in the control system?

Dr. FROSCH. I think what it means is that before all of the control systems were delivered we arrived at the point where the program was shifting from the F-111 to the F-14 and rather than have them completed and delivered, we wanted to hold them so they could undergo the reconfiguration for the other aircraft. It was a change brought about by the shift in aircraft.

Mr. MAHON. As I understand, it was indicated in May of 1969 that you would negotiate with Hughes for development and fabrication of AWG-9 systems for the F-14 aircraft. Are these the remaining undelivered systems?

Dr. FROSCH. Yes. That is a negotiation to take the undelivered systems and change the requirements from those that are associated or were associated with the F-111B to those associated with the F-14.

ASK TO MODIFY FOR F-14 USE

Mr. MAHON. What is the estimated cost of modifying the AWG-9 missile control system for the F-14 aircraft? How does this compare with the original AWG-9 cost?

Dr. FROSCH. The estimated cost for the changes to the system and all of the support that goes with putting that system together with the airframe is $129 million.

USE IN F-111B

Mr. MAHON. In March 1969 it was reported that the Naval Air Systems Command would negotiate with Hughes for materials and services necessary to install one of the systems and associated instrumentation into the F-111B aircraft. Will this be the newly configured AWG-9 system for the F-14?

Dr. FROSCH. Partly. This came about because there was, as you may recall, a crash of an F-111 which was being used for tests of the Phoenix missile system. This left us short of test aircraft assets to continue with the program even before the reconfiguration began and this F-111B is to have one of the systems installed so we can continue testing the Phoenix system. This will not be a fully reconfigured system though there will be some changes made in the course of installing it.

PHOENIX COST ESCALATION

Mr. MAHON. The GAO report mentioned earlier indicated the initial cost estimate for the R.D.T. & E. portion of the Phoenix was $148 million and that the current estimate is ———million. Do these figures agree with your estimate?

Dr. FROSCH. I would have to check the estimates.

Admiral GADDIS. Those are approximately correct, sir, as I recall them, related to the relative cost of the Phoenix program as constituted in fiscal year 1962 when it was initiated, and the Phoenix program, as constituted today. There is a large number of changes to the program. For instance, the addition of the initial AWG-9 development. The modifications that have been found necessary to have an effective Phoenix missile and so forth. The numbers, as I recall them, are $136 million in 1962 before the first missile contract was negotiated and ——— million as of today.

Dr. FROSCH. Some functions have been added to the system as the threat and the things it is intended to be fired against have been changed. I don't believe, for example, that the ——— detector and control portion of the system were originally contemplated in 1962. Subsequently, there have been lots of changes in electronic warfare that have made the possibility of that dual capability necessary so there have been that kind of change in the system in the course of the years in part to recognize the fact that the threat it is intended to be fired against has changed.

Mr. MAHON. What is the total estimated cost of the Phoenix for all appropriations? The GAO report indicates it totals ——— million for R.D.T. & E. and procurement accounts.

Dr. FROSCH. I have only the figures for the R. & D.

Admiral GADDIS. I do not have the total number with me. I would provide that for the record. I would say it is a reasonable estimate.

Mr. MAHON. Give us the R.D.T. & E.

Dr. FROSCH. The total R.D.T. & E. through fiscal 1974 is expected to be ——— million.

PHOENIX LAUNCHER

Mr. MAHON. We have been advised that a new Phoenix launcher for the F-14A aircraft will have to be designed because the one designed for the F-111B cannot be used. What is the estimated cost of designing

the new launcher and how does it compare with the cost of the F–111B launcher?

Dr. FROSCH. That is part of the aircraft design rather than part of the Phoenix design. This comes about because the aircraft design of the F–14 is considerably different than the aircraft design F–111. The F–111, you will remember, had a bomb bay and pylons out on the wings and its launcher was adjusted to that configuration. The wing pylons may have been contributors to the drag difficulties of the F–111. The proposal for the F–14 is a pallet which is under the fuselage so it requires a new launching system. I don't believe I have a broken-out figure for that particular item from the airframe total, but I think we can provide that for the record.

(The information follows:)

The Phoenix launchers for the F–14 are included in the F–14 development contract and included in that contract's cost. The launchers are mounted externally on the F–14 and serve the dual purpose of carrying air-to-ground weapons. Because the launchers were contracted for as a part of the F–14 development contract and serve dual purposes, a cost figure to compare the Phoenix launchers for the F–14 and the F–111B are not available.

E–2C

INCREASE IN 1969 PROGRAM

Mr. MAHON. With respect to E–2C aircraft, you are requesting ——— million in fiscal year 1970 for the E–2C aircraft. You were funded $4 million in fiscal year 1968 and your program for fiscal year 1969 is stated to be $25.9 million. Why has your fiscal year 1969 program increased $14 million over that approved by Congress? Where were these additional funds obtained?

Dr. FROSCH. I am not familiar with that increase.

Mr. MAHON. Captain Jessen?

Captain JESSEN. In determining what we would do with the follow-on aircraft in the AEW family before it received the definition "E–2C," we had a funding profile that related to an advance AEW carrier aircraft without a designation. We had some money accumulated in the fiscal years 1967 and 1968. When the program finally was defined as the E–2C, some of those moneys were applied to the same task although the definition of the task is now called E–2C. It was appropriated money by Congress intended for use in airborne early warning aircraft.

C MODEL

Mr. MAHON. Are you developing a new aircraft model or just the equipment going into the aircraft?

Dr. FROSCH. We are using the basic airframe that has been built and used as the E–2A and putting a new radar and new electronics into the aircraft.

Mr. MAHON. What can the C model do that the A and B models could not do?

Dr. FROSCH. There is a great improvement in reliability. Also, the new radar has a capability ———.

Mr. MAHON. Please make sure that the record indicates why the existing A and B models cannot be modified for the mission.

(The information follows:)

The E–2A and E–2B aircraft are equipped with the APS–96 radar which does not provide the ——— capability of APS–111 radar. The present E–2 program calls for ——— E–2C aircraft which will supplement our E–2A and E–2B inventory in order to provide the required aircraft carrier deck coverage. Modification of the E–2A and E–2B aircraft with the APS–111 will not solve the deck coverage problem.

DEVELOPMENT COST

Mr. MAHON. The total estimated cost of the E–2C development is shown as ——— million. Why has there been such a significant increase over your last year's estimate of $79.5 million? Is that for the purpose of completion?

Dr. FROSCH. I think that is a matter of whether the "Procurement aircraft and missiles account" money is included in your figure or not. I think in one of the figures you just have the R.D.T. & E. figure and in the other you have the totals——

Admiral RUCKNER. The original development contract paper approved by the Department of Defense had a mixed funding for the total development in which the PAMN charges picked up certain work which was considered production.

In reviewing the rules under which they were assigning costs, they decided this was not a proper cost to PAMN and should not be funded out of R.D.T. & E., so they directed us to fund it out of R.D.T. & E. and I believe there was a fund transfer from PAMN into R. & D.

Mr. MAHON. Expand on that for the record.

(The information follows:)

The total R. & D. cost for the E–2C program is presently estimated to be ———. The original R. & D. cost in Development Concept Paper No. 26 approved April 18, 1968, was $60 million R. & D. The reason for the increased R. & D. cost is the transfer of PAMN costs to R. & D. and the inclusion of the passive detection system. The PAMN transfer was the result of Bureau of the Budget review which sighted the PAMN expenditure as a justified R. & D. cost. The passive detection system ($19.2 million) was a subsequent addition to the development program.

Mr. MAHON. How much of the ——— million is for aircraft development and how much is for electronics equipment for the aircraft? Supply that for the record.

(The information follows:)

The total R. & D. expenditures is ——— for the aircraft and ——— is for the electronics.

PROCUREMENT SCHEDULE

Mr. MAHON. How many such aircraft do you hope to buy?

Admiral RUCKNER. We expect to buy ——— of the new models. We need the ——— to fill out the inventory. We were stopped in procuring the E–2A's before we had a full inventory.

Mr. MAHON. What is the total estimated procurement cost of the aircraft including the equipment?

Admiral RUCKER. I am sorry, sir. I will supply that for the record.

(The information follows:)

The total estimated procurement cost of the aircraft including the equipment is ———.

Mr. MAHON. When will the C model be delivered to the fleet?

Admiral RUCKNER. The first aircraft delivery will be in ——— and they will follow at a rate of ——— a month.

Mr. MAHON. Do you have considerable confidence in that estimate?

Admiral RUCKNER. Yes, sir. The equipment that goes in this airplane is flying on what you might call a brassboard stage right now.

Mr. MAHON. How many E–2A and E–2B aircraft do we have operational and under contract?

Admiral RUCKNER. I will have to supply that, because I don't know the inventory right now, sir.

(The information follows:)

42 E–2A aircraft operational, 4 in training status, 6 in PAR, and 1 E–2B Grumman A/C. There are none under contract.

ADVANTAGE OF E–2C OVER E–2A/B

Mr. MAHON. How much do you obtain in performance from the E–2C compared with the E–2A/B aircraft to justify an R.D.T. & E. expense of ——— million? There is a question here of priorities.

Dr. FROSCH. In using the E–2A—there is no B actually—at one point we were designating an aircraft B which would have been an aircraft, a new aircraft, and, in order to save our confusion, we shifted to the C because there were too many documents which labeled the B as something else.

In our experience in using the E–2A in Southast Asia, we had two problems. ———.

Relative to my earlier comment, there is a designation, E–2B, which applies to a modification to some of the E–2As. An aircraft rework, with a change in the computer and the C, follows that. There was never a major aircraft change called the B.

EA–6B

DEVELOPMENT TO DATE

Mr. SIKES. Turning to the EA–6B, you are requesting ——— million in fiscal year 1970 for the EA–6B aircraft. The Navy was funded $25.9 million in fiscal year 1969, and $121.7 million in fiscal year 1968 and prior years. How have prior year funds been spent?

Dr. FROSCH. The prior-year funds have been spent to develop the jamming pods and the on-board electronic warfare equipment; to design the aircraft to take a previous A–6A and modify it into an EA–6B configuration, with four places instead of two, so it can be used as a flying test bed for the aircraft; and, before beginning of construction of the actual R.D.T. & E. aircraft, to be built as complete models of the aircraft for test and evaluation of the equipment.

The present status is that the equipment is flying in the flying test bed and, so far, in its tests, it is performing very well. This is not to say there are not minor problems, but so far it has been a successful program.

EA–6B COMPARED TO E–2C

Mr. SIKES. I think it would be well for the purposes of the record to have a comparison provided of the functions and purposes of the E–2C, contrasted with the EA–6B. You might do that at this point and provide more detail for the record.

Dr. FROSCH. The E-2C is intended for two purposes. Its principal purpose is as an early warning aircraft—namely, to fly near a fleet element, a carrier task force, above it or out from it, for the purpose of searching for incoming aircraft that might be unaccounted for, or intend to attack the carrier task force or group. It has been used in Southeast Asia for an additional purpose and that is ———.

The EA-6B is intended ———.

1970 PROGRAM

Mr. SIKES. What do you expect to accomplish with the fiscal year 1970 funds that are being requested for the EA-6B?

Dr. FROSCH. We expect to continue the development, and most particularly the test and evaluation. This will, I believe, complete or bring close to completion the test aircraft that are required for the total completion of R.D.T. & E., and of the final jammers. There will be some extension of ——— that have not yet been constructed. We expect to, in the course of the testing, correct any problems that have turned up and essentially carry the program on into the major test phase of the program. What we have done so far is the early stages of testing.

Mr. SIKES. Will the funds now requested complete the development of the aircraft?

Dr. FROSCH. We expect, after the fiscal 1970 funds over the 3 years, we would expect to acquire ——— million to carry the completion of the development and testing into the Board of Inspection and Survey, and the final introduction into the fleet.

Mr. SIKES. When is this introduction to be?

Dr. FROSCH. ———.

INCREASED DEVELOPMENT COST

Mr. SIKES. The justifiction pages indicate the total cost of developing this aircraft is ——— million. This is $17.8 million more than a similar estimate given last year. What are the reasons for the increase?

Dr. FROSCH. There are two reasons. This is a contract which has both a target and a ceiling. The estimate last year was based on the target and the state of the contract with respect to the target at that time. There has been an increase in cost beyond the target, but there has been no increase in cost beyond the ceiling, so we are still between target and ceiling.

There is an additional portion of cost to add some ———.

Mr. SIKES. How much of a cost increase is attributable to Navy changes and how much to contractor problems?

Dr. FROSCH. I believe the contractor problem is about $8 million above target, and the remainder would be the changes——

Mr. SIKES. Supply additional information for the record on that.

(The information follows:)

The projected R. & D. cost increase is ——— to meet contractural obligations and ——— is needed for the Navy growth effort to provide necessary ———.

PROCUREMENT

Mr. SIKES. How were the four aircraft which were funded in fiscal year 1968 under the PAMN appropriation used? What is the history of those four aircraft?

Dr. FROSCH. These are the preproduction test aircraft. They are now being used as part of the testing program. They are in PAMN, as in other cases, because they will end up as fleet training aircraft.

Mr. SIKES. Since development and trials haven't been completed, is it realistic to procure ——— additional aircraft in fiscal year 1970 under the PAMN appropriation?

Dr. FROSCH. We believe we are at the stage where we are flying the actual hardware in a changed airplane and the characteristics are being generally met, both in reliability and in the performance. I don't mean to say everything is perfect and all details are operating perfectly, but such problems as seem to be cropping up seem to be minor and things for which correction is understood.

With this flying going on, we feel we have proved the system, and this is a sufficient milestone passed to be able to go into production.

This is the kind of milestone whose passage we have tied production options to in this proposed S–3 contract I mentioned yesterday. This is a "fly before buy" point. We are flying hardware in tests before we come to the purchase of the aircraft.

Mr. SIKES. Is there any possibility that this procedure will result in a duplication of a smaller version of the situation we have experienced with the F–111B?

Dr. FROSCH. Of having later development difficulties while we are in production?

Mr. SIKES. Yes.

Dr. FROSCH. I would never deny there is a possibility of such a thing happening, but I believe we have a very much greater level of confidence based on actual flight of the aircraft than we had at any point in the F–111B.

In the F–111 case, we were in a production state at a time when we knew that some of the aircraft performance program requirements had not been met in the development aircraft and we were essentially proceeding on the basis they could be met with certain changes.

Here we have an aircraft which is meeting all of the basic specifications and so the risk of having a major difficulty is very, very greatly decreased.

A–7E

Mr. SIKES. Turning to the A–7E, there is a request for ——— million for that aircraft. The 1969 program was $6.8 million and this was an increase of ——— million over last year's estimate. How much are you asking for the fiscal 1970 for the A–7E?

Dr. FROSCH. ——— million.

Mr. SIKES. How much are you asking for fiscal 1969?

Dr. FROSCH. $6.8 million.

INCREASE IN 1969 PROGRAM

Mr. SIKES. Dr. Frosch, the fiscal 1969 program is shown as $6.8 million for justification purposes. This is an increase of ——— million

over last year's estimate for fiscal 1969. What is the reason for the increase in the current year's program?

Dr. FROSCH. I believe there was an adjustment at apportionment time of ——— million. That is the number I have.

Mr. SIKES. Clear that up for the record if you will.

(The information follows:)

This increase is due to decisions subsequent to the initial program estimate which approved installation of the increased thrust Allison TF-41-A-2 engine in both the Air Force A-7D and the Navy A-7E. The additional funds are being used for mockup, ground testing, and flight testing of the A-7E/TF-41-A-2 aircraft in order to assure a sound new engine installation, structural integrity, and operational aircraft performance.

1970 PROGRAM

Mr. SIKES. What will be accomplished with fiscal 1970 funds?

Dr. FROSCH. I believe we will be—we are in flight test program and final work on the heads-up display, I believe it goes to Board of Inspection and Survey (BIS) trials—it is in BIS right now and first fleet delivery is beginning so this is essentially final flight testing and cleanup.

Mr. SIKES. Will the funds now being requested complete the development program?

Dr. FROSCH. We show ——— million in fiscal years 1971 through ——— essentially to take care of any final things that are shown up by BIS and need to be done as the aircraft is introduced into the fleet.

PRODUCTION CONCURRENT WITH DEVELOPMENT

Mr. SIKES. Is it sound policy to propose to buy ——— of the A-7E program in the fiscal 1970 PAMN budget when you will be running trials and continuing development of the aircraft through ———.

Dr. FROSCH. I think the answer is "Yes." The aircraft has had a considerable amount of flight testing as satisfactory. The Board of Inspection and Survey Trials are the final formal acceptance of the aircraft by the Navy. There is every reason to believe and no reason to think contrary to the fact that it will be acceptaed as a satisfactory aircraft.

However, in every Board of Inspection and Survey Trial there are some items that turn up that need to be changed in the first several years of fleet operation of any new system things turn up that could not possibly have turned up during a testing period because they are connected with actual operational use and we do need at that time to make some alterations in the aircraft. Usually these are not retrofit, though they sometimes are. They are usually changes made on the production line to correct deficiencies or make improvements that are obviously required.

Mr. SIKES. You are in the process of procuring ——— aircraft in fiscal 1968 and 1969 PAMN budgets. Are all these the A-7E model?

Captain JESSEN. In the A-7 we procured on the order of ——— A-7A's and ——— A-7B's. We are now working on the E's. There have been crashes and combat losses. I am not sure of the number on board at this moment, but this is the third major Navy buy.

TF–41 ENGINE

Mr. SIKES. Will the TF–41 engines be retrofitted to aircraft previously procured?

Dr. FROSCH. No.

Mr. SIKES. Will the aircraft procured with fiscal 1970 PAMN funds have the TF–41 engines?

Captain JESSEN. That is right. We will start at aircraft No. ——— in the A–7E series with the Allison-produced engine.

Mr. SIKES. Does that mean the first ——— A–7E aircraft will not have the TF–41 engines?

Captain JESSEN. At the present time we will receive ——— that will be powered otherwise.

TF–30–P–8

Mr. SIKES. How long has the Navy been aware of the fact that the TF–30–P–8 engine did not provide the thrust needed?

Dr. FROSCH. The P–8 engine was put into the A–7 series of aircraft based upon the power-to-weight ratio with a certain loading of weapons. The aircraft airframe is capable of flying with a higher loading of weapons, more weight than was intended with the overall engine-aircraft combination.

In use in Southeast Asia it began to be the case that some of the commanders wished to load the aircraft ———. In that sense, it is an upgrading of the engine to give it a better power-to-weight ratio and a higher capability than was originally the intention when the aircraft was adopted.

DELAY IN SWITCHING TO NEW ENGINE

Mr. SIKES. There seems to be grounds for criticism, after this situation was revealed, that the Navy waited 2 years before deciding to acquire the more powerful engine.

Dr. FROSCH. We started the decision process of trying to decide which more powerful engine to get when we began to get the reports from the field. There were several competing engines, all of which required some completion of development before they could be put in the aircraft.

Mr. SIKES. The engine you are going to acquire, however, was in use by the Air Force during that time; wasn't it?

Dr. FROSCH. It was in use by the Air Force—it was being bought by the Air Force for their aircraft, but it is not or was not yet installed and in use.

Mr. SIKES. It seems strange that you would not take advantage of Air Force experience and testing and move immediately to correct this deficiency rather than to explore a new set of engines and I assume including some that the Air Force had already tested and rejected.

Dr. FROSCH. At the time we were exploring other engines, the Air Force was in, I believe, the early stages of testing the TF–41 and it was still not a proven engine. They were not flying it in aircraft and there was room for some technical argument as to whether that was the better engine or not.

In the end we concluded to go with that engine and have adopted the TF–41. There was, incidentally, some considerable discussion between the Navy and OSD as to whether, going to a more powerful

engine for the purposes of uprating what the aircraft could carry was in fact justified expenditure. We felt strongly that inasmuch as we had an aircraft which has been demonstrated in combat as successful and has been demonstrated as having a higher capability if we could put in an uprated engine that this was a warranted expenditure but there was lively discussion as to whether we should uprate the aircraft beyond the original intention.

In the end our arguments were convincing, but that took a while.

PROCUREMENT OF AIRCRAFT WITH OLD ENGINE

Mr. SIKES. Again, you purchased ——— aircraft during the period that the consideration of a more advanced engine was in progress. During this time I presume the TF–41 was available through Air Force channels. Doesn't that assume to be a situation that is somewhat indefensible?

Dr. FROSCH. I do not believe the engine was actually available throughout the period of that ——— aircraft buy. That is one point. In addition, I do not remember the precise chronology, which we can supply, but it seems to me that we were asking during part of that period, and had not yet received permission, to buy the other engine.

Admiral GADDIS. Additionally, sir, the earlier model of the A–7A or B as appropriate, was badly needed in the fleet in Southeast Asia in order to uprate our capability for a light attack day aircraft. The A–4, a rather much older type aircraft, has significantly less load capability, and also range capability and ability to avoid Sam missiles on strikes into North Vietnam, which were going on at the time that these questions were being considered.

Dr. FROSCH. There is one additional point, and that is that the TF–30–P8 engines that are in the A–7B's and the first A–7–E's can be uprated by a very simple retrofit, now that we have had enough experience with the engine to bring them up to about ——— pounds of thrust, which is less than the ——— pounds of thrust of the TF–41, but considerably improved the thrust to weight ratio of the aircraft.

Mr. SIKES. It is the committee's understanding that ——— is one of the very things that caused a drawback in this P–8 engine. It is my understanding that was one of the reasons it required more thrust.

Admiral GADDIS. With the full load of munitions which were desired to be carried by the operational commanders, yes, you are exactly correct. But the A–7 ——— was still far superior to the capability of the A–4, sir.

Mr. SIKES. Are there questions at this point?

NUCLEAR AIRSHIP FEASIBILITY STUDY

Mr. LIPSCOMB. A news article of February 20, 1969, indicated that Qatron Corp., Computer Systems Division, is studying the feasibility of a nuclear airship for the Naval Air Systems Command. The company will investigate the state of the art technology pertinent to airframe, guidance and control system, and powerplant. Utility of such a craft in support of present and future fleet requirements will be considered.

What is the study about and what is the cost of the study effort?

Dr. FROSCH. That is an exploratory development. I do not know the cost. We will have to find that out. Being an exploratory development for that kind of a job it would be a very small kind of study effort.

REQUIREMENT FOR STUDY

Mr. LIPSCOMB. What would bring about a Navy study of nuclear airship after the studies we have made in the past?

Dr. FROSCH. For one thing I can say, the studies in the past in fact are now in the past. Most of the work on the nuclear aircraft is now at least a decade in the past.

The technology is different. That is one difference. The other difference is the studies of the nuclear aircraft were essentially in connection with Air Force missions and problems, and it might well be worthwhile to have a look at whether such a thing would be of any particular use for Navy missions. This is simply a process of keeping track of all the technological options that might be important to future Navy uses.

Mr. RHODES. If the gentleman will yield, are you saying, Doctor, that this is not actually an experimental venture but an attempt to gather data which is available from other experimentation to determine what effect it might have on the future plans for the fleet.

Dr. FROSCH. I cannot be sure without reading what the contract is whether it is experimental or not. I would expect that it would not be experimental, that it would be two kinds of things: One, it would be looking back at what has been done, and seeing what can be said today about changes in technology and naval missions. It probably involved some theoretical work and theoretical engineering to see whether any of the new technology changes the picture of what can be done, and also attempting to see what the usefulness for Navy missions would be.

Mr. RHODES. When the NASA felt a requirement for a nuclear engine for the NERVA system, it went into a consortium with the AEC for the production of the reactor and those elements which are directly related to the use of the atom. I would assume that if the Navy decides in the future to get into something like this, it would follow the same route and not get into any type of duplication of facilities.

Dr. FROSCH. For statutory reasons as well as good sense, I do not believe we could or would go into that kind of enterprise without going to the AEC.

Mr. RHODES. I thought that before, and found it not to be true. So I am just reiterating my hope this will not be done.

Thank you, Mr. Chairman.

INITIATION OF STUDY

Mr. LIPSCOMB. How would a study like this be initiated? Would it be by the Navy or would the Qatron Corp. come to the Navy?

Dr. FROSCH. It could be either way. It could be someone in the Air Systems Command whose job it is to think of Navy problems having an idea. It could be somebody in the laboratories having an idea and deciding that there were some things that were worth looking into

and looking for somebody that was competent to do it. It could also be that the corporation in question had an idea and put in a proposal which had enough interesting and promising aspects so that the Air Systems Command people felt that it was worth pursuing.

Mr. LIPSCOMB. Do you know this company?

Dr. FROSCH. I do not know the company.

QUALIFICATIONS FOR PERFORMING STUDY

Mr. LIPSCOMB. What would a computer systems division expertise be in a nuclear airship?

Dr. FROSCH. I don't know. I would have to look at what the backgrounds of the people who are working on the contract were. It is perfectly possible that they have some special expertise. It is possible, for example, that they have some computer expertise that makes it possible for them to make some theoretical computations that were not previously possible. I don't know. I would have to look at the contract.

Mr. LIPSCOMB. For the record, would you put as much information in as possible on this contract?

(The information follows:)

This is a no-cost contract or policy agreement between the Qatron Corp., of Rockville, Md., and the Naval Air Systems Command. Qatron has offered to conduct a preliminary feasibility study of the nuclear dirigible in an antisubmarine warfare (ASW) role, reflecting the current state of technology. It was necessary to negotiate a contractual agreement in order that Qatron Corp., with proper clearances, may establish a need to know for certain Navy ASW mission information.

BOOZ, ALLEN AIR TRAFFIC STUDY

CONTRACT VERSUS IN-HOUSE STUDY

Mr. LIPSCOMB. In November 1968 the Navy awarded a $94,511 air traffic study contract to Booz, Allen Applied Research. The contractor is to screen advanced development objectives, identifying those development areas which are most needed, and for establishing an order of priority among the remaining development objectives. They are to collect and analyze data relating to mission, employment, requirements for fleet tactical support aircraft, and fleet support helicopters. Dr. Frosch, this appears to be the type of work which should be done in-house by military personnel. What is your opinion on this?

Dr. FROSCH. I think it depends on precisely what work they will do under that. The description sounds like a military kind of task, but it implies in the description a good deal of data collection and data analysis which is not necessarily particularly military in character. I think the important point is that the military should be those who would examine the results and not necessarily those who would collect the data and do theoretical analysis on the data.

Mr. LIPSCOMB. Do you or your supporting witnesses have any records on this particular contract?

Dr. FROSCH. I very much doubt it, not at that level.

REQUIREMENT FOR STUDY

Mr. LIPSCOMB. How would the necessity for a contract like this be determined?

Dr. FROSCH. I would expect that it would be determined in the office which has cognizance over that collection of ADO's, documents, and problems which office would be in the Air Systems Command. I would expect that they would decide that they needed the work done. They would in general look within headquarters and within the laboratories to see whether the work could be done in-house, or was sensible to be done in-house and, if not, then they would go out generally with a request for proposals, either generally competitively or usually in a case like this a very large list of potential bidders who are known to be competent to do the work.

STUDY TO REDUCE COMBAT LOSSES OF AIRCRAFT

Mr. LIPSCOMB. In 1968 the Naval Weapons Center, China Lake, awarded a contract to investigate the technical options available for the reduction of combat losses of U.S. technical aircraft by analyzing the means whereby enemy aircraft and surface-to-air missile defenses may be attacked and destroyed, neutralized, or avoided. This appears, Dr. Frosch, to be a study analysis which should be made by the Naval Weapons Center itself and not contracted out. For the record, could you indicate the contractor involved and what is the cost of the contract?

(The information follows:)

The Naval Weapons Center, China Lake, Calif., maintains an in-house analysis effort so that future technical possibilities may be evaluated with respect to future Navy requirements. In particular cases, where it may be advantageous to the Navy to seek out qualified experts or perform a specialized task, this laboratory as well as others contracts with industry. There is not sufficient information in Mr. Lipscomb's question to definitely identify one of these studies. However, it appears to be generated by recent Southeast Asia activities and may be a study with Delex Systems Inc., Arlington, Va. The dollar amount was $80,005.

NEED FOR PRIORITY SYSTEM ON CONTRACTS

Mr. LIPSCOMB. Has there been a method devised or a survey made on how we could utilize our resources better without indiscriminately making contracts? We hear about priorities these days, but there does not seem to be any priorities in the allocation of funds for contracts, studies, and analyses.

Dr. FROSCH. I think that we do run a priority system on letting such contracts and on doing studies and analysis. Certainly we do not do all of the studies and analysis that people inside the Navy Department suggest, and we certainly do not take all of the proposals that are given to us on studies and analyses. I think we need to be very careful when we assign priorities, that we do not put them in the order of immediate urgency, in the sense that we do not use all of our money to do things that are needed immediately, whether they are completely urgent or not, at the expense of doing analyses for long-term future use. There are some things that would need to be done immediately but are not as important as long-term things.

Mr. LIPSCOMB. No one is suggesting this. I think we all understand the need for basic research, exploratory research, but you have a tremendously large sized operation in-house, you have a tremendous operation in university studies, you have all kinds of resources available for these purposes, and yet the defense research agencies seemingly keep going out and gathering in more. How can we put some strings or limitations on how we spend these resources? At times it seems as though someone feels we have unlimited resources.

Dr. FROSCH. I certainly do not feel we have unlimited resources. I certainly do face a set of problems which I cannot accommodate within the resources we have.

Mr. LIPSCOMB. Isn't there some way we can look deeper into this? What kind of thought has been given to this?

Dr. FROSCH. There has been a tremendous amount of thought to how we examine and keep track of these contracts. It is a subject on which we spend a great deal of time.

In fact, we have made organizational changes and made changes in our information systems and in our accounting systems. We have made organizational changes in the laboratory systems, in part, precisely to bring this kind of problem into aggregations that would have clearer responsibility so that we would know precisely what they were able to do. This is, as you say, an extraordinarily difficult area because there are a large number of relatively small things that have to be looked at. So we automatically generate a very large number of small tasks. This does give us a problem in management. It is one we have certainly been working on. I cannot claim that it is one that we have solved.

Generally what is done is that the responsibility for these things is passed down to the level which has the most direct contact with the need and work. The higher levels of management try to essentially keep track of it on the basis of aggregations of work and whether the general area is sensible and in the right priority area.

STUDY RESULTS NOT PUT TO USE

Mr. LIPSCOMB. We have all heard statements and allegations that many of these reports come back, are put in files, and that is the end of them. That they are not circulated or read to any great degree.

Dr. FROSCH. No; I think as a general matter just watching the flow of material that comes to my level it is quite clear the material is looked at and sorted just from the fact that quite frequently I receive the results of a contract of the kind and size that you describe. This means that someone at the level where he is getting contract results has seen a report which he thinks is interesting and important and has referred it on up the line, and some of these actually get to me for action or to Admiral Ruckner for action, and get incorporated into the program.

I do not know what percent of results of such exploratory contracts really turn out to be useful in the sense that they are finally built into military hardware.

But clearly that is one of the areas from which we are getting new technological ideas and new possibilities.

Admiral Ruckner points out that frequently a report that says something is not a good idea or is not sensible or should not be pursued further is a very good study result to have in hand.

Mr. LIPSCOMB. When it gets that attention it is probably worthwhile.

Dr. FROSCH. I think generally these do. It may not get that attention at my level. If I were to read all of those reports, I would not even get that done.

Mr. LIPSCOMB. I would suggest that the reports you see are the ones that really produce something.

Dr. FROSCH. They are certainly the ones that are outstanding because they do that. There is no question about it.

PROJECT THEMIS

Mr. LIPSCOMB. I am going to refer back to Themis for just a moment.

GUIDELINES FOR ALLOCATING FUNDS

Did I understand you to say yesterday that the guideline for allocating a Themis program to a university was based upon some monetary criteria?

Dr. FROSCH. That is one of the guidelines, which is not, I believe, absolute, but it is a guideline.

The guideline on the money is a college or university—I will read the guideline precisely so there will be no ambiguity—a college or university that expended more than $3 million during fiscal 1968 from DOD grants and contracts is not encouraged to submit proposals. That is not an absolute thing, but it is a discouragement. There are other eligibility criteria, five of them in toto.

Mr. LIPSCOMB. You mean if they were already receiving $3 million in DOD grants, they would not be considered?

Dr. FROSCH. No. The guideline does not say that. It says they are not encouraged to submit proposals. Should I read the other guidelines? Would that be of assistance?

Mr. LIPSCOMB. It might be helpful. Are they very lengthy?

Dr. FROSCH. I will read the titles. One is, current capability; that is, if they already have a strong research capability then they should not be eligible. Current leadership: They have got to have good enough people to be able to do the job. Organization: That is, the willingness of the university to produce a suitable organizational structure to take the work. What are called coupling mechanisms, that is, the willingness by stating how they will do it, to take the output of the research and couple it in a useful way to the Department of Defense and the technical community at large both by publishing in a suitable way and by willingness to provide advisory assistance to DOD.

Finally, the item of current DOD funding which I read. Then there is one additional one which is simply that an institution cannot submit more than three proposals in a given year.

Mr. LIPSCOMB. Wasn't one of the thoughts of Themis to spread the work around in order to create what were defined as centers of excellence?

Dr. FROSH. The idea was to spread the work more widely and the hope was to create some additional centers of excellence.

Mr. LIPSCOMB. One of the institutions which presumably comes under those criteria that you have just given, one that is listed in your justification book as a typical operation of Project Themis is the University of Minnesota. In the report put out by the National Science Foundation for fiscal 1967, the University of Minnesota has total Federal obligations of $49,459,000: Department of Agriculture, $3.9 million; AEC, $2.3 million; Department of Commerce, $85,000; Department of Defense, $2.5 million; Health, Education, and Welfare, $31.4 million; NASA, $3.1 million; National Science Foundation, $5.6 million; and miscellaneous, $321,000.

Now here is one of your participants in the Themis university program: The University of Minnesota already with $47.5 million in Federal science funds in fiscal 1967. Of course, we realize they no doubt have the expertise and the staffing and all but the Themis program at Minnesota just adds another layer onto our already large grant program. What is gained by using Themis funds for this? You could have given them a grant under any one of a dozen of your other programs just like the studies I have read here.

Admiral OWEN. There are several considerations, Mr. Lipscomb. There are two Themis contracts at the University of Minnesota: One having to do with infrared and laser studies and another the study of the performance of gas turbines and phenomena associated therewith.

The proposals are submitted by the universities throughout the country under the DOD guidelines. They are judged by representatives of the Army, Navy, and Air Force for their quality content and their potential promise to Department of Defense problems. The decisions in this competition are finally arrived at and announced by the Director of Defense Research and Engineering. With respect to Minnesota, from the way we look at it, it was excellent work that was proposed. It was pertinent to Navy problems. They were within the guidelines announced by the Director of Defense Research and Engineering. The final selection and approval was made by him. We think we are getting good work and it is a good investment.

Dr. FROSCH. I would like to add one comment to that, if I may. The Department of Defense was faced, when the program was announced, with the problem of deciding on some way that could be announced and carried out that would define essentially who is already a rich center of excellence, and who is not a rich center of excellence. Having defined a mechanical procedure to be carried out, essentially anybody who fitted within those guidelines which may not be perfect, we felt and the DOD felt, had to be considered equally; that is, it would be unfair and improper to announce a set of guidelines as to who was eligible and who was not eligible, and then proceed to violate the guide-

lines, provided the work was good, after the proposals came in. I think in some of these cases it may well be that the institution involved fits within the guidelines that we have put out, but there are certainly some questions as to whether they always fit within the general principle. The idea was that having put out a set of procedures we were essentially fairly well bound to follow the procedures. It may be that those procedures should be changed.

NEED TO WORK WITH SMALLER UNIVERSITIES

Mr. LIPSCOMB. One of the reasons that I am stressing this so much is that it had been my understanding from hearings before this committee that the purpose for project Themis was to gain more qualified people working in the area of Government research, by spreading the Themis funds out to the smaller universities in order to have them build this expertise and competence.

Dr. FROSCH. I do not recall whether smaller was the point.

Mr. LIPSCOMB. Let me finish, please.

This was my understanding. And DOD had always had the opportunity to work with such institutions as Minnesota, the University of California, California Institute of Technology, and Massachusetts Institute of Technology. But the idea was to spread the work out to the smaller universities. As I look at your Themis program, you are going right back to the universities that have always been qualified, have the expertise, the faculties, large funding, and all the rest. You may pick out a few that do not, but this is the appearance and I have only mentioned one. I could mention others if you want me to.

Dr. FROSCH. As I look at the list, I do not know precisely what the amounts of Federal money in these schools are. But as I look at the list, it seems to me the preponderance of them I know to be schools that do not have large DOD involvement.

Mr. LIPSCOMB. I am not talking about DOD alone.

Dr. FROSCH. In some of them I will go farther, I am certain they do not have appreciable Federal involvement.

DUPLICATION WITH NATIONAL SCIENCE FOUNDATION

Mr. LIPSCOMB. The National Science Foundation is doing basically the same thing you are trying to do. You can find the National Science Foundation with studies allocated in exactly the same areas that you are allocating study funds to, if you could take the time to look into it.

On infrared studies, the National Science Foundation is making all kinds of allocations. In the area of nuclear research they are making all kinds of studies. If you would go down the list of National Science Foundation grants, you would find that you are in the same areas as they are in many instances.

The National Science Foundation has the setup, they have the organization and they have the mission. All the Department of Defense would have to do is to lay on the requirement of what you desire and let them administer it.

You would not be taking military personnel, military funds, and working in a mission that is not your area. The support of education is not the real mission of the DOD.

Dr. FROSCH. It is perfectly true that the National Science Foundation is doing infrared research as we are doing infrared research. I would submit, however, that merely saying that has no significance with regard to whether we are doing the same work. Saying that two places are supporting infrared research is like saying that infrared work is mentioned two places in a book—it may not be the same book—it may not be the same research. Infrared is a very large field and we have rather specific interests that are quite different in many cases from the general scientific interest of the NSF.

Mr. LIPSCOMB. You could set forth the requirements of what you need. You are not doing, as you said yesterday, any classified confidential work. It is all for publication. This is exactly the mission of the National Science Foundation and in some cases other agencies of the Government.

I think this is an area that DOD should turn over to the proper administering authority. You have been in this program since fiscal 1967. When we ask questions of the Navy on this subject, you are hard-pressed to tell us of any meaningful reports or of any meaningful evaluation of the program to date except you know, or at least you say you know, that it is working well.

Admiral OWEN. Excuse me, sir.

Mr. LIPSCOMB. Yes, Admiral.

Admiral OWEN. I did not mean to leave any impression with the committee that no look had been taken at the continuing performance of the Themis universities. Indeed, they have been visited on repeated occasions. We have assessments as to their productivity and performance, reports issued, and so forth. I do not have those available with me, sir.

I did not mean to leave the impression that nobody had looked at it.

Mr. LIPSCOMB. If you did not know that Themis was going to be questioned in depth here at these hearings, you did not remember last year. You recall yesterday we talked about Case.

Admiral OWEN. Case-Western Reserve; yes, sir.

Mr. LIPSCOMB. In Ohio.

Admiral OWEN. Yes, sir.

Mr. LIPSCOMB. In 1967 $6.4 million worth of Government obligations went to Case. The AEC had over a million going in there. HEW had almost $2 million. The National Science Foundation had a million and a half dollars worth of grants going in there. Then along comes your study on research. Why didn't you give Themis funds for that study to some little school that was not participating to that extent?

Dr. FROSCH. Mr. Lipscomb, it is a more general statement than that. You cannot pick a subject of research and then say here is University X that is not doing any research, I will go to them and have them do it. It simply cannot be done that way, even if it is physics research and they have a physicist. Physicists are not interchangeable. You look for the individual who you think is capable of doing the work. This is a very individual matter.

NEED TO USE NATIONAL SCIENCE FOUNDATION

Mr. LIPSCOMB. I hope, Dr. Frosch, with your great background in education that you would inspire somebody over at DOD to take a look at the university program and see if it could not be administered and

applied to greater advantage through some other agency that works in the field of basic and exploratory research. Then you could benefit from that program. If you are not tapping the National Science Foundation's operations now, and just setting up your own, this is a waste of effort.

Dr. FROSCH. Mr. Lipscomb, I would like to review the history. The first organization in the Federal Government that was put together for the purpose of tapping academic research for Government purposes was the Office of Naval Research, which was set up by statute in 1946 to do so. In fact, it was the ONR that established most of the original arrangements and kinds of arrangements for working with the university research community. Later when NSF came along it began to take up that work. Over the years we have examined the question and we frequently do, whether it does make sense for us to go out of the research business in some sense and have other agencies of Government do it and simply read their reports.

Every time we have looked at this possibility and examined it, it turns out to be a very poor idea in our judgment because it decouples us from the community of people with whom we want to deal directly. It loses us control of the areas of research and the kinds of things we want to be done.

TRANSFER OF THEMIS TO NATIONAL SCIENCE FOUNDATION

Mr. LIPSCOMB. Nobody is advocating so far as I know that you go out of this business. I am talking about your Themis program, the university studies.

This is an extra layer on your research program in the DOD. We know how it happened and we know how it got started. We have been told by Dr. Foster.

It was not the specific idea of the Department of Defense. It was put onto it. It is time to look at it and see where it can be done better. That is all. It would have been well to have had Dr. Foster, the Director of Defense Research before us because I might forget when he is the witness.

Dr. FROSCH. I will pass the message on to him personally.

Mr. LIPSCOMB. When we get the record, I hope to see that he gets it, too.

Dr. FROSCH. Incidentally, just for the record the actual Themis contract with Case-Western Reserve is an Army contract with a Navy transfer of funds to the Army for the first year.

That doesn't change the principle.

Mr. LIPSCOMB. I have taken a great deal of the committee's time on Themis, Mr. Chairman, and that is the end.

AIRCRAFT PROPULSION EVALUATION

Mr. SIKES. You are requesting ——— million in fiscal year 1970 for aircraft propulsion evaluation. Your program for the last 2 fiscal years totaled $4.4 million. How was the $4.4 million utilized and on what specific engines?

(The information follows:)

1968 AND 1969 FUND USAGE BY ENGINE

	Fiscal year 1968	Fiscal year 1969
TF30-P-8 performance evaluation	X	X
TF30-P-12 performance evaluation	X	
TF30-P-1 performance evaluation	X	
Engine characteristics summary	X	X
Maintainability of powerplants		X
TS8-GE-14 environmental evaluation	X	
T56-A-14 corrosion evaluation	X	
T64-GE-12 performance evaluation	X	
T63 performance evaluation	X	
T76-G-10/12 performance evaluation	X	
Auxiliary power units evaluation	X	X
Starters (verification and qualification)	X	X
Fluid systems evaluation and service problems	X	X
Fuels service problems	X	X
Oils service problems	X	X
Spin pit heating capability	X	
Current limiter evaluation	X	X
TRW roller drive evaluation	X	X
Engine oil qualification	X	X
OCTARD		X
J79-GE-8 corrosion evaluation		X
Helicopter transmission		X
The particular engines are:		
TF30-P-1	X	
TF30-P-8	X	X
TF30-P-12	X	
TF58-GE-14	X	
T56-A-14	X	
T-63	X	
T76-G-10/12	X	
J79-GE-8	X	X

USE OF 1970 FUNDS

Mr. SIKES. How do you propose to spend fiscal year 1970 funds?

(The information follows:)

The TF30-P-12 altitude qualifications, water ingestion, altitude relight, and anti-icing tests will be completed. Steam ingestion tests will be started. The simulated salt water tests and evaluation of the sermetal-coated J79-GE-8 will be completed and test results will be correlated with engines operating in actual salt environment to determine that the tests accurately simulate the fleet environment. TF41-A-2 performance evalution will be completed. Contaminated fuel tests on the fluid system of the TS8-GE-16 engine will be completed. The qualification of additional suppliers of aircraft engine and transmission lubricants, engineering evaluation and verification tests of auxiliary power units, starters and related components, and the development of coordinated engine specifications will continue.

Mr. SIKES. How much of this effort is devoted to the TF-30-P12 engine for the F-14A aircraft?

(The information follows:)

$0.637M for the following tests:

(a) Complete altitude, qualifications, and performance tests.
(b) Complete water ingestion tests.
(c) Complete altitude relight tests.
(d) Complete anti-icing test.
(e) Begin steam ingestion test.

Mr. SIKES. Why do you have to evaluate the TF41 engine when it is being evaluated by the Air Force?

(The information follows:)

The Air Force is evaluating the TF41-A-1 engine whereas the Navy is evaluating the TF41-A-2 engine which has a higher thrust rating at a higher engine rotor revolutions per minute.

AIRCRAFT FLIGHT TEST

Mr. SIKES. Your fiscal year 1970 program for aircraft flight test totals ——— million. How were the fiscal year 1968 and 1969 funds totaling $5.6 million used including the aircraft tested?

How do you propose to use fiscal year 1970 funds and for what aircraft?

(The information follows:)

The fiscal year 1968 funds were used as follows:

BIS trials, A-7A, OV-10A, F-4J, UH-2C, A-4F, P-3B, CH-53, EC-130Q, TC-4C.

Witness contractor demonstrations, A-7A, CH-53, TC-4C, F-4J, OV-10A.

Shoehorn evaluations, A-4, F-8, A-1, F-4, A-6.

Navy preliminary evaluations, A-7A, X-22A, OV-10A, TC-4C, F-4J, UH-2C, A-4F, P-3B, CH-53, EC-130Q.

Smoke abatement evaluations, A-4, A-7, F-8.

CH-46A, antenna pattern.

A-6A, vertical reference gyro modification evaluation.

F-4, 600-gallon fuel tank evaluation.

EA-6A, ALQ-76, ECM pod evaluation.

T-2B, spin evaluation.

Rain repellant evaluation.

F-4, MK-2 smoke tank evaluation.

The fiscal year 1969 funds were used as follows:

Flight test and evaluation of aircraft weapon system configurations and modifications were supported for 35 models and series of aircraft. This included, among others, witnessed contractor demonstrations and conducted NPE on OV-10A, F-8J, CH-53, and RA-5C, supported BIS trials on F-4J, OV-10A, CH-53D, and EC-130Q and conducted NTE of speed brake on T-2C, updated Shoehorn installation in A-4, A-6, F-4, and F-8, sonobuoy dispensing system on P-3C, and navigation system in TA-3B.

The planned program for fiscal year 1970 includes supporting BIS trials on the P-3C, O-3A, T-38A, DC-130, HH-2C, AH-1J, HH-3C, and EA-6B, witnessing contractor demonstrations of the AH-1J, and conducting NPE's/NTE's of newly developed configurations and modifications to the CH-46E, A-3, A-6, RA-5C, F-8J, F-4, CH-46, OV-10A, and A-4.

AIRCRAFT EXPLORATORY DEVELOPMENT

Mr. SIKES. You are requesting ——— million for aircraft exploratory development. Your program for the last 2 fiscal years has been running over $20 million each year. Generally, how have these funds been spent during the past 2 fiscal years?

Dr. FROSCH. In the past 2 fiscal years the funds for aircraft exploratory development have been expended in a comprehensive program involving conceptual studies, small hardware developments and engineering support of naval aviation and aircraft operational problems in the marine environment. Emphasis in the past 2 years has been concentrated on advanced aircraft concepts, increased turbine inlet temperature for propulsion systems, composite propulsion systems, composite material applications in aircraft structures, reduction of aircraft smoke emission, and improvements in cockpit man-machine interfaces involving displays, emergency equipment, and environmental control systems.

Mr. SIKES. How do you propose to spend fiscal year 1970 funds?

Dr. FROSCH. The fiscal year 1970 program will include continued emphasis in new concepts and propulsion projects. Studies and analyses will be initiated and continued to investigate light attack aircraft, to study the impact of ——— technology on ASW, to develop ——— to demonstrate an advanced ———. An accelerated program of developing high-modulus composite structures is planned. Investigation of a new approach in fatigue life-prediction theory will continue. ———. A flight research program will continue to determine the significant stability and control parameters to establish flying qualities acceptability criteria for V/STOL aircraft. Specialized investigations will continue to improve methods of predicting aircraft stability and control characteristics and to improve simulation techniques. Development of ——— techniques will be expanded to include an ———. Work will continue on the solid state aircraft electrical system, employing multiplexing techniques to reduce wiring runs. Full-scale tests will be conducted for new designs of energy absorbers for aircraft arresting systems.

Mr. SIKES. Identify the ——— aircraft and related equipment mentioned on page 95 of your justification book.

Dr. FROSCH. The 12 projects in aircraft exploratory development are advanced aircraft concepts, aerodynamics, structures, control and instrumentation, electrical generation, propulsion, auxiliary machinery, acoustic silencing, habitability and personnel protection, vehicle handling and servicing, maintenance and support, and electromagnetic silencing.

AIRBORNE ASW DETECTION SYSTEMS

Mr. SIKES. Describe the work done under the subactivity airborne ASW detection systems.

Dr. FROSCH. Airborne ASW detection systems includes a number of developments. Specifically they are:

Airborne ASW avionics, the development of advanced acoustic concepts through a flyable prototype. The end product of this project is a set of system performance specifications.

Airborne acoustic search sensors concerns the development of future acoustic systems beyond the DIFAR and CASS systems.

Command active sonobuoy system is a command activated, active ——— sonobuoy system having detection ranges approximately ——— than the present system. CASS is expected to be operational in ———.

ASW helicopter attack system is a modification program to increase the capability of the SH–3D helicopter. The system will include an integrated tactical display, towed MAD, radar, active sonobuoys, improved navigation and stabilization subsystems, and the latest ASW airborne torpedo.

Airborne ASW radar is the development of a high resolution airborne radar system ———. This radar, designated the APS–116, will be first used operationally in the S–3A.

Improved MAD is an integrated MAD system built around our newest MAD detector ———. This system will be installed in the P–3C and the S–3A.

The moored sonobuoy system is a long-life, bottom-moored passive sonobuoy. This development has been transferred to the ASW surveillance subactivity in fiscal year 1970 because the system is more in line with developments in that area.

INCREASE IN 1970 FUNDING

Mr. SIKES. Your fiscal year 1970 program is ——— million, an increase of ——— million over the fiscal year 1969 program. Why has this program been increasing for the past 2 fiscal years?

What do you hope to accomplish with fiscal year 1970 funds?

Dr. FROSCH. The increases over the last 2 fiscal years in the airborne ASW systems subactivity were caused by two different factors. In fiscal year 1969 the command active sonobuoy system development was in its most costly development year requiring slightly more than $4.5 million. Other project requirements remained fairly constant between fiscal years.

The inclusion of the airborne acoustic search sensors project, requiring $2.2 million, is the primary reason for the fiscal year 1970 increase.

As for what we hope to accomplish:

In the advanced ASW avionics portion an advanced avionics system will be installed in an RA-3B and flown against U.S. submarine targets. A data processing system, integration, installations, tests, analysis, system simulation, and laboratory support require funds.

Airborne acoustic search sensor funds will provide for the start of the development of a deep passive sonobuoy. Work will primarily be centered around the development of a breadboard system to begin testing the concept and gathering of required data. Work on items critical to the development will also be done.

The command active sonobuoy system, CASS, will complete operational evaluation and initiation of pilot production and later letting of the production contracts will take place. Work will continue on the ——— CASS, or DICASS, portion of the development.

The ASW helicopter attack system project requires integration of active sonobuoy and dipping sonar displays and the completion of the evaluations of some of the test equipments.

The airborne ASW radar will undergo extensive testing both in the airborne and ground installation environments. The Navy will also contract for service test models of the radar.

The integrated MAD system will undergo operational testing and contracts for the development of magnetic shielding for the MAD detector will be let.

AVIONICS ADVANCED DEVELOPMENT

USE OF 1970 FUNDS

Mr. SIKES. Under avionics advanced development, the 1970 program is ——— million. What is to be accomplished with these funds?

Provide that for the record.

(The information follows:)

There are five projects in the avionics advanced development element: $700,000 are programed for the development of a high frequency antenna system for ocean surveillance and ASW aircraft. This system will permit the simultaneous trans-

mission on two HF frequencies with a minimum of interference to HF receivers and to ASW and other sensors. In fiscal year 1970 we will complete the design of antennas, filters, and couplers and commence system integration.

In a second project we propose to initiate the development of a highly reliable nonmechanical teleprinter for use in ship and aircraft and at shore activities. In this program we are striving to develop technology which will result in failure rates as low as 10,000 hours between failures. It is anticipated that the equipment resulting from this project will be capable of operating at 3,000 words per minute, will be smaller than teleprinter equipment now available, and will satisfy some of the requirements of the other services and Federal agencies.

In another project we have programed $300,000 for the development of small avionics components for aircraft. This development is a followon to exploratory development efforts and includes the fabrication, testing, and updating of specifications for such items as power supplies, converters, vibration isolators, and microcircuits.

CAINS—fiscal year 1970—1,206K.

R–F data link capability plus update of ship signal generation will be demonstrated in fiscal year 1970. Expect to contract for 11 engineering development models of the airborne CAINS and complete design of calibration and maintenance models.

USE OF 1968 AND 1969 FUNDS

Mr. SIKES. Also provide for the record a statement showing how the fiscal 1968 and 1969 funds were used.

(The information follows:)

The development of the HF antenna system for ocean surveillance and ASW aircraft commenced in fiscal year 1968. $245,000 were provided in that year and $461,000 were provided in fiscal year 1969. These funds were used to conduct initial baseline studies, to let contracts for the development of a dog leg receiver and transmit antenna and an electrically short receive only antenna, and to conduct tests of HF radio and receive couplers.

The $15,000 provided for the teleprinter development in fiscal year 1969 was utilized for the preparation of technical plans for the development effort which will commence in fiscal year 1970.

Advance development of a standard GFE carrier aircraft inertial navigation system and support system capable of 5 minute alignment via data link thus eliminating the need for flight deck cables from the ships inertial system. System to be installed in F–14, E–2C and S–3 fiscal year 1968 and 1969 feasibility demonstrated and contract for advanced development models.

AIRINC RESEARCH CORPORATION CONTRACTS

Mr. SIKES. In early January 1969, it was reported that the Navy Air Systems Command was negotiating a contract with Airinc Research Corp., for the analysis of the effectiveness of the P–3C aircraft avionics subsystem. What is the cost of this contract, the avionics subsystem being studied, and the purpose?

Dr. FROSCH. That is $323,623.

This is the avionics system of the aircraft. It deals with the logistic support.

To understand particularly the problems that will be involved in the logistic support of that avionics system as it goes into the fleet and to see whether improvements can be made in the proposed logistics system is the purpose.

Mr. SIKES. In May 1969, it was reported that the Navy Air Systems Command was negotiating a contract with Airinc for a study of the reliability, maintainability, and cost effectiveness characteristics of the Grumman A–6A aircraft avionics subsystem. What is the cost of this contract?

Dr. FROSCH. $175,000.

Mr. SIKES. Why is this study necessary?

Mr. FROSCH. This is an independent check of what is being done in the updating of the A-6 system. I think it is reasonable from time to time for us to go to a third party to look at what both we and a prime contractor are doing.

V/STOL AIRCRAFT

NAVY X-22A

Mr. SIKES. Under the V/STOL developments, what is the Navy now doing in that area?

Dr. FROSCH. We have, I believe, the following: We have completed the work on the X-22A which was the principal aircraft that we had been working with. We are looking at the rotor problems.

Mr. SIKES. With what result?

Dr. FROSCH. With a good deal of data on control and, I think, no real satisfaction or intention to build that kind of a V/STOL aircraft. As you know, the marines have proposed to buy some Harrier aircraft for the purposes of operational evaluation. That is not particularly a development program but an operational evaluation. That is the only reasonably successful V/STOL aircraft that I know of flying today.

Mr. SIKES. Do you propose to continue with the development of the X-22A?

Dr. FROSCH. No, we do not.

Mr. SIKES. Would there be any future expenditures of funds on this aircraft?

Dr. FROSCH. There will be not future development fund expenditures on this aircraft, but some exploratory development is being planned for a joint interagency flight research program utilizing the X-22A under Navy management.

COST AND STATUS OF X-22A PROGRAM

Mr. SIKES. For the record, tell us what the cost on the X-22A has been thus far and the present status of the program.

(The information follows:)

The cost of the X-22A thus far has been $33.4 million to the Government, plus $2.2 million to the contractor under cost sharing provisions of the contract.

The X-22A flight research aircraft developed under the contract has successfully completed the contractor's flight demonstrations and triservice military preliminary evaluations. The Navy accepted delivery of the aircraft for the Government in May 1969.

A flight research program is planned, utilizing the X-22A research aircraft which incorporates a variable stability system to simulate flight characteristics typical of the range of potential future V/STOL aircraft, for investigation of control parameters in slow and zero speed regimes. The research is planned for Navy management under sponsorship of an interagency committee composed of membership by the participating agencies (currently the Navy, Air Force, and NASA, with possible participation by the Army and FAA). Funding requirements in the order of $800,000 annually will be shared equally by the participating agencies.

BENEFITS OF X–22–A PROGRAM

Mr. SIKES. Show for the record what has been gained for the service as a result of the studies and development to date.

(The information follows:)

The gains for the service from the X–22A program includes proving out the advantages and disadvantages expected of design concepts for use in future design selections, development of power train design technology usable in all propeller-type V/STOL designs, establishment of flight test experience for use in evaluating future V/STOL's (already used for in Harrier evaluation), and provision of a needed flight research vehicle for determining flight control design criteria for future military V/STOL's.

NAVY V/STOL EFFORTS

Dr. FROSCH. Mr. Chairman, may I make a general comment on the V/STOL area?

Mr. SIKES. Yes.

Dr. FROSCH. For about a decade and a half there has been great interest in getting an aircraft that would have fixed wing aircraft performance and still have the vertical kind of capability that a helicopter has. This obviously has high-military payoff. There has been over most of that period of joint Army, Navy, Air Force coordinated project to do development work in all kinds of systems. We divided up which kind of approach each service would take. In general there have been some V/STOL aircraft that were built and flown. That is the best that can be said for most of them. The one which appears really to be a real aircraft in a V/STOL is the Harrier. It should be commented that there was Navy money and other DOD money put into the earlier stages of development that led finally to the Harrier.

Mr. SIKES. Is the triservice development program still in progress?

Dr. FROSCH. It still exists and the X–22 was in fact part of that program. It is at the end. We do not have any further Navy projects that are part of that program. I do not know offhand what either Army or Air Force are continuing with.

Mr. SIKES. In what other V/STOL developments has the Navy participated?

Dr. FROSCH. The CL–84, I believe.

V/STOL PROGRAM

Mr. SIKES. Why don't you give us a complete statement for the record on V/STOL programs that have been undertaken, the status of those to date and what the costs have been.

(The information follows:)

The principal V/STOL programs with Navy participation include a family of three research aircraft undertaken under the triservice V/STOL development program in 1960: the XC–142 (Air Force managed), the X–19A (Air Force managed), and the X–22A (Navy managed). In addition, the XV–6A (P–1127) tripartite (US/UK/FRG) program resulted from U.S. interest in 1962 in continuing a development program begun by the British. The Army was designated the U.S. program manager.

Status of the programs are as follows: The XC-142 development program was completed in 1968 with evaluation by a triservice team. The one remaining aircraft has been turned over to NASA for further research. The X-19A program was terminated in late 1966 after the aircraft crashed. The X-22A development program was completed with delivery of the aircraft to the Navy in May 1969. A joint agency exploratory development program utilizing the X-22A aircraft is planned. A U.S. team including Navy members participated in evaluation of the XV-6A (P-1127). The British have gone into production of the Harrier aircraft, which the U.S. Marine Corps is interested in procuring.

Regarding costs of the programs, joint funding was terminated in 1964, with the programs subsequently managed and funded by the individual services with triservice participation continuing. Navy cost sharing of the programs to date includes $29 million for the XC-142, $2.7 million for the X-19A, and $4.2 million for the XV-6A (P-1127). Costs of the X-22A total $33.4 million.

FAILURE OF U.S. TO DEVELOP SUCCESSFUL V/STOL

Mr. ANDREWS. The Marine Corps is requesting funds for fiscal 1970 to purchase 12 Harrier fighter aircraft. Is the Navy engaged in a research program to develop an aircraft similar to the Harrier?

Dr. FROSCH. No, it is not. But as I just mentioned, we had earlier provided some of the funds in the earlier stages of the British development of the Harrier.

Mr. ANDREWS. Were all our funds spent on the V/STOL type plane concentrated on the X-22A?

Dr. FROSCH. No, that was simply the last of the types of aircraft we were looking at.

Mr. ANDREWS. The Harrier, they say, is a good plane. The Marines are very anxious for it. They had a demonstration at Andrews the week before last. How do you account for the fact that the British could come up with this type of plane after we had worked for years, spent millions of dollars and we were unable to do so?

Dr. FROSCH. I think the correct way to say this is that when the V/STOL program started there was a large collection of ideas of how to do it.

In order to avoid duplication, I think is the best way to say it, the ideas that were being pursued in this country were divided up among the services for support, and we did not pursue in this country any ideas that someone had begun on in Europe, but rather we elected to help support their pursuit of those ideas.

That is why we put money into the British Harrier development, so that they would continue that development and we would not have to duplicate that work here.

As it happened out of the large collection of ideas it appears that the first one that has really worked out is the one that the British started on.

Mr. ANDREWS. Did you put anything other than money into the Harrier effort?

Dr. FROSCH. I don't believe we did except to have observers and discussing the program.

Admiral GADDIS. There was some interchange of ideas; yes, sir.

Dr. FROSCH. I think we had pilots who flew the aircraft during the development.

Mr. ANDREWS. The fact that they came up with the plane and our people could not, do you consider that a significant fact in the scientific community?

Dr. FROSCH. I think not. One of the ideas we could have pursued in this country was that particular idea.

But since the British elected to pursue it, we elected not to pursue it.

It is not so much a scientific idea as it is one of a number of engineering schemes that they worked over a long period of time and finally made work.

The schemes that we worked on did not turn out to be practical. It is really more a matter of how the division of technological work was made between the United States and the United Kingdom rather than a statement that our scientists are not as good or our engineers are not as good as theirs. It is a case where they started on the idea. Having seen them start it we decided not to duplicate the work.

Mr. ANDREWS. Did the Germans work on this type of plane?

Dr. FROSCH. Yes.

Mr. ANDREWS. Did we make a contribution to their effort?

Dr. FROSCH. Yes, we did.

Mr. ANDREWS. What became of that plane?

Dr. FROSCH. I don't believe it was finally successful. I think there is still some work.

Captain JESSEN. It was carried out through the U.S. Air Force and the West German Air Force. The Germans were involved in the Harrier in its early stages and did participate along with us. Referring to the other program which was under Air Force sponsorship, that died when the total development cost was assessed, they decided it was too expensive to go that route. It was about 18 months ago that decision was made in the Department of Defense. The Navy did not participate in the decision against it or in the planning that went into the program.

Mr. SIKES. Since we have been seeking through our own effort to develop a V/STOL concept for many years, it is difficult to understand why these efforts have not been successful, but that the British Harrier apparently does enjoy at least a promising measure of success.

How would you explain the situation of that kind?

Dr. FROSCH. I think there were a large number of approaches, all of which looked plausible in the beginning or many of which looked plausible in the beginning but most of which were not. When we divided up the work both nationally and internationally, the one they started to work on turned out to be the best of the lot. There is another important point, and that is, the thing that makes the Harrier really capable is not only the engineering scheme for changing the lift, but the fact that the jet engine has come along in the intervening years to have a high enough power-to-weight ratio so it can power such an aircraft. The earlier version was not a satisfactory military aircraft, although it could go into vertical flight and then into horizontal flight, in large measure because at that stage of the state of the art the jet engine was simply not good enough in power-to-weight ratio.

Now it has come along so that it can actually run the aircraft as an attack aircraft. The expectation is that over the next couple of years as the state of the art in jet engines improves it will get to be a better and better aircraft.

ADEQUACY OF V/STOL FUNDS

Mr. SIKES. Have the Navy's efforts in this field been limited by lack of funds?

Dr. FROSCH. I think they have been principally limited by dividing up the work among the services and among the countries. In my opinion I think they have been limited by the fact that there have not been all that many good ideas around for how to build the vertical takeoff aircraft.

Mr. SIKES. But you were provided funds in keeping with the amounts you thought were needed to continue the effort to produce such a plane.

Dr. FROSCH. I believe that is generally correct.

AIR-TO-SURFACE FIRE CONTROL SYSTEMS

Mr. SIKES. The fiscal year 1970 program for air-to-surface fire control systems totals ——— million. This program has been over $4 million for the past 2 years. How much of this effort is devoted to the F–14 aircraft and in what areas?

(The information follows:)

The sum of $2,397,000 has been devoted to the F–14 aircraft in the area of ——— advance development. This is planned for the F–14C.

ADVANCED AIRCRAFT PROPULSION SYSTEM

Mr. SIKES. You are requesting —— in fiscal year 1970 for a new subactivity entitled "Advanced Aircraft Propulsion System." Is this effort devoted to the advanced technology engine for the F–14 aircraft?

Why was this new subactivity established?

Dr. FROSCH. This effort is not devoted to the advanced technology engine for the F–14 aircraft.

This project was established to support the advanced development of aircraft propulsion systems and subsystems with the objective of providing systems suitable for engineering development and introduction into fleet use in the time period 1978–85. Selected systems and subsystems, presently being investigated under exploratory development programs, will be integrated into effective flight-weight demonstrator systems to prove concepts, demonstrate technology advancements, define propulsion/aircraft interfaces, and verify effectiveness prior to initiation of engineering development.

Mr. SIKES. Where was this work funded in the past year?

Dr. FROSCH. The fiscal year 1969 effort was funded under exploratory development and will be ready to move into advanced development in fiscal year 1970.

AIRCRAFT ENGINE COMPONENT IMPROVEMENT

USE OF PROCUREMENT FUNDS FOR R. & D.

Mr. SIKES. Earlier this year our investigative staff submitted a report on engines for tactical aircraft.

One of the many interesting things learned from this study was the fact that for years funds for further engine development, upgrad-

ing engines, and component improvement have been obscured in the production engine prices.

In your opinion, Dr. Frosch, does this not amount to the use of procurement funds for essentially research and development effort?

Dr. Frosch. I think that this is one of these cases in which some or all of the work that is being done is just on the margin between developing something new and improving something which already exists. It is frequently very difficult to draw a precise line when you are changing something. The example would be if you take an engine and you say, I can improve this engine by making some changes I already know about in the turbine blades. Then you say that is a product improvement and you have improved the engine. Then you may come along a little while later and say the improvements in the turbine blades now give me a turbine performance which means I can put a slightly better compressor on, so I will do that. It is possible through this process to back into a new engine.

I think we try to avoid doing that and successfully avoid doing that in a systematic way. In other words, this is not used as a way to go around developing a new engine. But it does turn out frequently that over a sequence of natural technological improvements one has effectively done that. This is also in my opinion a pretty muddy area in which there are these difficult decisions to be made. I am not sure that we have always been able to find a way to make them systematically enough. This is an area that we have been trying to look at and understand somewhat better.

CIRCUMVENTION OF STATUTES

Mr. Sikes. Could it be said that there are statutory or regulatory prohibitions which are circumvented in this process?

Dr. Frosch. I do not know of any case that I would regard as a purposeful circumvention of statute or regulation. I think the problem is more one of the fact that the statutes and the regulations divide the appropriation according to terms like development and product improvement.

Frequently, when one takes a particular technical case it is a very difficult matter of judgment to decide whether the proper term to apply to that technical change is development or is product improvement. If one were to try, as I have tried, incidentally, to write down as precisely as I could a technical definition of what a development was and what a product improvement was, I rapidly become mired in great difficulty in making a precise distinction.

There is a fuzzy area between the two. In fact, I would go beyond that and say there is a fuzzy area between what is the end of development and what is the beginning of production. The distinctions we normally make are based upon the end use of the object, the appropriate appropriation, and the tooling is hard or soft tooling. In fact, I know of no transition between the two in which there were not some things done in production that could have been labeled developed and some things at the end of development that could not logically be labeled production.

It is a very difficult area for reasons of intrinsic difficulty with the technical definition.

PRODUCT IMPROVEMENT

Mr. SIKES. The committee understands that the Navy designates engineering effort designed to improve performance within the engine specifications as product support, and effort designed to exceed the specifications as product improvement. Both types of effort are funded in the production engine contract using procurement money.

Could it not be said that product improvement is actually nothing more than providing a contractor with additional funds to complete a development to contract specifications?

Dr. FROSCH. Product improvement because it is intended to go beyond the requirement I think could not be said to do that. Generally as applied, it is my understanding that it is intended in fact to go beyond the performance that is required in a contract to see whether there is a way to take the next step of improvements.

The history of aircraft engines has been such that the technology has been moving in a way where if you start with a given engine design, the most economical and sensible way to get to a somewhat higher power or somewhat lighter weight engine, or both, is to make small incremental changes in the engine over a period of time. That has been a more profitable route technologically and a cheaper route than freezing an engine design and starting a whole new engine design. As a result, what we have are families of engines which are basically the same engine but change in a way that is consistent with their basic technology over a period of years. Then from time to time we introduce a new engine which is based on a radical change in technology and then it has a period of life over which it improves as a result of small changes.

Mr. SIKES. Would you say that product improvement should be an R.D.T. & E. effort, funded from R.D.T. & E. funds?

Dr. FROSCH. It is very difficult for me to make a generalization on that. There may be cases in product improvement where I would make that judgment and I am certain there are cases where I would not want to do that.

This is an area which we are trying to look at and make a better division among various kinds of things. We have not gone at it enough yet so that I would be willing to make that judgment.

Mr. SIKES. Could it be said that the product improvement effort inhibits competition for the development of a better engine?

Dr. FROSCH. I do not think so in the sense that there is always the possibility of building a much better engine. But we would not entertain very seriously in any case a competition to make a small improvement in engines. The development costs for a brandnew engine are such that it does not make sense to go the route of a completely new engine for a small change. It is much better to make improvements incrementally.

Mr. SIKES. That is good enough.

INDIRECT FUNDED COMPONENT IMPROVEMENTS

Mr. ANDREWS. According to the staff study, the component improvement funding trend for the Navy and the Air Force for the period 1957 through 1969 indicates that the $1.3 billion had been funded directly and about $1.4 billion had been funded indirectly for this pur-

pose. Inasmuch as the $1.4 billion funded indirectly had been included in production engine prices, it would appear that production engine prices were inflated by that amount over the 13-year period.

Do you believe these indirect efforts are of sufficient importance to have warranted competition with other projects in the R.D.T. & E. and procurement appropriations?

Dr. FROSCH. Inasmuch as those expenditures are in the procurement accounts, I am not familiar enough with them in detail to make that judgment.

Mr. ANDREWS. I wish you would comment for the record.

(The information follows:)

In the case of Navy procurements of Navy and Air Force development and component improvement from Pratt & Whitney for the period 1957 through 1967, the total indirect funding has been about $527 million. To that degree, it may be stated that production engine and spare parts costs have been inflated over that 11-year period. That portion of the $527 million, which was used to cover a portion of development and product improvement costs, was matched by an amount three times as large on direct contracts and thus, the projects did compete with other projects in the R.D.T. & E. and procurement appropriations.

The portion of the $527 million which was used to cover product support costs did not compete with other projects in the procurement appropriations in a strict sense; however, the product support work was a necessary ancillary to the successful operational use of the production hardware so including such ancillary costs in the production hardware prices appears to be one step closer to indicating total costs of that hardware.

There have been no indirect costs for development, product improvement or product support in production prices at Pratt & Whitney since January 1, 1968. All such military work is procured under direct contracts since that date.

In summary, it is considered that all such indirectly funded effort competed to the degree desirable and practicable with other projects in the R.D.T. & E. and procurement appropriations. To assure such competition and to provide increased visibility, however, the indirect funding practice has been discontinued by the Navy at Pratt & Whitney beginning January 1, 1968.

EFFECT ON NEW ENGINE MARKET OF COMPONENT IMPROVEMENT

Mr. ANDREWS. It would appear that component improvement of existing engines perpetuates existing military engine markets and in some cases tends to eliminate new military engine markets. For example, the Pratt & Whitney J-52 engine after component improvement replaced the Curtis-Wright J-65 engine. What is your opinion?

Dr. FROSCH. I do not know that specific case, but my opinion is that we are seeking the most economical route to improve our engines. For relatively small increments of improvement it is not sensible to pay the development costs of a brand new engine. It is only sensible to pay that if there is a real change in the technology. The sensible route for small improvements and for building up improvements is to go an incremental route. In a case like that presumably both companies and

both engines had the option for proposing incremental changes that would improve it.

I would presume that Pratt & Whitney either did so or Curtis did not or the Pratt & Whitney engine was capable of more improvement than the Curtis engine.

ENGINE OBSOLESCENCE

Mr. ANDREWS. Do new engines come in cycles?

Dr. FROSCH. Not in cycles so much as there are jumps in the technology.

Mr. ANDREWS. How long would you say an engine is a new engine?

Dr. FROSCH. The life of an engine, as a model type, in some cases for 10 years.

Mr. ANDREWS. I don't mean that. How long is it considered a new engine before the engine becomes obsolescent?

Dr. FROSCH. That is a difficult question because there are a lot of senses in which obsolescence can be meant. It can become obsolescent in the sense that its performance is not as good as the performance of newer engines. It can be obsolescent in the sense that the technology is technology of 10 years ago but not obsolescent in the sense that the performance is still that which is required for the task of that engine.

The rate of technological obsolescence in the engine business is pretty rapid in the sense that there have been things I would consider to be technological changes coming along in periods of time of every couple of years.

The engine business has been building up very rapidly in a technological sense. To some extent that is true in the performing sense. That does not automatically mean that for a given task we want to put new technology engines into that task.

For example for an aircraft which is used for freight and passenger purposes, a logistics aircraft, probably there is frequently no sense in putting a brandnew engine in that airframe because we would not be able to pull more performance out of it. A case like the A–7 where the airframe is strong enough to carry more weight than the original engine contemplated is one in which it makes sense to say the engine is obsolescent and we ought to put a higher performing engine in.

R. & D. FUNDS MORE APPROPRIATE FOR COMPONENT IMPROVEMENT

Mr. SIKES. Mr. Secretary, in answer to the chairman's question on product improvement, I feel that the committee can agree it is more economical to take an existing engine and uprate it rather than going into a completely new research and development effort. However, I think the thrust of the question was more to the area of, is it not more the province or the area of R.D.T. & E. to take an existing engine and use R.D.T. & E. funds to improve it rather than to utilize procurement funds for this effort? I think this was the thrust of the question.

Dr. FROSCH. I think that really depends on how big the improvement is at a given time. For example, if the improvement in the engine were to change the material of a heat shield so that an electrical component stays cooler in the control system, then I think there would be little point in calling that a development as opposed to a production-type product improvement. It is the kind of thing which is normally in

commercial practice done as a commercial line change rather than a development change. If one talks of changing an engine by making a radical change in the whole aerodynamics system in the compressor, then I would regard that as a real developmental change.

I have given you two extremes which are clear and easy to see. As one goes into the middle it gets more and more difficult. Suppose we take a case where I want to make a change in the material of the blades in the turbine because they will stand the temperatures better and I will have a longer turbine life, with the engine otherwise the same. Then I think the question of whether it is development or production product improvement depends on whether the materials are all developed and well understood, and whether the tests have been completed. Then, if it is is a replacement essentially one for one with the new material, it might well be quite legitimate for production. On the other hand, if the material were radically different, and so there were some real questions of development and testing, then probably it should be a development program.

CONTRACTOR COST SHARING

Mr. SIKES. Up until 1968, it was Navy policy to obtain contractor cost sharing of its R.D.T. & E. engine development programs, including product improvement and product support. In reviewing the approved military program with Pratt & Whitney for 1966 and 1967, our investigative staff noted that there was no cost sharing of the product support program for the TF-30 engines totaling $66.3 million nor in development costs of the TF-30-P-12 engines, the total program of which was $44.1 million for those 2 years. Why were these costs not shared by the contractor in accordance with the Navy practice?

(The information follows:)

It has been and is the Navy policy to obtain contractor cost sharing of its engine development, product improvement and product support programs in consonance with the Department of Defense policy as stated in ASPR 4-110. In substance, it is the policy to use cost sharing only when there is a high probability that the contractor will receive substantial present or future commercial benefit. In the case of Navy contracts with Pratt & Whitney, it is the practice to obtain cost sharing of development and continuing engineering costs in those cases where the engine has current or potential future commercial use.

In the case of TF-30 engine product support during calendar years 1966 and 1967 as well as the TF-30-P-12 development, the TF-30 has no current commercial use nor is it considered to have potential for future commercial use. For this reason, cost sharing was not obtained.

It is noted that the $44,149,303 in the 1966 and 1967 approved military program at Pratt & Whitney reflects repetition in 1967 of $12,500,000 shown on the 1966 program. In addition the final phase of this program in 1968 cost $5,719,155 for a total cost of $37,368,458.

Mr. SIKES. Are these questions at this point?

Mr. LIPSCOMB. No, Mr. Chairman.

Mr. SIKES. Very well, gentlemen.

Thank you very much.

The committee will resume its hearing at 2 o'clock.

(AFTERNOON SESSION)

Mr. ANDREWS. The committee will come to order.

DESTROYER HELICOPTER SYSTEMS

We will discuss the destroyer helicopter systems.

For fiscal year 1970 the Navy had established the subactivity destroyer helicopter systems. For what purpose will ——— million being requested be used?

Dr. FROSH. The ——— million required in fiscal year 1970 will fund necessary studies and analysis in support of concept formulation as well as a flight test and evaluation program and the development of needed avionics.

LAMPS

Mr. ANDREWS. Does the Navy propose to develop a new helicopter for the LAMPS mission, or to use a light helicopter in the Navy inventory?

Dr. FROSCH. The Navy plans to use an off-the-shelf helicopter for LAMPS. By off the shelf I mean modifications to an existing helicopter system not necessarily military but in production. It is too early in the development to pin down likely candidates, but the Navy is presently investigating the most cost effective methods of obtaining the required capabilities from available military and civil equipment.

QH–50 DRONE

Mr. ANDREWS. The committee understands that the loss rate had been high for the QH–50 Drone antisubmarine helicopter when used in Vietnam in the battlefield reconnaissance role. Why was this and is it still being used for that purpose?

Dr. FROSCH. The Navy has used the DASH helicopter for gunfire support and reconnaissance missions in Vietnam during the past 2 years. From August 1967 to June 1969 we have lost ——— DASH vehicles in support of these missions, this is an average of a little over ——— ———. Because of the nature of drone operations in Vietnam the exact causes for most of the losses cannot be specifically determined, but several have been lost due to battle damage, others to equipment malfunction, and some to operator error. The QH–50 Drone is still being used for gunfire support and reconnaissance in Vietnam. Additionally, three of the DASH helicopters were bailed to the Advanced Research Projects Agency, ARPA, to do development testing for a battlefield reconnaissance project. They were configured and deployed to Vietnam in April 1968 and operated from a Navy ship, the U.S.S. *Blue*, in support of the U.S. Marines. ——— ARPA has no vehicles in Vietnam at this time but is continuing development of the battlefield reconnaissance capability with other DASH vehicles.

USE OF T–63 ENGINE WITH DASH AIRFRAME

Mr. ANDREWS. Reportedly, Gyrodyne had been awarded a Navy contract to replace the Boeing T–50 engine in the DASH with the Allison T–63 engine. What is the reason for this change in engines? Has this been tested yet?

Dr. FROSCH. Gyrodyne has not been awarded a contract to replace the T–50 engine, however, they have been given a contract to conduct

a limited test program of the T-63 engine with the DASH airframe. The testing has not yet taken place as Gyrodyne has just recently taken delivery of the engines and the experimental vehicle is being assembled. These tests were required because the contract for the Boeing T-150 engine terminated in March 1968 and the Navy was unable to assure continued funding for a future contract. With an unassured availability of the T-50 engine in the future the Navy determined it necessary to investigate an alternate source.

DASH VERSUS LAMPS

Mr. ANDREWS. Has your experience with the DASH in Vietnam caused you to question the effectiveness of a drone helicopter to the point the Navy is now considering the manned LAMPS concept?

Dr. FROSCH. No, sir. The capabilities required in a LAMP's helicopter far exceed those attainable in a drone vehicle.

RYAN FIREBEE

Mr. ANDREWS. Would you describe the use to be made of the Ryan Firebee ———?

Dr. FROSCH. The purpose of this development is to provide ——— organic to the Navy and responsive to the Fleet/Task Force Commander. The concept of operations will be to launch a modified RYAN 147S drone that is presently operational in the USAF ———.

Mr. ANDREWS. What is the status of its development?

Dr. FROSCH. The development is two phased ——.

Mr. ANDREWS. How much has it cost to develop this drone and will it be used by all the services?

Dr. FROSCH. This development consists of modifying existing USAF 147S reconnaissance drones for ———. The total cost of the program is $8.5 million of which $2.9 million is R.D.T. & E. The other services have no plans to use the Navy SPRA at this time.

S-3A (VSX) ASW AIRCRAFT

Mr. ANDREWS. Now, the S-3A (VSX) ASW aircraft. You are requesting ——— million in fiscal year 1970 to begin engineering development of the S-3A (VSX) ASW aircraft airframe and to continue development of the engine and avionics of that aircraft. This is a ——— million increase over the fiscal year 1969 program. Will you briefly describe this aircraft?

DESCRIPTION OF AIRCRAFT

Dr. FROSCH. This is intended to be a follow-on aircraft to the S-2. It will incorporate in it new avionics, including a ———.

It will carry Mark 46 ASW torpedoes. The avionics system, the airborne electronics system for the S-3 will be essentially the kind of system we have in the much larger land-based P-3C aircraft, repackaged and somewhat advanced beyond so that it will fit into a carrier-based on antisubmarine aircraft. It will be a complete updating of the electronics to the latest state of the art.

It also will have a very much longer range and/or time on station depending on whether fuel is used for loitering or to fly out a distance, than the current S–2 aircraft, so it can cover a great deal more ocean in the ASW role.

The S–2, which it replaces, I believe, first came into the inventory in 1954 and is now obsolete both in the range and the time it can spend in search and in the electronics that can be put into it.

Mr. ANDREWS. Will this aircraft give you added capability in ASW?

Dr. FROSCH. It will give us a very greatly improved capability over the current ASW carrier aircraft capability.

Mr. ANDREWS. I would like to read into the record the characteristics from that slide. A crew of four. The gross weight is ——— pounds. It has two engines. It has ——— nautical mile range maximum. The cruise speed is ——— knots. The maximum speed is ———. minimum endurance, ——— hours at sea level. At this point in the record I wish you would have inserted the characteristics of the plane that this will follow.

Dr. FROSCH. Certainly.

(The information follows:)

The S–2E has a crew of four, a gross weight of 26,500 pounds, two reciprocating engines, a normal cruise speed of ——— knots, a maximum speed of ——— knots, and an endurance of over ——— hours giving it a maximum range of ——— miles.

AIRCRAFT DEVELOPMENT COSTS

Mr. ANDREWS. How much has been spent on this aircraft development through fiscal year 1969?

Dr. FROSCH. $80.6 million if I am adding correctly in my head.

ENGINE DEVELOPMENT

Mr. ANDREWS. How long has the engine been under development and what type of engine is it?

Dr. FROSCH. The engine is a fan jet engine which is being developed by the General Electric Corp. The contract was let to GE in March 1968.

Mr. ANDREWS. Does the engine have a designation at this time?

Dr. FROSCH. I believe it does but—TF 34–GE2 is the designation.

Mr. ANDREWS. Will this be able to operate from all the ASW carriers currently in the fleet?

Dr. FROSCH. Yes.

PROGRAM–SLIPPAGE

Mr. ANDREWS. How far has this program slipped?

Mr. FROSCH. The projected time for the awarding of the contract has been along in July 1969 all along. The contract award has not yet been made, but until we get to July of 1969 it will not have slipped at all.

Mr. ANDREWS. Do you think you will meet that schedule?

Admiral GADDIS. The contract itself is in the Office of the Secretary of Defense for approval.

Mr. ANDREWS. The Navy is through with it?

Admiral GADDIS. The Navy is ready to meet the time.

DOD REVIEW OF S-3A PROGRAM

Mr. ANDREWS. It has been reported in the press as recently as May 22, 1969, that the Secretary of Defense still had the S-3A project under review. Is that correct?

Dr. FROSCH. Yes.

Mr. ANDREWS. What is the purpose of the review, if you know?

Dr. FROSCH. There have been several purposes for the review. One I mentioned I think yesterday or the day before, and that was to reexamine the contractual terms and to see whether the contractual terms that we have finally negotiated with the two potential contractors are saisfactory in terms of giving enough margin for possible slips.

Mr. ANDREWS. The review was in connection with the contract.

Dr. FROSCH. That was the first review. There is now a review of the two potential contractors' capabilities to carry out the contract satisfactorily.

Mr. ANDREWS. Has there been any review of the question of the need?

Dr. FROSCH. I don't know of a formal review.

Admiral GADDIS. In connection with the budget amendment, sir, of the current administration, this review of the S-3 was very extensively pursued. It was nominated as a program which had to be rejustified on the basis that this was a new start which involved procurement in the out years and, therefore, a recertification of the requirement had to be established.

Mr. ANDREWS. Has that been resolved?

Admiral GADDIS. This was established and it was resolved by the inclusion of this aircraft in the amendments submitted by President Nixon in April.

Mr. ANDREWS. So the only thing before the Secretary of Defense today is questions dealing with the contract and the capability of the proposed contractors?

Dr. FROSCH. That is my understanding of the situation.

DESCRIPTION OF S-3A CONTRACT

Mr. ANDREWS. What type of contract do you plan to sign for the development of this aircraft?

Dr. FROSCH. The contract is a fixed price incentive-type contract in which the incentive is on cost only. There is a sequence of production options following after development. There is a clause in the contract which allows us to delay the initiation of the production lots if it is necessary to do so. We are obligated only to start a production lot with a delay of anything up to a year allowed until certain milestones in the development program have been passed. These include, for one lot, the actual operation of a complete operating setup of the electronics for another lot; it is the actual flying of an aircraft with the complete system in it.

The lots each have a ceiling price which cannot be exceeded at the time the individual production lot is to be negotiated. There will be a negotiation for what the actual ceiling for that lot will be, but the actual ceiling in all cases must be lower than the ceiling now stated in the contract.

Mr. ANDREWS. I wish you would place in the record a concise description of the contract including the options, when they may be exercised, the cost options.

Mr. FROSCH. Yes, sir.

(The information follows:)

S-3A CONTRACT

The S-3A engineering development (R. & D.) contract is for the development of ——— R. & D. aircraft, tests and demonstrations, and related data.

This contract will be fixed price incentive (cost only). The target cost, target profit, target price, and ceiling amount for this effort will be set forth in the contract and, of course, is different for each of the two remaining competitiors. The contract will include five option lots, the first of which is an extension of the R. & D. effort and buys ——— aircraft. There are then four production lots of aircraft.

Each of the four production lots is designed to allow for the procurement of aircraft at or below a stipulated ceiling or maximum price. This price is negotiable downward only to either a firm fixed price or fixed price incentive contract. If a fixed price incentive contract is negotiated, the ceiling amount cannot exceed the maximum price now in the contract.

Each lot sets forth a nominal number of aircraft. A variable quantity formula is included which will adjust the maximum price for increases and decreases in aircraft quantities up to approximately 50 percent of the lot nominal quantity. It should be noted that exercise of a quantity greater than nominal decreases the maximum unit price and exercise of a quantity less than nominal increases the maximum unit price.

In addition, the exercise of each option is keyed to an option date of October 1, of each year and the accomplishment of established milestone events. If the event is accomplished on or before October 1, date, the program is presumably proceeding as expected and the option will be exercised. If, however, the event is not accomplished due to the fault of the contractor, the October 1, date slips day for day for maximum of 1 year. This approach allows the Government to delay the ordering of production aircraft until the contractor accomplishes the milestones of development he has agreed to meet.

Some other features of the contract include separate pricing of each lot, no pricing formula tied to actual cost, a provision for adjusting the lot maximum prices either up or down prospectively if there are abnormal fluctuations in the national economy and, at all times, the Governments' maximum termination liability is covered within the amount of funds obligated.

The adjustments for economic fluctuation are made automatically by tracking Bureau of Labor Statistics indexes and are made prior to the exercise of the option.

FLY BEFORE BUY CONTRACT

Mr. ANDREWS. Do you contemplate going to a prototype development?

Dr. FROSCH. No, not in the sense. We will have, during development, however, actual flying aircraft. Usually when prototype development is described nowadays it generally means two separate competitors, both building aircraft. We will not be doing that.

Mr. ANDREWS. Will you fly the aircraft for any length of time before you exercise option for production?

Dr. FROSCH. I believe the answer is yes. Now, the first production lot is lot III which is for a nominal ——— aircraft, but it might be as few as ——— aircraft. The milestone on which a go-ahead for that lot is based—that could be as little as the first ——— aircraft—as a laboratory demonstration of the acoustic processing and display system.

Lots I and II are development.

Mr. ANDREWS. How many will be in those two lots?

Dr. FROSCH. ——— aircraft. Lot I is ——— aircraft. Lot II is ——— aircraft. The ——— aircraft in lot I are paid from R.D.T. & E.

The ——— aircraft in lot II are paid from PAMN funds. That is the same problem we discussed before.

Mr. ANDREWS. That takes care of your first ———. Will you fly one of those ——— before you exercise option for procurement of additional aircraft?

Dr. FROSCH. One of the milestones to be satisfied before we exercise an option for lot III is the flight of the aircraft.

Mr. ANDREWS. So if it doesn't work, you are only purchasing ———.

Dr. FROSCH. That is right. The option for lot IV, which could be ——— aircraft or as few as ——— aircraft——

Mr. ANDREWS. How many in lot III?

Dr. FROSCH. It is ———. It is a nominal number but it could be as few as ——— or as many as I believe ———.

Mr. ANDREWS. Lot IV is where you really get into production?

Dr. FROSCH. That is right. That might be ———. The whole system must be flown and demonstrated before we have to exercise that option.

CONTROL SYSTEMS RESEARCH CONTRACT

Mr. ANDREWS. Reportedly the Control Systems Research, Inc., will work in development planning. What is the cost and purpose of this contract effort?

Dr. FROSCH. The purpose is to give the Air Systems Command some independent backup in doing their planning and assessing the proposed plans of the prime contractor. The cost of it I don't believe I have broken out here.

Mr. ANDREWS. Supply it for the record.

(The information follows:)

The Control Systems Research contract price was $96,000 (fiscal year 1968 funds). An extension from April 1, 1969, to June 30, 1969, in the amount of $28,000, utilized fiscal year 1969 funds.

Mr. ANDREWS. What is the purpose of the contract effort?

Dr. FROSCH. To give the Air Systems Command some help with their planning for systems to follow the prime contractor's work and to get some independent evaluation——

Mr. ANDREWS. Is this Controls Systems Research organization one of those so-called nonprofit organizations?

Dr. FROSCH. No; it is not. It is a commercial operation and you pay for what you get.

JOHN D. KETTELLE CORP. CONTRACT

Mr. ANDREWS. The committee understands that Naval Air Systems Command will soon negotiate a contract with John D. Kettelle Corp. to perform analysis in support of the S-3A aircraft. What is the proposed cost of this contract and why is this study effort necessary?

Captain JESSEN. It is a very small contract. It deals with ASW data to further substantiate design of the sensors and the need for their integration in the type and way we are doing it right now.

Mr. ANDREWS. Tell us something about the Kettelle Corp.

Captain JESSEN. It is a very small corporation somewhere in the Washington area.

Mr. ANDREWS. What will that corporation do that the control systems research organization will not do? Are you going to have two contracts?

Captain JESSEN. The control research contract has been executed and is primarily associated with the type of data we use for technical development plans and for various formal documents that we develop to support a major program like this.

The John D. Kettelle Corp. contract is directed toward ASW data: not directly S–3 data per se, but ASW oceanographic sort of data to support the design of the systems in the S–3.

Mr. ANDREWS. You say the Kettelle Corp. is a small organization. What capabilities does it have that the Navy does not have in-house?

Captain JESSEN. We would have to supply that for the record.

Mr. ANDREWS. You are asking a small organization located here in Washington to do some ASW work for you when the Navy should be the best qualified when it comes to ASW?

Dr. FROSCH. What we are asking him to do I am certain is a particular data analysis task; not a generalized ASW analysis, but a particular task.

Mr. ANDREWS. Does anybody know what that contract is going to cost with the Kettelle people?

Captain JESSEN. It is estimated at $25,000, sir.

Mr. ANDREWS. How many people will be employed and how long will they work?

Captain JESSEN. We will have to supply it for the record, but it sounds like about two people for several months. The amount of the control systems research contract, sir, was $96,000.

Mr. ANDREWS. How many people were involved there and how long will it take?

Captain JESSEN. We will have to supply that for record.

(The information follows:)

A contract with the John D. Kettelle Corp. was initiated to prepare supporting analysis in response to specific questions directed at the S–3 program by Offices of the Secretary of Defense. The cost of this contract was $25,000 which provided for the services of two senior analysts over a period of 2½ months, a total of 832 man-hours. Since the required task involved specialized knowledge it was necessary to augment in-house Navy capabilities to provide detailed responses within the time limits established. The personnel assigned by the John D. Kettelle Corp. were two of the most knowledgeable ASW analysts available to the Navy by both experience and background.

The control systems research contract provides the services of three people full time.

Mr. ANDREWS. Mr. Secretary, before you award these contracts, do you decide conclusively that the Navy can't get the job done in-house?

Dr. FROSCH. That is certainly a part of the Air Systems Command in deciding to do that, yes.

Mr. ANDREWS. How many other studies have been made and how many additional studies do you plan to conduct in connection with this aircraft?

Captain JESSEN. Those are the only two.

ADVANTAGE OF S–3–A OVER S–2E AND P–3C

Mr. ANDREWS. You stated at page 27 of your statement that the S–3A aircraft is the primary development in the area of air ASW. How will the S–3A aircraft be used where the S–2E and P–3C aircraft cannot, for the ASW role?

Dr. FROSCH. As I have mentioned, the S–2 is hampered by antiquated sensor systems and we can't put modern senor systems in it and it has a much shorter range than the S–3. The S–3 gives you a capability of a much higher search rate and greater search.

The P–3C is a land-based aircraft. The argument for having the carrier-based aircraft in addition has to do with the range and time on station that a ship can use in the ocean from a certain base structure. If you plot out where those aircraft can be used and how much search they can accomplish, you find there are areas even with our current overseas base structure where it becomes very inefficient to use a land-based aircraft and so we need a carrier-based ASW aircraft to cover those areas.

In addition, should be in the future give up some overseas bases, it would be impossible to carry out the air ASW portion of the mission over large portions of the ocean without a carrier-based structure.

Mr. ANDREWS. When do you expect to have an S–3A if all goes well, in the fleet, operational?

Admiral GADDIS. Fiscal year ——— is my recollection. In ———.

Mr. ANDREWS. Does this development mean that the role of the ship-based helicopter has been downgraded as an ASW weapon——

Dr. FROSCH. This is merely a replacement of fixed-wing aircraft The helicopter roles remain as they were principally in the vicinity of the task group where the fixed-wing aircraft ranges out to much larger distances.

Mr. ANDREWS. What does a fixed-wing plane have as a primary mission, location?

Dr. FROSCH. Location and kill.

Mr. ANDREWS. The same as a chopper?

Dr. FROSCH. The same as a chopper, but they cover different ranges.

Mr. ANDREWS. One has much less range?

Dr. FROSCH. Yes. We would not send the chopper 300 or 400 miles away from a carrier base, which is what the purpose of the fixed-wing aircraft is.

COST OF S–3A

Mr. ANDREWS. What is the total development cost of this aircraft?

Dr. FROSCH. The total R. D. T. & E. estimate is ——— million including the ——— aircraft purchased.

Mr. ANDREWS. How many such aircraft does the Navy propose to buy?

Dr. FROSCH. ——— production aircraft.

Mr. ANDREWS. And what is the total estimated procurement cost?

Dr. FROSCH. ——— million.

Mr. ANDREWS. What does that come out as in a unit cost?

Dr. FROSCH. ——— million unit cost.

Mr. ANDREWS. It is an expensive aircraft?

Dr. FROSCH. Yes. Largely because it has a very elaborate and expensive electronics detection system.

Mr. ANDREWS. Does that include spares and equipment or is that just the cost of the aircraft?

Dr. FROSCH. That is the total PAMN estimate which includes spares and equipment.

Mr. ANDREWS. Are there any questions on the S-3A?

VERSATILE AVIONICS SHOP AND TEST EQUIPMENT (VAST)

Mr. ANDREWS. For the record, Mr. Secretary, you are requesting ——— million in fiscal year 1970 for continuing development of versatile avionics shop and test equipment. The Navy has been funded a total of $59.7 million in the PAMN account for the procurement of this equipment, and in fiscal year 1970 there is a request for another $——— million for the procurement of VAST. Why are we buying this equipment if it is still being developed?

Supply that for the record.

(The information follows:)

Procurement of VAST to meet the Integrated Helicopter Avionics System. A-7E, and F-14A requirements is being pursued. VAST developments must continue in order to meet the continuing requirement developments such as the E-2C, S-3A and joint in-flight data transmission system.

TRIM/COMBINED SENSOR VEHICLE SYSTEM

Mr. ANDREWS. You are requesting ——— in fiscal year 1970 for the TRIM/combined sensor vehicle system. How was the $25 million programed for fiscal year 1968 and 1969 used?

How do you propose to use the fiscal year 1970 funds?

Answer that now if you can.

Dr. FROSCH. There are two models of the TRIM aircraft. ———.

Mr. ANDREWS. What is the mission of the plane?

Dr. FROSCH. The mission is to ———.

Mr. ANDREWS. What kind of weaponry does the plane carry?

Dr. FROSCH. ———

Mr. ANDREWS. TRIM. What success have you had with this operation?

Dr. FROSCH. ———.

Mr. ANDREWS. How many people in a crew of one of these planes?

Dr. FROSCH. I don't know what it is in the P-2 TRIM. In the A-6 it will be pilot and an operator. The P-2 has about seven.

Mr. ANDREWS. They go out on a mission looking for trucks or other objects?

Dr. FROSCH. When they find them, they attack them.

Mr. ANDREWS. I wish you would put something in the record about the success they have had in reference to the number of trucks and other equipment destroyed.

Dr. FROSCH. Yes, sir.

Admiral GADDIS. They can also be designed ———.

(The information follows:)

During the entire ——— of combat operational evaluation approximately ——— were positively destroyed and approximately ——— probables. These would include: trucks, water-borne logistics craft enemy encampments, supply

cables, anti aircraft automatic weapon sites, power generators, and other tactical targets.

Mr. LIPSCOMB. In regard to the kills that you have on trucks that the chairman asked about, could you also put in the record the supplier of those trucks to North Vietnam?

Dr. FROSCH. If we have the information, I would put it in the record.

Mr. LIPSCOMB. It is available. The only problem you will have is giving it to us unclassified.

Dr. FROSCH. I deduce you know something I don't know.

(The information follows:)

Trucks have been provided to North Vietnam by the following countries: U.S.S.R., Poland, Rumania, Czechoslovakia, East Germany, China, and North Korea.

Mr. ANDREWS. Do you know whether or not more trucks are going into North Vietnam and on down into South Vietnam than they are able to knock out?

Dr. FROSCH. I am not up to date on that situation. Certainly in the past ———.

Mr. ANDREWS. We were told that the tonnage going into the port of Haiphong in 1968 was ——— what it was in 1967. I think we have been told that most of the trucks that go into North Vietnam go through that port. Many of them, if not all of them.

Has that port ever been bombed effectively? I have never read or heard anything about it.

Dr. FROSCH. I am not sure we ever———

Admiral GADDIS. We have never specifically bombed Haiphong from the point of view of disabling Haiphong completely.

Mr. ANDREWS. And you haven't bombed it, period, since the so-called bombing halt?

Admiral GADDIS. That is correct.

Mr. ANDREWS. They didn't halt when you ordered that halt, did they?

Dr. Frosch, you mentioned that the AP2H TRIM aircraft, which became operational in September 1968, ———. You later discuss the TRIM version of the A–6 aircraft, ———.

Dr. FROSCH. ———.

Mr. ANDREWS. How much have we spent on the AP2H aircraft and how many have been procured?

Dr. FROSCH. Now, the P–2 airframes that are being used in the aircraft we have used in ASW, which were replaced by the P–3, what was done with these aircraft was essentially modification and the introduction of the sensors that I described before. I do not have the cost broken out as between the P–2 and A–6, but we can get that.

(The information follows:)

The cost of the AP–2H program was $25.5 million on R.D.T. & E., Navy contract and $3.8 million for advanced sensor development for a total of $29.3 million.

The cost of the A6C TRIM program was $13 million for R.D.T. & E., Navy contract, $8.6 million R.D.T. & E., Navy feasibility contract plus advanced sensor development and $32.9 million for PAMN contract.

Mr. ANDREWS. Have the AP2H aircraft been tested in Vietnam?

Dr. FROSCH. Yes, sir; they have been used operationally in Vietnam.

WEAPON SYSTEM FOR CARRIER-BASED TRAIL AND ROAD INTERDICTION AIRCRAFT

Mr. ANDREWS. It has been reported in the press that in late December 1968 the Naval Ordnance Systems Command was to negotiate with Lockheed for study, analysis, and weapon system design for carrier-based trail and road interdiction aircraft. What type of weapon system is involved and on what aircraft will it be used?

Dr. FROSCH. I would have to look that up.

Captain JESSEN. I don't believe I have the precise answer, but I think it is not the Ordnance Systems Command, but the Air Systems Command, and I believe it was an exploratory contract that looked ——— to the next generation of sensors that we might install on interdiction aircraft in the future. We have begun to look beyond these.

———.

Mr. ANDREWS. Are there any questions about these type aircraft before we take up the F-14B/C aircraft?

F-14

MULTI-MISSION RADAR

You have been funded a total of $31 million through fiscal year 1969 for the advanced multimission radar and advanced technology engine program which will be used in the F-14B/C aircraft.

What is the status of development of the advanced multimission radar and what does it involve?

Dr. FROSCH. This is specifically for the F-14C rather than the B. The difference between the B and the A is the change to the advanced-technology engine. It would only be beyond that that we would put the multimission radar in.

The idea of the multimission radar is to take the kind of radar that we now have in fighter aircraft, which are principally air-to-air radars with only moderate air-to-ground capability, and build a radar which would have several modes of operation so it could be used both for air-to-air fighting and for air-to-ground attack, and would combine what are now several separate kinds of radars; it would compress the size and weight of the electronics in those radars and with the miniaturization, it would give a higher reliability.

This is a radar concept which has been in development for some time and is continuing, and we hope can be developed and finally go into the F-14.

ADVANCED TECHNOLOGY ENGINE

Mr. ANDREWS. How about the advanced technology engine development?

Dr. FROSCH. This is the engine that I referred to which would go into the F-14B. This would change the F-14A to F-14B.

The engine which is being developed is being developed as a joint Air Force-Navy engine development, at least for the core of the engine. It would be a fan jet engine. It will have a considerably larger thrust-to-weight ratio and a larger thrust than the TF-30P12, which is to go into the F-14A, and will change a good fighter aircraft into probably the best that the current state of the art can provide.

The current status of the eng.. program is that there is a competition between G.E. and Pratt and Whitney to provide running basic common core engines, after which there will be a joint Navy-Air Force decision as to which engine to proceed further with.

Mr. ANDREWS. According to your justification book——

Dr. FROSCH. Excuse me, Mr. Chairman. What the slide shows is the way that the B advanced technology engine can fit into the airframe. The point is that the two engines, the new engine and the TF-30P12 are of such a relative size that with the same airframe design and only very minor modifications to the fixtures that hold the engine, one engine can be used to replace the other. In fact, the early tests of the advanced technology engine are proposed to be done by taking an F-14A and replacing the TF-30P12 on one side of the aircraft with an advanced technology engine and flying the aircraft with one of the old engines and one of the new engines for a direct comparison.

Mr. ANDREWS. Has that ever been done before?

Dr. FROSCH. I don't think we have ever done this. We have never been in a position to do anything like that.

Admiral RUCKNER. We have put single engines in multi-engine aircraft to test them, but we have never done this before.

R.D.T. & E. COST FOR F-14 COMPARED TO F-4 AND F-111B

Mr. ANDREWS. According to your justification book, the R.D.T. & E. cost for the F-14 series aircraft is estimated to be $1.2 billion through fiscal year 1974, not counting procurement costs. How does this compare with the R.D.T. & E. costs for the F-4 and the F-111-B aircraft? Supply that for the record.

(The information follows:)

It is difficult to compare R.D.T. & E. costs of the F-4, F-111B and F-14 aircraft because of the different concepts and timeframes associated with the development of these aircraft.

The F-4A and F-4B were developed in the mid 1950's with ARPN funds. The F-4J airframe consisted of an improved F-4B airframe in the mid 1960's funded from the PAMN account and the AWG-10 missile control system development for the F-4J consisted of changing the APQ-72 radar in the F-4B from pulse compression to pulse doppler with R.D.T. & E. funds. Therefore, the R.D.T. & E. funds expended on the F-4A, F-4B and F-4J totaled $32 million; however, it is estimated that ARPN and PAMN funds totalling $470 million were also used in these developments.

The total F-111 development program is in excess of $1 billion. However, the Navy was charged with funding "Navy peculiar" component developments only in that program. The development costs of components common with components of Air Force versions of the F-111 were funded with Air Force R.D.T. & E. funds. Navy F-111B/Phoenix R.D.T. & E. costs totalled approximately $658 million of which $245.8 million were expended on F-111B airframe and engine components and $412 million were used to develop the Phoenix missile and missile control system.

The F-14A, F-14B, and F-14C development costs will be totally funded from the Navy R.D.T. & E. account. The total development costs of this series of aircraft is estimated at $1.2 billion.

FIRMNESS OF F-14 COST ESTIMATE

Mr. ANDREWS. According to a newspaper article yesterday the Bureau of the Budget had indicated that it has been their experience that cost increases and cost overruns have amounted to between 200 and 300 percent for major weapons systems.

In view of this, how firm can you be on your predicted cost estimates for the F-14 aircraft?

Dr. FROSCH. All we can say, of course, is that we have carefully tried to cost the aircraft using our own Navy Air Systems Command cost people. We have, of course, compared those during the competition with the proposed cost of the competitors. Presumably—and we believe as far as we can tell actually—the competitor's costs were all independent and were made independently of the Naval Air Systems Command cost estimates and the spread among the competitors was significant but not, as I recall, gigantic, and the contractor selected proposed costs which agree in the main fairly well with the Naval Air Systems Command cost.

Admiral GADDIS. And with the second competitor in the final competition.

Dr. FROSCH. So as far as we can tell, we have the most accurate cost that it is possible to predict at this time.

PROVISION FOR INFLATION

Mr. ANDREWS. Of course, you have no firm prediction or anything to do with prices in the 1973 fiscal year?

If I remember correctly, you have cranked into the contract figures certain predictable inflationary costs.

Dr. FROSCH. There are some provisions for escalation, based, again if I remember correctly, upon the Bureau of Labor Statistics—

Mr. ANDREWS. We have had an unfortunate wave of inflation in the last few years. It has been longer than ever before in the history of this country. Many people fear there is no end in sight.

The idea is to build today because it will cost more next year.

Dr. FROSCH. There is another point I would make on this. There has been a lot of talk about overruns which were very imprecise in the matter of stating what the overrun was to be measured from. In some cases the figure that was quoted as the base figure upon which the overrun was built was a number which was in somebody else's estimate long before they got to be a hard program. So some of that has been exaggerated. This is not to deny the fact that there have certainly been overruns but a good deal of discussion of some of the cases has been exaggerated—by, purposely, I believe, data taken too early in the cycle for anyone to expect there to be firm costs.

If one is to measure overruns from the first number that an engineer considering a program writes down on a piece of paper, then we are measuring it from a "not very accurate or useful" number.

I think one has to look at things like what the service prediction was when it made a formal statement to the Department of Defense or to the Congress as to what a program would cost and, properly speaking, the determination overruns refers to a contractor overrun. That is, a case where the contractor's charge to the Government was more than was in the firm signed contract.

Mr. ANDREWS. Overrun means different things to different people. It depends on how you are looking at it.

Let me ask you this question: Suppose this pendulum were to swing and we had a downward trend in prices over the next 3 or 4 years. That is unpredictable at this time, but is a possibility.

Would the Government be protected in these contracts for the F–14 if there is a deescalation of prices?

Dr. FROSCH. I believe the escalation clause applies to, say, the ceiling to the Bureau of Labor Statistics indexes going in both directions, so if the Bureau of Labor Statistics indexes would have decreasing prices, then the ceilings would move down in accordance with that deescalation.

Admiral GADDIS. We have an additional protection on the F–14 and the S–3 as well, Mr. Chairman, in that for the first time in history, that I can recall at least, we have a firm, signed contract obligation on the part of the final competitors for this development and this aircraft. As compared to the normal procedure of estimating, then letter contracts, then definitized contracts.

FIGHTER AIRCRAFT REQUIREMENTS IN 1985 TIME FRAME

Mr. ANDREWS. It has been reported that based upon an unsolicited proposal, the Naval Air Systems Command in March 1969 awarded a contract to Lockheed for a study of naval fighter aircraft requirements in the 1985 time frame. Doesn't a study of this nature result in the Navy receiving a parochial viewpoint and also tend to place the study contractor in a favorable position in any future fighter development contract negotiation?

Dr. FROSCH. I believe the 1985 time frame is so far away that the whole picture of the competition in the industry might well have changed by then. This is very long-range planning which would be used for exploratory determination kind of work only at the present time. At any time there was actual contemplation of a fighter aircraft competition I would expect the results of that study to be made available to all of the competitors.

Mr. ANDREWS. Is there any truth to this report?

Dr. FROSCH. I don't know.

Mr. ANDREWS. Find out and provide an answer for the record.

(The information follows:)

As a result of discussions with various interested contractors and the receipt of several unsolicited proposals, a decision was made to award the Lockheed California Co. a contract for a $90,000 advanced technology study of possible aircraft designs for a 1985 Navy fighter. This is a 6-month effort that will advise the Navy on how new technology in aerodynamics, high-temperature propulsion, composite materials, and new schemes in weaponry will affect the size, weight, and performance of a possible 1985 Navy aircraft. This work guides ongoing basic research and exploratory development in the component area that requires long leadtime to insure availability in the 1985 period.

Mr. ANDREWS. Does the Navy have any other such fighter studies with other contractors?

Dr. FROSCH. We may well have. There have been a number of studies in the Navy and with various contractors.

Mr. ANDREWS. Put them in the record, please.

Dr. FROSCH. Surely.

(The information follows:)

Additional fighter studies with other contractors are as follows:

1. For fiscal year 1968:

VTOL fighter aircraft study; N00019-68-C-0538; June 3, 1968; LTV; 90K.

VTOL escort fighter study; N00019-78-C-0550; July 2, 1968; Sikorsy; 99K.

2. For fiscal year 1969:

1985 naval fighter study; N00019-69-C-0348; March 17, 1969; Lockheed California; 90K.

DLI aircraft study not signed yet; McDonnell-Douglas; 67K.

Mr. ANDREWS. It has been reported also that Lockheed is now performing a study of carrier-based advanced heavy attack aircraft for the 1985 time period. What is the cost and details of this study effort?

Dr. FROSCH. I would like to put that in the record.

Mr. ANDREWS. Do you know anything about it?

Dr. FROSCH. No.

(The information follows:)

The following is a description of a carrier-based attack aircraft system study for the 1985 time period. This is a 7-month study effort with the Lockheed California Co., which began on March 28, 1969. In the discussions prior to awarding this contract, it was obvious that the long-range viewpoint and technical effort offered by Lockheed was superior to the other interested contractors.

The total fixed price for this study is $90,000. Briefly the study will define and identify critical technical areas that require exploratory and advanced research and development. The problem approach is to compare projected aircrafts design with possible missions and tasks. A major objective is to uncover gaps and deficiencies in our ongoing research and development program.

The Navy provides continuous guidance to insure practicability and adherence to Navy needs. The technical state of the art estimates are compared to these Navy needs. Parametric design analyses will provide the Navy information on sensitivity of the technology advances and permit estimation of operational risk. The study is approximately 30 percent complete.

Mr. ANDREWS. Does the Navy, based on intelligence estimates, conduct in-house studies to determine future Navy fighter aircraft requirements to meet a postulated enemy threat?

Dr. FROSCH. Yes, indeed; to a certain level of detail but if we go beyond that level of detail, we frequently seek outside professional help.

STUDIES OF FUTURE AIRCRAFT REQUIREMENTS

Mr. ANDREWS. Provide for the record the number of studies completed in the past 2 fiscal years and those under contract at the present time, indicating the type of aircraft under study, the contractor, and the costs. Also indicate what in-house study effort is underway or completed in the last 2 fiscal years.

(The information follows:)

List of studies for the past 2 years:

ANTIAIR WARFARE

	Percent complete
Fiscal Year 1968:	
VTOL fighter aircraft study; N00019-68-C-0538; June 3, 1968; LTV; 90K	80
VTOL escort fighter study; N00019-78-C-0550; July 2, 1968; 99K; Sikorsky	80
Fiscal Year 1969:	
1985 naval fighter study; N00019-69C-0348; Mar. 17, 1969; 90K; Lockheed, (California)	30
DLI aircraft study not signed yet; McDonnell Douglas; 67K	0

AIRBORNE ATTACK

Fiscal Year 1968:	
Close air support study N00019-68-C-0539; June 28, 1968; 88K; LTV	100
TRIM 80 aircraft study N00019-68-C-0575; June 27, 1968; 88K; Lockheed (California)	90
TRIM 80 avionics study N00019-68-C-0488; June 14, 1968; 90K; Honeywell	90
Close air support propulsion study; N00019-69-C-0029; Sept. 16, 1968; 98K; Lockheed (California)	70
Fiscal Year 1969:	
Attack aircraft study; N00019-69-C-0417; Mar. 28, 1969; 90K; Lockheed (California)	30
TRIM 80 aircraft study phase II; N00019-69-C-0545; June 4, 1969; 95K; Lockheed (California)	0
Advanced attack aircraft study; N00019-69-C-0677; LTV; 99K; not yet signed	0

AIRBORNE ASW

Fiscal Year 1968:	
Long endurance patrol aircraft; N00019-68-C-0250; Apr. 11, 1968; 98K; Lockheed (California)	90
VPX aircraft study (phase III); N00019-68-C-0589; June 27, 1968; 99K; Lockheed, (California)	70
Fiscal Year 1969:	
1985 advanced ASW air systems concept study: N00019-69-C-0411; Mar. 26, 1969; North American, (Columbus); 96K	20

AMPHIBIOUS ASSAULT WARFARE

Fiscal Year 1968:	
Marine air assault; N00019-68-C-0500; July 6, 1968; Boeing; 76K; Vertol	100

AIRBORNE COMMAND AND CONTROL

Fiscal Year 1968:	
Advanced reconnaissance system; N00019-68-C-0095; Dec. 16, 1967; 91K; North American, (Columbus)	80
Fiscal Year 1969:	
Effect of LSI and micro electronics on aircraft design: 90K; N00019-69-C-0108; Nov. 26, 1968; Texas Instruments	50
Advanced airborne avionics; not signed yet; 99K; Sanders Associates	0

VFAX

REASON FOR DROPPING PROGRAM

Mr. ANDREWS. Now, the VFAX aircraft. The F-14C aircraft reportedly replaced the original Navy proposal for a VFAX aircraft. Was it the original plan that the Navy VFAX and the Air Force FX aircraft would be a joint airframe and engine development program?

Dr. FROSCH. There was no such firm plan. There was a discussion of the possibility when the VFAX was first under discussion. The Navy's older plan was to have the F-111B as a carrier interceptor protection aircraft. The F-111B was not satisfactory as a highly maneuverable fighter——

Mr. ANDREWS. We have heard all about that.

Dr. FROSCH. I just say the other part of that plan was to have an airplane called the VFAX which would be both an attack and fighter for those purposes.

When the F-111B went out of the picture and we began to look at the F-14, it became clear we could design an aircraft that could combine things we wanted in both the F-111B and the VFAX. Hence we dropped the VFAX.

APPROPRIATIONS FOR VFAX

Mr. ANDREWS. How much has been appropriated through fiscal year 1969 for the VFAX? How were those funds used and what was done with the unused funds subsequent to the decision to develop the F-14 series of aircraft?

Dr. FROSCH. I don't know the history numbers on the VFAX. What was done with the money was principally working on the multimission radar that we discussed a little bit earlier, and some analysis and study of what the aircraft would be like and what its missions and characteristics would be.

The multimission radar work is transferred into the F-14C. I believe if there were unused funds they were also transferred to the F-14 program but we will examine and insert the correct information.

(The information follows:)

VFAX

	Millions
Fiscal year 1968:	
Appropriated	3
Deferred by OSD	2
Expended—Advance avionics (F-14C)	1
Fiscal year 1969: Appropriated	30
Expended: Advanced engine (F-14B)	30

F-111B

RECOUPMENT OF R. & D. FUNDS

Mr. ANDREWS. In March 1969 the General Accounting Office provided this committee with a report on the costs and benefits of the F-111B aircraft and costs of the Phoenix missile. According to this report, $28 million of unexpended research and development funds for the F-111B aircraft program could be recouped but as of December 16, 1968, only $8.8 million had been recouped. How much of the remaining funds have now been recouped?

(The information follows:)

R. & D. funds totaling $22.9 million have been recovered from the F-111B program. A defense contract audit agency review of the F-111B contract is currently in process and some additional funds, possibly ——— should be recovered later in fiscal year 1970; however, the PAMN objective of ——— has not yet been reached.

TOTAL R.D.T. & E. COST

Mr. ANDREWS. What is your most current estimate of the total R.D.T. & E. costs for the F-111B, including termination costs?

(The information follows:)

R.D.T. & E. funds in the amount of $245.8 million have been appropriated for the F-111B. Of these funds, $22.9 million have been recovered to date. Further, a defense contract audit agency review currently in process should result in the recovery of additional funds. It is estimated that a total recoupment as high as ——— should be achieved by the end of the review. This estimated recoupment deducted from the R.D.T. & E. appropriations leaves R.D.T. & E. costs less termination costs at ———. The contractors have 12 months to audit contracts and submit claims for termination costs. These should be available in mid-fiscal year 1970. It is significant to note that the F-111B program manager estimates that $150.2 million of the ——— F-111B costs will benefit other development programs such as the F-14 and the Air Force F-111 series in that the TF-30 engine will be fully developed and the Phoenix missile and missile control system nearly developed under this program.

LOST COSTS

Mr. ANDREWS. The GAO report indicated that the Navy estimates that the residual cost or lost costs on the R.D.T. & E. funds obligated for the F-111B would amount to about $105 million. Do you agree with this estimate, Dr. Frosch?

(The information follows:)

R.D.T. & E. funds in the amount of $245.8 million were allocated to the Navy for F-111B purposes. Of this amount, it is estimated that a total of ——— will be recouped when the Defense Contract Audit Agency review is completed. Additionally, the ongoing contract to support the F-111B's used in F-111B and Phoenix development test programs is for $28.5 million (The F-111B's are being used to continue Phoenix development test to insure the missile and missile control system will meet the F-14 IOC). When the estimated recoupment and the ongoing contract are added to the R.D.T. & E. benefits to other programs estimated at ——— and the total is deducted from the total R.D.T. & E. appropriations for the F-111B, the residual or lost costs become ———. Additionally, PAMN residual costs are estimated at ——— residual costs.

F-4 PHANTOM

Mr. ANDREWS. Now, the F-4 Phantom aircraft.

CONTRACT FOR ADVANCED MISSILE CONTROL SYSTEM

It has been reported that in December 1968 Airinc Research Corp. received a contract costing approximately $1 million from the Naval Air Systems Command for evaluating and improving the effectiveness of an advanced missile control system for the F-4 aircraft. The contract will run for 2 years and will involve Airinc personnel stationed at various Navy installations as well as at the Annapolis home office. What is the purpose of awarding a 2-year contract for a missile control system for an aircraft to be replaced by the F-14?

Dr. FROSCH. This is a study of the AWG-10 radar system which is in the F-4J. This is an attempt to collect data and analyze the performance and characteristics of the radar, including its maintainability and logistics characteristics as it is now actually in the fleet.

There are two purposes to this, I think One is that, of course, while we will be replacing the F-4 with the F-14 in future years, the F-4 will be with the fleet for quite a long time and we want to be sure we can get the most out of the AWG-10 system which has had some problems.

Secondly, I think it is useful to do this kind of study of an aircraft system that we have just recently brought into being because from it I would hope we can learn more about how to do this kind of development and how to bring an aircraft system into the fleet.

It is clear from the discussion we have just had and from the history of this that we still have a number of things to learn about how to bring this system into being.

CONTRACT VERSUS IN-HOUSE RESEARCH

Mr. ANDREWS. Again we have a case where you are contracting with an outside firm to do work for the Navy, where you should have an in-house capability.

Dr. FROSCH. This is a question of whether we should have in-house the capability in terms of manpower to do all of the special jobs that come up from time to time that we think ought to be done. This is a job that takes specialized engineers in a number of field stations, collecting special data and then analyzing it. There is no question but what we have that kind of competence in the Navy. However, we don't have enough people to use for that job in comparison with other problems that we think are more urgent, although this one is also important.

Mr. ANDREWS. I wish you would go into that at length in the record as to why you are awarding this contract to Airinc instead of doing it in-house.

(The information follows:)

AIRINC CONTRACT

Airinc had developed a unique capability through their work with the Aero-1A missile control system to provide rapid and effective response. They had trained people available who could be sent quickly to field stations and activities to accumulate necessary data which was fed into a central computer. As a result, a data bank on the AWG-10 system was created expeditiously. This data bank, which is utilized by both Navair and ASO, permitted the Navy to provide an operational AWG-10 system to the fleet months in advance of the time that normal procedures would have permitted.

The Navy could have performed a similar function. However, personnel who were employed in other phases of the program would have had to be utilized. This could only have been accomplished at the expense or disruption of the overall program and its attendant delays. Navy people were fully occupied in the program and were required to implement the results of studies and the data bank information obtained.

The wisdom of the Airinc approach is believed demonstrated in that both Navair (AIR-04) and ASO utilized the Airinc generated data and analysis and incorporated it into the data bank currently in use for procurement and support of the AWG-10 system.

APPLICABILITY OF AWG–10 STUDY TO F–14

Mr. ANDREWS. How can this study of the AWG–10 radar system help you with the F–14A?

Dr. FROSCH. This can help us with the F–14 by telling us what things we did wrong with the introduction of the AWG–10 for the F–4, when we bring the AWG–9 Phoenix system into the fleet with the F–14.

Mr. ANDREWS. The study won't be completed for 2 years.

Dr. FROSCH. There will be lots of data and in 2 years we will be just about the time we are hoping with the beginning of the logistic and maintenance introduction of the F–14.

TENDENCY TOWARD CONTRACT RESEARCH

Mr. ANDREWS. I won't say this trend might lead into the Navy contracting out all of its work, but each year there are more and more of these outside contracts to do things this committee has felt could be done by the Navy in-house.

Dr. FROSCH. Mr. Chairman, the major laboratories of the Navy, for example, have gone down an average of 2,150 people between 1968 and 1970 as a result of the Expenditure and Manpower Limitation Act. So the in-house group is declining essentially by direction and many of the jobs still continue and there are new jobs that come up.

Mr. ANDREWS. Would you put in the record at this point the total number of contracts you have with outsiders for this type work, study, and analysis?

Dr. FROSCH. Certainly.

(The information follows:)

There are currently 64 separate private contractors, universities, foundations, and research institutes involved in studies and analysis effort.

Mr. ANDREWS. What is the total cost of this Airinc contract and what missile system is involved?

Dr. FROSCH. This is the AWG–10 system for the Sparrow missile control. The total amount of the contract we will put in the record.

(The information follows:)

The contract to Airinc Research Corp. is in the amount of $930,426.60.

RCA STUDY CONTRACT

Mr. ANDREWS. In late April or early May 1969, the Naval Air Systems Command reportedly awarded a contract to RCA Service Co., to determine system reliability and effectiveness of the F–4 aircraft.

What is the cost and purpose of this study effort?

Dr. FROSCH. We will have to put that in the record.

(The information follows:)

The contract to RCA Service Co. is in the amount of $74,877. The purpose of the contract is an analysis of the AERO 1A/Sparrow III system. The AERO 1A is the weapon system for the F–4B aircraft and the study is underway to determine the most cost effective improvements that can be incorporated to improve reliability and maintainability of the system.

OV-10A Coin Aircraft

PROBLEMS WITH THE AIRCRAFT

Mr. Andrews. On page 13 of your statement, you mentioned the OV-10A Coin aircraft which is seeing service in Vietnam and on page 25 you further extoll this aircraft. Isn't it true that the aircraft has been somewhat of a disappointment, that it is unacceptable as a coin or reconnaissance light armed helicopter escort aircraft, and that it is only being used in the role of an FAC aircraft in Vietnam?

Dr. Frosch. I believe it has had a lot of use as an FAC aircraft which was one of the principal missions that the aircraft was designed for. There has been a problem with the stabilizers, and there is at the moment a ——— as the result of a crash which has not yet been fully investigated.

There are problems with the aircraft.

Mr. Andrews. Where did the crash take place?

Dr. Frosch. I do not know.

Captain Jessen. I believe it was during the test phase.

Mr. Andrews. Put something in the record about the crash, if you will.

Captain Jessen. Yes, sir.

(The information follows:)

The crash occurred at Columbus, Ohio, during a maximum velocity dive test. The pilot ejected safely.

Mr. Andrews. Have you been disappointed in this aircraft, Mr. Secretary?

Colonel McNeil. As a reconnaissance aircraft which was its original purpose it is a fine aircraft.

Mr. Andrews. Did you try to push it to missions other than its original planned use?

Colonel McNeil. No. There are other aircraft in the Marine Corps that are better fitted for the other missions.

Dr. Frosch. There is some hope that it could be used for attack on ———

Mr. Andrews. What other aircraft do you have in the Navy or Marine Corps, Colonel?

Dr. Frosch. We use the O1 and, to an extent, some helicopters are used in the close support reconnaissance role. The aircraft is really referred to as a tactical light armed reconnaissance aircraft and it has been satisfactory in that role. ———.

OV-10A'S BORROWED FROM MARINE CORPS

Captain Jessen. Mr. Chairman, it might be useful to insert at this juncture that when we got into trouble over the OV-12 aircraft about a year or so ago we could not borrow helicopters from the Army. We did patch together a program by which the Navy borrowed some Marine OV-10 aircraft. We have since commissioned our first squadron of Navy OV-10's by borrowing from the Marine Corps and we are excited about the possibility of using them in the role we spoke of. We are relatively satisfied from a Navy standpoint.

Mr. Andrews. Colonel, does the Marine Corps like this aircraft?

Colonel McNeil. Yes, sir.

Mr. Andrews. What do you use it for?

Colonel McNeil. It is a light armed reconnaissance aircraft which can protect helicopters by performing reconnaisance ahead of helicopters in transit and in the landing zones and by attacking light floating targets.

OV–10A COMMUNICATION EQUIPMENT

Mr. Andrews. What kind of communication equipment does it have good or bad?

Dr. Frosch. Good voice communication equipment, that appropriate to a small simple aircraft. It is not elaborate equipment.

Mr. Andrews. Can they communicate with the choppers that follow them?

Dr. Frosch. Yes.

Mr. Andrews. Short range.

Dr. Frosch. Tens of miles at any rate by the use of long range, non-line-of-sight, high frequency single sideband equipment.

CHANGE IN SPECIFICATIONS

Mr. Andrews. Were the original specifications and the original mission of the OV–10A changed in order to accommodate deficiencies in this aircraft?

Dr. Frosch. I do not believe so, Mr. Chairman.

Captain Jessen. Yes, sir; with regard to specifications. When we were in the process of development we found that certain of the requirements established as specifications with the original engines could not be met. These were in the area of takeoff role in particular.

We shifted to an uprated engine producing several hundred more horsepower and we lengthened the wing tips in order to produce more wing area. We then revised the specifications to reflect that. Against the revised specifications, the aircraft met or very nearly met all of the requirements. I believe it missed maximum speed by about 1 knot, and it missed its ferry range by 2.4 miles or something like that.

Mr. Andrews. Who paid for these modifications, Captain, the contractor or the Government?

Captain Jessen. I believe we shared in the cost of the modifications?

Mr. Andrews. Who was the contractor on this aircraft?

Captain Jessen. North American Rockwell.

CHANGE IN MISSION BECAUSE OF DEFICIENCIES

Mr. Andrews. Here is a confidential communication to the staff of the committee from the Office of the Secretary of Defense, dated March 11, 1969:

It should be noted that while deficiencies were discovered during the first NPE of YOV–10A, the correction of these deficiencies in terms of the current configuration of the aircraft is somewhat immaterial in that currently planned missions of the aircraft with associated performance specifications are different than the mission and associated performance specifications of the developmental YOV–10A. The essential difference relates to the original mission of light armed helicopter escort reconnaissance aircraft versus the current mission for fast forward

air controller aircraft requiring greater takeoff weight, engine horsepower, and stores capability associated with the external fuel requirement to meet an expressed mission range and time required.

So according to this, the committee has informed that the original mission of the plane was changed because of deficiences in the aircraft.

Dr. FROSCH. That refers to something that was done during the course of the development. I am not sure that communication squares completely with my understanding of the history of the mission or the aircraft, but I will be happy to check into the history which I must admit that I do not completely recall.

Admiral GADDIS. One step back further in the history of the aircraft, it was designed to be a light reconnaissance aircraft and an aircraft to move men and materials into unimproved short runway fields. The helicopter escort mission developed during its development and incident to the development of helicopter tactics in Vietnam.

Mr. ANDREWS. Have somebody put something in the record on this. Also put in the record, if you don't have it now, what the total cost was and what the unit cost per plane is.

Dr. FROSCH. Yes, sir.

(The information follows:)

HISTORY OF THE OV-10A

As far as the history of the light reconnaissance aircraft is concerned, the Marine Corps originated the initial operational requirement for a light armed reconnaissance aircraft (LARA) which was to be capable of providing close reconnaissance support to ground forces. In addition, it was to be capable of escorting and protecting helicopters, and itself, through its inherent ability to attack light fleeting targets in a lightly defended or permissive enemy environment.

During the early stages of its development, it was decided in the Office of the Secretary of Defense that such an aircraft would be ideally suited as an aircraft system which could be provided to small and less prosperous countries through the U.S. military assistance program (MAP). In order to make it more compatible with total MAP requirements, it was necessary that the aircraft also be capable of moving men and materials in and out of short, unimproved airfields. As was later discovered in the initial flight tests, it was largely these MAP requirements that degraded the originally planned performance and certain changes had to be made in order for it to adequately perform the military mission. These changes were primarily increased engine horsepower and wing area needed to offset increased airframe weight and aerodynamic drag.

The combined effect of the MAP requirements and the resultant changes caused the costs to rise sharply. In an effort to maintain costs as low as possible, a joint OSD sponsored steering committee directed that only the essential equipments necessary to perform the MAP requirements were to be included in the basic production configuration. Additional equipments necessary for the U.S. military mission were to be added later. Consequently, various reconnaissance sensors, air-conditioning, some ordnance capability, etc., were not included in the basic production configuration.

In essence, the Marine Corps mission, as originally planned has not changed. However, its performance has been degraded and it does have some shortcomings, but in general, it is performing well in Southeast Asia.

One hundred fourteen aircraft were purchased for a total cost of $46 million, making the unit cost $403,508.

HORIZONTAL STABILIZER FAILURE

Mr. ANDREWS. How many OV-10A aircraft have we lost due to the failure of the horizontal stabilizer?

Dr. FROSCH. One, and that is the suspected cause.

Mr. ANDREWS. What about the stabilizers on the ones in use now, are they in good condition, Captain?

Captain JESSEN. Sir, the problem has essentially been identified as a flutter condition that occurs in the horizontal stabilizer.

The flutter condition is being investigated jointly by the contractor, Navy and Air Force design engineers. Since the aircraft does not meet original design specifications, the contractor has been cited for this deficiency and he bears the responsibility for funding. Meanwhile, the OV-10A's ———.

NUMBER OF OV-10'S IN USE

Mr. ANDREWS. How many OV-10 aircraft do we have in South Vietnam?

Colonel MCNEIL. Two squadrons.

Mr. ANDREWS. How many planes is that, Colonel?

Colonel MCNEIL. ———.

Mr. ANDREWS. How many do they have in other spots, total?

Colonel MCNEIL. Eventually we would like a total of ———.

Mr. ANDREWS. How many do you have now?

Colonel MCNEIL. 114 aircraft were originally purchased for the Marine Corps. Eighteen of the original buy are on loan to the Navy. Combat losses and other attrition has reduced the total inventory to ——— aircraft.

Mr. ANDREWS. Do you know what the rate of production is?

Admiral GADDIS. They are not in production.

Captain JESSEN. The production run has just been completed on the original buy.

The U.S. Air Force has approximately an equal or greater number of forward air controller aircraft, OV-10's in Southeast Asia, to match those the Marines are referring to, and the Navy warfare people will be there within a month with one squadron of about 20 aircraft.

Mr. ANDREWS. Is it true that all the OV-10's that the Navy owns or has are now in Southeast Asia?

Captain JESSEN. No, sir; that is not true. There are some still training in the United States.

But they have all been produced and in our system. There are no more waiting to be produced.

AIR CONDITIONING FOR THE OV-10A

Mr. ANDREWS. The Navy is requesting $1.4 million in fiscal year 1970 to modify the OV-10A aircraft by installing an air-conditioning system and making communications improvements. Why were these things not done while this aircraft was in R.D.T. & E.?

The committee can fully understand the need for air conditioning in Southeast Asia.

Captain JESSEN. Again, it was a problem that grew during the course of the development of this particular airplane. In the development process it was recognized that weight was of the essence and we were trying to get in and out of very small fields. So a decision was made to not install an air-conditioning system in this very light aircraft.

Mr. ANDREWS. How much additional weight would the air-conditioning system put on the plane?

Captain JESSEN. I do not have the precise information but I would estimate some 30 to 40 pounds for this sort of an airplane.

The original requirements as they were laid down did not include an air-conditioning system. They did include some windows that could be opened or vents that could be opened in flight to allow the natural ambient air to circulate through the aircraft. As it turned out in Southeast Asia where the airplanes went the temperatures were of the extreme that the crews decided that they needed for crew comfort an air-conditioning system, and as a modification out of the PAMN fund we plan to do that?

Mr. ANDREWS. The question is why in R.D.T. & E. they didn't think about the air-conditioning system.

Dr. FROSCH. I think it was thought about, but there was a weight problem with the aircraft and the decision was that natural ventilation should be satisfactory. It is not anything of a development problem to put the air-conditioning in.

Mr. ANDREWS. It can be done in Vietnam.

Dr. FROSCH. I imagine it can; yes.

CORRECTION OF HORIZONTAL STABILIZER

Mr. ANDREWS. Are there any plans in being to correct the deficiency in the horizontal stabilizer, which is a safety hazard?

Captain JESSEN. I believe we have those funds as part of our aircraft modification money. They are not in R.D.T. & E.

Mr. ANDREWS. It did not show up in the PAMN budget.

Admiral GADDIS. It is not in the modification line of the P-1, sir.

Mr. ANDREWS. Do you have the money to correct the trouble?

Admiral GADDIS. There is no money assigned in the budget at this time; in either 1968, 1969, or 1970.

Mr. ANDREWS. We would think you would want to correct that before you put an air-conditioning unit in the plane.

Captain JESSEN. I am certain it is going to be corrected. It may be in the preparation of these tables and amounts the flutter problem which was not known——

Mr. ANDREWS. I wish you would check on that for the record and answer for the record whether or not the stabilizing problem will be corrected.

Captain JESSEN. It definitely will be corrected.

(The information follows:)

There are plans to correct this deficiency. The contractor has been cited and we expect him to develop a satisfactory solution which would be backfitted into all operational aircraft.

There are no funds identified, R.D.T. & E., PAMN, or otherwise to accomplish this program. The contractor is proceeding to resolve this problem at his expense.

OV-X RIVERINE WARFARE AIRCRAFT

Mr. ANDREWS. For the record, you will recall that last winter the Navy was desirous of buying a riverine warfare aircraft, specifically the OV-12A heli-porter.

Is there still a valid Navy requirement for an OV–X riverine warfare aircraft today?

Dr. FROSCH. Yes. It is being met at the moment with the OV–10A, when we can get them.

HEAVY-LIFT CRANE HELICOPTER

Mr. ANDREWS. For fiscal year 1970 the Navy is requesting approximately ——— million for a heavy-lift crane helicopter. What is the purpose of this program?

REQUIREMENT FOR HEAVY-LIFT HELICOPTER

Dr. FROSCH. The purpose is to be able to recover downed aircraft up through the size of the CH–53 helicopter complete in the field without having to dismantle them on the ground and pick up pieces.

Mr. ANDREWS. Is that what you are doing today?

Dr. FROSCH. That is what we are doing today. When we try to recover one frequently under combat conditions, we either strip it down and pick up the pieces or we essentially leave the helicopter where it is.

Mr. ANDREWS. Either way is expensive.

Dr. FROSCH. Leaving it is expensive and taking it apart is expensive and may be dangerous or impossible. An additional use of this helicopter would be to assist in logistic support of amphibious operations and cargo delivery and so on, so it could be used in underway replenishment and in amphibious uses as well.

MODIFICATION OF CH–53

Mr. ANDREWS. The total cost estimated of this development is ——— million. How much would it cost to modify the CH–53 crane helicopter to perform this mission?

Dr. FROSCH. I believe this cost is based on the assumption that is essentially what would be done.

Admiral RUCKNER. We are building from the crane helo a new helo, if you will, but it is not a radical new development. It is what you might call an uprating of an earlier helo.

ARMY AND AIR FORCE REQUIREMENTS

Mr. ANDREWS. Are the Army and Air Force initiating development of a heavy-crane helicopter?

Dr. FROSCH. Both the Army and Navy have put in requests to develop a heavy-lift helicopter. There is some difference in the requirement. The Army wants a helicopter which could lift a considerably heavier payload than the Navy requires.

We could use a helicopter that lifts that much, but the design of a helicopter that lifts that much comes out in a size and weight that makes it impractical to operate on and off shipboard, or to fly in a C–5A. The Army needs to pick up heavy tanks and such equipment. They need the heavier lift. It is not yet decided whether both Army and Navy will proceed, whether one or the other will proceed, or whether some combination of the two will be made. The decision rests in the Office of the Director of Defense Research and Engineering.

POSSIBILITY OF TRI-SERVICE DEVELOPMENT

Mr. ANDREWS. Why couldn't this be made a joint or tri-service development program?

Admiral RUCKNER. I tried that, sir. I got together with General Betts and we agreed if it were at all possible and it was advantageous to both of us that we have one development. We brought all the people together of the Combat Development Command and the Air Systems Command and my own office and we tried very diligently to produce a set of specifications that both of us could live with.

Mr. ANDREWS. And you could not do it.

Admiral RUCKNER. We could not do it for the very simple reason that the Army has a very valid requirement for the heavier lift, and there are no ships that we have except the big carriers that could possibly handle a helo of that gross weight.

When you get that much lift the gross weight of the helo has a deck loading greater than the decks of our ships will take. On top of that the rotor diameter is such that you cannot efficiently spot them in the ships.

Mr. ANDREWS. You do not need a crane chopper on a ship.

Admiral RUCKNER. We have to operate them from our LPH's and our logistics ships if we are going to bring the stuff back.

Mr. ANDREWS. Just for transportation and not for use on the carrier.

Admiral RUCKNER. No, we could not put them on anything except the big carriers much less operate them.

ARMY HELICOPTER TOO HEAVY TO TRANSPORT

Mr. ANDREWS. How is the Army going to transport theirs?

Admiral RUCKNER. The Army will have to transport them by ship disassembled.

Mr. ANDREWS. Disassembled?

Admiral RUCKNER. Yes, sir. Our design will fit in the hull of a C–5A, and it meets 90 percent of the requirements of both Air Force and ourselves.

Mr. ANDREWS. But the Army is going to use the C–5A?

Admiral RUCKNER. Not to transport this helo.

Mr. ANDREWS. They won't?

Admiral RUCKNER. Not this one.

Dr. FROSCH. It would be too big.

Mr. ANDREWS. I did not think anything was too big for the C–5A.

Dr. FROSCH. Apparently that helo would be.

Mr. ANDREWS. Does the Air Force admit that? Does it admit that the C–5A cannot handle a crane chopper?

Dr. FROSCH. Yes.

Admiral RUCKNER. The C–5A will handle the helo we propose and that is the helo that will meet the Air Force requirement as well as our own.

Mr. ANDREWS. You and the Air Force are together but cannot get the Army with you.

Admiral RUCKNER. The Army has a very valid reason for not being with us because they have to lift armor. The armor loads are much heavier than we need to lift.

Mr. ANDREWS. Under what conditions will the Navy use the C–5A to transport a crane chopper?

Admiral RUCKNER. We would not contemplate it, but the Marines might want to do that. We want it for the Marines, ourselves, and the Air Force.

Dr. FROSCH. I can suggest a situation. If we had the C–5A in operation now, I could think that there would be situations in which we would want to transport things rapidly like helicopters to Southeast Asia. Certainly if we were in a situation where a conflict like that was just beginning and we were just at the stage of trying to get troops or aircraft or helicopters over there, we might well want to use the C–5A to transport such equipment. That is what the aircraft was designed for according to my understanding.

JOINT ARMY-NAVY INSTRUMENTATION RESEARCH PROGRAM

Mr. ANDREWS. Under the joint Army-Navy instrumentation research program, two different radars for helicopters were developed and were tested. What is the current status of this effort?

You can put that in the record.

(The information follows:)

Effort on these radars was performed under the following contracts:

Contract Nonr 4032(00); David W. Young, Associates; 3–D radar sensor; active from November 15, 1962 to July 31, 1964.

Contract Nonr 4148(00); Bell Helicopter Co.; rotor blade radar evaluation; active from April 15, 1963 to September 30, 1966.

The David W. Young Associates effort was to demonstrate the feasibility of a helicopter terrain avoidance sensor which was intended to give the pilot a view of distinguishable terrain features over ranges of from 100 feet out to 5 miles. The system employed two associated radar antennas, the prime one being a longslot array which slowly leaked radar energy through a series of small mechanical phase shifters. The reflected radar beams were detected by the second antenna which electronically scanned at a rapid rate. The resultant information was displayed on a TV-type cathode-ray-tube scope.

The 3–D radar sensor was initially evaluated by the contractor through field tests and subsequently was evaluated by the Naval Ordnance Test Station, China Lake, Calif. On the basis of the initial encouraging test results, a decision was made to attempt to incorporate the primary antenna within a helicopter radar blade, and the second contract was initiated. Mr. David Young, became a consultant to the Bell Helicopter Co. for the second task.

The Bell Helicopter Co. effort, which employed the Texas Instruments Corp. as a source of detailed radar assistance, extensively refined the D. W. Young design, demonstrated how the slotted antenna could practically be incorporated into either the leading or trailing edges of a helicopter rotor blade, and further demonstrated by brief flight tests that the radar provided a useful adjunct for helicopter pilots.

It is understood informally that both Lockheed Electronics and Texas Instruments are advocating further development of the system, and that the Army, Air Force, Navy, and Coast Guard are reviewing the work done to date to determine if further development would be of value to their services.

NAVY/AIR FORCE COOPERATION IN ELECTRONIC COUNTERMEASURES

Mr. ANDREWS. For the record, how closely is the Navy cooperating with the Air Force in the airborne electronic countermeasures program?

Dr. FROSCH. There has been continual discussion over that kind of equipment between the two services.

(The information follows:)

Navy and Air Force cognizant officers meet frequently with members of D.D.R. & E.'s staff to discuss commonality of the electronic countermeasures program. In addition, both services have representatives on the applicable working panels of the Defense Science Board. Mutual exchanges of information occur and visits are made to the various industrial firms producing equipment.

As new development objectives are established, requirements documents are written, describing the equipment needed. These documents are forwarded to the Air Force requesting information as to any related requirements and if a joint development effort is desired. For urgent, rapid developments where requirement documents are not written, descriptive summaries are exchanged between Navy and Air Force.

Technical aspects of many research projects are presented to the subgroups of the technical cooperation program which include members from both services. A program summary book is published annually containing descriptive summaries of R. & D. programs for each service.

Mr. ANDREWS. Can you show instances where the Navy and Air Force are utilizing the same airborne countermeasures equipment?

Dr. FROSCH. I believe we can. I will comment on that for the record.

(The information follows:)

There are many electronic countermeasure equipments in service use that are common to both the Navy and Air Force. In fact certain Navy developed countermeasures fly in Air Force aircraft and vice versa. Some of these equipments that have proven highly effective in SEASIA are listed below:

APR-25 ———
APR-27 ———
ALE-29A ———
ALQ-51 ———
ALQ-71 ———
ALQ-100 ———
BIGLOOK ———
BRIGAND ———

POSEIDON MISSILE

INCREASE IN 1970 BUDGET

Mr. ANDREWS. For the record, the fiscal year 1970 revised program for missiles and related equipment totals $564.6 million, which is $148.8 million less than the current fiscal year, but an increase of $12.4 million over the original budget request.

Why was this budget activity increased during the Nixon review? You may answer that for the record.

(The information follows:)

The Navy request for development of the Poseidon ——— guidance system was reduced by $22.4 million and the operational date delayed 1 year in the original budget submitted to the Congress. Upon reviewing that budget submission the current administration decided that the Navy request had been reduced too much and the IOC delayed too much and therefore proposed restoration of $12.4 million to offset part of the delay.

GUIDANCE SYSTEM SLIPPAGE

Mr. ANDREWS. What is the significance of the Poseidon ——— guidance system, how far has the program slipped, and what impact will this slippage have on the Poseidon conversion program?

Dr. FROSCH. The ——— million increase that you just referred to was for the ——— guidance. With regard to the status of the program I would ask Admiral Smith to comment.

Admiral SMITH. The ——— guidance program requires a somewhat different fire control system and some differences in the structure of the missile from the ——— system that is to be in the initial deployment.

The ——— program has progressed far enough to define those differences and to provide for the initial missiles being constructed in a way that the ——— guidance can be backfitted without modification of the missile. Also, the design of the shipboard fire control equipment was modified earlier enough so that there are only module and cabinet changes required to accommodate missiles with ——— guidance. All the wiring and ship structure changes go in the initial submarines.

On the fire control system, the current plans are to have the fire control system for the ——— submarine in the 31 submarine conversion program—no, it is the ——— with all of the modules in the system as initially installed in the submarine suitable for the guidance system. So with those provisions the guidance system can be introduced into the program really at any time. So any slippage in the complete development of testing and all of the guidance system will not influence the conversion program.

STATUS OF CONVERSION PROGRAM

Mr. ANDREWS. Is the conversion program on schedule?

Admiral SMITH. Yes, sir.

Mr. ANDREWS. This ——— guidance system is not delaying the program?

Admiral SMITH. For the reasons I have enumerated it is not delaying or influencing in any way either the missile program or the conversion program.

Mr. ANDREWS. When do you expect to have those ——— ships completed?

Admiral SMITH. I do not have that date handy.

I will supply it for the record, sir.

(The completion date was supplied to the committee and is classified.)

Mr. ANDREWS. But they are all on schedule?

Admiral SMITH. Two have entered the yard and those two are on schedule. The equipment for the next two is being constructed and is on schedule.

Long lead equipment suitable to go in four more is also on schedule.

Mr. ANDREWS. Where is the work being done?

Admiral SMITH. The first one in Electric Boat in Connecticut. The second in Newport News Shipbuilding and Drydock Co. The third one I expect to go into Electric Boat. The fourth in Mare Island.

Mr. ANDREWS. You do assure the committee the overall program is on schedule?

Admiral SMITH. The overall program is on schedule.

The program of reentry bodies for the initial missiles I expect to be delayed about ———.

Mr. ANDREWS. Put the detail in the record.

(The information was provided to the committee and is classified:)

Mr. ANDREWS. Has the Observation Island completed its conversion to the Poseidon missile?

Dr. FROSCH. Yes, sir.
Mr. ANDREWS. Can she still fire the Polaris missile?
Dr. FROSCH. Yes, sir.

1970 POSEIDON DEVELOPMENT

Mr. ANDREWS. How will the fiscal year 1970 funds be spent on the Poseidon program?
(The information follows:)

Fiscal year 1970 POSEIDON development (dollars in thousands):

Missile development	———
Re-entry system development	———
Fire control subsystem development	———
Launching and handling subsystem development	———
Navigation subsystem development	———
System integration	———
Test instrumentation development	———
System effectiveness and vulnerability	———
Total	———

SSBN DEFENSE

Mr. ANDREWS. What is involved in the new subactivity "SSBN Defense" for which you are requesting ——— million in fiscal 1970?

Dr. FROSCH. We have a long term concern in principle over the vulnerability of the SSBN force.

We have good evidence now that it ——— but we believe it wise to worry ahead as to what developments in the future conceivably might change this relative invulnerability.

So this program is intended to keep a close watch on U.S. and Soviet capabilities for changing the vulnerability of each other's fleet ballistic missile systems, to try to look at all the possible threats we can think of for detection, identification and tracking of USSBN's. We want to design tactical tests which will enable us to measure in the field what the effectiveness of any of these proposed schemes might be.

If there are any schemes that look as if they might change the vulnerability picture to be able to test them, to determine what the equipment requirement would be to carry them out, and determine what we have to do to our submarines to restore their invulnerability. This is all based not on a particular feeling that there is any known system that we are aware of that can find the submarines, but we feel they are sufficiently important to the deterrent so that we should make a significant effort, so identified, to keep specific track of this problem.

Mr. ANDREWS. Do you have any information to indicate that the Soviets are capable of ———?

Dr. FROSCH. We do not.

Mr. ANDREWS. Do you think this could be done?

Dr. FROSCH. We do not. The only proposed scheme I have ever heard of was the ———.

Mr. ANDREWS. That would really be like the proverbial needle in the haystack.

Mr. ANDREWS. How will the 1970 funds be used?

Dr. FROSCH. For the initial examinations that I detailed in the answer to the previous question.

Mr. LIPSCOMB. How will you do the job?

What do you intend to do with ——— million dollars in funds in this SSBN defense?

Are you going to retain some firm or research organization? How will you dispose of ——— million dollars on such a study?

Dr. FROSCH. I can give you an example of what we have done before not under a separate line item, but as part of other research efforts.

Mr. LIPSCOMB. I know, but this is a line item of ——— million for this study.

Dr. FROSCH. Precisely. I want to explain what we have done because it outlines the way in which we will proceed with the work in the future.

Mr. LIPSCOMB. How did you arrive at the ——— million?

Dr. FROSCH. By an examination of a series of tests and operations that we would like to carry out. We can estimate ship days and equipment to be purchased and the manpower required to work on the program, and so on.

Mr. LIPSCOMB. Do you think you could get by on ——— million in 1970?

Dr. FROSCH. We would be doing considerably less of the work that we have planned to do.

Mr. LIPSCOMB. Do you think this has high enough priority that we ought to move ahead faster to protect the invulnerability of our submarines?

Dr. FROSCH. We think it has a high priority and we measure the amount of work that we think we could usefully do in terms of the amount of money asked for.

Mr. LIPSCOMB. Tell us how you can expend ——— million in fiscal 1970, on this particular study and how it would be done.

We know what you are trying to obtain.

Dr. FROSCH. ———.

Mr. LIPSCOMB. Excuse me, Doctor, but what I am trying to determine is: Are you going to hire a firm, or do it in-house, or just what will be the plan?

Dr. FROSCH. This will be a combination of in-house study, the use of fleet components and Navy laboratory and in-house capabilities to do experiments. We will be purchasing and certainly contracting out for the construction of some detection equipment which may better be done out of house than constructed in Navy laboratories. There may be some contracting for study work ———.

Mr. LIPSCOMB. This ——— million is just for an illustrative program at the moment. You have no real specific plan.

Dr. FROSCH. I believe Admiral Smith has some specific plan.

Mr. LIPSCOMB. Oh, I didn't know. Reportedly, Admiral Smith thinks it is invulnerable.

Admiral SMITH. I think you are referring to a statement I made at an earlier hearing. I made a comment in that statement that my opinions were based on carrying out the programs we had planned and

obtaining the funding we were requesting, which was not under consideration at that time. This is part of that funding.

PLANNED CONDUCT OF STUDY

Mr. ANDREWS. Mr. Secretary, does this work involve computer schemes and simulation, ———.

Dr. FROSCH. ———.

Mr. ANDREWS. Why will this new program cost a total of ——— million through fiscal year 1974?

What else do you plan to do?

Dr. FROSCH. I think this out-year funding is based on the assumption that we will have to take some actions to keep the vulnerability as low as it is. That is the estimate which I believe was constructed by the Office of the Director of Defense Research and Engineering. We do not have an estimate for the out years that we are sure of yet.

It all depends really on what we find in the initial year or so of testing. ———.

Mr. ANDREWS. You might not spend all this money.

Dr. FROSCH. We might spend none of the out-year money or some of it. We just do not really know.

Mr. ANDREWS. In other words, you are looking for something and if you find it, that is it.

Dr. FROSCH. If we find something then it may be an expensive thing to fix. If we do not find something or if we find something that is cheap to fix it may not cost all that money.

Mr. ANDREWS. Do you agree with that, Admiral Smith?

Admiral SMITH. All except the statement we might not spend any of the out-year money.

It seems to me that this is the kind of program that, because of its importance, we must continue ———.

Dr. FROSCH. That would be a remote contingency. Conceivably we might run out of schemes, but that is unlikely.

Mr. ANDREWS. You can pursue that argument in the record.

Dr. FROSCH. Thank you, Mr. Chairman, but I have nothing further to add to the foregoing discussion.

SAFEGUARD PROGRAM

NAVY EFFORT

Mr. ANDREWS. You are requesting ——— million in fiscal 1970 for ABM support. Your program in fiscal 1969 was $5 million and you estimate it will require another ——— million to complete the project. What is this program?

Dr. FROSCH. This is a program of providing targets for intermediate range ballistic missile targets as targets for the Army ABM program. We provide POLARIS boosters to fit target requirements laid on us by the Army Safeguard program, and fire them from the Observation Island as targets for their radars and detections in the ABM system.

Mr. ANDREWS. This is part of the so-called ABM or Safeguard program.

Dr. FROSCH. It is part of the research and development that goes with SAFEGUARD.

Mr. ANDREWS. The project listing book has a listing for Sentinel support. Did the change to the Safeguard ABM system affect this program in any way?

Dr. FROSCH. No; it did not, because whichever configuration or arrangement of ABM system would be chosen a key piece of information is how incoming missiles look to radar systems. So this is still part of the R. & D. for any configuration.

Mr. ANDREWS. Will this program involve the actual launching of inert Polaris test missiles against the Kwajalein test site?

Dr. FROSCH. Yes.

Mr. ANDREWS. How many?

Dr. FROSCH. We will have to supply that for the record.

Mr. ANDREWS. Also provide the cost.

(The information follows:)

Phase I of the program consists of supporting the Army's Safeguard program by providing targets for antiballistic-missile tests. This is to be accomplished by the firing of Polaris missiles from the Navy launch ship *Observation Island* (AG–154) into the Kwajalein area. As presently outlined the program calls for the utilization of ———. The first test firing will be conducted in ———. Total estimated costs for phase I through fiscal year 1973 are as follows:

Navy	———
Army	———
Total	———

The basis for the above funding split is as follows:

ARMY

(*a*) Modification of launch ship, if required.
(*b*) The refurbishment and modification of missiles and missile components provided by the Navy from inventory to make them usable for the Safeguard target program.
(*c*) The procurement of any new missiles and missile components required for the Safeguard target program, and any subsequent modification costs required to satisfy Army requirements.
(*d*) ———.
(*e*) Procurement, modification, or refurbishment, as necesasry, of ground and shipboard equipment, including that necessary for range support and safety, if initial acquisition or use is required exclusively for the Safeguard target program.
(*f*) Development of the miss distance indicator oscillator.
(*g*) Facilities furnished to contractors for research and development, production, or modification.
(*h*) Incidental investment costs of the Safeguard target program.

NAVY

(*a*) Launch ship operation and launch expense in support of the Safeguard target program.
(*b*) Facilities at Navy owned and operated activities, if required.
(*c*) ———.
(*d*) Special training of launch ship crews.
(*e*) Expenses of any other Navy activities engaged in support of the sentinel target program.

1969 AND 1970 FUNDING

Mr. ANDREWS. How were the fiscal 1969 funds spent and how will the 1970 funds be utilized?

Dr. FROSCH. I will put it in the record.

(The information follows:)

Navy funding for fiscal year 1969 and fiscal year 1970 provides for the following:

TARGET DEVELOPMENT

(*a*) Design of payload and ejection hardware including dispensers in general accordance with Army specifications.
(*b*) Design of associated missile modifications to accommodate the required payload.
(*c*) Design of support equipment for the above.

OPERATIONS AND SUPPORT

(*a*) Planning for logistic and launch support from the Observation Island (AG–154).
(*b*) Range safety studies.

Navy funding for the above is as follows:	*Fiscal Year 69*	*Fiscal Year 70*
Target development	4,608K	———
Operations and support	392K	———
Total	5,000K	———

Operations and Support funding in fiscal year 1971 is ———. This increase reflects the start of flight tests in ——— 1970.

Mr. LIPSCOMB. Mr. Chairman.

Mr. ANDREWS. Mr. Lipscomb.

MODIFICATION OF EXCESS POLARIS MISSILES

Mr. LIPSCOMB. Mr. Secretary, according to your statement on page 103, you say $——— million for modification of excess Polaris missiles to a target configuration in support of the Army Sentinel program. This is the same item we are talking about.

Dr. FROSCH. Yes.

Mr. LIPSCOMB. It is for the Safeguard program.

Admiral RUCKNER. It was Sentinel when this went to press. It is now Safeguard.

Mr. LIPSCOMB. This statement is not that old.

Dr. FROSCH. We had completed the statement then and it was not all completely re-edited.

Mr. LIPSCOMB. Is the total $——— million for modification?

Dr. FROSCH. It is for design of the modification and the support of the firings.

Admiral SMITH. I do not believe ——— with the 1970 funds.

Dr. FROSCH. Admiral Smith said that the firings will be ———.

Mr. LIPSCOMB. Why do they have to be modified?

Admiral SMITH. ———.

Mr. LIPSCOMB. How many Polaris are in excess now?

Admiral SMITH. There are ——— A–2 in excess right now. There are missiles that came off submarines that were carrying A–2 that are modified to carry A–3. These are A–2 missiles. The remainder will be A–3, and the number excess will depend on the progress of the Poseidon conversion. The A–3's become excess as submarines are converted from A–3 to Poseidon.

Mr. LIPSCOMB. Polaris missiles are in excess to what standard? How do you determine that standard? You are going to reconfigure the Polaris to the Poseidon? Do they become excess on that basis alone?

Admiral SMITH. Yes.

Mr. LIPSCOMB. Is that the standard you use?

Admiral SMITH. The standard we use is those required to outfit the submarines, a small number for a repair pipeline, and the number required for follow-on operational test.

Mr. LIPSCOMB. When we are talking about the 1970 budget now, how many excess Polaris missiles do you plan to modify in fiscal year 1970 with the $——— million?

Admiral SMITH. I do not have that number.

Mr. LIPSCOMB. How did you arrive at the $——— million? How much per missile?

Admiral SMITH. The program is derived from the Army Safeguard program of the number of tests that they want ——— and then finally the modification. The modification costs are funded by the Army.

In 1969 and 1970 a major part of those funds will be for those design efforts.

Mr. LIPSCOMB. Does it take a significant amount of funds for a redesign of the Polaris for firing in a test program for the Safeguard?

Dr. FROSCH. ———

Admiral SMITH. It is also a program that the Air Force is participating———.

SUSPENSION OF WORK ON SAFEGUARD

Mr. ANDREWS. If the gentleman would yield, the Assistant Secretary of Defense has been quoted in the paper as having said that nothing would be done about the new Safeguard system until authorization and approval had been given by Congress. Now you are asking for money here to take part in the Safeguard program, the testing program. The system has not been authorized or approved by Congress yet.

Dr. FROSCH. My understanding is that the congressional hold was on procurement and deployment of the system, but that the Congress agreed that the research and development work should continue. This is a portion of the research and development work.

Mr. ANDREWS. If you are going to rework these Polaris missiles to be used as targets, what will be used to shoot the target?

Dr. FROSCH. Research and development Sprint and Spartan missiles that the Army has procured under the R. & D. portion of the Sentinel and then the Safeguard work.

Mr. MAHON. If the gentleman will yield, isn't it true that probably there was an area of misunderstanding as between the Department of Defense and certain members of the legislative body?

I had thought that the Department of Defense or any official from the DOD would be willing to say that all work on the ABM system would be suspended until Congress has taken action on the 1970 program.

Dr. FROSCH. I don't know the details of precisely what was agreed with regard to deployment or procurement.

I do recollect quite firmly that it was agreed certainly that the development work that was necessary to understand how to build such a system could continue

Mr. MAHON. We have been working on this system now for 10 years or more and spent several billion dollars. It would be a monumental mistake to agree to suspend all activity prior to a congressional enactment into law of something stopping the system.

Dr. FROSCH. I agree with you, Mr. Chairman. I just do not know the details of what was discussed.

(Discussion off the record.)

SUFFICIENT MISSILES ON HAND FOR TEST PROGRAM

Mr. LIPSCOMB. Admiral Smith, will it be necessary to buy new Polaris missiles for the 10 Polaris submarines we will retain in the SSBN fleet?

Admiral SMITH. ———.

Mr. LIPSCOMB. You must have enough plans to know you will have excess missiles to participate in the Safeguard program.

Admiral SMITH. The plans are to take care of all those needs. I couldn't say that the ones that are left, those missiles, would last forever.

Mr. ANDREWS. What is the life of a Polaris missile?

Admiral SMITH. ———.

IMPORTANCE OF TEST PROGRAM

Mr. LIPSCOMB. And a deletion of these funds for modification of the Polaris could well slow down the time schedule on the Safeguard system because of lack of testing?

Dr. FROSCH. I think that is right and even beyond that, even if there was a decision not to deploy a Safeguard system, I think there is general agreement that it would still be important to continue with the research and development ABM systems and this kind of testing program would be essential for that continuation. Certainly a deployment decision would mean that the testing would go on. It would be important to that deployment.

Mr. LIPSCOMB. This is a significant part of the research and development effort?

Dr. FROSCH. Yes, it is.

Admiral GADDIS. It provides necessary knowledge, that is right, sir.

Mr. ANDREWS. Are there further questions.

The committee will adjourn until 10 a.m., tomorrow.

Friday, June 6, 1969.

CONDOR MISSILE

Mr. MAHON. We come now to a discussion of the Condor air-to-surface missile.

The fiscal year 1970 budget request contains ——— million to continue Condor air-to-surface missile development. A total of $117.7 million has been spent on this program through fiscal year 1969.

This missile, at least from the standpoint of the hearings, has been around for quite some time. Will you give us a little background on it?

DESCRIPTION OF MISSILE

Dr. FROSCH. Yes.

This is one which I personally think is one of the most important developments in missilery and weaponry, that has become possible with recent technology. This is a weapon which has a television camera in the nose of the weapon, and a ———. So this means that for the kind of target for which it is designed, which are principally ———.

CAPABILITY OF PHOENIX MISSILE

Mr. MAHON. Does the Phoenix missile have an air-to-surface stand-off capability?

Dr. FROSCH. You are shifting now from Condor to Phoenix?

Mr. MAHON. No.

Dr. FROSCH. You are just asking a question. The Phoenix missile we believe will have a capability to hit targets that are close to the ground, that is the cruise missile kind of targets. It could be used with a capability against targets on the ground but it is not particularly designed for that.

AIRCRAFT TO BE EQUIPPED WITH CONDOR

Mr. MAHON. What aircraft are to carry the Condor?

Dr. FROSCH. We are firm on using it from the A–6A. We are looking at the possibility of using it from the A–7A. The problem is that this is a missile that has to be ———. The A–6A has a second man in it, of course, who is a missile control officer and bombing navigation officer and can do that job. We believe it may be possible for the A–7A pilot to ———.

Mr. MAHON. Did the Navy originally propose that the F–14 would carry the Condor missile?

Dr. FROSCH. No, we did not. It is conceivable that it might be an interesting thing to look at, but it is not planned for the F–14.

DEVELOPMENT PROBLEMS

Mr. MAHON. Is the Condor having severe technical problems?

Dr. FROSCH. We are having problems with the propulsion motor. Curiously that is not where we thought the real difficulties with the Condor were. We have apparently solved all of the ——— problems. The contractor chose to solve the problem with a liquid fueled rocket because we had asked for certain flexibility of ———.

His first subcontractor failed to produce a suitable motor and he shifted to a second subcontractor, which was a division of his own organization, and that motor also has had some trouble. We are now examining the question of whether it would be best to solve that problem with that ——— of a kind that we know can be made reliable and satisfactory.

Mr. MAHON. I assume any weapon worth developing requires some risk and some difficulty. You are not really trying to do easy things in trying to improve the capability of the forces. You are trying to get out in front as far as you can. This adds great complication.

Dr. FROSCH. This weapon would be a major improvement in capability. We are expecting a ——— mile range with that kind of point accuracy ———. That is part of the risk and the problem in building the weapon. Furthermore, this is the first of a kind of weaponry that can be built on this sensor in the weapon with a ——— concept. We have ideas for how to build a version of the Condor that would have a ——— so it would be ——— weapon that could be sent out toward a ——— so we could have ——— highly accurate weapon.

Mr. MAHON. For the record, when did we begin development of the Condor?

(The information follows:)

Condor development began with Project Definition Phase in fiscal year 1965.

COST ESCALATION

Mr. MAHON. Have you experienced any cost increases and overruns in the Condor missile development and give us some background on that.

Dr. FROSCH. The funding estimate in fiscal year 1965 for $78.1 million was based upon the program being an in-house effort. The fiscal year 1966 estimate of $118.8 million was made after the Project Definition Phase was completed January 1, 1966, and was based upon estimates of two contractors.

The remainder is principally due to program stretch-out caused by the technical problems experienced with ——— increased contractor flight test support; expanded Navy technical evaluations, increased costs of warhead development; and previously unprogramed effort such as reliability/maintainability and electromagnetic interference. Also additional increase includes completion of concept feasibility effort of the SOR follow-on ——— version and in-house field activities stretch-out costs for fiscal years 1972–73. Contractor costs increased (1) from the precontract estimate to the contract target price as negotiated, and (2) increase from target to ceiling price as a result of increased development costs primarily in the engine.

CONDOR ADVANTAGES

Mr. MAHON. What will the Condor missile be able to do that other standoff missiles and bombs, such as Walleye, and so forth, cannot do?

Dr. FROSCH. The Condor standoff capability allows it to be launched ———

POSSIBILITY OF JOINT NAVY-AIR FORCE DEVELOPMENT

Mr. MAHON. Is the Air Force developing a standoff missile having similar characteristics?

Dr. FROSCH. The Air Force has been looking at a weapon called Maverick which is a homing air-to-surface missile. It is not a weapon that is ——— but is more like the Walleye ———.

It has a very much shorter range. It is designed to have a range of at most ——— whereas Condor is designed for a range of up to ——— nautical miles ———.

Mr. MAHON. Would the Air Force and the Navy have a requirement for a similar weapon to do this type job, the type that the Condor is designed to do?

Dr. FROSCH. I think there are strong similarities in the requirement. They are both ground attack, tactical air missiles.

Mr. MAHON. Should we abandon one of them and concentrate on the other?

Dr. FROSCH. I think one could certainly consider that question profitably.

The difficulty is that there is an economic question here, Mr. Chairman. If one abandons the Maverick, which is the shorter range ——— missile and sticks only to Condor, then in many situations where the simpler and cheaper weapon could be used we would be forced to use the more complicated and expensive weapon. On the other hand, if we do not build the long-range weapon, then we will be restricted in the use of this kind of weapon to the shorter range. So the military advantage is on the side of a clear requirement for some long-range stand-off missiles like Condor, but if we were to buy only Condors, then they might well be very expensive to us in tactical situations where only a shorter range simpler weapon were required. So there is an economic trade off between the cost of developing two and having them in inventory.

CONDOR TO REPLACE STANDARD BOMBING

Mr. MAHON. Will certain missiles or other weapons be replaced by the Condor if it develops into an effective weapon?

Dr. FROSCH. The Condor is a brand new concept for a weapon. Until we have had enough of them to test them and understand how to use them tactically I think it would be premature to say it will replace other things in the inventory.

I think it will certainly replace the use of standard bombing for many kinds of targets and situations.

So even if it does not replace certain kinds of bombs completely it will replace their use.

ADVANCED SPARROW

Mr. MAHON. With respect to the advanced Sparrow missile, what happened to the advanced Sparrow missile development? You are not requesting funds in fiscal year 1970 for this purpose?

Dr. FROSCH. At the time the fiscal year 1970 budget was prepared, the development effort was progressing to the point that, very pos-

sibly, the effort could have been completed by the end of fiscal year 1969. In later tests some problems were encountered in the fuzing and guidance areas. These problems have been corrected and test firings are scheduled to resume in August 1969.

During reapportionment, $2 million R.D.T. & E. funds were requested for fiscal year 1970 to continue the advanced Sparrow development.

Mr. MAHON. How were the $2.9 million programed for the current year utilized? You may supply that for the record.

(The information follows:)

	Millions
Field station support for missile tests and evaluation of missile tests	$1.4
Missile development	.3
Develop AWG-10/AIM7F compatibility	1.2
Total	2.9

Mr. MAHON. Are there any funds remaining in the program which have not been obligated?

Dr. FROSCH. All fiscal year 1969 advanced Sparrow development funds will be obligated by the end of the fiscal year.

PHOENIX MISSILE

Mr. MAHON. Your fiscal year 1970 program for the Phoenix missile system is $17.5 million. The fiscal year 1969 program is shown as $31.9 million. Isn't this a decrease from the amount made available by Congress for the current fiscal year?

Dr. FROSCH. The Phoenix fiscal year 1969 funding was reduced from $36.870 million to $31.975 million in order to hold overall Navy R. & D. expenditures within budgetary limitations.

Mr. MAHON. Is this program on schedule with the F-14A program?

Dr. FROSCH. The Phoenix missile and missile control system developments are on schedule with the F-14A. Missile firing tests are being conducted from F-111B aircraft. Although one F-111B was lost in an aircraft accident a replacement F-111B has been provided so that the program should continue on schedule.

Mr. MAHON. How do you plan to utilize the funds requested in fiscal year 1970?

(The information follows:)

AWG-9 reconfiguration and development for the F-14A	———
Field station support for AWG-9 and Phoenix missile tests and test evaluation	———
Integration of AWG-9 and F-14A avionics (ECM, navigation, communications equipment)	———
Transition to VAST support	———
Sparrow/AWG-9 Interface	———

SURFACE MISSILE SYSTEMS PROJECT

IMPROVEMENT TO THE 3T MISSILE SYSTEMS

Mr. MAHON. You are requesting ——— million in fiscal year 1970 for the surface missile systems project which was established to correct deficiencies and improve the reliability and performance capabilities of the 3T missile systems.

Through fiscal year 1969, you have spent a total of $214.4 million on this effort. What have we gained in the areas of correcting deficiencies, and improving the reliability and performance capabilities of the 3T missile system?

Dr. FROSCH. The reliability and performance improvements of the 3T missile systems, as measured by fleet reported data, are summarized in tables 1 and 2. Shipboard equipment reliability is measured by the status index (table 1), the percentage of the time the equipment is in an "up" condition. Status index is summarized in terms of one or two channels available. Estimates given for fiscal year 1963, the first year data was collected on surface missile system availability, is considered typical of the equipment reliability prior to the corrective actions initiated by the SMS project. Reliability of shipboard equipment and the missiles during firings is compared in table 2, in terms of firing success rates.

TABLE 1.—STATUS INDEX OF 3T EQUIPMENT

	At least 1 channel		2 channels	
	Fiscal year 1963	Fiscal year 1969	Fiscal year 1963	Fiscal year 1966
Tartar	———	———	———	———
Terrier	———	———	———	———
Talos	———	———	———	———

TABLE 2.—3T FIRING SUCCESS RATES

	Fiscal year 1962	Fiscal year 1969
Tartar	———	———
Terrier	———	———
Talos	———	———

The early SMS program included a large number of hardware changes, primarily in the form of Ordalts, to improve availability and firing performance and to correct identified problem areas. This is largely completed and the installed systems have achieved a ——— level of availability and firing success rates. The systems will continue to require additional Ordalts to overcome aging effects, correct routine disclosures of new troubles and to exploit new materials or technical advances for efficiency or reliability. The performance goals of such actions are to sustain the current levels of effectiveness during the lifespan of the installed systems.

Following the early program, a major effort was initiated to provide improved capability in more difficult threat situations by updating the installed systems. The major thrust of this was to extend 3T capabilities to more difficult target vehicles, target tactics and to minimize environmental effects on system performance.

The frigate modernization program, currently in progress, provides a major updating of the Terrier systems. The modernized system provides ability to operate in more severe countermeasure environments and permits increased utilization of the ——— mile range capability of the Terrier and Standard missile (ER).

Terrier and Tartar missiles are scheduled for replacement by Standard missile (ER) and Standard missile (MR). In addition to procure-

ment and logistics advances provided by the Standard missile concept, the following performance advances are provided: improved capability to ———. Most of these improvements are being incorporated into existing inventories of missiles by retrofit changes.

IMPROVEMENT IN RANGE AND ACCURACY

Mr. MAHON. Would you compare the accuracy and range of the 3T missile system before this project was started with their capabilities in these areas today?

Dr. FROSCH. The range and accuracy of the 3T missile systems are compared as follows:

Range	1962	1969
Terrier	——	——
Std Msl (ER)	——	——
Tartar	——	——
Std Msl (MR)	——	——
Talos	——	——
Accuracy:[1]		
Terrier	——	——
Tartar	——	——
Talos	——	——

[1] Average miss distance, excluding failures.

Note.—In 1962 the low-angle capability (ability to engage a low flyer below 1,500 feet or surface target).

FUTURE FUNDING REQUIREMENTS

Mr. MAHON. Your justification book indicates that this program will continue in future years but no dollar amount is indicated. Do you have any idea of what future costs will be?

Dr. FROSCH. The projected ——— requirement for the SMS project element is as follows: ———.

Prior to fiscal year 1970 the 3T R.D.T. & E. effort performed under the SMS project program element included development of necessary subsystem and component improvements required to improve missile system availability, reliability, and performance commensurate with the ever changing threat. In fiscal year 1970 and subsequent years the scope of this program is limited to ———. The 3T major systems development program element was established to develop evolutionary improvements to existing 3T systems to maintain capability against an advancing threat. The projected ——— requirement for the 3T major systems development element is as follows: ———.

ALTERATION OF TARTAR FIRE CONTROL RADAR

Mr. MAHON. In March 1969, the Navy awarded a $1.3 million cost-plus-fixed-fee contract to Raytheon for the development of ordnance alterations for the AN/SPG-51 Tartar fire control radar, which is used with both the Tartar and Standard medium range (MR) missile. Does this mean that the 10 ships already converted for the Standard MR missile will receive these alterations?

Dr. FROSCH. This contract provides necessary fleet support for three cruisers, 29 destroyers, and six destroyer escorts and has as its objective improvement of the Tartar fleet's ——— capability. This Raytheon contract for the AN/SPG-51 B/C radar is to develop and test required improvements and corrections of deficiencies based on results obtained and maloperations encountered during development assist tests, operational evaluation, and fleet reports. Ordnance alterations developed and tested under this contract will be installed in the AN/SPG-51 radar of the Tartar MK 74 fire control system. These ordalts are separate and distinct from the modification required to convert the shipboard system for Standard missile (MR).

SHRIKE MISSILE DEVELOPMENT

Mr. MAHON. You are requesting ——— million in fiscal year 1970 to continue development of the AGM-45A Shrike air-to-surface antiradiation missile. You have already spent $82.3 million through fiscal year 1969 for development of this missile and it has been procured in large quantities since fiscal year 1965. What is the Navy doing in the area of continuing development of this missile?

Dr. FROSCH. The amount requested for fiscal year 1970 is ——— million. The continuing developments in this program include improvements in the Target Identification and Acquisition System to improve delivery tactics in ———.

Mr. MAHON. How will the fiscal year 1970 funds be utilized?

Dr. FROSCH. The developments in this project for fiscal year 1970 include completion of a Target Identification and Acquisition System (TIAS) for the A-4 aircraft, continued work on the AGM-45A-8 missile, and improvement in the A-7 aircraft Shrike system.

Mr. MAHON. Does the Navy plan to phase out Shrike as a result of the fact the Standard Arm missile has proven to be ———.

Dr. FROSCH. No. The Standard Arm provides us the capability to attack ———. The Shrike provides an important self-defense capability for strike aircraft when they must penetrate enemy defenses to deliver other types of munitions against selected targets. In addition, there are versions of Shrike in development and production which enable us to attack ———.

Mr. MAHON. Why has the fiscal year 1970 procurement been cut back to only ——— Shrike missiles?

Dr. FROSCH. The expenditure rate for Shrike has been drastically reduced by the curtailment of bombing operations in North Vietnam. Previously funded procurement and the desire for economy in the budget have caused us to reduce the buy for Shrike to ——— missiles.

Standard Arm Missile

Mr. Mahon. The fiscal year 1970 program for the AGM–78 Standard Arm air-to-surface missile totals ——— million. Through 1969, the Navy has spent a total of $100.6 million on the development of this missile. It has not been approved for service use but ——— such missiles were funded during the current fiscal year, and the Navy is requesting $25 million in fiscal year 1970 for ——— Standard Arm missiles.

What is the status of this program and when will this missile be approved for service use?

Dr. Frosch. Production of the initial version of Standard Arm, the AGM–78A, has been completed. It has been employed successfully in combat by both the Navy and Air Force. The second version, the AGM–78B, is currently undergoing technical and operational evaluation. This version will permit the Standard Arm to attack a ———. Its progress has been satisfactory and it should be ———. A follow-on version which will provide improved producibility over the 78B will enter production later ———.

Mr. Mahon. What problems have you been experiencing in the development of this missile?

Dr. Frosch. The AGM–78 A, B, and C missile developments have progressed quite satisfactorily, especially since they were conducted at a very rapid rate. The Target Identification and Acquisition System for the ——— has required extensive development efforts which are continuing in order to achieve desired performance over the wide frequency band width of the 78 B and C models.

Mr. Mahon. Can you compare the accuracy and reliability of this missile with that of the Shrike?

Dr. Frosch. The reliability of both the Shrike and Standard Arm has been quite high. The Shrike has demonstrated a circular error probable (CEP) of ——— against radiating targets and the Standard Arm has shown a CEP of ———. The difference is primarily due to the much ——— velocity of the Standard Arm.

Mr. Mahon. How do these two missiles compare in unit cost, and what is the total estimated cost of developing the Standard Arm missile?

Dr. Frosch. The Shrike unit cost for fiscal year 1969 is ———. The Standard Arm cost for fiscal year 1969 is $222,266. These figures include production and fleet support costs for the production buy. The total estimated cost of developing Standard Arm is ———.

Mr. Mahon. How will the fiscal year 1970 funds be utilized?

Dr. Frosch. Funding limitations will limit fiscal year 1970 efforts to completion and fleet introduction of the AGM–78C and the ——— TIAS.

Sidewinder Missile

Mr. Mahon. With respect to the Sidewinder missile, last year we read of the theft of a Sidewinder missile from a NATO air base near Neuberg, West Germany, and its subsequent shipment to the U.S.S.R. Has this missile been compromised in any way as a result of this theft?

Dr. Frosch. ———.

Missile Propulsion

Mr. Mahon. You are requesting ——— million in fiscal year 1970 for missile propulsion. Through fiscal year 1969, a total of $20.2 million has been funded for this purpose. How has the $20.2 million been utilized, for what missile systems, and how you plan to make the fiscal year 1970 funds.

Dr. Frosch. The resources in exploratory development are usually not directed toward the development of a specific missile system, rather, it is directed toward the advancement of the science and technology which will permit the Navy to meet any future need, requirement or threat in this area. Future Navy missiles will require increases in range, speed, and manuverability, which will require marked advances in missile motor performance. The program in missile propulsion covers investigations in new propellant (solids, liquids, and hybrids) in new missile propulsion design concepts and propulsion systems which will provide the hardware for future (1980–90) Navy air, surface and undersea missions.

There are three major areas of concentrations:

1. Solid propulsion which includes the investigation of advanced solid propulsion systems and system components for surface-to-surface, surface-to-air, air-to-surface, and air-to-air tactical missiles for the 1980–90 time period. Future systems must weigh less; contain less volume and provide with high reliability and longer shelf life greater speed, range, and maneuverability.

2. Liquid and hybrid propulsion which offers the potential advantages of controlled thrust which provides more easily controlled speed and maneuverability and higher specific impulse but lower density when composed to solid rockets.

3. Air-breathing propulsion which provides integral solid and liquid rocket ramjets. These systems offer the potential advantages of a two-fold increase in range and/or payload over the conventional rocket combined with the acceleration for maneuver or terminal task.

Typical examples of accomplishments are:

1. New propellants ——— delivering high specific impulse have been demonstrated.

2. The low-volume ramjet ——— has progressed from analysis to design and component testing.

3. New nozzle material of ———.

4. A new antioxidant was found that markedly reduced air oxidation during the aging of propellant, increasing shelf life.

5. ——— a new tactical missile concept developed and proven in exploratory development is now being pursued in advanced development.

In fiscal 1970 the design, development, and testing of the integral rocket-ramjet will be extended to establish the criteria for an advanced development program leading directly to an improved fleet-defense ———. Synthesis of high energy oxidizes and binders will be continued in order to develop high energy propellants. The technology of a motor with thrust vector and magnitude control will be confirmed in full-scale test. New areas of exploratory examination will be undertaken:

———.

These are but a few of the task to be undertaken in the coming fiscal year.

STRIKE WARFARE WEAPONRY EXPLORATORY DEVELOPMENT

Mr. MAHON. You are requesting ——— million in fiscal year 1970 for strike warfare weaponry exploratory development. A total of $53.9 million was funded for this purpose through fiscal year 1969. Dr. Frosch, what is meant by the term "strike warfare weaponry"? What kind of weapons are we developing?

Dr. FROSCH. Under the strike warfare weaponry exploratory development program, the technology is developed which will provide the Navy with the weapons and ordnance (other than mines and torpedoes) to meet future needs and threats in all offense and defense areas: Airborne attack, surface attack, submarine attack, amphibious assault, sea-based strategic systems, airborne antiair warfare, and surface antiair warfare. Included within the elements are the technological areas which are related to strategic and tactical weapons system components such as guided and unguided missile structures, warheads and fuzes, aerodynamics and ballistics, weapon guidance and control, explosive research, weapon launching, service technology, and safety.

Mr. MAHON. Toward what specific weapon developments was the $53.9 million utilized?

Dr. FROSCH. The $53.9 million representing the fiscal year 1968 and fiscal year 1969 funds provided strike warfare weaponry development has been used to advance the technological base essential to insuring the availability of new and improved strike warfare weapons during the next decade and beyond. Specific weapon technology developments undertaken during this period include the following: A program to determine the capabilities and limitations of fluidic component and subsystems was initiated. Fluidic design techniques were evolved and applications to ——— problems are being investigated. Tests have been developed to determine the effectiveness of shielding against radiation hazards ——— and to measure the effectiveness of ——— filtering between ———. Studies were conducted on the maneuver requirements of the Sparrow III missile in its final portion of air-to-air flight prior to interception, including the contribution to ——— improved guidance for future missiles. Proposed technical approaches—PTA's—and technical development plan's—TDP's—were prepared for the basic and advanced point defense systems for shipboard AAW. A study was conducted on the effectiveness of ——— and on the application of ———. A PTA was prepared for a ——— weapon system. Work was continued on a ——— and improve the sensor elements.

Thermal stresses in solid wall and sandwich wall radomes were computed. Studies have been completed on airborne ——— properties and were used to develop ——— identify targets at extreme range and were used to develop ———. Development of fuel-air-explosion—FAE— and hypervelocity cluster warheads has culminated in the present FAE and Hart/Zap weapons. A PTA has been prepared for advanced development of ———. Active ——— have been developed and are now in advanced development. Effectiveness data were derived for a long-range air-to-surface missile system. A methodology for designing ——— systems for future high-speed missile was developed.

The fiscal year 1969 program included some 83 separate task areas. These also addressed the spectum of technologies needed to develop air-to-air missiles, air-to-surface missiles, surface-to-air missiles, and surface-to-surface missiles as well as free fall bombs, rockets, guns, projectiles, and the surrounding peripheral subsystems such as fire control, displays, and signal processing.

These items apply to specific types of weapons; for example, for airborne interceptor weapons the following developments are underway. (1) A new antenna of superior performance integrated with a complete radar, (2) flight tests are underway of equipment that can indicate ——— and, (3) a study was completed contrasting an improved aircraft weapon system using guns instead of missiles or rockets as design guidance for our future weapon systems.

For more effective airborne attack of ground targets, range, and sensitivity improvements in ——— are being made; and a study of ——— from a target is also being made.

For general purpose airborne weapons a new radar is being developed that will use solid state devices and integrated circuitry in an effort to reduce weapon system size and to improve overall reliability. A study of ways to insure that an ——— is underway. A ——— is being evaluated. For attacking enemy aircraft, the design of a new radar that will ——— is being tested. A new radar signal processing technique to help identify specific targets by recognizing their salient characteristics is being tested.

Mr. MAHON. How do you propose to use the ——— million requested in fiscal year 1970?

Dr. FROSCH. The fiscal year 1970 strike warfare weaponry exploratory development program will expend ——— million to prosecute such specific tasks and objectives as the following: For antiair warfare systems, a new ——— of improved performance will be flight tested; a model of an ordnance ——— will be installed for test in an aircraft, if successful this system can reduce the ——— flight tests will be carried out on a radar target tracking system that is ——— system to be used by both equipments, thus obtaining a substantial saving of weight and a reduction in complexity. Antisurface weapon improvement efforts will include determining the feasibility of a new weapon concept capable of ——— to the enemy; a new warhead composed of a ——— control system, thereby markedly improving our ability to attack ——— surface targets; work will continue on improving techniques to ——— a target ——— will be readied for a feasibility demonstration; ——— tracking will be evaluated by fabricating and testing breadboard design to analyze the feasibility and usefulness for missile guidance and target identification; CCM improvements will be devised for ———.

Other efforts directed to improving our multipurpose weapons include: ——— project will be completed and a PTA prepared; an optimized ——— development will establish design parameters suitable for preparation of a PTA. Design effort will be accelerated on projectile and rocket dynamics, drag reduction, fluid dynamics and ballistic improvements to gun/rocket projectiles and missile structures to improve their range and accuracy. Effort will also increase for antiair and antisurface and multipurpose weapon guidance and control techniques to cope with increasingly severe ECM environment and to improve their accuracy.

FLEET BALLISTIC MISSILE CONTROL SYSTEM

CURRENT SYSTEM

Mr. MAHON. With respect to the FBM control system, you are requesting ——— million in fiscal 1970.

This program has totaled $56 million for the past 2 years. Would you describe generally the command and control system we now have

operationally for our SSBNs and supply for the record the various means of communication to and from the SSBN fleet?

Dr. FROSCH. The current system has as its primary mode of communications very low frequency radio from Cutler, Maine, from the State of Washington, from Balboa in the Canal Zone and from Northwest Cape, Australia. This is a radio system which can be detected by the submarines ———. The submarines monitor these broadcasts continually. As a backup to the VLF we have the same broadcasts that can be repeated on low frequency radio stations in a number of places around the world and on high frequency radio stations around the world. In addition we have Tacamo aircraft, fixed wing aircraft, which can essentially fly an orbit over a part of the ocean ——— broadcasting on low frequency.

(The information follows:)

SSBN COMMUNICATIONS

The operational command and control for our SSBNs consists of several fixed VLF stations such as the 1 megawatt transmitter at Cutler, Maine, and the 1 megawatt transmitter at Harold E. Holt station in Australia. These stations are backed up by four other VLF stations and a larger number of low frequency stations. These stations are vulnerable to nuclear attack; therefore, we have over the past several years introduced the Tacamo airborne VLF system into the fleet. This system is flown in an EC–130Q aircraft and radiates a VLF signal ———. By the end of the summer of 1969 we will have ——— of these aircraft in the fleet. Additional backup is provided by a large number of high frequency radio transmitters operating from naval communications stations worldwide. Transmissions from the submarine, ———. This system has been in existence for over ——— years and ———.

USE OF 1970 FUNDS

Mr. LIPSCOMB. What do you plan to do in fiscal 1970 with the ——— million requested?

Dr. FROSCH. We will be working on the contract definition and the beginnings of the construction of the phase II test facility for Sanguine which is the extremely low frequency project. This is intended to be a very large hardened antenna in Wisconsin which will cover all of the fleet ballistic missile areas with a radio frequency which has a deeper penetration into seawater than very low frequency so the submarines can receive it with onboard antennas at any depth.

We will continue that and go into the next phase of testing, presuming that the first phase of testing will have been satisfactory.

We will continue work on improvements to a higher powered TAKAMO transmitter.

Mr. LIPSCOMB. For the record, would you describe specifically how the ——— million will be spent?

(The information follows:)

1970 PROGRAM

The $41 million requested in fiscal year 1970 will accomplish the following:

(a) Fund the contract definition phase for the ELF transmitter system known as project Sanguine.

(b) Continue the development of an improved Tacamo system which will have ———.

(c) Continue concept formulation for the ——— VLF project ———

(d) Conducting an operational evaluation of ———.

(e) Developing several improvements to the submarine SSBN ——— system including ———.
(f) Conducting an operational evaluation of the submarine emergency communications transmitter system.
(g) Continuing concept formulation on a system known as ———.
(h) Various supporting efforts including those to better understand ELF and message compression techniques.

PROJECT SANGUINE

Mr. LIPSCOMB. Project Sanguine is included under this subactivity.
Dr. FROSCH. Yes, it is.
Mr. LIPSCOMB. For the record, would you describe Project Sanguine in detail but just briefly now?
Dr. FROSCH. Yes. By going from very low frequency to extra low frequency we go to a frequency which penetrates through seawater ———. To go to this lower frequency we need a very much larger antenna.
The antenna that is required is many miles in size but rather thin in the sense that what you have over a large area is occasionally what amounts to a buried power transmission line. So one makes a large grid of buried transmission lines. This is in the frequency region of about ———. These buried antenna cables, I would describe them as power cables to think what they are like—they are the antenna wires—can be built ———. One builds this grid with its own power network ———.
The principal problem with Sanguine is that when one puts out a high power pulse from the transmitter, there is a lot of radiated power in the area of the transmitter, and in earlier tests it has had the problem of ringing telephones, interfering with radio and television transmission, and it can produce a transient electrification of long wire fences. We have carefully examined the question on a study basis and with a little experimental work of whether one can mitigate the effects so that they do not make it impossible for the people in the area to live in a normal way. It appears that in fact this can be done.
The cost of doing so is included in our estimates of the cost of Sanguine. The purpose of the phase I and phase II tests is progressively not only to test the actual engineering of such an antenna, but more importantly to test whether in fact it is possible to mitigate these effects, so that this is a sensible thing to do in an area of the United States where people live.

COST OF SANGUINE PROGRAM

Mr. LIPSCOMB. What is the total estimated cost of the program?
Dr. FROSCH. The R. & D. cost or the system cost?
Mr. LIPSCOMB. All of the cost.
Dr. FROSCH. The total R.D.T. & E. cost projected out through fiscal ——— is ——— million.
Mr. LIPSCOMB. Do you have a projected cost on the construction and procurement?
Dr. FROSCH. The projected investment cost is $1,409 million.
Mr. LIPSCOMB. Have there been any slippages in the program?
Dr. FROSCH. No, I do not think so.
We are very close to the beginning of the program. We are just beginning the construction now on the phase I experimental area.

SPEED OF MESSAGE TRANSMISSION

Mr. LIPSCOMB. How fast will you be able to transmit messages via Project Sanguine?

Dr. FROSCH. Sanguine messages are ———.

One talks of rates which are of the ———. A bit corresponds to a dot or a dash in a CW code. So there is an associated effort of examinaing very carefully the messages to be sent and the coding, so that they can in fact be accommodated at this band width and rate of information transfer. The studies and examination of our current requirements indicate that certainly the essential war message to these submarines and the messages required to keep them up to date on what their targeting requirements are, can be transmitted through the ELF communication channel. Some of the information which is now sent on VLF, which is administrative and personal message information and so on, would not be sent, using Sanguine.

Mr. LIPSCOMB. How many letters or words a minute do you estimate?

Dr. FROSCH. One thinks of it in bits per second. This would be about ———. This would correspond probably to about ———.

VULNERABILITY TO NUCLEAR ATTACK

Mr. LIPSCOMB. How vulnerable will Project Sanguine be to nuclear attack and is it hardened in any way?

Dr. FROSCH. One of the principal factors in the design is to harden it so that it would not be very vulnerable to nuclear attack. The computations indicate that ———.

Mr. LIPSCOMB. Dr. Frosch will you expand specifically how you are going to harden Project Sanguine?

Dr. FROSCH. A baseline Sanguine system has been designed to withstand a ——— nuclear attack. This attack can be withstood because the transmitter buildings are to be hardened to ——— overpressure and the antennas to ——— pounds per square inch overpressure. In addition, the dispersion and multiple transmitter sitings allow about ——— of the system to be destroyed before it fails to transmit at the requested data rate to the most distant SSBN's. The ——— transmitter hardness is achieved by underground location and shock-absorbent construction techniques. The ——— antenna hardness is achieved by burial to a depth of ——— feet.

POSSIBILITY OF JAMMING SANGUINE

Mr. RHODES. Is there any guarantee that the signal from Project Sanguine complex could not be jammed by enemy action?

Dr. FROSCH. Jamming is one of the reasons why we are interested in going to ELF.

There are two reasons why it is extraordinarily difficult ———. ———.

RELIABILITY OF CURRENT SYSTEM

Mr. RHODES. You have very little faith in your present means of communications with the SSBN's under all circumstances.

Dr. FROSCH. No; we have a good deal of faith. In fact, we have carefully conducted a study as to what is likely to happen to our capability to communicate out through 1978.

Our faith in the present means of communication is principally based on ———.

One of the principal things that has made Sanguine attractive is the fact that in the long run it appears as though some ——— of our current communications systems are jammable if the enemy cares to make a sufficient effort to do so. So we want to add to the pack of communications systems something which is much more jam resistant than ——— those we are now using.

Mr. RHODES. Are you able to penetrate ocean water with your present systems?

Dr. FROSCH. The present frequencies of electromagnetic radiation penetrate ———. The VLF frequencies penetrate at most to about ——— feet in a usable way and generally for efficiency the ———.

With the ELF the penetration is down to ——— feet, so the submarine would essentially be freed of the necessity of———.

Mr. RHODES. So you have no means of communicating with an SSBN whose antenna is below the level of———feet?

Dr. FROSCH. That is correct. For that reason the SSBN's now operate at———.

This is a restraint on their operating freedom———.

Our doctrine is that they are in———.

Mr. RHODES. So the Project Sanguine would allow the SSBN to increase the scope of its maneuverability and operating areas———.

Dr. FROSCH. Exactly. That is one additional major reason why we are interested in it, because it———.

Mr. RHODES. I should think it would make it much harder———.

Dr. FROSCH. Yes, sir.

This is connected in that sense with the subject of SSBN vulnerability that we were discussing yesterday, I believe.

By freeing the submarine from restraints connected with communications, it gives him better maneuver and depth capability to use what he can do so that he is at all times———.

Mr. RHODES. Am I correct in my belief from your testimony Project Sanguine would allow you to communicate with a submarine at———

Dr. FROSCH. ———.

Mr. LIPSCOMB. Do you have an estimated target completion date?

Dr. FROSCH. Yes, I do. Partial completion in———. That would be initial operational capability.

Building up to full capability in the subsequent———. The antenna is built in an essentially modular piece-by-piece way. So as soon as there is a singificant portion of it completed, it goes on the line. What we get out of building the rest of the antenna is a higher powered radiated and the rest of the resistance to nuclear attack.

Mr. LIPSCOMB. Were the costs you described to us scheduled to fiscal 1977?

Dr. FROSCH. They were scheduled through fiscal 1977.

ADVANCED ARM MISSILE

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for advanced ARM systems. A total of $4.3 million has been funded for this effort in the last 2 fiscal years.

Your justification book speaks of ———. Are our present ARM missiles ineffective against radar emissions of these frequencies?

Dr. FROSCH. Our present antiradiation missiles are capable of attacking radars ———.

Mr. LIPSCOMB. Can this work be done effectively by improving our present ARM missiles, or are we looking toward the development of an entirely new ARM missile?

Dr. FROSCH. The developments from this program will be utilized in follow-on models of Shrike or Standard ARM where appropriate, but will also be used to identify performance characteristics of the successor to these missiles. An example of these "spin-off" developments is a ——— which is ready for flight testing and is being considered for use in the Standard ARM to provide ———. Another example is the ——— which may enable us to counter the enemy's radar ———. The follow-on missile concept should be pursued in order to incorporate the lessons learned from recent combat experience and the new capabilities evolving from this program.

ADVANCED AIR-TO-AIR MISSILE SYSTEM

INVENTORY OF AIR-TO AIR MISSILES

Mr. LIPSCOMB. You are requesting ——— million for advanced air-launched air-to-air missile systems.

A total of $3.8 million was funded for this purpose through fiscal year 1969. What is our current inventory of air launched air-to-air missile systems and how effective are they?

Dr. FROSCH. The current inventory of air-to-air missiles consists of Sparrows and Sidewinders. Phoenix is under development and will be operational along with the F–14A in 1973. The AIM7E–2 is the latest Sparrow in operational use. The AIM–7E is a ——— guidance missile designed for the all-weather intercept role to be effective at ranges from ——— in head-on encounters. These ranges are degraded when ———. A modification has been incorporated to increase the size of the launch envelope when the AIM7E is used, particularly in maneuvering engagements. The modification includes changes to ———. The modified missile is known as AIM7E–2. An advanced Sparrow, AIM7F is under development. The AIM–7F will have greater maximum range and better ECM capabilities than the AIM7E or AIM7E–2. Performance in close-in maneuvering engagements will be similar to AIM7E–2. Sparrow is a very effective missile in the intercept role; however, its effectiveness is limited in ———. The Sparrow is compatible with all F–4 missile control systems and will be included in the armament loads of the new F–14 and F–15 fighter aircraft.

Sidewinder AIM9C is a ——— missile developed to provide the F–8U Crusader with an all-weather intercept capability. The AIM9C has not been employed in combat.

Sidewinder AIM9D employs IR guidance. The AIM9D is the most effective missile employed in air-to-air combat in Southeast Asia. Although IR guidance limits AIM9D usage to visual flight conditions, it is a passive missile and is not subject to ———. Additionally, the AIM9D can be launched quickly and its success is not dependent upon the missile control system. The major limitation is that the AIM9D launch envelope is limited to an area within about ———. Since AIM9D is not dependent upon air-to-air missile control system, it can be adapted to all operational aircraft. Thus, it can be

used as a defensive air-to-air weapon on attack aircraft such as the A4, A6, and A7.

Phoenix is a new long-range all-weather multiple shot missile under development for the F-14. Up to ——— Phoenix missiles can be launched nearly simultaneously at different targets at ranges from ——— n.m. to ranges in excess of ——— n.m. This new long-range multiple shot capability will significantly improve fighter performance in the fleet air defense role.

COOPERATION WITH THE AIR FORCE

Mr. LIPSCOMB. Are you working with the Air Force on this project, or is the Air Force engaged in a similar development effort?

Dr. FROSCH. The work on the advanced air-to-air missile in the Navy has been confined to studies and simulations to determine the necessary performance requirements and advanced development of components to define an optimum missile to meet these requirements.

Although there is a free exchange of study results between the Navy and Air Force and the Air Force is working with the Navy on new propulsion guidance techniques, I cannot fully describe the Air Force program for you.

SYSTEMS TO BE REPLACED

Mr. LIPSCOMB. What missile systems will this advanced weapon replace?

Dr. FROSCH. The advanced air-to-air missile will replace Sidewinder and provide the ——— quick reaction, ——— launch capability for close-in maneuvering engagements.

ADVANCED AIR-TO-SURFACE MISSILE

Mr. LIPSCOMB. You are also requesting ——— million in fiscal year 1970 for advanced air-launched air-to-surface missile systems. A total of $5.3 million has been funded for this purpose through fiscal year 1969. Is the Air Force also engaged in a similar development?

Dr. FROSCH. Yes, the Air Force is developing the AGMX-3. The Navy-Air Force effort is coordinated to avoid duplication.

Mr. LIPSCOMB. What missile systems are you seeking to replace by this development?

Dr. FROSCH. These developments are directed against the ——— threats and are intended to provide highly accurate air-to-surface missiles effective against a broad spectrum of land and sea targets in adverse natural and countermeasures environments. The advanced capabilities will be used to improve or replace systems that are in ———.

ADVANCED FUZE DESIGNS

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for advanced fuze designs. A total of $4.6 million has been funded for this effort through fiscal year 1969.

ROCKEYE II

Are you doing work on Rockeye II under this activity?

Dr. FROSCH. A new ——— type fuze is under development which may be employed to open the Rockeye dispenser at a preselected ——— to the target for a wide range of pilot delivery tactics. This fuze will provide much-improved characteristics over current ——— fuzes and will be much less ———. It will be usable on many other munitions.

Mr. LIPSCOMB. The committee understands you are continuing development of the Rockeye II weapon warhead to improve its antivehicular and antipersonnel capabilities. What kind of improvements are required and why?

Will these improvements be included in the ——— Rockeye weapons for which procurement funds are sought in fiscal 1970?

Dr. FROSCH. The only Rockeye II developments in progress are product improvements which will improve producibility and reduce cost. It has been employed extensively in Vietnam and has proven to be highly reliable and well-liked by FAC's and attack pilots. A follow-on development, the AP/AM, antipersonnel/antimaterial, cluster munition is being developed for improved effectiveness against personnel and light material targets at lower cost. This will be the first cluster munition capable of ———. It will utilize the Rockeye II dispenser in order to standarize fuzing and weapon handling equipment.

The AP/AM is in engineering development and is not expected to enter production until ———. The product improvements to Rockeye II are continuing detail modifications to improve costs and producibility.

ADVANCED SEA-BASED DETERRENT

Mr. LIPSCOMB. You are requesting ——— million for advanced sea-based deterrent. Through fiscal 1969, a total of $9 million was funded for this purpose. What are we attempting to develop in this area?

Dr. FROSCH. In fiscal 1970 that is budgeted at ——— million, and there are two items in the budget line item. One is further study work and analysis of the concept of the sea-based antiballistic missile system, which would be a complementary system to Safeguard, using ships with interceptors in forward areas, forward in the sense of being closer to the Soviet Union ———.

This could turn into a system which would be part of a defense in depth of a Safeguard system. There are a number of difficult technical and some military issues involved in understanding the technical details of this concept, and some of the military aspects of possible vulnerability to direct attack or to jamming. The ——— million additional is connected with management and analysis for the overall strategic force development problem. It backs up all of these items that we have been talking about.

Mr. LIPSCOMB. I believe, Dr. Frosch, you have explained $2.2 million which has been funded through fiscal year 1969.

Dr. FROSCH. Yes.

That is the SABMIS and that is ——— million requested for 1970.

Mr. LIPSCOMB. An additional ——— million will be required for this program through fiscal year ——— according to the justification book.

Dr. FROSCH. Yes, sir.

Mr. LIPSCOMB. This is a sea-based ABM system. How much do you propose to spend in development of the total system?

Dr. FROSCH. We have not yet come to the stage of knowing precisely what the system would be like so that we could be certain of what the totals would be like. But at the stage we are at now the total investment that is predicted if we were to go ahead—the total R.D.T. & E. that is predicted if we were to continue through a complete development through fiscal ——— would be ——— million.

Mr. LIPSCOMB. Would you say that the SABMIS concept has been proven at this time?

Dr. FROSCH. No. I would say it has been analyzed enough so that it looks promising enough so that we should continue to study it.

Mr. LIPSCOMB. Would deployment of such a system involve billions of dollars?

Dr. FROSCH. It would certainly involve figures above a billion dollars.

Mr. LIPSCOMB. What type ships do you envision having this capability?

Dr. FROSCH. This would be a special ship constructed for the purpose.

Mr. LIPSCOMB. How would these ships be deployed?

Dr. FROSCH. The deployments that have been looked at so far are in the ———.

UNDERWATER LONG-RANGE MISSILE SYSTEM

Mr. LIPSCOMB. We note that the underwater long-range missile system ULMS, was mentioned under SABMIS. Is ULMS proposed as an improved submarine and missile weapons system as a follow-on to Poseidon?

Dr. FROSCH. Yes, that is what we are looking at.

COST OF PROGRAM

Mr. LIPSCOMB. How much is in the fiscal year 1970 budget for this?

Dr. FROSCH. ——— million.

Mr. LIPSCOMB. How much have we spent on the ULMS concept through fiscal year 1969?

Dr. FROSCH. $5.4 million.

Mr. LIPSCOMB. What is the proposed total estimated cost for ULMS?

Dr. FROSCH. I do not believe we have a total yet. It is very difficult to say what the total would be since it has not been completely defined and designed yet.

Mr. LIPSCOMB. Would you describe your fiscal year 1970 ULMS program?

Dr. FROSCH. The final year 1970 ULMS program will include ———. Investigation and coordination of interfaces with all other subsystems, will continue throughout the year, as will technological and effectiveness tradeoffs influencing system characteristics.

DESCRIPTION OF ULMS PROGRAM

Mr. RHODES. I have never heard of this. Would you mind describing it?

Dr. FROSCH. The following question has arisen in connection with the vulnerability question. Suppose the Soviets make some major breakthrough in ASW in the course of the 1970's, so our current submarines become vulnerable for acoustic reasons to sonar, what are the best things we can do to build a sea-based deterrent which maintains our current very low vulnerability? We see two things that can be done. One is to increase the range of the missiles, so that the submarines, instead of being deployed in only portions of the ocean, could be deployed over most of the oceans of the world, so that the problem of finding them becomes very difficult just on an area basis.

The second thing we could do would be to build a submarine for this purpose which would be even quieter and more difficult to find than the current submarines. The third question arises, while we are doing those two things would it be possible to improve the economy of the system, and the principal way to do that appears to be to carry a higher load of missiles in a given submarine.

That is a satisfactory thing to do and a cheaper way to deploy the system provided one is satisfied with the individual submarine's invulnerability. So the ULMS program is an attempt to look in some detail as to what the best ways would be to carry out that class of improvement.

Examination of the problem indicates that most of the difficult technical problems appear to be connected with the submarine vehicle rather than with improving the range of the missile. So initial attention has gone to the design of possible submarines that would have better noise characteristics and be more economical in terms of the number of missiles that they can carry. That is in essence about where we have gotten to, except a good many design capabilities and characteristics of various submarines have been looked at.

Such questions as whether we should ———. These are engineering considerations which bear on the size and characteristics of the submarine, how quiet it can be made, what depth it can go to, what its vulnerability is.

Mr. RHODES. This is a study project.

Mr. FROSCH. At this stage it is a matter of studying the project. The proposal is that if we come up with a concept that we are happy with we actually design and build a prototype submarine and work out all of the problems so we have on the shelf, so to speak, the complete tested out plans to go to an improved Poseidon should we see progress in the Soviet ASW or other areas that means we need to go to another generation.

PROTECTION OF SSBNS

Mr. RHODES. You have not mentioned two elements that I think would be important in the future and that would be depth and speed. You mentioned quietness but you did not say anything about speed. We have been very much preoccupied with increasing the speed. I think you ought to be concerned with the increased depth .

You make it that much harder for the enemy to detect and kill your SSBNs.

Dr. FROSCH. The question that raises is how do you build an FBM type sub which has the lowest vulnerability. The direction that appears from all of our analysis to be best is the ———.

The depth trade-off still remains to be examined. That is one of the things that is involved in the question of whether the ———.

That bears a good deal on the strength and size of the hull.

Mr. RHODES. Thank you, Mr. Chairman.

NEED FOR ULMS

Mr. LIPSCOMB. We have read recently in the press that with the advent of Poseidon, 10 Polaris SSBNs may not be needed, and someone in the Pentagon recommended that all 10 be sunk in the ocean. With this thinking, the committee can visualize that with the advent of ULMS, someone 15 or 20 years from now suggesting we get rid of our Poseidon submarines. Do you see a definite need for ULMS?

Dr. FROSCH. Yes, based on the evolutionary development of improved SSNs and ASW weapons capability in our own forces, and the known efforts devoted to achieving a similar capability in the Soviet Navy, it is possible that the Soviets will eventually develop an SSN, or other ASW forces which may constitute a threat to our Polaris/Poseidon submarines. Therefore, we see a definite need for a vigorous program to improve our existing systems and/or develop new systems which are capable of maintaining our present margin of security ———. This system would employ a long-range missile of the Poseidon type and have improved characteristics ———. The very extensive ocean patrol areas made usable by the longer range missiles and the improved submarine characteristics will provide further assurance of continued sea-based strategic offensive force security against any possible Soviet countering action. Additionally, if the Soviet threat indicates the need to move additional strategic offensive force capability to sea, the pursuance of an orderly but vigorous development program now would permit us to deploy an increased capability, highly survivable sea-based system.

If the need is identified for increasing the national strategic offensive force capability, the development now of the ULMS would permit deployment of this increased capability, highly survivable sea-based system in a timely manner. The development program would also permit the timely deployment of a system which is expected to be an eventual economic replacement for existing systems.

HARPOON MISSILE

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for the air-launched/ship-launched antiship missile, known as the Harpoon. This program was initiated in fiscal year 1969 and $3.5 million funded for this purpose. Your justification book indicates that concept formulation for the air-launched version was commenced in fiscal year 1968. How was this funded?

Dr. FROSCH. Fiscal year 1968 funds were reprogramed to initiate concept formulation studies.

Mr. LIPSCOMB. Is it still the Navy plan to develop a single Harpoon missile which can be both air launched and ship launched?

Dr. FROSCH. Yes, sir.

Mr. LIPSCOMB. What was the recommendation of the Joint Task Force of the Naval Material Command?

Dr. FROSCH. ———.

Mr. LIPSCOMB. Will this missile carry a conventional warhead?

Dr. FROSCH. Yes, sir.

Mr. LIPSCOMB. The total estimated cost of developing this missile through fiscal year 1974 is shown as ——— million. What missile systems will Harpoon replace?

Dr. FROSCH. The Harpoon will not replace a missile system.

Mr. LIPSCOMB. Where do the budget elements entitled "advanced air-launched air-to-surface missile system" and "advanced surface-to-air weapon system" fit into this development?

Dr. FROSCH. The Harpoon was first funded under the advanced air-launched air-to-surface missile system as the ALSAM—air launched ship attack missile—project. The Harpoon program has no connection with the advanced surface-to-air weapon system.

Mr. LIPSCOMB. In February 1969, the naval air systems command announced it is seeking firms to help it develop an air-to-surface/surface-to-surface guided missile system comprised of the missile, an associated fire control system—aircraft or ship—ground support equipment, and missile auxiliaries. Is this contract for contract definition or for further study?

Dr. FROSCH. Contract definition.

POINT DEFENSE MISSILE SYSTEM

SYSTEM DEVELOPMENT

Mr. LIPSCOMB. Dr. Frosch, the committee is deeply interested in the point defense missile system. You are requesting ——— million in fiscal year 1970 for the point defense missile system, and a total of $20.1 has been funded for this purpose through fiscal year 1969.

In another subactivity of the budget, you are requesting ——— in fiscal year 1970 for the basic point defense missile system, while a total of $3.5 million had been funded for this system through fiscal year 1969.

On page 110 of your statement, you discuss an improved point defense surface missile system. In still another subactivity, you are requesting ——— in fiscal year 1970 for the advanced point defense surface missile system. Through fiscal year 1969, a total of $2.4 million has been funded for this purpose. This is all related to countering the cruise missile threat. I believe the committee would appreciate a very comprehensive and clear discussion of the point defense missile system, the reason for the various pockets of money, and why an advanced point defense surface missile system, which I assume is your ultimate goal, is being developed in a seemingly hodge-podge and uneconomical fashion.

Dr. FROSCH. I can start. You made in the question a very clear statement of what the structure of the program is. We faced an immediate problem of providing point defense for existing ships against

cruise missile kind of threat. For that purpose we devised an immediate solution which was to put on some of these ships the basic point defense surface missile system which is based on the Sparrow III missile with an existing shipboard launcher and a simple modification with a ——— between tying the whole system together.

It has been put on for an immediate capability. The point defense system development improvement line is to take these systems of the type that are put upon these ships and make the kinds of improvements that over a reasonable period of time can be retrofited to them. At the present time they are ———.

The schedule for that is that there will be fleet deliveries of these improvements to the basic point defense in ———. Looking out at the threat in the future, it appears clear to us that we cannot get to the kind of capability that we think we really ought to have for a basic point defense system on the ships by patching additional retrofits onto the basic system. So that separate from the two things of what we can put on the ships immediately and then fix up in a period of time, we have set out to design what would be a proper point defense system for that size ship, still trying to keep it as simple as possible and economical, but going beyond what can be done by retrofiting current existing equipment. That is called the advanced point defense missile system. It is in the stage of advance development. The basic point defense missile system is in the fleet and it is characterized now as a fleet development item.

The point defense improvements are in ——— where they are now in the stage of actual hardware development aimed at delivery in ———.

In advanced development, which is before the stage of actually trying to develop a complete system, but in the stage of developing components and capabilities and understanding that could turn into a complete system, we have what is called advance point defense. It is an attempt to design the best relatively simple point defense missile system that we can to be put into the fleet in the mid to late 1970's.

EQUIPPING OF FLEET

Mr. LIPSCOMB. How many ships have the basic point defense surface missile system?

Admiral GADDIS. Three ships are now installed.

Admiral RUCKNER. We have about ——— systems going in in 1970 and about ———. That is our planning.

Mr. LIPSCOMB. What kind of ships?

Admiral RUCKNER. We have them on the high value ships right now. The carriers have them and the larger ships. Our first priority was to put them on the carriers.

Admiral GADDIS. The immediate plan, sir, is to be responsive to the ships that require this on-station off Southeast Asia in the near term.

REACTION TIME

Mr. LIPSCOMB. What is the reaction time and known weaknesses of the basic point defense surface missile system?

Admiral RUCKNER. The basic problem is ———.

Mr. LIPSCOMB. How long did you say the ——— period is?

Admiral RUCKNER. About ———. The natural tendency is, if you are in a very close environment, to ———.

Dr. FROSCH. I think what this suggests is that the time in the engagement is controlled by two sets of decisions. One decision is a decision by the commanding officer of the ship that he is in a situation where he is likely to require point defense, and he should go to either general quarters or man the basic point defense system. Once the basic point defense system is manned, then probably the controlling decision time is the decision time of the man who ———.

After that it is just the ——— and the flight time of the missile.

Mr. MINSHALL. When you say ——— what do you mean?

Admiral RUCKNER. We put ———.

Mr. MINSHALL. Is this similar to a ——— arrangement?

Admiral RUCKNER. Yes. All of these missiles have to have some ———.

NEED TO IMPROVE DESIGN

Mr. MINSHALL. You cannot design one that would not ———.

Admiral RUCKNER. Yes, we could.

I think you must remember how these systems came into being. We needed an inexpensive system that we could put in many ships to give them some capability against low-flying aircraft or missiles, which is the same thing as the low-flying aircraft. In doing this we took the Sparrow that we use in the aircraft. Sparrow is really an air-to-air missile. We made a system around it and an existing launch platform to get these things launched. We built a box launcher with a bunch of cells and put the missile in the cells and put this on a gun carriage and put one of the old handlebar directors in the system.

That made a very inexpensive, very light system that you could put in practically any ship at all.

Mr. MINSHALL. My point is this, Admiral: As long as you are designing it and knowing you are going to have a situation arise where you are going to have to keep the gyro going on an alert basis for more than ——— why wouldn't it be the proper thing to do to design one that would run a lot longer?

Admiral RUCKNER. The missile that we are using in the first place is perfectly fine for the use it is in. We can modify the missile to change the ———.

But actually, in most situations around the world your ——— is really nothing. It is only if you have somebody looking down your throat day after day, and week after week, sitting on your starboard quarter, that this becomes a problem.

Dr. FROSCH. Let me add a point to that. That is precisely one of the points about the program. The idea was to get the basic system on these ships as soon as possible.

The decision was that we would put as much as possible of equipment we had precisely in the configuration we wanted it on these ships. So we took the Sparrow without modification and put it in.

Now we have the point defense improvement program and in that we are taking these basic point defense systems and retrofitting them with improvements and we have the possibility of making improvement to the missile if the examination of the payoff, the military payoff of those improvements indicates that it is sensible.

As we design an advance system which will replace all of this in the sense of being designed specifically for this shipboard defense purpose, that kind of consideration of ——— would automatically be part of the engineering decision.

Mr. MINSHALL. If you had this to do over again, would you design it with this ——— in it?

Dr. FROSCH. If I were designing the Sparrow missile as an air-to-air missile—we would do precisely the same thing. The time to do another missile would have just made it impossible to get anything on the ships immediately.

Mr. RHODES. Does the Hawk missile have that same situation?

Dr. FROSCH. I do not know.

Admiral GADDIS. The standard Hawk has ——— requirement. The improved Hawk has a ——— and this is the one we are going to, sir. This is a state-of-the-art feature of surface-to-air missiles and in some effect air-to-air missiles, where we did not have this capability when the systems were originally designed. We do have this capability now.

MODIFICATION OF EXISTING SPARROW MISSILES

Mr. MINSHALL. Would it be feasible to retrofit or modify the existing Sparrow missiles?

Admiral RUCKNER. Yes, sir, but we are not really sure that is worthwhile.

Admiral GADDIS. The point here, sir, on the preliminary system is that the immediate system which we are putting in now on an urgent basis has ——— requirement into the system. This is the same order of magnitude of ———.

Admiral RUCKNER. At the expense of muddying up the water a little bit more, which apparently I have done——

Mr. MINSHALL. I am afraid I have done it.

DEVELOPMENT OF BASIC POINT DEFENSE SYSTEM

Admiral RUCKNER. I would like to run through the sequence of these things because I think maybe we are getting a little off the track.

Basic point defense took existing hardware which was used in other systems and put them together in a small, quick, cheap, dirty system to give us the capability.

The next step in the chain is the NATO Sea Sparrow project which we are in with three other NATO countries and this will give us a modified Sparrow missile, ———.

The next step in the chain, and not part of the NATO project, but which we are doing for ourselves, is the improved point defense which gives you, in addition, a ———. Up to this point it is all ———. That carries the point defense systems as they now exist based on the Sparrow missile ———. The advanced point defense system is one which we hope will be more capable and more sophisticated. It is a longer term development. It is one which we have not settled on yet because, driving us in all of these point defense systems is the fact that we want a system which is inexpensive enough so we can buy it in quantity and put it in a great number of ships. If we go to too big a missile, too sophisticated a missile, then we run

into larger weights; we must have power-handling equipment to load the missiles into the launcher and then the system becomes big, heavy, and complex. This is what we are trying to avoid.

CRUISE MISSILE THREAT

Mr. MINSHALL. Thank you very much. We asked this question last year, if my memory serves me correctly: When did you first have knowledge of this Cruise missile threat and when did you first react to it insofar as getting actual hardware is concerned?

Admiral RUCKNER. We have known about Cruise missiles for a long time and we have been working rather diligently on getting just this kind of a system. That is why we went to using existing hardware.

Mr. MINSHALL. Give me some dates, would you please, Admiral.

Admiral RUCKNER. The first time I looked at this was ———.

Mr. MINSHALL. And when did you first react and actually order some hardware?

Admiral RUCKNER. The 3T systems do have a capabiilty and were developed in about that time frame.

Mr. MINSHALL. I am talking about the modification of the Sparrow missile.

Mr. LIPSCOMB. Excuse me. Would you yield?

Mr. MINSHALL. Yes.

Mr. LIPSCOMB. Admiral, we went through this last year. We are talking now about the Styx missile threat on the KOMAR, and OSA class and ———.

Dr. FROSCH. The Tartar and Terrier have ———.

So in that sense they are a point defense system. That is the test result. By actual test they also have a surface-to-low-flying capability.

Mr. LIPSCOMB. You have made those tests in the past year?

Dr. FROSCH. In the past 2 years, yes.

Mr. LIPSCOMB. The Styx missile is a ——— range, low-flying missile, a real dangerous threat. The 3–T's weren't designed for this purpose. ———.

Admiral RUCKNER. The defense against the Styx missile is not just any one system.

Mr. LIPSCOMB. We have been working on these things but the fact is that only in the last year or two we recognized the ———.

Admiral RUCKNER. What you are saying, Mr. Lipscomb, is partially correct and partially incorrect.

The problem we have recognized for a long time. Yes, today we are moving ———. But if you go back over the course of events, although we recognize the problem of this type of missile, we were tied for many years to the Mauler development. You will remember you heard for many years about Sea Mauler, and then the Mauler development did not come through on schedule so we had to take some other approach.

Mr. LIPSCOMB. It couldn't come through on any stage. It disappeared.

Admiral RUCKNER. Yes, sir.

The implication that we have been sitting on our hands for many years doing nothing—I don't think is fair.

Mr. LIPSCOMB. We are not saying that. ———.

Dr. FROSCH. ———

Mr. LIPSCOMB. In the testimony this morning, if you say that 3-Ts have this capability, why are we using the Sparrow?

Dr. FROSCH. I think if you go back you will see that what I said was the 3-Ts have "a" capability ———.

The other thing is, as in many other similar threats, the way one constructs a real defense is by a defense-in-depth kind of arrangement and the weapons we are talking about here are relatively short range ———.

The fact that the 3-T's have "a" capability, and we are fortunate that they do ———.

Mr. RHODES. Are you working toward a system which would not only be operated by a radar-detection system, but also by computer?

Dr. FROSCH. The kind of final concept of a system that we have—and let me describe it for a fairly large ship because that puts all the elements we could put into the system on the ship—is a ship which has ———.

Mr. RHODES. The rest of the question, of course, is whether or not you are going to use these same target-acquisition capabilities to launch a missile against an incoming missile.

Dr. FROSCH. In addition, we would have ———.

ASMS

Mr. RHODES. I have heard of an ASMS, but I don't see it anywhere.

Dr. FROSCH. The ASMS is the system we are looking at to come in the late seventies as a replacement for the 3T's, the Tartar, Terrier, and Talos, to make the jump to the current state of technology, to get a much more rapid reaction at that time than we can get with the 3T's, to get a higher firepower capability, more missiles in a given time, and to handle more targets and higher performance targets.

That is now in the stage where we have been out on contract definition, the proposals from the contractors are now in, or are about to come in, to be precise, and sometime in the next month I believe the proposals ought to be in and the evaluation of those proposals will start. So, so far it has been entirely a study, analysis, proposal, and some advance-development kind of experimental work.

Mr. RHODES. Do you have any money in this budget for ASMS?

Dr. FROSCH. Yes. There is ——— million in the budget to do the beginnings of engineering development on ASMS.

CRUISE MISSILE THREAT

Mr. MINSHALL. We never got on the record the date you actually reacted to your first knowledge of the threat. I mean this year.

Dr. FROSCH. The first knowledge of the fact that the Soviet had some kind of Cruise missile I believe dates from about ———.

The basic point defense missile system I think started some time in 1967.

Mr. MINSHALL. Thank you.

Mr. LIPSCOMB. The have had 18 or 20 Komars with Styx missiles deployed in Cuba ever since the Cuban crisis.

Dr. FROSCH. Yes.

Admiral GADDIS. This sort of threat, Mr. Lipscomb, goes all the way back to World War II when the threat was from an air-launched missile. The surface-launched missile is an extension of that as well.

The initial defense, of course, was to spread out task forces, to have air cover, to have air-carried radar to extend the radar coverage and to spread out the antiair defense, both with aircraft-controlled intercept and with missile intercept. That was our defense for many years. We called it the anti-air warfare defense in depth, haystack formations and so forth.

We also went to the point of making false radar targets within these formations so that they could not pick out the carrier, or the major capital ships in a naval formation and so forth.

Now, the principal emphasis—not the initiating emphasis, but the principal emphasis on basic point defense and quick-reaction capability to surface-to-surface missiles evolved from ———.

STYX MISSILE DEFENSE

Mr. LIPSCOMB. We are doing a ———. We went through this last year and I am personally glad to see that we are working on it. The faster, the better. Mr. Secretary, I think in order for the committee to obtain an appreciation of just what is being done here, I think it would be helpful if we could have something for the record that indicates, for example, how far away the various cruise missiles can be seen in a "no general quarters" situation, and how many seconds does it take the various Cruise missiles to hit a ship after they are first seen.

Then under the basic system, how many seconds will it take to react, ——— fire the Sparrow after the missiles are first seen?

Also, into the basic system, how many cruise missiles can be handled at one time? Are we talking about one missile or various missiles?

(The information was provided to the committee and is classified.)

COST OF POINT DEFENSE SYSTEM

Mr. LIPSCOMB. Then how much will the basic system cost in the areas of R.D.T. & E., procurement, modification, installation, in all appropriation accounts. Then what will it take for the improved system, what it will cost in all appropriation accounts, and how will this improve your basic system from the standpoint of reaction time and kill probability?

In addition, what will the advance system cost by all appropriation accounts?

And in these cost figures I think we should have the installation, modification, retrofit and all the costs involved so we can get an idea of what we are buying in each of these situations, the basic, the improved, and ultimately the advanced.

I don't think we have an appreciation of that.

Admiral GADDIS. That is available and we can supply that.

(The information follows:)

The Navy is presently formulating firm plans for development of the improved and advanced systems. Realistic cost estimates for achieving the necessary performance capabilities reveal funding requirements substantially in excess

of presently approved levels. While NATO Seasparrow requirements and costs have been established, the degree of sophistication of the TAS necessary to provide reliable all-weather detection of antiship missiles is still under consideration.

The significant improvements to be realized by the improved system over the basic system are the ———.

Studies on the optimum configuration of the advanced dual mode missile are in progress, and although procurement and installation cost estimates (*) for this missile cannot yet be determined, it should be recognized that integration with the improved system will require only minimal modification and costs.

A summary of estimated costs is as follows:

POINT DEFENSE SYSTEMS COSTS

[In millions of dollars]

	Approved R.D.T. & E.	Estimated		
		Development	Procurement	Installation
Basic	——	——	——	——
Improved:				
NATO Seasparrow	——	——	——	——
TAS/integration	——	——	——	——
Total	——	——	——	——
Advanced (missile)	——	——	——	——

Estimates for BPDSMS include procurement and installation of ——— systems. Estimates for IPDSMS are based on ——— and ——— although delivery and installation will extend beyond ——— APDSMS estimates are based on start of missile ———.

NO DEPLOYMENT OTHER THAN ULTIMATE WEAPON

Mr. LIPSCOMB. Dr. Frosch, a question that comes to mind in this discussion is, Why not stop now and develop the ultimate system you desire and then install this equipment aboard ship?

Dr. FROSCH. Because, developing the ultimate system will take us some years and the installation will take some time and we would then be in a position where we might go for as long as 5 years with no defense capability of this type, and no defense capability at all on some of the smaller ships. This seems unwise. The risk of a period of vulnerability seems too high.

SURFACE MISSILE SYSTEM PROJECT

Mr. LIPSCOMB. What role, if any, does the surface missile system project play in the point defense missile system development?

Dr. FROSCH. The budget element surface missile systems project is not related to the point defense missile system development.

SHIP ANTIMISSILE INTEGRATED DEFENSE

Mr. LIPSCOMB. Will you explain what relationship the budget element entitled "Ship antimissile integrated defense" (SAMID) for which you are requesting ——— million in fiscal year 1970 has to this program?

Dr. FROSCH. The budget element for SAMID is related to the basic point defense system only to the extent that the SAMID project

performs the shipboard system integration of the point defense system with all other systems related to defense against the antiship missile threat. This is applicable for those ships wherein both the SAMID and point defense system are designated for installation.

3T MAJOR SYSTEM DEVELOPMENT

Mr. LIPSCOMB. In the discussion on the basic point defense system you mentioned the 3T major system development. I believe the committee requires some clarification on the 3T major system development. For fiscal year 1970 you are requesting ——— million for the 3T major system development. This is a new element created in fiscal year 1968 and a total of $18.3 million has been funded for this purpose through fiscal year 1969.

Under another element you are requesting ——— million in fiscal year 1970 for the surface missile systems project. This is to improve the 3T missile system and a total of $214.4 million has been funded for this purpose through fiscal year 1969.

In still another element we have the advanced surface missile system for which you are requesting ——— million for fiscal year 1970. Through fiscal year 1969 a total of $26.5 million was funded for this program and you estimate that the total estimated cost for this system through fiscal year 1974 will cost ——— million.

Will you provide the committee with a clear and comprehensive explanation of how these various elements fit together to provide us with a second generation surface-to-surface missile system, with a secondary capability for surface-to-air use?

Dr. FROSCH. I think the best way to respond would be to ask Captain Sappington, who is the surface missiles project officer, to reply.

Captain SAPPINGTON. There are now two program elements (SMS project and 3T major systems development) which support all the development effort associated with Terrier, Tartar, and Talos weapon systems. Prior to fiscal year 1968 there was only one element.

The 3T major systems development element was established in fiscal year 1968 in order to better define and support major improvements to Terrier, Tartar, and Talos weapon systems. It had become apparent at this time that the development of replacement components and subsystems would be required on a continuing basis in order to maintain these systems current with the threat insofar as their inherent design capabilities would permit. However, the establishment of this element did not eliminate the need for the SMS project element. Prior to fiscal year 1968, the SMS project provided for both major developments and the necessary fleet support of operational systems which required and continues to require the correction of deficiencies in reliability, availability, and performance as identified through operational use. Since the establishment of the 3T major system development element there has been a gradual reduction of effort under the SMS project element. The ——— in fiscal year 1970 and similar amounts in outyears is the minimum necessary to support the 3T's in the area of fleet support.

The ASMS element provides for the development of a new missile system which will be installed in DXG/DXG(N) new construction. This system will provide the Surface Fleet with area-defense capability to meet the visible ——— threat including low-flying cruise and

other guided or tactical missiles in a strong enemy countermeasure environment and have flexibility to adapt to new threats of the ———. It will also be effective against ocean surface targets, furnish Class I air control, and have capability for ———.

Although the Navy's new shipbuilding program includes ASMS installations which will counter the 1970–1980 threat era, the present SMS Fleet must carry AAW surface escort burden until ASMS is available in substantial force levels. For example, in 1980 ———. Because of this projected role for 3T ships, special emphasis continues to be placed on improving their performance capability and reaction time, especially against the low-altitude cruise missile threat. The funds requested in fiscal year 1970 and outyears under the 3T major system development element will provide ———.

Dr. FROSCH. May I make one comment about these last two questions? When I went through my statement, I pointed out that we used for our own internal purposes a different arrangement of the items in the budget, an arrangement by mission analysis. It was precisely because of this kind of difficulty in tracking different projects that are related to the same military mission that we went to the other way of arranging our budget for that purpose. We have faced some of the difficulties that I sense the committee faces in tracking the relationships of these things.

ADVANCED SURFACE MISSILE SYSTEM

REPLACEMENT OF 3T'S

Mr. LIPSCOMB. Will the advanced surface missile system replace the 3T's?

Dr. FROSCH. At first the advanced surface missile system will go into ships that are built new of the kind that if we didn't have the ASMS we would put elements of the 3T's into. Probably there will not be retrofit of the ASMS into 3T ships. Rather, as we build new missile ships in the future, we will put ASMS in and the 3T ships, as they come to the end of their life, will simply be retired.

There is one footnote on that, and that is that the time scale for the ASMS development is such that its precise relation to the DXG program, can it be precisely predicted so it may be that some of the DXG's would start their lives with Tartar-D and then have a retrofit to ASMS. But we have designed the ASMS requirements and are designing the DXG so that that retrofit is a simple one-for-one replacement without reconstruction of the ship.

REPLACEMENT OF TARTAR AND TERRIER

Mr. LIPSCOMB. Which of the 3T's will it replace and in what time frame?

Dr. FROSCH. It will replace Tartar and Terrier and the time frame is connected with the DXG's. The first ———.

DXG RETROFIT

Mr. LIPSCOMB. The justification book indicates that your program beyond fiscal year 1970 would involve installation of a hybrid system, using standard missiles in a new DXG in midcalendar year ———.

The justification book states this will result in future system retrofit. Why not wait until calendar year ——— for the system to be fully developed before installing the system in ships?

Dr. FROSCH. This is a problem of fitting a missile system and a development program and a ships development program together. It seems to us that the most economic and sensible way to do this was to put the ASMS radar and fire control system into the ship at the appropriate time and use the standard missile with it because the retrofit that is required when one goes from standard missile to the ASMS missile is a relatively minor retrofit in the fire control and radar system, whereas if one waited one would either build the first DXG's with Tartar-D and have a much more extensive retrofit problem to go to the ASMS, or leave them forever with the older-type missile system. What we have done is select the way of doing it that has the highest probability of meshing the delivery and completion of the development of the missile system with the completion of development and construction and delivery of the ship with the minimum amount of retrofit possible.

If the ship for some reason not now foreseen were to come out a year later, then I think automatically we would be in a no-retrofit stiuation. Or, if the ASMS development were to come a little faster, we would eliminate that retrofit.

DXGN PROGRAM

Mr. LIPSCOMB. The Navy is requesting funds to embark upon a new DXGN frigate building program. The committee understands the first two will receive the Tartar-D missile system and the advance surface missile system will not be installed until the ——— DXGN. Is that what the justification book refers to?

Dr. FROSCH. I believe so.

DLG CONVERSION PROGRAM

Mr. LIPSCOMB. Is the advanced surface missile system planned for the DLG conversion program?

Dr. FROSCH. No, it is not.

STANDARD MISSILE BLOCK V

Mr. LIPSCOMB. The committee has been advised that the standard missile block V program is designed to improve the standard missile by providing increased capability against maneuvering targets and against countermeasures. Are funds to provide this capability in the R.D.T. & E. or the PAMN budget for fiscal year 1970?

Captain SAPPINGTON. It is expected that the standard missile block V R.D.T. & E. effort will be completed during fiscal year 1969. The fiscal year 1970 PAMN funding for standard missile block V is $2.3 million.

Mr. LIPSCOMB. For the record, will you itemize the funds for fiscal year 1969 and 1970?

Captain SAPPINGTON. Yes.

Mr. LIPSCOMB. And also include the amount of funds in the PAMN budget?

Captain SAPPINGTON. Yes, sir.

(The information follows:)

The R.D.T. & E. and PAMN funding for the standard missile block V program is as follows:

[In millions of dollars]

	Fiscal year 1969	Fiscal year 1970
R.D.T. & E.	2.2	0
PAMN	0	2.3

Pacific Missile Range (PMR)

FUNDING

Mr. Lipscomb. Your fiscal year 1970 program for the Pacific Missile Range totals ——— million. Your justification book indicates the fiscal year 1969 program totals $63.3 million. Is this correct?

Dr. Frosch. Yes.

Mr. Lipscomb. The program approved by Congress for this fiscal year was $58.2 million. What is the reason for the increase?

Dr. Frosch. The increase was for the purchase of telemetry equipment required in order to convert from VHF to UHF as directed by the JCS.

NAVY TESTS AT PMR

Mr. Lipscomb. Dr. Frosch, will you provide for the record a table showing the number of missile tests conducted by the Navy at the Pacific Missile Range for each of the last 3 fiscal years, and the anticipated activity planned for fiscal year 1970?

Dr. Frosch. Yes, sir.

(The information follows:)

	Fiscal years—			
	1967	1968	1969	1970 (projected)
Missile operations	15,907	15,052	[1] 12,721	15,264
Missiles fired	3,497	3,931	[1] 3,513	3,648

[1] Number for last 10 months.

RELATIONSHIP OF PMR AND WTR

Mr. Lipscomb. Dr. Frosch, will you describe the relationship of the Pacific Missile Range with the Air Force Western Test Range at Vandenberg?

Dr. Frosch. In consonance with DOD Directive of November 16, 1963 the Pacific Missile Range and the western test range are autonomous National ranges under management of the Navy and Air Force respectively. AFWTR is the western launch lead range for ICBM launches into the Pacific Ocean, for launches of space vehicles, and for launches of polar orbiting satellites. PMR is responsible for support of all sea-based launches in the Pacific and for the support of test and evaluation of the shorter range tactical weapons systems.

PMR and AFWTR provides mutual support to each other's launch operations under the National lead range/support range concept. This support is in the form of metric tracking, telemetering, safety, command and control and destruct systems, communications, weather, area clearance and control, frequency interference control and data processing.

1970 TEST PROGRAM

Mr. LIPSCOMB. Dr. Frosch, give us an idea of the types of missile tests to be conducted at the Pacific Missile Range in fiscal year 1970.

Dr. FROSCH. Surface-to-air, air-to-air, air-to-ground, surface-to-surface, and intermediate range ballistic missile.

MILITARY ASTRONAUTICS AND RELATED EQUIPMENT

Mr. LIPSCOMB. The fiscal year 1970 program for military astronautics and related equipment totals $24 million, an increase of $6.1 million over the fiscal year 1969 program. Will you describe the work being done in the area of satellite sensors ———. You can do that for the record.

(The information was provided to the committee and is classified.)

TRANSIT NAVIGATION SATELLITE SYSTEM

Mr. LIPSCOMB. What is the Navy transit navigation satellite system? Why was it developed and who are "limited users" referred to in your statement?

Dr. FROSCH. The transit satellite system is a navigation system which was developed principally to provide an extra source of highly precise navigation to the fleet ballistics missile submarines. It is a satellite which broadcasts a radio tone and a radio message. By receiving the radio tone from the satellite for a short period of time, the receiver can determine his position to great accuracy. If he also reads the message from the satellite, which tells him what the satellite's orbit is, and makes appropriate computations. It is being used operationally by the fleet ballistic missile submarines to update their SINS navigation. It is also being used by attack carriers to give them that accuracy of navigation which is about a tenth of a mile.

It has also been released for commercial production of the receivers and the computers, since the system throughout has always been unclassified as far as its broadcast of equipment went. It is being used extensively by oceanographers in their research and is beginning to come into use in commercial areas where they need that accuracy of navigation.

While the messages are unclassified and so on, if we were to choose to do so, we could put the messages in crypto form and deny it to users who did not have the appropriate crypto.

NAVY NAVIGATIONAL SATELLITES

Mr. LIPSCOMB. How many navigational satellites does the Navy have in orbit and how many more are planned?

Dr. FROSCH. The current number is four. That is the minimum to have a usable system. The proposal is to maintain four. They need to be

maintained because, while we have gotten very good life out of them up to a couple of years, they do finally deteriorate ———.

TRANSIT EXPANSION

Mr. LIPSCOMB. How and why will the use of transit be expanded? Last year you testified it would become fully operational by the end of fiscal year 1968.

Dr. FROSCH. Well, it is fully operational. The expansion in question is the provision of receivers and computers to additional Navy ships and, as I mentioned, the release for manufacture of receivers for commercial use.

Mr. LIPSCOMB. What is the cost of that, of expanding its use?

Dr. FROSCH. The investigation planned is aimed at development of a low cost, about ——— small ship receiver that would use a low cost, ——— computer for a total cost of ——— per installation. If a ship already has a computer on board, the additional computer would not be necessary.

Mr. LIPSCOMB. Mr. Secretary, in your statement you indicated it would be expanded and we are trying to determine how far it will be expanded, in other words, to how many ships in the fleet?

Dr. FROSCH. I think we will have to provide that for the record. I don't have that.

(The information follows:)

The extent of expansion of the transit system in question will depend first of all on the results of the planned investigation which addresses cost/design tradeoffs for a small ship receiver with an accuracy objective of 0.5 to 1.0 NM. Once a small ship receiver is developed, it will be compared with other means of navigation on a cost effective basis to define the number and types of ships that would use it. The target cost for the small ship receiver is ———.

RELATIONSHIP OF TIMATION TO TRANSIT

Mr. LIPSCOMB. What is the Timation navigation satellite and how does it differ from Transit?

Dr. FROSCH. When you use Transit, you are receiving a tone whose frequency, as the receiver sees it, varies as the satellite goes by in the same way that a train whistle is heard at a different frequency as the train goes by and by interpreting this information and knowing the orbit of the satellite, one can find out the position in the same way that one uses the position of the sun and other celestial bodies.

The idea in the Timation satellite is that this satellite could be higher, or in a different orbit, such that the orbit was extremely predictable over a period of time and rather than listening to a tone and having to make a computation, one would receive pulses from several satellites, sent at a precise time known to the receiver; the receiver having a precise clock, could simply time the difference in times of arrival of these pulses and get effectively a range from the three satellites. The reason for going to this is that it does not require as much detailed information and computation on the receiving ship. The computations can be done directly using tables and simple forms of computational device not involving electronic computers, and we believe the orbits can be put in such a way that orbital information doesn't have to be continuously updated through the satellite.

So, that, in the long run, this could produce a system simpler from the point of view of maintaining the satellites in orbit and simpler from the point of view of the user.

USE OF TRANSIT BY AIRCRAFT

Mr. MINSHALL. Doctor, would aircraft be able to use the Transit navigation satellite?

Dr. FROSCH. We are working on a receiver for use in aircraft. The problem there is that with a ship you can make the assumption that during the period that you are listening to the satellite tone for navigation the ship is not moving. Or, at least the correction for its motion is very small. For an aircraft the correction for the motion of the aircraft while it is receiving the signal is no longer negligible and so the computation problem and the sensor problem is much more difficult. We believe we have that problem in hand so that we will be able to put Transit navigation, for example, in P–3, ASW aircraft, and possibly I think in the S–3, ASW aircraft, and other aircraft which would be a great help.

If we were to go to the Timation system, the problem of the aircraft navigation would be greatly simplified, and the accuracy that one could get in an aricraft would be increased.

EFFECT ON LORAN

Mr. MINSHALL. Would this system in any way supplement or perhaps make obsolescent Loran?

Dr. FROSCH. It has an accuracy which is better than Loran A, but not quite as good as Loran C. For ships that have satellite navigation, as long as there are satellites up, I suspect that they will not use their Loran A. If they have highly accurate navigation to do in areas where there is a Loran C system, then for purposes that require that extreme accuracy, they might use Loran C.

ACCURACY OF SYSTEMS

Mr. MINSHALL. When you refer to accuracy, what tolerances are you talking about?

Dr. FROSCH. Transit navigation for a ship is good to a couple tenths of a mile. Loran C accuracy, if you are in the right position with relation to Loran C, can be down to a couple hundred yards.

Mr. MINSHALL. How about Loran A?

Dr. FROSCH. Loran A, under very good conditions I have seen it as good as half a mile. You can never depend on it for better than a mile. At night you are usually lucky to get 2 miles or so.

Mr. MINSHALL. Thank you.

TRANSIT COMPUTERS

Mr. LIPSCOMB. Dr. Frosch, what kind of computers do they use with the Transit?

Dr. FROSCH. It can be as simple as a small special purpose digital computer, but any general purpose digital machine can do it as a minor extra computational task, so ships that have any form of general pur-

pose digital computer can simply do this as an extra task. It is only a ship or an aircraft that doesn't carry any computation capability at all that requires the special purpose machine.

Mr. LIPSCOMB. Who makes those computers?

Dr. FROSCH. I believe the whole package is now being marketed by Magnavox and there is another manufacturer. I don't remember who it is.

Mr. LIPSCOMB. Does it have a trade name or a number?

Dr. FROSCH. I am sure it has a number. I don't know whether it has a trade name. I would have to find out.

Mr. LIPSCOMB. Foreign countries can buy this package to put aboard their ships?

Dr. FROSCH. They can if they are eligible for an export license. There are two lists of qualifications. One is the strategic materials list, and there is another one and it is on the lower level of the two lists and I don't remember which list. I can find out and supply that.

Mr. LIPSCOMB. If you would. I would like to know if it has a number or some other marking to identify it.

(The information follows:)

Commercial versions of the Transit receiver are built and marketed by ITT and Magnavox. The ITT version, called model 4007, uses the PDP-81 computer built by the Digital Equipment Corp. of Maynard, Mass., while the Magnavox version, called model MX702HP, uses a Hewlett Packard model 2115 A computer.

Foreign countries can buy these commercial sets under international traffic in arms procedures through the Department of State under the munitions list.

USE OF TRANSIT FOR MISSILE FIRINGS

Mr. LIPSCOMB. Did I understand one of the limited users could be missile trackers? Does Transit have anything to do with missile firings?

Dr. FROSCH. No. Only in the sense that the submarines, the FBM submarines use it for navigation of the submarine and ships that are involved in range exercises may use it for navigation, but not the missiles themselves.

NAVY NAVIGATION SYSTEMS

Mr. LIPSCOMB. Dr. Frosch, the Navy currently has a Loran Navigation Station covering a fraction of the earth, and plans to complete an eight-station Omega navigation system which will cover the globe providing about 1- to 2-mile accuracy for ships and planes. We have just discussed the Transit and Timation. How many different navigation systems does the Navy have in being, under development and in the planning stage and how are they used by various units of the fleet?

You may provide that for the record.

(The information follows:)

The Navy has the following navigation systems in being:

Loran A: General fleetwide use.

Omega: Will replace Loran A.

Loran C: Limited use by special units and missions requiring high accuracy.

Navy navigational satellite system (Transit): FBM submarine, attack carriers.

Sins: FBM submarines, attack carriers.

The following navigation systems are under development and in the following stage:

Timation: If the technique proves out, a system could be configured to serve all fleet units.

Marine inertial navigation system: Low cost inertial system for small ships.

Electrically suspended gyro navigator: High long-term accuracy inertial system for ships and submarines.

FUTURE USE OF SPACE SYSTEMS CONTRACT

Mr. LIPSCOMB. In January 1969, the Navy space systems activity at Samso awarded an $800,000 contract to Planning Research Corp. to aid in further investigation of Navy use of space systems. What is the purpose of this study effort?

Dr. FROSCH. This contract with Planning Research Corp. is for general support and covers all aspects of Navy space interest, that is, program 749, communications, navigation, and meteorology. The planning Research Corp. function and relationship with Navy space systems activity can be compared to those of Aerospace Corp. with Samso.

LORAN MANPACK RECEIVERS

Mr. LIPSCOMB. Earlier this year the Naval Applied Sciences Laboratory ordered two manpack Loran-C/D radio navigation receivers for test and evaluation as potential equipment for the Marine Corps. Isn't this oversophistication?

Dr. FROSCH. The Loran manpack receivers were evaluated on the initiative of the Applied Science Laboratory as to their potential to meet the specific Marine Corps requirement to locate a man in the field to an accuracy of ——— relative to a command post. The tests showed that the requirement could not be met and no further procurement is planned.

MARINE CORPS NAVIGATIONS SYSTEMS

Mr. LIPSCOMB. In your statement you mentioned manpack field user equipment to be used with Transit. How many different navigation systems do the Marines require?

Dr. FROSCH. The Marines require only one navigation system, provided it meets their specific operational requirements.

DOD SATELLITE COMMUNICATION SYSTEMS

Mr. LIPSCOMB. Dr. Frosch, your statement refers to development of two different shipboard satellite communication terminals, one for phase II of the defense satellite communications program, and another for the tactical satellite communications system. Will you briefly describe these two satellite communications systems?

Dr. FROSCH. There are two Department of Defense satellite communications systems. These are: (1) defense satellite communications system and (2) tactical satellite communications program.

DSCS—DSCS is an operational satellite communications system managed by DCA. The space system consists of 25 orbiting satellites at near synchronous altitude over the equator. The earth complex consists of 29 shore terminals and one shipboard terminal. The DSCS is designed to satisfy the long-range strategic communications needs

of the Defense Department. DSCS operates in the SHF (7–8 GHz) band.

Tacsatcom—Tacsatcom is an R. & D. program designed to determine how to satisfy the communications needs of highly mobile, land, sea and air tactical users. The space segment consists of two R. & D. satellites (LES–6 and Tacsat I) at synchronous altitude over the equator and numerous mobile terminals. LES–6 operates in the UHF band only whereas Tacsat I operates in both UHF and SHF. Tacsatcom is managed by a committee, the tactical satellite communications executive steering group (TSEG).

NAVY USE OF TWO SATELLITE COMMUNICATIONS SYSTEMS

Mr. LIPSCOMB. Communication with ships at sea is accomplished primarily through shore-based naval communications stations, a Navy tactical communications system. Why does the Navy now have a requirement for two different satellite communications systems to serve ships of the fleet?

Dr. FROSCH. The Navy does not have a requirement for two different satellite communications systems. Rather, since there are two systems, the Navy has requirements to operate in both systems. This requirement results from the nature of the systems, (for example, DSCS, strategic and tacsatcom, tactical).

USE OF ONE TERMINAL FOR STRATEGIC AND TACTICAL COMMUNICATIONS

Mr. LIPSCOMB. Why can't one shipboard terminal be used for both the strategic and tactical satellite communications systems?

Dr. FROSCH. The Navy is designing a shipboard terminal which will operate in the SHF band of both systems. However, in Tacsatcom, both SHF and UHF terminals are employed.

Mr. LIPSCOMB. How many ships are now equipped with satellite communication terminals?

Dr. FROSCH. We have one ship equipped with an SSC–3 operating in the DSCS. This terminal is in the SHF band and is R.&D. only. We have four terminals in ships operating in Tacsatcom. These terminals are in the UHF band and are also R.&D.

FUNDS FOR SHIPBOARD TERMINALS

Mr. LIPSCOMB. Will you provide for the record a statement showing how the ——— million for the satellite communications element will be used, and the same for the ——— million requested for the tactical satellite communications element? You might also describe how earlier funds were used for these two program elements.

Dr. FROSCH. The ——— million will be used to develop a family of SHF shipboard terminals which will provide reliable and timely long haul communications for Navy ships. The proposed project is to develop one 6-foot antenna for large ships and one 3-foot antenna for smaller ships. Both terminals are to be highly reliable with an availability of .997 and will be interoperable with both DSCS and Tacsatcom (SHF).

The ——— million in the tactical satellite communications is for the installation, tests and evaluation of UHF shipboard terminals and

related subsystems in selected ships and submarines. Testing, the collection of data, and data analysis are the major items in this program.

Earlier funds in DSCS program element were used to develop and support the SSC–3 terminal development. Earlier funds in the Tacsatcom program were used for the procurement and testing of the UHF equipments. Additionally, modification, installation, and reinstallation were required due to changing satellite configurations.

PROGRAM 749

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for program 749. A total of $886,000 was funded for this purpose in fiscal year 1969. Your justification book indicates the total estimated cost of this program is ——— million through fiscal year 1974. Dr. Frosch, will you describe this program to the committee?

Dr. FROSCH. ———.

VLF PROPAGATION SATELLITE

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for a relatively new program called VLF propagation satellite. Will you briefly describe this program?

Dr. FROSCH. This is a carry-on of Project LOFTI. The requirement is a low-level experiment to determine the feasibility of transmitting VLF signals from a satellite to a submerged submarine. The fiscal year 1970 funding is to initiate spacecraft design in preparation for a fiscal year 1973 launch.

COMMUNICATIONS WITH SUBMARINES

Mr. LIPSCOMB. Is it possible to use either the DSCS satellite or the tactical satellite for communicating with submarines?

Dr. FROSCH. It is not possible at this time for a submarine to communicate in the DSCS due lack of a suitable SHF antenna. It is possible for a submarine to communicate in the tacsatcom system provided the submarine has a UHF antenna above the wate. The VLF system will permit a submarine to communicate to a submerged submarine.

SHIPS, SMALL CRAFT, AND RELATED EQUIPMENT

Mr. LIPSCOMB. The fiscal year 1970 program for ships, small craft, and related equipment is $345.2 million, an increase of $1.3 million over the fiscal year 1969 program.

FLAGSHIP DATA SYSTEM

Dr. Frosch, what is the flagship data system for which you are requesting ——— million in fiscal year 1970? I note that a total of $2.9 million was funded for this purpose through fiscal year 1969.

Dr. FROSCH. The flagship data system is an afloat command-oriented data processing system, the prototype of which is to be installed in U.S.S. *Providence* commencing in January 1970. The system will assist a numbered fleet commander in rapidly making the best deci-

sions concerning the employment, command, and control of his forces. The system's data banks contain ———.

Mr. LIPSCOMB. How will this system differ from the naval tactical data system?

Dr. FROSCH. The primary differences between the flagship data system and the naval tactical data system are in the type of data processed by each system, the sources of such data, and the command level which each system is designed to serve. The naval tactical data system is a ship-oriented system which obtains its data essentially from shipboard sensors, such as radar, located on board the ship in which the NTDS is installed, or from other NTDS-equipped ships within range of the NTDS digital data link—approximately ——— miles. This data is related to the movements and tactical status of friendly and hostile forces within a localized ocean area. The system provides a real-time capability for the commander of a ship or group of ships to exercise tactical command and control of his forces in the local area. The flagship data system is a command-oriented system, the function of which is to assist a numbered fleet commander in rapidly making optimum decisions concerning the employment of the extensive forces under his command. The data within the flagship data system is ———.

Mr. LIPSCOMB. Why is this required and on how many ships will it be installed?

Dr. FROSCH. The flagship data system is required to assist the numbered fleet commander to make rapid, optimum decisions concerning the employment, command, and control of his forces. A numbered fleet commander must evaluate and correlate large amounts of information concerning the status and movements of his own and other friendly forces, and intelligence information. This information is at present processed ———.

Mr. LIPSCOMB. What is the total estimated cost of this program?

Dr. FROSCH. The total estimated cost of the flagship data system R.D.T. & E. program is ——— million.

ALL WEATHER CARRIER LANDING SYSTEM

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for the all weather carrier landing system. A total of $2.9 million was funded for this purpose in the last 2 fiscal years. On how many ships are these systems installed?

Dr. FROSCH. Twelve CVA's are now equipped with the AN/SPN-10/42 AWCLS. Four NAS's are now equipped with a shore-based version all weather carrier landing system for training. Approximately 750 aircraft are now equipped with the AN/ASW-25 Link 4 data link receiver and the airborne augmentor.

Mr. LIPSCOMB. I note in fiscal year 1970 you plan to upgrade the landing systems installed on CVA's to the second generation equipment. Why were these systems installed aboard ship before they were fully developed and tested?

Dr. FROSCH. The two systems are essentially the same with the second generation SPN-42 equipment a solid state version of the original SPN-10 system. Recommendations from the fleet users have also been incorporated in the newer model resulting in certain modifications to the control consoles.

Mr. LIPSCOMB. The fiscal year 1970 PAMN budget contains a request for funds to install carrier landing systems in various aircraft. Are these equipments fully developed and tested?

Dr. FROSCH. The aircraft hardware has been fully developed and tested. Aircraft AWCLS participation and status depends on the type of aircraft with the F4J and A7B farthest along. All aircraft are still undergoing testing at Naval Air Test Center, Patuxent River, Md., and aboard CVA's as they become available.

Mr. LIPSCOMB. What is the difference between the AN/SPN-41 and the AN/SPN-42 all-weather carrier landing system?

Dr. FROSCH. The AN/SPN-42 shipboard system consists of a precise tracking radar, data stabilization unit, flight path computer with a deck motion compensator and a surface data link transmitter. The airborne subsystem consists of a data link receiver, cockpit display and autopilot connection, approach power control and a radar signal augmentor.

The AN/SPN-41 shipboard system consists of two KU band transmitters feeding scanning beam antennas. One antenna scans vertically and the other scans horizontally and the scans are synchronized so that the same frequency can be time-shared. In the aircraft a KU band receiver intercepts and decodes the scanned signals and lateral/vertical error is shown on the cockpit display. The SPN-41 is an entirely separate and independent monitoring system for the SPN-42 used by the pilot during automatic approaches.

Mr. LIPSCOMB. What is the total estimated cost of this program?

Dr. FROSCH. The total estimated cost of the AWCLS program is ——— which includes the F-14 and S3A hardware and the required software and testing for the flight path computer.

AN/SQS-26 SONAR

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for the AN/SQS-26 sonar, a total of $85.1 million having been funded for this sonar through fiscal year 1969. Dr. Frosch, will you describe how this sonar is used and its importance to surface ships, in view of its cost?

Dr. FROSCH. The AN/SQS-26 sonar is the most advanced of our surface ship sonars and provides not only long-range direct path detection and tracking in the surface duct when conditions permit, but also long-range bottom bounce detection and tracking, under favorable environmental conditions, against the more difficult below-layer target where the direct path mode, characteristic of our earlier sonars, is constrained to comparatively short ranges. In addition, the AN/SQS-26 sonar takes advantage of the convergence zone propagation mode when it exists to permit detection ———. The long-range detection and tracking capability is directed toward countering the increased range of the latest submarine torpedoes and denying the submarine the option of firing his torpedoes with impunity from outside the surface ship detection envelope of our older sonars.

Mr. LIPSCOMB. Will you explain in greater detail your statement on page 29 relating to the ———?

Dr. FROSCH. The AN/SQS-26 sonars in their current configuration have ——— operating frequencies in the ——— band. As the older

high frequency sonars phase out and are replaced by SQS–26 sonars in our new construction ships we will evolve into an essentially ———. As the AN/SQS–26 becomes preponderant in the inventory it is anticipated that ———.

Mr. LIPSCOMB. Why could this not have been predicted before the introduction of this sonar to the fleet?

Dr. FROSCH. The same ——— we foresee for the future is not sensitive to the AN/SQS–26 design *per se*, but rather to the ———.

Mr. LIPSCOMB. Will you explain for the record how the fiscal year 1970 funds will be used?

Dr. FROSCH. The ——— million in fiscal year 1970 funds will be used to complete the AN/SQS–26CX development, support the XN–1 and XN–2 prototype models currently installed in operational ships until they can be replaced by production CX models, support the operational appraisal of the SQS–26 sonar, and continue an AN/SQS–26 improvement program which includes ——— as well as state-of-art improvements based on operational experience as the sonars are introduced into the fleet.

Mr. LIPSCOMB. Your justification book shows you will require another ——— million to complete the development of this sonar. How many have already been installed aboard ship before completion of the development?

Dr. FROSCH. ——— of the older models (AX and BX) and ——— of the new CX models are currently operational.

Mr. LIPSCOMB. What will be required to complete the development of this sonar?

Dr. FROSCH. To complete the development we must complete the operational appraisal, accomplish the near-term improvement program, replace the XN–1 and XN–2 prototypes with CX sonars and resolve the ———.

SUBMARINE SILENCING

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for submarine silencing. A total of $17 million has been applied to this program through fiscal year 1969. What do you have to show there for this expenditure? For example, have any portions of our fleet submarines had their noise level reduced as a result of this effort?

Dr. FROSCH. The submarine silencing program has provided a wide variety of quieted hardware and noise reduction techniques for reducing machinery system noise which controls the slow speed submarine noise signature. These quieted components are being incorporated in new construction submarines and have resulted in a measured ——— improvement up through about ——— knots speed. This improvement enables the SSN 637 class submarine to ——— the value that would have been possible without these silencing modifications. The quieted hardware and — —— techniques are being backfitted on nuclear submarines, which did not receive them during construction, during their scheduled overhauls. Approximately ——— percent of the deployed nuclear submarines have received some of these improvements to date. The remainder are scheduled to receive applicable silencing modifications during overhauls in the next ——— years.

Mr. LIPSCOMB. The total cost of this program is ——— million. This appears to be a very large expenditure to correct deficiencies in

———. Dr. Frosch, hasn't there been a considerable amount of research over a period of many years in this area in connection with the design of submarines?

Dr. FROSCH. Yes; considerable research has been conducted over a period of many years, that has been applied in our submarine designs. As a result of these efforts we were able to produce the SSN 594 class submarine in 1962, the SSBN 616 class in 1963, and the SSN 637 class in 1967, which has enabled us to maintain our superiority in quiet submarines. The SSN 594 class was a major step forward in quiet submarine design and ———.

TACTICAL INTELLIGENCE PROCESSING SUPPORT

Mr. LIPSCOMB. Dr. Frosch, will you explain and describe the new element tactical intelligence processing support for which you are requesting ——— million in fiscal year 1970?

Dr. FROSCH. The objective of the tactical intelligence processing support effort is to develop hardware and software improvements for our integrated operational intelligence centers currently installed on nine aircraft carriers. This basic system has been operational since 1962 and now requires some developmental work on equipment components and software changes in order to implement required improvements to the storage and retrieval subsystems of the integrated operational intelligence centers. This will require developing new computer software and system design for adding new equipment to the system, such as a data entry/display console, an on-line card reader and punch, and a high-speed printer.

Mr. LIPSCOMB. How does this relate to the element entitled naval intelligence data handling system?

Dr. FROSCH. The tactical intelligence processing support effort is directed toward improving the capabilities of nine shipboard systems, whose purpose is to automate the processing of intelligence data for use by commanders afloat. The naval intelligence data handling system effort, on the other hand, is to develop software to update and improve the shore-based data system at the naval intelligence processing system support activity, located at Arlington Hall, here in the Washington area. Except for the fact that both systems process intelligence data, there is no relation between the systems.

SSN NAVIGATION SUPPORT

Mr. LIPSCOMB. Under SSN navigation support, the justification book indicates there are ———.

Dr. FROSCH. The deficiencies which exist in SSN navigation equipments do not prevent the SSN from carrying out its current missions ———. In addition to the ——— requested in this budget item there is also ——— requested for ships inertial navigation (SINS) improvement under program element 64514N. This effort is directly applicable to correction of SSN navigation deficiencies.

Mr. LIPSCOMB. How have these deficiencies affected the assigned missions of SSN's?

Dr. FROSCH. ———.

SPECIAL COLLECTION ACTIVITIES

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for an element entitled "Special collection activities." This program has been funded a total of $36.4 million in the past 2 years. This is a rather large sum for a classified project. Has the committee been advised of the details of this project heretofore?

Dr. FROSCH. Yes, the committee has been advised of the substance of this project.

WORLDWIDE MILITARY COMMAND AND CONTROL SYSTEM

Mr. LIPSCOMB. You have a new element entitled worldwide military command and control system, for which you are requesting ——— million in fiscal year 1970. Will you explain what this system is and its relationship to the national military command system?

Dr. FROSCH. The worldwide military command and control system (WWMCCS) is an organized, integrated grouping of facilities, equipment, communications, procedures and personnel that provide the technical and operational support involved in the function of (command and control of U.S. military forces. The system is comprised of:

(*a*) The national military command system (NMCS), which is the primary element of the WWMCCS, and which directly supports the national command authorities in execution of their operational command function.

(*b*) The subsystems of the commanders of unified and specified commands.

(*c*) The subsystems of the service headquarters.

(*d*) The subsystems of the commanders of component commands.

(*e*) Those elements of the subsystems of other Department of Defense agencies and offices, which directly support the command and control function, for example DASA, DIA, DCA.

The WWMCCS provides the means by which the President and the Secretary of Defense can apply the resources of the military departments and, through the Joint Chiefs of Staff, exercise strategic and broad operational direction of the unified and specified commanders.

Mr. LIPSCOMB. Does this request relate to the national military command post afloat?

Dr. FROSCH. The request for ——— million for the worldwide military command and control system does not relate to the national military command post afloat.

NAVAL NUCLEAR PROPULSION

Mr. LIPSCOMB. Your fiscal year 1970 for naval nuclear propulsion is $19 million, the same as in fiscal year 1969 in every category. Will you provide for the record the unobligated balances for this element by fiscal year?

Also, is this effort directed toward nuclear propulsion for any particular type of ship?

Dr. FROSCH. The unobligated balances for naval nuclear propulsion for fiscal years 1967–69 were negligible—specifically, fiscal year 1967, $44.00; fiscal year 1968, $412.46; fiscal year 1969, $7,662.00.

This effort is not directed toward nuclear propulsion for a particular type ship. The naval nuclear propulsion program is a comprehensive program of research, development, test and evaluation directed toward the application of nuclear propulsion to naval ships ranging from small submarines to large combatant surface ships. This program generates the data and base technology required for the development and improvement of nuclear propulsion plants for naval service. Work is undertaken in the areas of nuclear materials development, nuclear engineering, nuclear instrumentation and control equipment development, coolant chemistry, shielding design analysis, refueling equipment development, chemical process development and plant safety.

SSN 688 CLASS SUBMARINES

Mr. LIPSCOMB. Your fiscal year 1970 program for reactor propulsion plants totals $30.6 million, $10 million of which will be used for the advanced high-speed nuclear attack submarine. Dr. Frosch, is this reactor for the SSN 688 class submarine?

Dr. FROSCH. No sir. The $10.0 million requested for the advanced design high-speed nuclear attack submarine is to support the development of an improved higher performance nuclear propulsion plant for application in a nuclear submarine in a mid-1970's shipbuilding program. Also included in the $30.6 million for reactor propulsion plants is $5 million to support the development of the high-speed nuclear attack submarine propulsion plant for the SSN 688 class nuclear attack submarines.

Mr. LIPSCOMB. There are two high-speed SSN 688 class submarines in the fiscal year 1970 shipbuilding program. Will the funds requested in your fiscal year 1970 R.D.T. & E. program support both boats?

Dr. FROSCH. The two high-speed SSN 688 class submarines included in the fiscal year 1970 shipbuilding program will use the new high-speed nuclear attack submarine propulsion plant now under development. The $5.0 million included in the fiscal year 1970 budget is to support the development of the high-speed nuclear attack submarine propulsion plant which will have application to the two high-speed SSN 688 class submarines included in the fiscal year 1970 shipbuilding program and to all future SSN 688 class submarines.

Mr. LIPSCOMB. What will be the speed of the SSN 688 class submarine compared with our latest SSN's?

Dr. FROSCH. The SSN 688 class submarine will have a top speed of at least ——— knots as compared to the top speed of ——— knots for the SSN 637 class and ——— knots for the SSN 594 class.

NUCLEAR REACTORS FOR DESTROYERS

Mr. LIPSCOMB. For the last two fiscal years you have been funded a total of $6.5 million for a nuclear propulsion reactor for destroyer-type ships. In fiscal year 1970 you are requesting ——— million for this purpose. There are no nuclear destroyers in the fiscal year 1970 shipbuilding programs. For what ship will this plant be used?

Dr. FROSCH. The project provides for the development of an improved nuclear propulsion reactor plant with a substantial increase in core life and suitable for future installation in existing nuclear frigates and other destroyer-type ships contemplated for future shipbuilding programs, including DXGN's.

MARINE GAS TURBINES

Mr. LIPSCOMB. The fiscal year 1970 program for marine gas turbines is ——— million. Will you briefly describe this interesting program, which I understand involves the use of aircraft-type jet engines to power ships?

Dr. FROSCH. This program takes advantage of the developmental effort used in producing new aircraft jet engines by taking existing engines and adapting them for marine propulsion use. We have qualified the Pratt & Whitney FT4 for marine use, and it is presently installed in the *Alexander Hamilton* class Coast Guard cutters, the MSTS ship *Adm. Callaghan*, two Danish frigates and will be used in the Canadian DDH. General Electric is marinizing the LM 2500 gas turbine and we expect to install and test it on the *Adm. Callaghan* this November. It will replace one of the two FT–4 engines presently installed.

The gas turbine cannot be reversed like a steam turbine can, so we have considered several methods of reversal and decided that a controllable, reversible pitch propeller (CRP) is the best method for reversing the ship. The largest CRP that has been built is rated at 22,000 HP. Since the kind of propulsion system we envision for a DE or DD will require ——— thousand HP per shaft we have started development of a ——— HP CRP. This CRP is presently being manufactured by Baldwin Lima Hamilton and will be installed on a 1052 class DE for at sea testing.

We are also testing several designs of clutches that are required to shift the gas turbines on to and out of the power train.

Mr. LIPSCOMB. Your statement indicates that Pratt and Whitney aircraft turbo type engines are currently propelling a high speed MSTS cargo ship. What is the speed of this ship compared with what it was before the conversion?

What kind of fuel is utilized, what fuel consumption is realized and how does this compare with the original power plant?

Dr. FROSCH. The conversion of the MSTS ship has not yet been accomplished. The *Adm. Callaghan* was originally constructed with two Pratt & Whitney FT–4 gas turbines for propulsion. The General Electric Co. is marinizing the LM 2500 gas turbine which we plan to install on the *Callaghan* this November. The LM 2500 which will replace one of the two FT–4 engines is in the same horsepower range so there will be no effect on the speed of the ship. However, this newer or second generation engine is expected to have a 20 percent lower fuel consumption which will increase the range of the ship and lower the operating costs. All of these engines can burn commercially available diesel oil.

Mr. LIPSCOMB. Has this engine technique been tested during fiscal year 1969 in a DE class ship, as your justification book indicates?

Dr. FROSCH. These large gas turbines have not been installed in any U.S. Navy ships to date. We had planned to construct one of the DE's authorized in the fiscal year 1968 shipbuilding program with gas tur-

bine propulsion but were forced to delete the ship from the program due to budgetary constraints. However, we do plan to install the CRP on a steam propelled DE for at sea testing.

Mr. LIPSCOMB. Will the new DX destoyers in the fiscal year 1970 shipbuilding program be powered with the marine gas turbine engine?

Dr. FROSCH. The contractor's proposals for the DD 963 class destroyer—formerly DX—are now being evaluated by the Navy. All three contractors have recommended gas turbine propulsion. Unless our review uncovers vital errors in the contractor's proposals this class of ships will be powered with marine gas turbines.

Mr. LIPSCOMB. How large a ship can be propelled effectively with gas turbine engines?

Dr. FROSCH. By installing four shafts and using the ——— HP CRP with two of these turbines on each shaft we could propel a ship as large as an ———. That is about ——— tons displacement.

NEW SHIP DESIGN

Mr. LIPSCOMB. You are requesting $12.2 million in fiscal year 1970 for new ship design. A total of $20.1 million has been funded for this purpose in the last 2 fiscal years. How many different type ships were designed with fiscal year 1968 and 1969 funds?

Dr. FROSCH. During fiscal year 1968 and 1969 we completed concept formulation on the DD 963 class destroyer—formerly DX—and DXGN, also we have been in the process of doing concept formulation on the MCS, LFS, AGS, DXG, SSN, and CVAN.

Mr. LIPSCOMB. What type ships do you plan to design with fiscal year 1970 funds?

Dr. FROSCH. During fiscal year 1970 we will continue concept formulation on all of these ships and may complete the MCS, LFS, and SSN.

AIR CUSHION CRAFT

Mr. LIPSCOMB. In the last 2 fiscal years, the Navy was funded $393,000 for air cushion craft. There are no funds in the fiscal year 1970 R.D.T. & E. budget for this purpose. What is the Navy doing in this area?

Dr. FROSCH. The air cushion craft project was originally established to investigate riverine and inshore warfare applications for these craft. Concurrently we were investigating these same type of craft in our amphibious assault landing craft project. It appeared to us that both of these craft would have very similar characteristics so we decided to concentrate on the amphibious aspect and, therefore, dropped the air cushion craft project.

Mr. LIPSCOMB. A press article in January 1969 indicated that the Navy and Department of Commerce, under the Joint Surface Effect Ships Program Office, will split $3.1 million in fiscal year 1970 for detailed engineering designs for a prototype 100 ton, air cushion ocean vehicle capable of traveling 80 knots. You have been funded a total of $5.9 million in the last 2 fiscal years, and in fiscal year 1970 you are requesting ——— million. Why are you requesting ——— million when you only require ——— million for this purpose?

Dr. FROSCH. The ——— will come from fiscal year 1969 funds and as you have stated this will get us the detailed engineering designs for

two prototype craft. In fiscal year 1970 we want to start the construction of these craft. The Navy's share of the first year's construction cost is ——— million.

Mr. LIPSCOMB. How will the remaining funds be used?

Dr. FROSCH. The remaining ——— million will be used for research into supporting technologies such as propulsion lift systems, and lightweight structures as well as the initiation of an investigation into the technologies that may be required for larger craft.

Mr. LIPSCOMB. Why is this not funded under the air cushion craft element?

Dr. FROSCH. There are two major types of air cushion craft, those that have a flexible skirt completely around the craft and those that have rigid sidewalls, somewhat like a catamaran, with flexible skirts fore and aft. These latter are referred to as captured air bubble or CAB craft. The surface effect ship program is oriented toward developing multithousand ton surface effect ships with a transoceanic capability. At the present time the CAB principle appears to be the most practical and efficient direction to go if we are to reach this goal. Craft and ships with a CAB design will not be amphibious as the solid sidewall must pierce the water's surface.

The fully skirted craft we were investigating under the air cushion craft project have a true amphibious capability. As I mentioned before these craft are now being developed in the amphibious assault landing craft program.

Mr. LIPSCOMB. What is the military requirement for this type craft?

Dr. FROSCH. The surface effect ship program is in the very early stages of development and we are just getting started on investigating military applications. Many applications of course will be dependent on the final configuration of the craft. Preliminary studies indicate that this type of ship will have a great potential for ——— in that its very shallow draft and high speed will make it ———. Also the use of this ship in an ——— appears very promising. ———.

HYDROFOIL CRAFT

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for hydrofoil craft. You were funded $9.2 million in the past 2 fiscal years for this purpose. What are we doing in this area and how will the ——— million be spent?

Dr. FROSCH. In our hydrofoil program we have developed the 110-ton *High Point* (PCH–1) into a reliable craft on which we can test mission oriented equipment. Early test firing of the 40-millimeter gun on this craft revealed deficiencies in the ———. The deficiencies were corrected and the changes have been incorporated in the ——— systems of the two operational hydrofoil gun boats *Flagstaff* (PGH–1) and *Tucumcari* (PGH–2). We have developed a ——— which will be tested on PCH–1 starting September this year. If this system tests satisfactorily we will consider development of a ——— to go with it.

The 320-ton *Plainview* (AGEH–1) the world's largest hydrofoil was delivered to the Navy this March. It is being fitted out with an extensive instrumentation suit and will soon start an extensive trial program. This craft will be our stepping stone to an ocean going hydrofoil capability.

Mr. LIPSCOMB. What is the military requirement for this type craft?

Dr. FROSCH. The two operational hydrofoil gunboats I mentioned earlier are just now completing operational evaluation. These 60-ton craft have negotiated waves as high as ——— feet with no impairment of their capabilities since they are completely stabilized by the foil system.

We have initiated a preliminary study to determine the cost and effectiveness of a 150-ton hydrofoil equipped with a ———. This size of craft will be capable of carrying the ——— system that we are experimenting with so we can have an ——— hydrofoil in this size range.

ADVANCED COMMAND DATA

Mr. LIPSCOMB. The fiscal year 1970 program for advanced command data is ——— million. In the last 2 fiscal years, $3.4 million has been funded for this purpose. From a review of your justification book, it would appear that this program is directed toward making the tactical data systems of the various services compatible.

When the military departments entered into their tactical data systems, why didn't OSD require that they be designed along compatible lines?

Dr. FROSCH. That is not correct although compatibility among the tactical data systems of the other services is a major consideration in the selection of certain equipments. The primary objective of this program is to develop necessary display, peripheral and software systems for the AN/UYK–7 central processor system to permit effective integration into Navy command data systems. A secondary objective is to facilitate necessary interfacing with command data systems of other services. Compatibility with existing NTDS equipment and software will be maintained while providing the improved and increased capabilities made possible by the advance features of the UYK–7 system. Integration of additional tactical functions will be accomplished, and extensions of the UYK–7 system to other integrated command and management data systems will be investigated. In addition, software management methods and standardization procedures to insure system compatibility and reduce software production costs will be developed and evaluated.

The tactical data system requirements for each service are really quite different and each service has developed a system to best satisfy its individual needs with the compatibility requirement secondary. This is as it should be because groupings from a service function as a tactical entity and crosstalk between services generally occurs only in the higher level, decisionmaking areas. Therefore, each of the tactical groups pass information freely among themselves and crosstalk between services must pass through an interface computer.

Mr. LIPSCOMB. What is the relationship of this program to such naval systems as the IDHS, NTDS, flagship data system, tactical intelligence processing support, and others?

Dr. FROSCH. This program is intimately related to all Navy command data systems. The major function of the program is to develop the necessary display, peripheral, and software systems to permit effective integration into Navy command data systems such as IDHS, NTDS, flagship data system, and others. This program will insure

that integration of additional tactical functions are accomplished and that extension of the UYK–7 system to other integrated command data systems is investigated.

SHIPBOARD ELECTRONIC WARFARE

Mr. LIPSCOMB. The fiscal year 1970 program for shipboard electronic warfare totals ——— million. In fiscal year 1969 the program was $31.1 million and in fiscal year 1968 it was $25.6 million. Will you briefly describe this rather expensive program?

Dr. FROSCH. This is a program that will provide advanced equipments that are capable of being integrated into an overall electronic warfare system (for ships) that will detect, recognize, locate, and counter enemy electromagnetically controlled weapons in the ever-increasing sophisticated electronic environment that our Navy must operate in.

The program would develop several different systems as briefly described below:

(*a*) *Ships advanced EW system (Shortstop).*—A modular system composed of electronically scanned passive receivers, computerized threat recognition and computer-assisted reactive countermeasures control against known and postulated threats.

(*b*) *Infrared countermeasures.*—Infrared receivers, trackers, countermeasures, decoys, and signature suppression means.

(*c*) *Tactical EW deception system.*—Primarily chaff decoys ———.

(*d*) *Radar cross section reduction.*—Measurements of ships radar reflective characteristics and development of means for reducing it.

(*e*) *ECM tubes.*—Advanced development of electronic countermeasures tubes and power amplifiers.

(*f*) *Ships integrated electronics system.*—Total integration of all shipboard electronics equipment (radars, communications, electronic countermeasures, IFF, and so forth).

NEW SYSTEMS FOR DXGN

Mr. LIPSCOMB. The Navy is requesting shipbuilding funds in fiscal year 1970 to initiate construction of a proposal of a fleet of DXGN frigates. These ships will be equipped with several new systems, such as the Shortstop electronic warfare system, a new digital ASW fire control system, and a new MK–26 combined launcher system. How confident are you that these new systems can be developed in time for installation aboard the first DXGN frigate?

Dr. FROSCH. We consider these new systems to be low-risk programs and are confident that they will be ready in time for installation on the DXGN frigate. The first basic Shortstop will be delivered in ——— and this should leave ample time for the variant model to be developed for the DXGN. The contract for the design, development, and fabrication of the MK–26 launcher was awarded in March 1968. Completion of operability tests and life cycle testing is scheduled for October 1971 with delivery dockside of the first production unit in ———. Since the launcher utilizes many of the current state-of-the-art technology improvements that have satisfactorily passed prescribed operability tests, the risk involved in this program appears to be minimal. We are confident that the digital ASW system which uses

the AN/UYK-7 digital computer will be ready for installation on the first DXGN.

Mr. LIPSCOMB. With respect to these new systems for the DXGN frigates, are we facing the same risk that we had in the construction of the DE-1052 and DE-1078 class destroyer escort construction program?

Dr. FROSCH. No; we are confident that these new systems can be developed in time for installation aboard the first DXGN frigate.

Mr. LIPSCOMB. How much do we have in the fiscal year 1970 Navy budget, by appropriation, for each of the new systems we have just discussed?

What is the difference between the Shortstop, Sr., and Shortstop, Jr., EW systems?

Dr. FROSCH. The fiscal year 1970 funding is as follows:

[Dollar amounts in millions]

Equipment	R.D.T. & E., N.	SCN
MK-26 launcher	——	12.1
Digital ASW system	——	1.16
Shortstop	——	5.26

The difference is in the numbers and sizes of equipments required to provide maximum capability possible. The reason for development of Shortstop Jr. equipments is that smaller ships cannot physically accommodate the complete Shortstop system. Three variants—Shortstop Jr.—of the Shortstop system are being developed.

From the inception of the Shortstop program an overriding consideration has been the necessity for utilization of common hardware and equipment modules for reconfiguration into systems groupings of reduced complexity and cost/size—with reduced capability—for smaller ship classes. With approaching finalization of system design details in the development modules, it has been possible recently to establish a basic system configuration for major ship groupings. The rationale for these groupings has been developed from analysis of several recent studies concerning the emerging antiship threat and projected Navy ship construction programs such as DX, DXG and LHA.

The results of these analyses have been translated to procurement documentation to permit initiation of redesign, repackaging, and development of those elements of the system required to satisfy the smaller ship requirements. A composite of the different variants of system configuration is as follows:———.

Since these system elements do not represent radical techniques, development, or total system composites, technical and operational validation of their performance can be gained by injecting them into the continuing system complex at FAAWTC, Dam Neck prior to undertaking procurement of service equipment.

As a part of DXGN contract definition, some engineering is being accomplished in the digital ASW system but the dollar amount cannot be readily identified as it is a portion of the total combat system integration effort.

Shortstops total R.D.T. & E., N in fiscal year 1970 is 14 million of which 3.75 million is for the variant which applies to DXGN as well as other comparably sized ships.

OPERATIONAL PERFORMANCE DATA SYSTEM

Mr. LIPSCOMB. How does the operational performance data system for which you are requesting ——— million in fiscal year 1970 differ from all the other data systems we have been discussing?

Dr. FROSCH. The operational performance data system differs from the other systems in that it does not process data at the place where the data is recorded, and present the results in real time to the user, for command and control of forces. Instead, data relating to operational performance is collected by many different fleet units and is forwarded to a central processing facility where the data is reduced.

SHIP CONTRACT DEFINITION

Mr. LIPSCOMB. For the current fiscal year you were funded $17.4 million for ship contract definition. Exactly how were these funds utilized, by ship type, and whether in-house or to a contractor?

Dr. FROSCH. The fiscal year 1969 funds for ship contract definition are being used for the DXGN. This is primarily being conducted in-house. Certain portions of this effort have been contracted out.

Mr. LIPSCOMB. How much has been obligated to date?

Dr. FROSCH. To date we have obligated $12.4 million.

Mr. LIPSCOMB. For fiscal year 1970, you are requesting $25 million for this purpose. On what type ships will contract definition be conducted during fiscal year 1970?

Dr. FROSCH. We will not have firm plans on which ship will enter contract definition until we review our progress in concept formulation. The most likely candidates at this time are the DXG and the LFS.

Mr. LIPSCOMB. What is the relationship of this element to that of new ship design which we had discussed earlier?

Dr. FROSCH. Under the new ship design element we conduct concept formulation (CF) which is a prerequisite to contract definition (CD). During this first phase we conduct tradeoffs of different weapons systems and ship configurations to determine the most efficient combination of equipments to fulfill a mission. When we have satisfied ourselves that we have found the optimum combination of systems for the ship we then proceed to CD. During CD we invite industry to translate the broad parameters of weapons and ship performance into a ship design that will be most efficiently produced by their management procedures and manufacturing techniques.

HARPY

Mr. LIPSCOMB. Under the element communications systems, you have been funded a total of $5.5 million for HARPY. You are requesting ——— million for this purpose in fiscal year 1970. What is HARPY?

Dr. FROSCH. HARPY is a communication system ———.

PROJECT SECT

Mr. LIPSCOMB. It has been reported in the press recently that the Navy has awarded $4.2 million in contracts to Collins Radio since

the first of the year for project SECT submarine emergency communications transmitter. Is this the outgrowth of the loss of the *Scorpion*?

Dr. FROSCH. No, although the *Scorpion* loss did foster a proposed refunding, not yet approved, which would facilitate a limited acceleration of the SECT initial operational capability.

Mr. LIPSCOMB. Would you please describe this equipment and how it will be utilized?

Dr. FROSCH. The SECT system is contained in a cylindrical buoy (about 10 feet x 18 inches) which would be released either manually by the crew or automatically in case of a catastrophe. The buoy surfaces and transmits on four high frequencies to automatic receivers ashore. We plan to install this system on all submarines so that the transmitter can alert rescue authorities and also act as a homing beacon in locating a submarine in distress. On the SSBN, two SECT buoys will be installed for added reliability. The buoys are mounted external to the pressure hull. Internal to the pressure hull is a control system which would release the buoys if certain safety parameters are exceeded. This system will release the buoy when: (1) the water depth exceeds that of safe submarine operations, (2) subject to an internal pressure that exceeds certain limits, (3) a dead-man's switch is not reset by the crew at two hour intervals. The dead-man's switch has an alarm which warns the crew several minutes before release. The dead-man's switch ensures release of the buoy should the entire crew become incapacitated. It is expected that one of the two buoys in the SSBN would survive even though the submarine is hit with a torpedo midway between the buoys. This difficult survivability requirement is the primary reason for the extended development associated with this system.

INTELLIGENCE SYSTEMS

JOINT SERVICES IN-FLIGHT DATA TRANSMISSION SYSTEM (JIFDATS)

Mr. LIPSCOMB. Dr. Frosch, you are requesting ——— million in fiscal year 1970 for intelligence systems. A total of $16.1 million was funded for this purpose in the last 2 fiscal years. Will you explain briefly the joint services inflight data transmission system for which you are asking ——— million in fiscal year 1970?

Dr. FROSCH. Certainly.

One of the problems which developed in Southeast Asia was the difficulty of getting intelligence and reconnaissance information from the reconnaissance aircraft back to fleet, Army and Air Force—well, particularly Navy and Air Force headquarters ———.

There was considerable discussion of how to do this. In the end the Navy was assigned the managerial task of trying to bring such a system into being and that is what we are engaged in doing.

Mr. RHODES. You are asking ——— million in fiscal year 1970 for this program?

Mr. FROSCH. I believe that is correct.

STATUS OF JIFDATS

Mr. RHODES. What is the status of the program at the present time?

Dr. FROSCH. The status of the program is that we are now in the state, I believe, of expecting final proposals for total system integration.

This is a system-integration job. That is the best way to describe it. Some of the sensors and some of the equipment exists or has been developed or is in development. The basic problem is to find the pieces of equipment that exist, to develop the pieces that don't exist and to develop the things that tie them together into a system that can transmit the right information. So that the previous funds were spent principally on pieces of equipment and the beginnings of general design ideas. Now, we have gone out for proposal and I don't remember whether we are about to get the proposals—we are getting the proposals this month which will be evaluated and a contractor will be selected to do the development of the total system integration.

Mr. RHODES. Do you have any idea how soon the contractor will be selected?

Dr. FROSCH. We get the proposals this month and probably another month for evaluation so it would sound as if it is the end of the summer or the early fall.

Mr. RHODES. Are you having any problems with the other services as to getting agreement on the type of system that you want in this joint endeavor?

Dr. FROSCH. Yes. I think nothing extraordinary. The problems have come about because the three services have slightly different intelligence aircraft that they want to fit this system into, so there is a diversity of requirements and there is a real technical problem in building a system which will satisfy all the requirements. In order to do this sensibly, there has to be some discussion and jockeying around among the services to see what requirement would be shaved slightly at the edges so one could make a sensible system. I think that has been done over a period of months with quite a lot of discussion and I am sure a certain amount of table pounding but I think everyone is reasonably satisfied that we have a systems specification that satisfies all the needs.

Mr. RHODES. You see no insurmountable obstacles?

Dr. FROSCH. Not at this time. If there are problems, they will come when we begin to have detailed systems design and hardware going together, and there is still the possibility of not being able to fit everything into each airframe, but we see no problem like that at this time.

Mr. RHODES. Thank you, Mr. Chairman.

COST OF JIFDATS

Mr. LIPSCOMB. What was the original estimated cost of the system, and what is the current estimate?

Dr. FROSCH. Early cost estimates by the Inter-Service Coordinating and Integrating Group (ISCIG) in June 1965 were based on a system limited to a 5 MHz bandwidth and comprised of existing off-the-shelf components except for relay aircraft equipment. Estimates at that time were as follows:

	Million
First articles	$13.550
Production	31.200

Current budgetary estimates listed below are the results of several changes:

a. The 5 MHz bandwidth restriction has been rescinded.

b. Utilization of off-the-shelf components (which would have resulted in a system obsolete when first produced) is no longer required, thus enabling development of a state-of-the-art system.

c. Individual service requirements have been increased to require system compatibility with wideband sensor developments currently underway.

d. Planned production, based on individual service requirements have increased over original estimates.

	Million
Engineering development	$34.4
Production for all services	245.9
Total as of April 14, 1969	280.3

Mr. LIPSCOMB. Page 446 of the justification book indicates total estimated R.D.T. & E. costs to be $28.9 million; however, information furnished the committee indicates these costs to be $34.4 million. For example, your fiscal year 1969 funding of $7.990 million does not include reprograming and MIPR actions, which would bring the fiscal year 1969 funding to $13.9 million. Could the amount in the justification book be in error?

This system has been described in the press as ultimately costing $300 million to $400 million. Information furnished the committee indicates that proposed procurement of equipment will be approximately $66.3 million and this doesn't include nonrecurring costs, spares, publications, training, and contractor support. The estimated cost of modifying the aircraft to accept sensor and relay subsystems ranges from $70,000 to $124,000 per aircraft. In addition, there will be installation costs for surface terminals on the ground and aboard ships. Do you have any estimate for the overall cost of this program?

Dr. FROSCH. Information provided the committee reflecting a total amount of $34.4 million budgeted and planned for development was correct. The difference between the figure of $7.990 million actually appropriated in fiscal year 1969 and $13.9 million is represented by the $2 million each from Army and Air Force MIPR actions, and by $1.86 million reprogramed into fiscal year 1969 from prior years.

As of April 14, 1969, the R.D.T. & E., and total planned production requirements, installation including nonrecurring costs, spares, publications, training and ancillary costs for all services was estimated to be $280.3 million.

JIFDATS DEVELOPMENT

Mr. LIPSCOMB. How long has this system been under development?

Dr. FROSCH. The individual services commenced development of components that would transmit imagery of certain sensors as early as 1957. None had the capability that JIFDATS will have. No JIFDATS development contract has been let but source selection is nearing completion at this time.

Mr. LIPSCOMB. How far has this program slipped and what were the reasons?

Dr. FROSCH. The program has slipped approximately 2 years due to changes in direction received from D.D.R. & E., changes to accommodate revised technical requirements of the individual services and the change in method of contracting from a two-step formally advertised fixed-price contract for development and production to a cost-type contract covering development only to be followed later by a separate production contract.

Mr. LIPSCOMB. The committee understands the Air Force is buying data link equipment produced by Cubic under the Seaor–45 program because of slippage in the Jifdats program. Is this true?

Dr. FROSCH. This is not true. The Air Force contract is intended to procure equipment to satisfy an immediate Southeast Asia requirement. The equipment will have far less capability (IR data transmission only) than JIFDATS, and will not have the growth potential of JIFDATS.

Mr. LIPSCOMB. Has the Navy recently changed the proposed method of procurement from a two-step formally advertised fixed-price contract to a research and development contract only with no procurement? Why was this done?

Dr. FROSCH. The Navy did recently change the proposed method of procurement from a two-step formally advertised fixed-price contract to a development contract only. This was done because recent developments in wideband sensor equipment capability threatened to render production models of the JIFDATS envisaged under the original contract method obsolete by the time of delivery. Accordingly, the revised contract method permitted a greater opportunity to develop a system meeting the operational requirements of all the services and with the growth potential of meeting future requirements. It also permits more extensive test and evaluation prior to entrance into production.

ELECTRONIC WARFARE SYSTEMS

Mr. LIPSCOMB. Your request in fiscal year 1970 for electronic warfare systems is ——— million. In fiscal year 1969 your program was $12.7 million and in fiscal year 1968 it was $17 million. Will you provide for the record a brief description of the various subelements, and how the fiscal year 1970 funds will be spent?

(The information was provided to the committee and is classified.)

CONCERN OVER SOVIET ANTISHIP MISSILES

Mr. LIPSCOMB. Page 31 of your statement indicates that current concern over survivability of surface ships has been heightened by recent demonstrations of the effectiveness of some available weapons and delivery vehicles. When, where, and by what weapons and delivery vehicles has this been demonstrated?

Dr. FROSCH. The effectiveness of the Soviet Styx antiship missile was most recently demonstrated to the world in October 1967 when the Egyptians sank the Israel destroyer *Elath* in the Mediterranean. The following factors give the Navy cause for concern regarding antiship missiles:

a. The number and types of antiship missiles in the Soviet inventory continue to increase.

b. The variety of launch platforms available, that is, destroyer, cruiser, patrol craft, aircraft, submarine and shore sites and the ———.

c. The U.S.S.R. has exported several versions of their antiship missiles to other nations ———.

d. Apart from our capability to destroy enemy launch platforms or sites by attack carrier strike forces, the Navy possessed a ——— capability to counter this threat.

SHIP ANTI-MISSILE INTEGRATED DEFENSE (SAMID)

Mr. LIPSCOMB. Earlier this year the Navy reprogramed $13.3 million from the fiscal year 1969 Southeast Asia emergency fund to the procurement and O. & M. accounts for the Ship Anti-missile Integrated Defense. This action was to provide ——— ships with an immediate improved capability to counter the antiship missile threat. What equipment installation and modification work was involved in this immediate Samid program?

Dr. FROSCH. The $13.3 million programed for SAMID in 1969 has been utilized in accomplishing the following:

a. ——— ships will be outfitted with an improved capability to counter antiship missiles. These include ——— DD-710 class FRAM destroyers, ——— CLG-26 class guided missile frigates and ——— DDG's.

b. The immediate package consisted of the following improvements:

(1) Improved passive EW detection and improved active EW deception equipment ———.

(2) ———.

(3) Relatively simple modifications were added to several search radars to improve clutter performance and to improve the man-machine interface ———.

(4) The fire control systems were also given the best available modifications to improve their capability to detect, acquire, and track the anti-ship-missile-type target. The following mods were added to fire control systems:

———.

(5) The greatest need in combating an anti-ship-missile in present ships is to decrease the reaction time from detection to response as this is a critical element of the attack. A considerable effort was made to integrate for the first time active and passive sensors with all other elements of the ship. This was accomplished successfully through the utilization of data transfer units which improved inter/intra system data transfer and provided the decisionmaker with a much faster means of grasping the situation and initiating the proper response with deceptive EW equipment and/or weapons. This approach has proved most beneficial in all ships in which it has been installed. To supplement the equipments a comprehensive manual of integrated procedures was also developed and provided for each ship equipped.

(6) Finally an attempt was made to provide SAMID ships with an improved means of training to better prepare the crew to react to an anti-ship missile. This was accomplished by providing a 15E27ECM signal generator for training EW operators and an SPH-1 radar video

recorder which facilitates team training from prerecorded audio and video tapes prepared with appropriate scenarious to provide a realistic threat environment.

Mr. LIPSCOMB. Under what programs and for what purposes were the chaff rocket launchers and BMC equipment originally developed?

Dr. FROSCH. ———.

Mr. LIPSCOMB. When will installation be complete on the ——— ships involved?

Dr. FROSCH. ———.

Mr. LIPSCOMB. What kind of capability will be provided with this interim "quick fix" effort?

Dr. FROSCH. ———.

Mr. LIPSCOMB. What is involved in the so-called near-term SAMID program and what capability will it provide?

Dr. FROSCH. ———.

Mr. LIPSCOMB. How much is in the fiscal year 1970 Navy budget, by appropriation, for the near-term SAMID program?

Dr. FROSCH. ———.

Mr. LIPSCOMB. Will either the immediate or near-term SAMID program protect against a massive cruise missile attack?

Dr. FROSCH. ———.

Mr. LIPSCOMB. If the near-term SAMID program does not represent the ultimate in a surface missile defense system, what is the optimum system and how far away are we from its development?

Dr. FROSCH. ———.

Mr. LIPSCOMB. Isn't this a very expensive and time-consuming means of developing a surface missile defense system? Why not initiate and complete a new development program instead of going to the added expense of continually upgrading shipboard equipment until you get what you want?

Dr. FROSCH. Continual upgrading of shipboard equipment is expensive and time consuming, but often less expensive than new construction and long leadtime development programs when considering the overall needs of the fleet. The magnitude of the anti-ship-missile threat is such that a calculated risk to wait for the development of a completely new system appears unsound. Furthermore, the majority of ships of the operating forces in being often cannot accommodate complete new system concepts without major conversions which are often as expensive and time consuming as new construction which accordingly reduces the number of ships which can be properly equipped. In addition, current operational commitments are such that units of the fleet are being exposed to the threat now. The immediate and near-term programs are relatively low-cost programs when compared to the overall value of the ships being provided this capability and are providing an immediate response to a known threat.

RELATIONSHIP OF SAMID TO OTHER MISSILE SYSTEMS

Mr. LIPSCOMB. Will SAMID become a part of either the basic, improved, or the advanced point defense system?

Dr. FROSCH. The SAMID program is an integral part of the overall antiship missile defense program and is responsible for the integration of all subsystems into an integrated combat system. The basic point

defense system will be treated for integration purposes the same as any other weapon systems installed in program ships, e.g. gun systems, Terriar, Tartar or Talos, and EW countermeasure systems.

Mr. LIPSCOMB. What is the relation of SAMID to the 3 T's and the Advanced Surface Missile System?

Dr FROSCH. SAMID would promote and incorporate certain aspects of any weapon system which relates to antiship missile defense. The 3 T's are the Navy's foremost AAW weapons for surface ships and inherently possess capabilities against antiship missiles. The SAMID program has attempted to exploit those particular capabilities of the 3-T systems which are most applicable to countering this threat. In addition a systematic effort has been expanded in the integration of these systems with other sensors, active and passive, deceptive countermeasures, and command and control elements of the ships involved. Similarly the SAMID program will carefully monitor the ASMS development to insure system integration is achieved within the objectives of the overall antiship missile defense program. ASMD requirements have been included in the basic development contracts of ASMS.

ORDANCE, COMBAT VEHICLES AND RELATED EQUIPMENT

Mr. LIPSCOMB. The fiscal year 1970 budget estimate for ordnance, combat vehicles, and related equipment is $109.1 million, which is $54.7 million less than the current program.

MK-48 SHIP TORPEDO

You are requesting a total of $34.3 for the wire guided MK-48 antisubmarine/antisurface ship torpedo. In the last 2 fiscal years this program has been funded a total of $78.9 million. How much have we programed through fiscal year 1969 for the MK-48 torpedo family, all models?

Dr. FROSCH. A total of $207,201,000 has been provided through fiscal year 1969 for the MK-48 torpedo development.

MK-48 MOD 0

Mr. LIPSCOMB. Will you explain the reason for the different MK-48 programs, the MK-48 Mod 0 on the one hand, and the MK-48 Mod 1 and 2 on the other?

Dr. FROSCH. The MK-48 Mod 0 program is designed to fulfill our most urgent need—an antisubmarine torpedo for fleet use to provide a weapon to counter the current high speed-deep-diving threat ———. The MK-48 Mod 1 and 2 program will provide in a later time frame not only the ASW capability so sorely needed but will also provide an antisurface ship capability against the ever increasing numbers of enemy targets on the surface of the oceans. It is intended to ultimately have only the dual purpose version in the fleet.

Mr. LIPSCOMB. Your justification book indicates the MK-48 Mod O program will cost an estimated $202.8 million and a total of $178.1 million had been committed to this program through fiscal year 1969.

The Mod O program slipped because the torpedo did not provide acceptable ——— performance. How far has this program slipped, and have all the problems been solved and verified through tests?

Dr. FROSCH. Initial fleet delivery of the Mod O was scheduled for ———. Current estimate of fleet delivery is ——— indicating about a ——— slip overall. This, however, ignores the fact that in the fall of 1965, $8.7 million was approved to accelerate fleet delivery over the ——— date. Considering this I would estimate the program to be about ——— late. Solutions for all known problems have been identified and verification runs are currently being made.

Mr. LIPSCOMB. Your justification book states that during fiscal year 1969 problem solutions have been defined and in-water tests in the third quarter of fiscal year 1969 is expected to confirm this. Evaluation of this torpedo will continue through fiscal year 1970. In view of the problems experienced thus far and lack of confirmatory testing, why is the Navy requesting $110 million in fiscal year 1970 for procurement of ——— such torpedos?

Dr. FROSCH. The urgent need for an effective ASW torpedo dictates concurrent production and testing. We believe that as presently configured the Mod O version provides a ——— advantage over current weapons. It can ——— and therefore is considered worthy of production at its current testing stage.

MK–48 MOD 1/2

Mr. LIPSCOMB. You are requesting $14 million in fiscal year 1970 for the MK–48 Mod 1/2 torpedo development, and a total of $29.1 million has been programed for this purpose through fiscal year 1969. Why do you have two concurrent programs underway, when development of Mod O has not been completed, and a decision was to have been made in May 1969 between the Mod 1 and Mod 2?

Dr. FROSCH. Program slippage has precluded a ——— decision between the versions of the MK–48 torpedo. Our desire is to make production decisions based on in-water testing. Since the production decision matrix has not been completed by any version we consider it urgent to prosecute both programs until one results in a fully tested production model for fleet use.

Mr. LIPSCOMB. If Mod 1 or 2 is the ultimate, why buy any MK–48 Mod O Torpedoes at all? Why not wait until the follow-on torpedo is developed?

Dr. FROSCH. Procurement of the Mod O will fulfill the most urgent requirement of the Navy—the ASW version. This program will currently provide a fleet capability at least ——— earlier than the Mod 1 or Mod 2, and if we should run into any problems at all in the development of the dual purpose version, the Mod O will still provide a weapon to counter the most serious threat.

Mr. LIPSCOMB. Why is this torpedo requirements necessary when we have Subroc and ASROC?

Dr. FROSCH. ———.

Mr. LIPSCOMB. What torpedoes will the MK–48 replace?

Dr. FROSCH. The MK–48 is expected to replace ——— in the submarine force and may provide the surface forces with a heavy torpedo as an addition to their arsenal.

Mr. LIPSCOMB. How many different torpedoes do we have in the fleet at the present time? I have heard there are at least 16 different types.

Dr. FROSCH. ———.

Mr. LIPSCOMB. Is there any program or study being made to reduce the numbers of torpedoes in the inventory?

Dr. FROSCH. The MK–48 program will reduce the number of types of torpedoes in the inventory appreciably. Submarines will be reduced to ——— for instance, after the introduction of the dual purpose torpedo. The overall numbers in the torpedo inventory is determined by the nonnuclear ordnance requirements and this is reviewed annually.

Mr. LIPSCOMB. Provide for the record a list of the number of submarine-launched, ship-launched, and air-launched torpedoes, their mission, range, and other characteristics.

(The information follows:)

AIR-, SHIP- AND SUBMARINE-LAUNCHED TORPEDOES

Air launched torpedoes.—MK–46, Mod 0 and 1, MK–44-Mod 0 and 1.
Ship launched torpedoes.—MK–46, Mod 0 and 1, MK–44-Mod 0 and 1.
Submarine launched torpedoes.—MK–14, Mod 5, MK–16, Mod 8, MK–37, Mods 0. 1, 2, 3, MK–45. Mod 0 and 1.

(CLERK'S NOTE: The information on mission, range, and other characteristics was provided to the committee and is classified.)

WALLEYE II

Mr. LIPSCOMB. You have a request for ——— million in fiscal year 1970 to complete development of Walleye II and continue the improvement program. Your program for the last 2 fiscal years totals $11 million. What is involved in the improvement program?

Dr. FROSCH. The Walleye improvement program to essentially ——— the effective standoff range and the initiation of Walleye II, a larger ——— weapon that also will have the improved standoff capability.

Mr. LIPSCOMB. There is a request in the fiscal year 1970 OPN budget for ——— million to procure ——— Walleye weapons. Will these be of the Walleye II variety?

Dr. FROSCH. Yes, they will be of the Walleye II variety.

Mr. LIPSCOMB. When will you complete your evaluation and testing of Walleye II?

Dr. FROSCH. Evaluation and testing of Walleye II will be completed in ———.

Mr. LIPSCOMB. How much will it cost to complete the Walleye program?

Dr. FROSCH. The estimated R.D.T. & E., Navy cost to complete the Walleye II program is ———.

UNDERSEA WARFARE WEAPONRY

Mr. LIPSCOMB. You are requesting $20.8 million in fiscal year 1970 for undersea warfare weaponry. This program has been funded at a rate of $18.7 million for each of the last 2 fiscal years. What is the reason for the increase this year?

Dr. FROSCH. The increase of $2.1 million recognizes the existence of an upgraded undersea threat that will demand a significant increase

in the performance of our future ASW weapons. Submarines are being built stronger, quieter, and with a greater depth capability. The additional funds are being used to accelerate exploratory development in those areas which will provide greater improvement in the torpedo guidance and control systems and torpedo propulsion systems which are ——— and contain an energy source capable of functioning for longer periods of time thereby increasing the weapon's range. More emphasis is being placed on improving both the warhead and exploder effectiveness in order to insure optimum performance of torpedoes.

CURV II

Mr. LIPSCOMB. Your justification book mentions CURV II. Are you using this vehicle in connection with undersea warfare weaponry development?

Dr. FROSCH. The purpose of developing CURV II, the cable-controlled underwater research vehicle, is to locate and retrieve both experimental and operational weapons and ordnance from the sea floor and to perform work tasks on the sea floor at underwater weapon test ranges, test sites and other open ocean areas to depth of 2,500 feet. This will ultimately be extended to depths of 20,000 feet.

Mr. LIPSCOMB. What is meant by the ———.

Dr. FROSCH. ———.

EXPLORATORY DEVELOPMENT

Mr. LIPSCOMB. What weapons have been developed with the $37.4 million programed for the last 2 fiscal years?

Dr. FROSCH. The resources exploratory development are usually not directed toward the development of a specific weapon system, but toward the development of the science, technology, and expertise which will permit the Navy to meet any further need, requirement or threat in the area of undersea warfare weaponry. Future Navy undersea weapons—torpedoes, mines—will be required to operate at greater depths ——— for extended ranges and will have to be quiet, countermeasures resistant and effective—the ability to find and destroy its target. Practically every weapon now in existence has had its genesis in exploratory development.

The following are some of the accomplishments obtained in recent years:

1. The deep decovery system, CURV II, has been developed.
2. A new capability of detecting the ——— demonstrated.
3. Stored chemical energy propulsion system tests have demonstrated the feasibility of a closed cycle propulsion system for torpedoes.
4. A sea-water battery with ——— more energy density than batteries now existent in the fleet units was demonstrated.
5. The counter countermeasure—CCM—investigation of ———.
6. The deep-depth capability of DEXTOR ———.
7. ———.
8. An improved torpedo homing system was designed which incorporated the signal processing advantages of the ——— and the logic advantages of the ———.
9. A nonmagnetic, corrosion-resistant mine case ———.

Mr. LIPSCOMB. Will you explain how the fiscal year 1970 funds will be utilized?

Dr. FROSCH. The fiscal year 1970 funds will be utilized to promote the development of the technology in a number of areas. A concerted effort will be made to increase the undersea guidance and control of the torpedo to insure that it hunts, recognizes and attains its target. ——— and warhead technology will be pursued to insure that when the target has been located it will be destroyed effectively. New propulsion concept will be explored to insure quiet approach in order to avoid detection; extend range ——— to allow greater stand-off and greater speed ——— reliability and storage life. A portion of the resources will be used to develop mine structures capable of high-speed aircraft, submarine and surface delivery and mine mechanisms able to operate in deep and shallow water and in heavy ice-covered areas.

Specific examples of task areas in the fiscal year 1970 program are as follows:

1. A full-scale investigation of a high-density mobile mine hydrodynamic vehicle will be initiated.
2. The deep recovery system CURV III will be made operational at 7,000 feet.
3. The design of a wakeless propulsion system ——— will be continued.
4. Operational use will be made of the Cape North underice range in order to obtain needed data in this hostile environment in support of the Arctic cold weather ASW effort.
5. Ordnance penetration studies of sea ice will be conducted.
6. The ——— system investigation will be continued.
7. The analysis and evaluation of countermeasure susceptibility of advanced torpedo homing systems and the development of appropriate CCM techniques will continue in order to insure greater torpedo effectiveness.
8. A new family of mine cases containing an optimum payload and configurative is being developed.
9. In-water tests of an ——— which will increase the total effectiveness of a torpedo warhead will be conducted.

MARINE CORPS WEAPONRY AND VEHICLES

1970 PROGRAM

Mr. LIPSCOMB. You are requesting $2.4 million in fiscal year 1970 for Marine Corps weaponry and vehicles. The total program for the last 2 fiscal years was $5.9 million. In reading the justification book, there appears to be little work to be done in fiscal year 1970. Will you explain your fiscal year 1970 program?

Dr. FROSCH. Three task areas are funded in this program element in fiscal year 1970: Weapons improvement, rapid fire direct support weapon, and amphibious vehicle advanced study/design.

Individual projects under weapons improvement are in response to operationally developed requirements and for the expedient solution of minor problems attendant to existing systems. Therefore, while the Marine Corps expects to complete test programs on the Stoner weapons system and MECAR rifle grenades in fiscal year 1970, the full

effort is as yet undefined because of the immediacy with which operational requirements develop.

Fiscal year 1970 efforts on the rapid fire direct support weapon, a joint Army/Marine Corps project, will include exploratory development to define the parameters of the weapon prior to the award of a development contract and testing of a to-be-selected design approach.

The amphibious vehicle advanced study/design task area includes plans for the evaluation and testing of engines, transmissions, steer units, and auxiliary propulsion devices in fiscal year 1970, and on into fiscal year 1971. A program conducted by analogs, models and existing hardware in the areas of beach and surf conditions is also planned for fiscal year 1970 and fiscal year 1971 to determine:

(*a*) Surf classification relative to surf/vehicle model investigation:

(*b*) Methods to predict vehicle operations in the surf, transitional operations, and operations on the beach;

(*c*) Slope-strength relationship;

(*d*) River frequency for application of technique to beach operations; and

(*e*) Beach sand quick conditions, that is, conditions that exist on a beach which cause amphibian vehicles to become immobilized.

STONER WEAPONS SYSTEM

Mr. LIPSCOMB. The justification book mentions the Stoner weapons system. Is this weapon under test at the present time?

Colonel MCNEIL. The Stoner is a weapons system composed of the following:

(*a*) Assault rifle.
(*b*) Carbine.
(*c*) Light machinegun.
(*d*) Medium machinegun.
(*e*) Fixed machinegun.

The weapons are gas operated, air cooled, magazine or belt fed, semiautomatic or automatic weapons. All weapons of the Stoner system fire the standard 5.56-millimeter M193 (ball) and M196 (tracer) ammunition. To date, no problems have been encountered during the engineer design tests.

Mr. LIPSCOMB. Will you describe this weapon, the size projectile it will fire, and the problems you are experiencing with the weapon?

Colonel MCNEIL. Yes; two separate tests are being conducted: First, Stoner machinegun—the Marine Corps and the Army are conducting a joint engineer design and engineer test of the Stoner machinegun. Second, Stoner rifle and carbine—the Marine Corps is conducting engineer design and engineer tests of the Stoner rifle and carbine utilizing U.S. Army test facilities.

Mr. LIPSCOMB. What have been the Army/Marine Corps R.D.T. & E. costs for this weapon?

Colonel MCNEIL. Army R.D.T. & E. costs are involved primarily with one weapon of the Stoner weapon system, the Stoner machinegun. Joint Marine Corps/Army testing is being conducted with the Stoner machinegun for which each service is providing 50 percent of the costs.

Marine Corps R.D.T. & E. costs for Stoner weapons—machinegun, rifle, carbine, and associated equipment—will be $1,587,237, expended as follows:

Fiscal year 1964:	
Stoner-63 weapons	$272,738
Stoner ammo (.223)	16,943
Fiscal year 1965:	
Ammo for Stoner trial	3,528
Ammo for Stoner trial	16,980
Fiscal year 1966:	
Procure Stoner rifles, carbines, M.G., associated equipment and ammo. (1,080 weapons)	468,623
Ammo for Stoner	100,078
Magazine pouch	6,587
Stoner rebuild	30,000
Fiscal year 1967: Modify 8 Stoner 63 weapons to 63A configuration	13,484
Fiscal year 1968:	
Modify Stoner rifles	23,331
Stoner M.G. test	50,000
Stoner rifle and carbine engineer tests	80,000
Fiscal year 1969: Stoner M.G. tests with ammo	295,000
Fiscal year 1970: Stoner tests	210,000
Total MC costs	$1,587,237

Mr. LIPSCOMB. What weapon will it replace?

Colonel MCNEIL. If adopted, it is intended to replace our current small arms—M–1, M–14, M–16, light machinegun .45 caliber, and M–60 machinegun.

RAPID FIRE DIRECT SUPPORT WEAPON

Mr. LIPSCOMB. Will you describe the rapid fire direct support weapon mentioned in the justification book?

Dr. FROSCH. The rapid fire direct support weapon is the XM–164, a lightweight, towed 105 mm. howitzer which will fire all conventional and developmental 105 mm. ammunition. With rocket assisted projectile ammunition, its maximum range will be 15,000 meters. The weapon utilizes a variable recoil mechanism which reduces the amount of recoil in various firing positions—direct fire, high angle fire, and so forth. The XM–164 is the result of a Marine Corps development program that grew out of a stated requirement for a helicopter transportable 105 mm. howitzer. Its weight of 3,700 pounds is 1,300 pounds less than the present 105 mm. howitzer, thereby enhancing its helicopter transportability.

CHEMICAL AND BIOLOGICAL WEAPONS

Mr. LIPSCOMB. The fiscal year 1970 program for advanced BW/CW weapons is ——— million. This program totaled only $2.5 million for the last 2 fiscal years. Will you describe the fiscal year 1970 program to be funded, together with an explanation for the increase in this element?

Dr. FROSCH. ———.

Mr. LIPSCOMB. What is the difference between the BW/CW shipboard detectors under this budget element and the ——— requested for CW shipboard detector XM8 in budget activity 5 on page 433 of your justification book?

Dr. FROSCH. The M–8 is an Army field detector for CW agents and is being adapted for shipboard use. The BW/CW shipboard detectors will detect both biological and chemical agents.

Mr. LIPSCOMB. Will you provide for the record a table showing all Navy funding for CBR warfare in fiscal year 1970 for all appropriations?

(The information was provided to the committee and is classified.)

OV–10 TARGET MARKING SYSTEM

Mr. LIPSCOMB. How was $3 million funded in fiscal year 1969 used for the OV–10 target marking system?

Dr. FROSCH. The $3 million in fiscal year 1969 is being used to complete the feasibility demonstration models and complete contractor's flight tests of the complete OV–10 target marking system.

LANDING FORCE ASSAULT AMPHIBIOUS VEHICLES

Mr. LIPSCOMB. You are requesting $5.2 million in 1970 for landing force assault amphibious vehicles. Is this for the LVTPX–12 vehicle?

Dr. FROSCH. No; the money is for the LVTHX–5, the artillery vehicle in the LVTPX–12 family of vehicles.

LVPTX–12

Mr. LIPSCOMB. Are there any problems with the LVTPX–12 that have not been completely solved, such as high noise levels and other problems identified during engineering and service tests?

Dr. FROSCH. One problem exists. The contractor has yet to satisfy the requirement for serviceable weapons stations. The contractor has been advised of the necessity to expedite the contractual requirements concerning these weapons stations. Procurement will be withheld until these stations have gone through engineer and service tests and proved acceptable to the Marine Corps.

MARGINAL TERRAIN VEHICLE

Mr. LIPSCOMB. Last year we discussed the marginal terrain vehicle which looked very promising. Earlier this week we learned there still were problems with this vehicle. Will you describe these problems?

Dr. FROSCH. The problems that have delayed the development of the MTV are related directly to the suspension concept which the MTV is based on. The MTV is of the Airoll concept, which is best described as a series of free rolling, low pressure pneumatic tires which support the vehicle. The tires are connected by a pair of endless chains at the tire axles, with the chain being driven by a sprocket and idler arrangement. This suspension and propulsion system has the unique feature of operating as a wheeled vehicle on normal ground, and as a tracked vehicle when the tires are embedded in soft soil.

The primary problems occurring during engineering testing were the breaking or throwing of the chains, wheel axle failures, and sponson failure (structural problems).

The above problems occur when the vehicle is operating in extremely soft soil with extensive vegetation growth. Mud and vegetation have a tendency to build up in the rear sprocket area which causes extreme pressure on both the chains, and the entire suspension area—wheels, axles, sponsons, and so forth. The solving of this mud and vegetation buildup is the primary goal of the present program and should eliminate the problems described above. No problems have occurred with the powertrain—engine, transmission, steer unit—as they are already proven components and utilized in other military vehicles.

At the present time, a pilot vehicle is being rebuilt which will incorporate all modifications and engine changes and it is hoped that this will alleviate the previous development problems on the MTV. A thorough review of the MTV program will be conducted at the completion of the test of this vehicle to determine whether the MTV program will be continued or terminated.

Mr. LIPSCOMB. How much has been utilized for this vehicle and how much is unobligated?

Dr. FROSCH. Funds were provided to the Army Materiel Command by the Marine Corps as follows:

Fiscal year 1965	$120,000
Fiscal year 1966	990,000
Fiscal year 1967	4,420,000
Fiscal year 1968	2,200,000
Total	7,730,000

Of the $7,730,000, $5,515,000 has been expended by the Army Materiel Command in the development of the MTV; $2.2 million remains for the present and future development efforts.

Mr. LIPSCOMB. How much procurement funds do you have for this vehicle which has not been obligated?

Dr. FROSCH. A total of $9,042,500 was funded during fiscal year 1967 for the procurement of 200 XM759 MTV's. Of this amount, $916,000 were expended to procure powertrains, and $300,000 were set aside temporarily for contract termination contingencies. The remaining funds in the amount of $8.7 million were withdrawn to procure an additional 131 M116/M733's (MTV) due to delays in the XM759 MTV development.

Mr. LIPSCOMB. Does this vehicle now look as if it will be a valuable asset to the Marine Corps inventory?

Dr. FROSCH. Yes, sir. The MTV is designed to provide the landing force with a vehicle capable of operating freely over remote areas characterized by mud, sand, marsh, muskeg, snow, and inland waterways and still be capable of operating over hard surface and unimproved roads. The development program has indicated that the present XM759 has greater mobility over all types of marginal terrain than any known surface vehicle in use today or planned for the foreseeable future. This vehicle will provide the commander with a capability not presently available in the Marine Corps inventory.

ASW ROCKETS

Mr. LIPSCOMB. You have requested ——— million in fiscal year 1970 for ASW rockets. A total of $9 million has been programed for this purpose through fiscal year 1969 and the total estimated cost of this

program is ——— million. Will you describe this program and the reason for the increase in fiscal year 1970?

Dr. FROSCH. The extended range ASROC program is one which will ——— the range of an existing surface antisubmarine weapon system, maintaining our surface ASW weapon range on par with that of the expected enemy submarine launched torpedo threat and providing a weapon system that will complement achieved and expected improvements in sensor range performance. An increase in funds for fiscal year 1970 is required to support an increased level of activity now that we are proceeding into engineering development.

Mr. LIPSCOMB. What have you accomplished with the $9 million programed thus far?

Dr. FROSCH. Concept formulation, which includes six prerequisites on which conditional approval to proceed with engineering development depends, has been completed. This included flight-testing of six missiles and verification of preliminary missile design.

Mr. LIPSCOMB. What does your fiscal year 1970 program involve?

Dr. FROSCH. The fiscal year 1970 extended range ASROC program involves completion of contract definition, awarding a development contract and beginning rocket motor static testing.

CHEMICAL AND BIOLOGICAL WEAPONS

Mr. LIPSCOMB. Your request for BW/CW weapons in fiscal year 1970 is $——— million, which is at about the same rate for each of the last 2 years. Will you explain this program, Dr. Frosch?

Dr. FROSCH. ———.

Mr. LIPSCOMB. Why are you developing ——— under this element and ——— under the element entitled advanced BW/CW weapons to dispense what appears to be the ———. This appears to be either duplication or overkill.

Dr. FROSCH. ———. The difference is in the dissemination tactics and is not considered to be duplication or overkill.

IMPROVED HAWK SYSTEM

Mr. LIPSCOMB. Why is the Marine Corps asking for $500,000 in fiscal year 1970 for the improved Hawk system if it is an Army development?

Dr. FROSCH. These funds are required to support R. & D. efforts unique to the Marine Corps' utilization of improved Hawk, for example the service test of improved Hawk with the Marine Corps tactical data system (MTDS). The funds will also assist development of the assault fire unit, a portion of the Hawk missile battery comprised of a firing section, missiles and central equipment which is used during the assault phase of amphibious operations to provide close-in air defense. The Marine Corps will not have this capability with the improved Hawk system until this development is completed.

Mr. LIPSCOMB. The Army is still testing the improved Hawk system and I believe they may be experiencing some difficulties during tests. Is this so?

Dr. FROSCH. The Marine Corps is not aware that the Army is experiencing any undue difficulties in connection with the improved Hawk

testing; however, the U.S. Army can provide specific details regarding the status of tests.

Mr. LIPSCOMB. When will the improved Hawk be approved for service use? The first improved battery control central prototype will not be delivered until the first quarter of fiscal year 1970.

Dr. FROSCH. The current Hawk technical development plan (TDP) prepared by the U.S. Army Missile Command, Redstone Arsenal, Ala., lists expected type classification standard A during February 1971. The Marine Corps expects to approve the improved Hawk for service use following the completion of engineering and service tests.

Mr. LIPSCOMB. According to a news item of June [illegible], Raytheon was awarded a $953,000 initial increment to a $7.5 million cost-plus incentive fee contract for the improved Hawk missile system research and development program by the Army Missile Command. This doesn't sound like a developed system to me. What is the story on this contract?

Dr. FROSCH. This particular contract is for R. & D. of the improved self-propelled Hawk system in contrast to the improved Hawk which is a towed system. Since the Marine Corps is not planning to procure self-propelled or improved self-propelled Hawk, it is recommended that any specific questions regarding these systems be directed to the U.S. Army.

OTHER EQUIPMENT

MARINE CORPS TACTICAL DATA SYSTEM

Mr. LIPSCOMB. The fiscal year 1970 program for other equipment totals $280 million, an increase of $43.5 million. You are requesting ——— million in fiscal year 1970 for the Marine Corps tactical data system. Will you describe this system?

Dr. FROSCH. The MTDS provides semiautomated facilities for conduct of air defense/air control in the amphibious operating area. It provides, in a mobile configuration, the most advanced system of its type while providing an unprecedented reliability as witnessed by operations in RVN. Only the tactical air operations central (TAOC) and tactical data communications central (TDCC) have been introduced to the field at this time. The tactical air command central (TACC)) will be fielded shortly and a supervisory operators group/alternate tactical air command central SOG/ATACC) is under development to improve the capability of the TAOC.

Mr. LIPSCOMB. How much has been programed for this system through fiscal year 1969?

Dr. FROSCH. Funding to date has been as follows:

	Million
R.D.T. & E	$50.6
PMC	210.8
O. & M.M.C	18.3
O. & M.N	.1
MPMC	8.4
MPN	.5
MILCON	.9
Total	289.6

Mr. LIPSCOMB. Has this system been developed to be compatible and completely interfaced with the tactical data systems of the Navy, Army, and Air Force.

Dr. FROSCH. Yes, sir. The MTDS was designed to be compatible with the Navy tactical data system (NTDS) and airborne tactical data system (ATDS) and has demonstrated that capability most recently in the SEA interface testing. Data standards utilized are in keeping with JCS Pub 10 and testing to insure interoperability with emergent systems of the other services is a continuous effort.

Mr. LIPSCOMB. What is involved in your fiscal year 1970 program?

Dr. FROSCH. Proposed fiscal year 1970 Marine Corps expenditures are as follows in order of priority. Each succeeding item will be allowed for as funds become available; that is, from reprograming or subsequent fiscal year funding.

	Estimated expense
1. Support MTDS Test Unit	
2. SOG/ATACC	
3. Tactical Air Control Systems/Tactical Air Defense Systems (TACS/TADS) Joint Interface Test Program	
4. TAD in support of MTDS program	
5. Support for reliability and maintainability studies and limited systems analysis	
6. TABIL B/Improved Hawk Auto Data Processor (MBDL) Study	
7. AN/UYK-8, Micromin, Tactical, General Purpose Computer; Software Development for	
8. TACC Performance Study	
9. UHF Link 11 Development	

Mr. LIPSCOMB. Has any of this equipment been procured and delivered to the troops? You may provide that for the record.

(The information follows:)

The following equipments have been delivered to date: AN/TYQ-1, Tactical Air Command Central (TACC), none; AN/TYQ-2, Tactical Air Operations Central (TAOC), 9; AN/TYQ-3, Tactical Data Communications Central (TDCC), 14.

DEFENSE COMMUNICATION PLANNING GROUP

Mr. LIPSCOMB. You are requesting ——— million in fiscal year 1970 for the Defense Communications Planning Group. How much has been funded for DCPG through fiscal year 1969?

Dr. FROSCH. Navy R.D.T. & E. funding for DCPG has been for—

	In millions
Fiscal year 1967	$16.0
Fiscal year 1968	14.7
Fiscal year 1969	9.7
Total	40.4

Mr. LIPSCOMB. Will you describe the Navy's portion of DCPG and how you propose to use fiscal year 1970 funds?

Dr. FROSCH. ———.

Mr. LIPSCOMB. Have you been able to measure the effectiveness of this program compared with its cost?

Dr. FROSCH. A program for anti-infiltration-system development and the concurrent service responsibilities was started in Septem-

ber 1966 by the Department of Defense. Measures of effectiveness and total cost estimates did and do not provide a basis for estimating the effectiveness of this program compared with its costs.

Dr. John S. Foster, Director of Defense Research and Engineering, testified before the Commitee of the Armed Services, House of Representatives, April 30, 1969, as to the evolving field effectiveness.

Several fundamental facts have been illuminated during the program; specifically:

The use of sensors to extend the capability of military force elements to extract tactical data from hostile environments has been demonstrated.

———.

The benefits already obtained from the overall investment expended on special air-supported anti-infiltration efforts can be identified in:

———.

A system in being which was able to respond flexibly and remotely to the needs of the marines at Khe Sanh.

A base of knowledge, technology, and operational experience essential to the future development and fielding of sensors and sensor systems by the appropriate services.

The USMC and Navy are developing plans to integrate the technology into their normal roles and missions and initiate related new developments.

Mr. LIPSCOMB. How much will be required to complete this project?

Dr. FROSCH. The Navy does not have an estimate of funds required to complete the program. The program is managed by the Defense Communication Planning Group for the DOD.

UNDERSEA SURVEILLANCE SYSTEM

Mr. LIPSCOMB. The fiscal year 1970 program for undersea surveillance system is ——— million. The total estimated cost to complete this program through ——— is ——— million and a total of $61.8 million has been programed for this purpose through fiscal year 1969. Dr. Frosch, this is a rather expensive program. I realize you briefly discussed this in your statement, but would you elaborate on this in greater detail, explaining what equipment is being developed, what they will do, and how they will be deployed?

Dr. FROSCH. The program is broken out into two major efforts. These efforts are (1) engineering development which has as its goal the early introduction of improvements for upgrading performance of the present system to counter the immediate threat, and (2) advance engineering development which has as its goal the development of new subsystems to provide required capability for coping with the ———.

LABORATORY INDEPENDENT EXPLORATORY DEVELOPMENT

Mr. LIPSCOMB. The fiscal year 1970 program for "Laboratory independent exploratory development" is $10 million. A total of $22 million was programed for this purpose in the last 2 fiscal years. Will you explain the purpose of this money?

Dr. FROSCH. The purpose of the laboratory independent exploratory development program is to provide funds to the laboratory technical directors to capitalize rapidly on ideas generated by their staffs.

The existence of this program thus allows them to exploit in-house capabilities and to explore the feasibility of ideas without the necessity of competing for funds with weapon systems under development. In addition the program makes more attractive to the creative scientist or engineer the atmosphere of the in-house laboratory since he can initiate work on new ideas without the time-consuming effort required by the normal budget process. To continue to be supported by the technical director, however, he must compete with other in-house generated proposals.

Mr. LIPSCOMB. Under "Military sciences," you are requesting $16 million in fiscal year 1970 for in-house laboratory, a total of $29.7 million having been provided in the last 2 fiscal years for this purpose. In addition, under budget activity 8, "Programwide management and support," you are requesting $117.7 million for facilities and installation support, which are not chargeable to specific projects in other budget activities. Will you provide a clear and concise explanation of the difference between (a) laboratory independent exploratory development, (b) in-house laboratory, and (c) facilities and installation support?

Dr. FROSCH. The in-house laboratory element in category 6.1 (61101N) and the laboratory independent exploratory development element in 6.2 (62713N) are similar in nature but support different types of work. The in-house laboratory element (61101N) is used to stimulate original work in those fields of science and technology most closely related to the respective laboratory. Hence this program covers a wide spectrum of activity in the physical, engineering, environmental, and life sciences of potential benefit to the related developmental effort of each laboratory. The independent exploratory development program (62713N), on the other hand, supports in-house generated ideas for applying advances in the state of the art to the solution of Navy problems and to the improvement of weapons systems. Each laboratory's effort under this program is concentrated in those areas which are predominant in the laboratory's mission. Promising work under either program may be continued under other programs.

Funds for facilities and installation support provide for operation and maintenance costs at R.D.T. & E. activities which are not chargeable to specific projects in other budget subactivities and for investment costs in industrially funded activities. Costs include general administrative expenses and certain technical support; procurement of general-purpose equipment, technical instrumentation, and machine tools; equipment installation and laboratory alterations and rearrangements; and the operation of ships and aircraft in support of the R.D.T. & E. program.

The independent programs are sponsored in selected laboratories: the facilities and installation support program spans the total Navy R.D.T. & E. program.

Mr. LIPSCOMB. Will you provide some examples of the results of this research work in each of the three categories?

Dr. FROSCH. Examples of results of independent exploratory development (62713N) are:

(*a*) The effectiveness and practicability of adapting the ——— warhead to the ——— rocket were demonstrated. This warhead,

developed by the Naval Weapons Laboratory at Dahlgren for the Naval Air Systems Command, ——— and has the unique ability to defeat tough targets at large miss distances. This demonstration under IED showed such substantial gains in effectiveness that engineering development was funded in fiscal year 1969. The warhead has also become a leading candidate for application to other weapons.

(*b*) A special design of pump was developed which substantially ——— on submarines. A backfit program to incorporate this development in fleet submarines is underway.

(*c*) A high resolution radar system was constructed which shows promise for such uses as low-altitude obstacle avoidance especially for helicopters below 100 feet altitude.

Concepts originally developed under the in-house laboratory program (now 61101–N) led to missiles such as Sidewinder and Walleye and vehicles such as the surface effects ship currently under development. Examples of recent findings are:

(*a*) A nonacoustic submarine detection system was conceived and demonstrated. Some installations of this system have been made in the fleet for further evaluation.

(*b*) A new technique has been discovered which makes possible the diagnosis of eye defects by measurement of the brain's response to a visual stimulus. Medical and optometric professional groups are very interested in this technique for use with infants and others who are unable or unwilling to communicate their subjective response.

(*c*) Various types of stresses were found to produce changes in the levels of certain normal constituents of the blood; this finding shows great promise of enabling us to assess the stress level to which an individual is subjected.

No research work as such is done under facilities and installation support. These funds are used to procure equipment and instrumentation, to provide services of ships and aircraft to support feasibility tests and development programs, and to fund certain administrative and technical support at R.D.T. & E. activities which is not chargeable to specific projects in other budget subactivities.

Mr. LIPSCOMB. How do you propose to utilize the fiscal year 1970 funds for laboratory independent exploratory development?

Dr. FROSCH. The fiscal year 1970 funds for laboratory independent exploratory development will be used in the major Navy in-house laboratories as they have been in the past. As I mentioned before this program is planned at the local level. Plans are not reviewed and approved at the headquarter's level since this would nullify the independence and immediacy which are inherent in the purposes of the program. Accomplishments under this program are reported annually to the Director of Navy Laboratories by each laboratory participating in the program. In addition, visits to the laboratories by DNL staff members and representatives of the ONR branch offices are made to review the ongoing program and so headquarter's review is on a post-audit basis.

I might mention that this program has been very successful and we are well pleased with the results which have been achieved under it.

CHEMICAL/BIOLOGICAL WEAPONS AND DEFENSE

Mr. LIPSCOMB. The fiscal year 1970 program for chemical/biological weapons and defense is $1.7 million, a total of $2.3 million having been funded for this purpose during the last 2 fiscal years. Will you explain this program element?

Dr. FROSCH. The Department of the Army has the principal DOD responsibility for chemical and biological weapons and defense. The Department of the Navy utilizes information derived from the Army's program and maintains a relatively small technological effort of its own to explore those problems which are of unique Navy and Marine Corps interest. The element of chemical/biological weapons and defense supports the development of air-launched, surface-launched, and subsurface-launched BW/CW weapons and associated equipment with respect to safety, logistics, handling, stowage, delivery, new weapon concepts, and target analysis and effectiveness; and the development of detection devices and means to protect personnel, both collectively and individually, from environments both afloat and ashore contaminated by BW/CW agents.

Mr. LIPSCOMB. How does this program element differ from the other CW/BW program elements we have previously discussed?

Dr. FROSCH. In the area of chemical/biological weapons and defense we are not developing major systems but in this exploratory development area we are directing our efforts toward developing the technological base from which systems are derived. Typical of the areas of investigation are weapon concept formulation; explosive safety; binary chemical agent technology; advance warning and point sampling automatic detection investigations; and CB fleet defense requirements analysis.

UNDERSEA TARGET SURVEILLANCE

Mr. LIPSCOMB. Earlier we discussed a large program entitled "Undersea surveillance system." In fiscal year 1970 you are requesting ——— million for undersea target surveillance, and this program has been funded at a rate of about $26 and $27 million each of the last 2 years. Will you describe the undersea target surveillance program and tell us how it differs from the undersea surveillance system?

Dr. FROSCH. Whereas the undersea surveillance system program is dedicated to particular improvements in the ——— undersea target surveillance describes the exploratory development effort applicable to all our sensor systems related to undersea target surveillance. This includes airborne, surface ship, and submarine sensors ———. Analytical and experimental effort under the undersea target surveillance element is directed to demonstrating the technical feasibility of alternative surveillance systems, subsystems, and techniques to a degree which warrants their consideration for support in advanced development.

Mr. LIPSCOMB. Will you explain what equipment is being developed, what they will do, and how they will be deployed?

Dr. FROSCH. Specific equipments and systems to which work in undersea target surveillance applies include surface ship and submarine antisubmarine warfare (ASW) sonars, minehunting sonars, sensors,

airborne sonobuoy systems, ———. Improvements in these equipments will enhance our capability for detecting, classifying, localizing, and identifying enemy submarines and other undersea targets.

SURFACE/AEROSPACE TARGET SURVEILLANCES

Mr. LIPSCOMB. A total of $10.3 million is requested in fiscal year 1970 for surface/aerospace target surveillances. I note that in the past 2 fiscal years $19.6 million was funded for this purpose.

Will you expand on the remarks in your statement concerning this element?

Dr. FROSCH. My previous remarks emphasized two specific areas of effort pursued under the surface aerospace target surveillance program element. A general characterization of the work may be stated: Exploratory development to acquire the means to detect, classify, localize, and identify objects of interest. Such objects may be located on the surface, above the surface, in space, or in combination, and include surface vessels, ground-based targets, personnel, aeronautical vehicles, and astronautical vehicles. The detection of these objects may be made from surface vessels, ground bases, aircraft, space vehicles, or from hand held devices by naval personnel. Radiofrequency, optical, infrared, and ultraviolet technologies, in both the active and passive modes, are applicable. Development of intelligence collection and analysis techniques are also included.

Mr. LIPSCOMB. What have you developed in the past 2 fiscal years with the funds provided? You may provide that for the record.

(The information was provided to the committee and is classified.)

Mr. LIPSCOMB. How do you propose to use the fiscal year 1970 funds? Give us some examples?

Dr. FROSCH. Examples of planned effort using fiscal year 1970 appropriations include, ———.

COMMAND AND CONTROL

Mr. LIPSCOMB. The fiscal year 1970 program for command and control totals ——— million and about $12 million has been funded in each of the last 2 fiscal years for this purpose. We have already discussed a number of command and control research efforts earlier. Will you explain this budget element?

Dr. FROSCH. This budget element comprises exploratory development in support of Navy command and control systems which are designed to acquire, process, and disseminate information required by a commander in planning, directing, and controlling operations. Efforts encompass acoustic, electromagnetic, wire and other communications technology; acoustic, radiofrequency, optical/IR/UV, inertial and other navigation technology; and data processing including information transformation, storage, retrieval, and display technology, for ships, submarines, aircraft, and shore activities. Efforts also include the acquisition of observational data for predicting the position of celestial and space bodies, and the acquisition of oceanographic data for navigational and geophysical applications.

Mr. LIPSCOMB. What kind of equipment is being developed? You briefly discussed this in your statement, but I would like to have some specifics.

Dr. FROSCH. Equipment ——— for strategic applications and short-range acoustic communications for tactical operations between submerged submarines and surface ships are under development. Other equipment under development for ASW operations is the submarine/aircraft untethered communications buoy ———. Large screen displays operating in real time are under development for use on board ship in CIC's (Combat Information Center); command and control displays to assist attack submarine commanders in decisionmaking are also under development. Inertial navigation devices for ships are being developed ———. Also under development are airborne collision avoidance and station-keeping devices. Airborne reliable long- and short-range communications equipment with increased communications capability are also under development.

Mr. LIPSCOMB. What have you developed in the past 2 fiscal years with the $23.8 million provided?

Dr. FROSCH. There has been substantial progress in the development of broad-band antennas and multicouplers which has reduced the number of required submarine and shipboard antennas without impairing communications capability. Transducers have been developed which will permit underwater communications ———. A random access, 8-million bit memory storage has been developed which will increase the NTDS (naval tactical data system) capability. Another development which will greatly add to the NTDS capability, is the computer driven large screen display operating in real time ———. This display will shortly be placed on board ship for operational evaluation. We have also developed an airborne solid state teletypewriter with exceptional high reliability. We have made substantial improvements in the development of towed buoy antennas which permit operation at increased depths and higher towing speeds by submarines.

Mr. LIPSCOMB. How do you propose to use the fiscal year 1970 funds, with some examples?

Dr. FROSCH. The fiscal year 1970 program will include efforts to complete existing projects, continue others, and initiate new projects to meet the Navy's requirements. Such projects as the long-range acoustic communications project and the submarine-aircraft untethered communication buoys project will be completed and moved into advance development. Studies will continue on investigating the characteristics of underwater acoustic propagation. Work will continue on developing satellite and other type antennas for ships and submarines. Work will continue on submarine-towed communication bouys ———. Added emphaiss will be given in fiscal year 1970 to improving communication systems for use by amphibious/expeditionary forces by developing equipment which is smaller and more reliable. Projects will be initiated in fiscal year 1970 to improve airborne line-of-sight voice and data communications, investigate voice encoding techniques, and improve very low frequency communications between an aircraft and submerged submarine. ———.

New concepts in digital computer technology will be investigated, such as the modular computer which is projected for the 1975–80 time frame and which is intended as a general purpose digital avionics computer system that can be configured to meet different requirements by using a minimum number of standard building block modules.

COUNTERMEASURES

Mr. LIPSCOMB. Your fiscal year 1970 program for countermeasures totals ——— million and $11.4 million and $11.6 million was funded in fiscal years 1968 and 1969, respectively, for this purpose.

It appeared that the area of countermeasures was covered quite adequately in other budget activities and elements we have already discussed. What are you doing under this element that is not covered elsewhere in this budget?

Dr. FROSCH. In the countermeasures element we are performing development of an exploratory nature that will provide the technology base from which countermeasures systems and equipments are evolved. The work described elsewhere in the budget refers to those specific systems and equipments which have progressed from effort of an exploratory or general nature to that directed to producing a unique item to meet a specific operational requirement or need. Technology areas under investigation in this element provide the base for acoustic and electromagnetic jamming and deception systems that will be used to protect our surface ships, submarines, aircraft, and land bases from enemy attack by denying him a clear and unhindered view with his sensory equipments. Also, work is performed to improve our mine warfare equipment used to protect our forces from enemy mines by providing the basis for improving mine detection equipment, and mine sweeping and ordnance disposal equipment.

Mr. LIPSCOMB. What have you developed in the last 2 fiscal years with the funds provided?

Dr. FROSCH. During the last 2 fiscal years within the countermeasures element a number of program accomplishments have occurred ———.

Mr. LIPSCOMB. Please describe your fiscal year 1970 program with some specific examples.

Dr. FROSCH. ———.

MARINE CORPS EXPLORATORY DEVELOPMENT

Mr. LIPSCOMB. You are requesting $4.8 million in fiscal year 1970 for Marine Corps exploratory development; $6.3 million and $3.9 million was provided in fiscal year 1969 and 1968 respectively, for this purpose.

The justification book indicates that Battlefield IFF will progress out of exploratory development after fiscal year 1970 efforts are completed. Why is the Marine Corps requesting $1 million in fiscal year 1970 to procure 200 such equipments if exploratory development is not completed?

Dr. FROSCH. The service tests were completed during the second quarter of fiscal year 1969. Due to refinement which will be required prior to approval for service use, approval is expected during the third or fourth quarter, fiscal year 1970. The $1 million is in the procurement budget so that we may proceed expeditiously with procurement upon approval for Marine Corps use.

Mr. LIPSCOMB. How long has this equipment been under development and what has been the cost of this effort?

Dr. FROSCH. Equipment has been under development since March 23, 1967, when the Sierra Research Corp. proposal was accepted.

The cost for this IFF to date is $132,422.

Fiscal year 1966	$122,000
Fiscal year 1967	100
Fiscal year 1968	10,000
Fiscal year 1969	322

Mr. LIPSCOMB. When will tests be completed and when will this equipment be approved for service use?

Dr. FROSCH. Service tests have been completed. The final report was dated January 17, 1969. No further action on R.D.T. & E. of the BIFF will be scheduled until a decision is made with regard to the RCA AN/PPS-9 and General Dynamics Model 205 radars (AN/PPS-10). The Sierra BIFF was designed to be used in conjunction with the AN/PPS-6 which is a T/E item. The Marine Corps is looking at the 9 and the 10 with the view of the replacing the 6 with one of these devices. The advantage of the 9 and 10 over the 6 is weight—10 pounds as opposed to almost 40 pounds.

Mr. LIPSCOMB. Last year you testified that the Marine Corps works closely with the Army except where developments do meet amphibian requirements. Why is it that the Marine Corps developed a battlefield IFF system while the Army is developing a different system to meet a similar requirement?

Dr. FROSCH. As you are probably aware, BIFF systems are developed to be used in conjunction with ground surveillance radars. In that the Army and Marine Corps each have different ground surveillance radars, the Marine Corps developed a BIFF compatible with its system, the AN/PP-6. The Army utilizes heavier ground surveillance equipment, the AN/PPS-5.

SPECIAL LABORATORY SUPPORT

Mr. LIPSCOMB. What is special laboratory support for which $1.9 million is requested?

Dr. FROSCH. The special laboratory support project covers the Marine Corps test units task area which supports research and development efforts at the Marine Corps Development and Education Command (MCDEC), Quantico, Va., and the Naval Medical Field Research Laboratory (NMFRL), Camp Lejeune, N.C. MCDEC is responsible for the development of doctrines, tactics, and techniques to support amphibious operations. Tests of new equipment are also conducted at MCDEC prior to introduction into the Fleet Marine Force. Marine Corps funds provided to NMFRL are for exploratory work in the medical and dental aspects of amphibious operations.

Examples of efforts planned for MCDEC during fiscal year 1970 include:

(*a*) Support troop tests of LVTPX-12:

(*b*) Provide maintenance and test support of the medical unit, self-contained, transportable (MUST) system;

(*c*) Support test items, compatible communications system for tactical single channel secure communications; and

(*d*) Procure and evaluate test items, earthmoving and compaction equipment.

In all, approximately 50 projects will be assigned to MCDEC in fiscal year 1970 while some activity is expected on about 32 other proj-

ects ranging from maintenance support of battlefield surveillance radar to laboratory test support of sleeping gear (cold, wet, dry).

ADVANCED UNDERSEA SURVEILLANCE

Mr. LIPSCOMB. For fiscal year 1970, ——— million is requested for advanced undersea surveillance. This is an increase of ——— million over the fiscal year 1969 program.

Will you describe this work and how it differs from the other undersea surveillance work we have previously discussed?

Dr. FROSCH. The objectives of the long-range acoustic propagation project is to establish the environmental parameters which control long-range acoustic propagation for ——— systems; provide environmental support to the development, deployment, and operation of ——— and, provide oceanographic and acoustic propagation data to appropriate groups (R. & D., engineering, technical, and operational intelligence activities and the fleet). The principal direct tangible product will be numerical models relating environment to acoustic performance.

The ultimate integrated undersea surveillance system is envisioned as ———.

Mr. LIPSCOMB. Will you further describe Sea Spider, how it works and how it is deployed?

Dr. FROSCH. ———

Mr. LIPSCOMB. What has been developed under this element in the past 2 fiscal years with the $20.1 million provided?

Dr. FROSCH. ———.

Mr. LIPSCOMB. How do you propose to use fiscal year 1970 funds?

Dr. FROSCH. ———.

DEEP SUBMERGENCE SEARCH VEHICLE (DSSV)

Mr. LIPSCOMB. In the last 2 fiscal years, you have been funded a total of $52 million for ocean engineering systems development. For fiscal year 1970, you are requesting $30.4 million.

Why was $5 million eliminated from this program during the Nixon budget review?

Dr. FROSCH. DOD approved a development concept paper in January which called for serial rather than concurrent development of the deep submergence search vehicle. Consequently, when Bureau of the Budget and DOD reviewed the fiscal 1970 program, they reduced the funds identified for the search vehicle to a level which should permit serial development.

Mr. LIPSCOMB. What is the status of the DSSV development and what problems have been encountered?

Dr. FROSCH. No development problems have been encountered to date. The choice of a structural material for the control sphere has been narrowed to three candidate steels—a 9-nickel steel alloy, a 10-nickel steel alloy or an 18-nickel managing steel. Competitive contracts for the design of the fuel cell have been let to Pratt-Whitney and Allis-Chalmers. Lockheed is conducting a study on the impact of various tradeoffs in the vehicle/system configuration.

Mr. LIPSCOMB. How will this vehicle be utilized?

Dr. FROSCH. The vehicle will be used for deep ocean bottom search missions down to 20,000 feet and will have a 250-pound recovery capability. Consistent with budgetary considerations, it is planned to incorporate a heavy lift module in the vehicle. This would provide for an ——— recovery capability.

DEEP SUBMERGENCE RESCUE VEHICLE

Mr. LIPSCOMB. You have experienced cost overruns in the construction of the deep submergence rescue vehicle amounting to about $30 million. What will it cost to complete development of this vehicle?

Dr. FROSCH. The estimated total cost of the DSRV–I is ——— million. It will cost ——— million to complete development of this vehicle.

Mr. LIPSCOMB. How much is in the fiscal year 1970 budget for DSRV?

Dr. FROSCH. The amount budgeted in fiscal year 1970 for DSRV–I is $3.4 million.

Mr. LIPSCOMB. Will this amount be sufficient to complete construction of DSRV–1?

Dr. FROSCH. Yes it will be.

Mr. LIPSCOMB. How much will DSRV–2 cost, which is funded under other procurement, Navy?

Dr. FROSCH. ——— million.

Mr. LIPSCOMB. How many such vehicles will be required for the submarine rescue program?

Dr. FROSCH. The system, as originally conceived, called for six DSVR's. Two have been funded, with DSVR–3 budgeted for in fiscal year 1971.

DEEP OCEAN SURVEY VEHICLE AND THE NR–1

Mr. LIPSCOMB. What is the difference between the deep ocean survey vehicle and the deep submergence research ocean engineering vehicle, NR–1?

Dr. FROSCH. The deep ocean survey vehicle is a name of a project. We have no vehicle by that name. The intent of the project is threefold: first to determine if a manned submersible is more suitable than surface ships for certain types of ocean survey work, second to develop oceanographic equipments which can be used on submersibles, and thirdly to determine what the characteristics and capabilities of a submersible should be if one is built primarily for ocean survey use.

The NR–1 is a nuclear propelled underwater research and ocean engineering vehicle. It was built primarily to test the feasibility of a small nuclear propulsion power plant in a noncombatant deep diving vehicle.

Mr. LIPSCOMB. Will you describe the characteristics of the NR–1, its use, and operating depths?

Dr. FROSCH. The NR–1 has a ——— test depth, she is ——— feet long and can transit at ——— knots while submerged. The endurance of NR–1 is determined by the amount of consumable supplies she carries, so we rate her endurance in man-days. Her endurance is 210 man-days. She will carry a crew of five plus two research personnel.

We intend to use the NR–1 to conduct oceanographic research. During the first extended at sea period, NR–1 will conduct a bottom ———.

CABLE CONTROLLED UNMANNED RECOVERY VEHICLE (CURV)

Mr. LIPSCOMB. I would like to discuss the cable controlled unmanned recovery vehicle (CURV), and other vehicles for a moment. What is the operating depth limitation of the CURV I?

Dr. FROSCH. CURV I, now retired, was designed for a 2,000-foot depth. However, twice it made recoveries at depths exceeding its 2,000-foot design limit—the H-bomb recovery at 2,850 feet and one recovery of a torpedo at 2,466 feet.

Mr. LIPSCOMB. Now, that was followed by CURV II, with a 2,500-foot depth capability. During fiscal year 1970, you will introduce CURV III with a test depth of 7,000 feet, as well as the first deep submergence rescue vehicle (DSRV), which has a secondary mission capability of search, location, and small object recovery of 5,000 feet. You are also initiating a deep submergence search vehicle (DSSV) program. What is the 20,000-foot unmanned recovery device, mentioned on page 48 of your statement, which is planned for concurrent development with the DSSV?

Dr. FROSCH. The unmanned device is an extension of the CURV models previously referred to. There is money in the budget for the development effort necessary prior to constructing a CURV device suitable for 20,000-foot operation. A typical fiscal year 1970 effort is developing a suitable amplifier to insure a clear television picture is obtained through the long cable required. ———.

ALVIN-TYPE SUBMERSIBLES

Mr. LIPSCOMB. You also mentioned a certified titanium hull for the Alvin-type submersibles. Does this mean we will build more Alvins?

Dr. FROSCH. Not necessarily. The titanium hull is being fabricated for the Alvin-type submersible primarily because the pressure hull is releasable on this type vehicle. Therefore, the existing HY–100 steel hull on the *Sea Cliff* or *Turtle* can be quite easily replaced with the titanium hull. This will permit in-ocean utilization of the titanium pressure hull without the expense of building the entire vehicle.

Mr. LIPSCOMB. Would you provide a list showing the number of various types of underwater search vehicles available to the Navy, their operating depths, whether manned or unmanned, and their approximate cost? Also include those vehicles under contract or in the planning stage.

(The information follows:)

NAVY MANNED VEHICLES

[Dollar amounts in millions]

Vehicle name	Depth (feet)	Endurance (hours)	Approximate cost	Status
Trieste II	20,000	———	———	Operational.
DSRV No. 1	5,000	12 at 3 kts	$41.0	Operational fiscal year 1970.
DSRV No. 2	5,000	12 at 3 kts	23.0	Do.
DSRV No. 3	5,000	12 at 3 kts	28.8	Operational fiscal year 1974.
Sea Cliff	6,500	8 at 1.75 kts	1.8	Operational fiscal year 1970.
Turtle	6,500	8 at 1.75 kts	1.8	Do.
NR-1	———	30 days	67.5	Do.
DSSV	20,000	30 hours	138.0	Operational fiscal year 1976.

NAVY UNMANNED TETHERED VEHICLES

Curv II	2,500		$1.3	Operational.
Curv III	7,000		2.4	Operational fiscal year 1970.
Submerged object recovery device (SORD)	3,000		.7	Operational.
Curv IV or remote unmanned work system (RUWS)	20,000		5.0	Operational fiscal year 1974.

INDUSTRIAL VEHICLES

Mr. LIPSCOMB. The committee understands the importance of these vehicles and has supported these programs in previous years. However, we have *Trieste*, in addition to those discussed, and $3 million was eliminated from the fiscal year 1970 Navy budget to lease industry-developed vehicles such as the 8,000-foot depth *Deep Quest*, the 8,000-foot depth *Aluminaut*, and the 6,000-foot depth *Deep Ocean Work Boat*. In addition, the Navy leased the *Alvin* to Woods Hole Oceanographic Institution last year. Are we going overboard in the construction of these underwater vehicles?

Dr. FROSCH. Although *Alvin* has been operated by Woods Hole, during her last year of operation all dives made were in support of Navy programs. At present it appears that our research and ocean engineering programs will keep all Navy vehicles efficiently employed.

However, the low utilization of vehicles owned by industry indicates that perhaps industry may have over estimated the market for such vehicles. Since the Navy started using vehicles in support of oceanographic programs, our leasing costs for commercial vehicles has gone from approximately $166,000 in fiscal year 1965 to a peak of about $2.2 million in fiscal year 1968. In fiscal year 1969 Navy leasing costs, because of funding restraints, dropped to approximately $1 million. Planned commercial vehicle usage for fiscal year 1970 will also be around the $1 million level or slightly less.

Other than the Navy, there have been few Government agencies and industrial organizations who have made extensive use of submersibles.

The major reason for the present low utilization of vehicles perhaps can be attributed to the fact that we and industry failed to recognize and budget for the high cost of operating, supporting, and maintain-

ing a submersible. Although vehicle construction costs are high, the support ship, operating and maintenance crew, and other support expenses are now recognized as major submersible cost factors. The annual cost of operating and supporting an *Alvin*-type vehicle is approximately $1 million.

Mr. LIPSCOMB. Would you provide a table showing the number of underwater vehicles developed by industry, their capabilities, whether manned or unmanned, and their operating depths? I understand there are 30 such vehicles.

(The information follows:)

COMMERCIAL MANNED VEHICLES[1]

Name, depth, and owner	Length, beam, and height	Operational status	Crew, payload, endurance
Aluminaut, 15,000 ft., Reynolds	51 ft., 8 ft., 14.25 ft.		4 to 6, 6,000 lbs., 32 to 72 hrs.
American Submarine, 300 ft., MAKO Products.	13 ft., 4.2 ft., 4.75 ft.	Unknown	2, 450 lbs., 8 hrs.
Asherah, 600 ft., University of Pennsylvania.	17 ft., 7.7 ft., 7.6 ft.		2, 175 lbs., 10 to 24 hrs.
American Submarine, 600 ft., Mr. Ron Blivers, Silicone Systems.	13 ft., 5.5 ft., 5.2 ft.	Unknown	2, 750 lbs., 6 to 16 hrs.
Beaver MK IV, 2,000 ft., North American.	25 ft., 8½ ft., 9½ ft.		3 to 2, 2,000 lbs., 48 hrs.
Ben Franklin, 2,000 ft., Grumman	48 ft., 18 ft. 6 ins., 20 ft.		6c, 5 tons minimum, 4 weeks, 2-week emergency.
Benthos V, 600 ft., 1963, Lear Siegler	11.3 ft., 6.1 ft., 6 ft.	Not operational	2, 400 lbs., 8 to 16 hrs.
Cubmarine PC3A, 300 ft., Kentron Hawaii.	18.5 ft., 3.6 ft., 6 ft.		2, 750 lbs., 8 to 20 hrs.
Cubmarine PC3A, 300 ft., Kentron Hawaii.	18.5 ft., 3.6 ft., 6 ft.		Do.
Cubmarine PC3B, 600 ft., Perry Submarine Builders.	22 ft., 3.5 ft., 6 ft.		Do.
Cubmarine PC3X, 150 ft., Defense Research Laboratory.	18.5 ft., 3.5 ft.	Unknown	2, 750 lbs., 20 hrs.
Deep Diver Perry Link, 1,335 ft., Ocean Systems.	23 ft., 5.5 ft.	No operational	4, 1 ton.
Deep Quest, 8,000 ft., Lockheed	40 ft., 16 ft., 13 ft.		4, 7,000 lbs., 48 hrs. maximum.
Deepstar 2,000, 2,000 ft., Westinghouse	20 ft., 7 ft.		2-3, 8 hrs.
Deepstar 4,000, 4,000 ft., Westinghouse	18 ft., 11.5 ft., 7 ft.		3, 100 lbs., 12 to 48 hrs.
Deepstar 20,000, 20,000 ft., Westinghouse.	32 ft., 9 ft.	Operational in fiscal year 1971.	3, 1,500 lbs., 64 hrs.
DOWB, 6,500 ft., General Motors	17 ft., 8.5 ft., 8 ft.		3, 1,020 lbs., 65 hrs.
Guppy, 1,000 ft., Sun Shipbuilding & Dry Dock Co.		Operational January 1970.	2, 48 hrs.
Kittridge, 250 in., Undersea Research Vehicles.	10 ft., 3 ft., 5 ft.[1]		1.
Mai'a, 1,200 ft., Pacific Submarine, Inc.	22 ft., 4 ft. 7 in.		3, 1,000 lbs.
Nekton, 1,000 ft., General Oceanographics.	15 ft., 4 ft., 6 ft.		1-1, 300 lbs., 4 hrs.
Paulo I, 1,000 ft., Anautics, Inc	15 ft.	Unknown	2, 30 hrs.
Pisces I, 1800 ft., International hydro-Dynamics Co. Ltd.	16 ft., 11.5 ft., 10.5 ft.		1c, 2p, 800-1,800 lbs., 72 hrs.
Pisces II and III, 3,000 ft., International Hydro-Dynamics Co., Ltd.	20 ft., 10 ft., 12 ft.	III under construction	1c-2p, 1,500-3,000 lbs., 72 hrs.
Pisces IV and V, 6,500 ft., International Hydro-Dynamics Co., Ltd.	20 ft., 10 ft., 12 ft.	Both under construction	1c, 2p, 1,500-3,000 lbs. 72 hrs.
No name, 1,200 ft., Perry Submarine Builders, Inc.	22 ft.	Under construction	3.
Shelf Diver, 800 ft., Perry Submarine	23 ft., 5.5 ft.		4 2,200 lbs., 48 hrs.
Snooper, 1,000 ft., Sea Graphics	11 ft., 6 in. 50 ft.	Unknown	2 800 lbs.
Star I, 200 ft., Marine Museum, Philadelphia.	10.1 ft., 6 ft., 5.8 ft.	Not operational	1 200 lbs., 18 hrs.
Star II, 1,200 ft., General Dynamics	17 ft., 7.7 ft., 7.6 ft.		2 250 lbs., 48 hrs.
Star III, 2,000 ft., General Dynamics	24.5 ft., 6 ft., 8 ft.		3 1,000 lbs., 48 hrs.
Submaray, 300 ft., Hydrotech Co	13 ft., 3 ft., 5 ft.	Unknown	2 1,500 lbs., 12 hrs.

[1] All measurements approximate.

COMMERCIAL UNMANNED TETHERED VEHICLES

Name	Depth (feet)	General capabilities
"J-Star" (Jacobsen Brothers)	2,500	Equipped with lights, camera, TV, and hydraulically activated claws. No propulsion capability. Positioned with mooring lines.
Mobot (mobile robot), (Hughes Aircraft)	1,000	Equipped with lights, cameras, TV, and several mechanical arms. Has limited propulsion capability. Operational status unknown.
Unmanned work submarine (Sperry Rand Corp.).	2,000	Modular construction; closed circuit TV; manipulator with special-purpose tools and instruments; hydraulically powered propulsion thrusters, presently operational to 500 feet.

Note: This list may not be complete since some vehicles, particularly the small and shallow types, are constructed and made operational before the Navy is aware of their existence. Vehicles in a nonoperational or an unknown operational status are marked accordingly. Our records indicate that presently 18 manned and 2 unmanned vehicles are known to be operational.

Mr. LIPSCOMB. Why was $3 million eliminated from the fiscal year 1970 budget for the lease of industry vehicles?

Dr. FROSCH. In the final review of the fiscal year 1970 budget, when high-priority add-on items were competing, this listing emerged with a lower priority. Regrettably, neither our requirements nor available resources on a priority basis make possible funding of the leasing program proposed by the National Marine Council.

LOSS OF ALVIN

Mr. LIPSCOMB. Last October the *Alvin* research submarine of the Navy was lost in about 4,500 feet of water in the Atlantic Ocean about 120 miles south of Cape Cod. It was under lease to Woods Hole Oceanographic Institution at the time. In late November Woods Hole called off efforts to recover *Alvin* until the spring. What is the latest information on efforts to recover this Navy submersible?

Dr. FROSCH. On June 4, 1969, the USNS ship *Mizer* arrived in the area towing a "sled" equipped with lights, cameras, a side looking sonar and magnetometer, and commenced operations to locate and obtain photographs of *Alvin*. *Alvin* was located and photographed on June 10, 1969. A decision whether or not to recover *Alvin* will be made after the photographs have been studied and an estimate of the cost to recover has been made.

Mr. LIPSCOMB. Is Woods Hole paying for the recovery as well as the subsequent costs to repair the craft?

Dr. FROSCH. To date, recovery attempts have been paid for by the Navy. There is no money presently budgeted for repairs of *Alvin*. If the vehicle is recovered and repairs are undertaken, costs will be paid by the Navy.

Mr. LIPSCOMB. What impact has the loss of the *Alvin* had on your oceanography program?

Dr. FROSCH. *Alvin* was essentially on her last dive of the season when she was lost last October. Adverse weather and sea conditions generally preclude submersible operations off the New England coast from October through the latter part of May. During this time *Alvin* was scheduled to undergo an overhaul and would not have been available for operations. Therefore, to date, her loss has had little effect on our oceanography program. However, between now and the time that the new follow-on *Alvin* vehicle, *Sea Cliff*, becomes opera-

tional, the impact will be one of delaying some of our oceanography programs or, if funds can be made available, of having to lease commercial vehicles for conducting these programs.

Mr. LIPSCOMB. Was Woods Hole doing research work for the Navy at the time of the sinking of the *Alvin*?

Dr. FROSCH. Yes, *Alvin* was being used in support of a research program sponsored by the Office of Naval Research. At the time of her loss she was in the process of making an inspection of the mooring cables of an oceanographic data collection buoy.

OCEAN ENGINEERING TECHNICAL DEVELOPMENT

MAN-IN-THE-SEA PROJECT

Mr. LIPSCOMB. The fiscal year 1970 request for "Ocean engineering technical developments," is $13.1 million. You were funded $7.8 million in fiscal year 1969 and $4.7 million in fiscal year 1968 for this element. How much of the fiscal year 1970 R.D.T. & E. program relates to the man-in-the-sea project?

Dr. FROSCH. In fiscal year 1970 the man-in-the-sea project will be funded at ——— million.

"SEALAB III" AND TEKTITE PROJECTS

Will you explain the difference between *Sealab III* and the tektite projects?

The Tektite project was a joint Navy-NASA-Department of Interior-GE project to study the behavioral aspects of man's performance in an isolated hazardous environment, and the suitability of using shallow water bottom habitats and saturated diving techniques to study marine geology, ecology, and various other oceanographic subjects. The diving equipment used was off-the-shelf state-of-the-art scuba. The divers used a breathing mixture not too much different from compressed air. The depth involved was 50 feet, only 1½ amospheres different from surface pressure.

By contrast, *Sealab III*, which is a part of the man-in-the-sea project, has the objective of evaluating newly developed deep ocean mixed gas saturation diving equipment and techniques designed to give the Navy the capability of supporting diving operations on the Continental Shelf. The aquanaut's equipment, the deep diving system, the breathing mixtures, habitat power links, and so forth, have all been designed for this Continental Shelf operation. This equipment, when evaluation is complete, will be issued to the fleet. The Navy has never before operated at such a depth. The *Sealab* is definitely a pioneer R. & D. effort. The depth of *Sealab III* will be 600 feet, 20 atmospheres different in pressure from the surface.

LOSS OF DIVER BARRY L. CANNON

Mr. LIPSCOMB. In February 1969 you had a very unfortunate and tragic accident in the loss of Barry L. Cannon, a very capable and experienced civilian diver, who undoubtedly will be difficult to replace. Can you provide the committee with the latest information in your

possession concerning this accident, and what steps have been taken to prevent another such incident?

Dr. FROSCH. The Chief of Naval Material convened a Board of Investigation to determine the cause of this unfortunate accident. The results of this investigation are under review by the CNO, and, after further review by the Judge Advocate General will be forwarded to the Secretary of the Navy.

Although the precise cause of death could not be established, all available evidence indicates Mr. Cannon died of CO_2 poisoning which resulted from his probable use of an improperly assembled breathing apparatus which contained no CO_2 absorbant. Until the findings of the board have been reviewed by SecNav, no public disclosure will be made.

To prevent such accidents in the future, equipment modifications, as well as organizational and management changes have been made. The aquanaut equipment will be given additional laboratory testing and in-situ testing at progressively deeper depths before being used at 600 feet. The Sealab organization have been revised with the intent of renewing and strengthening the emphasis on safety.

All plans and changes are being reviewed by a "blue ribbon" committee chaired by Vice Adm. W. F. Raborn, retired. The members include representatives from industry and Government, all recognized for their expertise in ocean engineering. Admiral Galantin will not permit resumption of deep diving until every feasible step to increase safety and reliability of equipment and procedures has been evaluated and placed into effect.

SEALAB III

Mr. LIPSCOMB. You indicate on page 44 that it is not certain whether Sealab III will be undertaken in fiscal year 1970. How much is in the fiscal year 1970 Navy budget for Sealab III by appropriation account?

Dr. FROSCH. No money is specifically appropriated for Sealab but rather for the entire man-in-the-sea project, of which the Sealab III experiment is a part. For the MITS project in fiscal year 1970, ——— million R.D.T & E., $2.4 million OPN, and $600,000 O. & M.N. have been allocated.

What is meant by the statement on page 44 is that the habitat living portion of the Sealab experiment might not be conducted in fiscal year 1970. The entire Sealab experiment has been restructured into a four phase program. Phase I includes saturated and nonsaturated diving to 100 feet using the deep dive system MK II and thermal studies with aquanauts pressurized to an equivalent of 450 feet. The nonsaturated portion of this phase is in progress now. Phase II includes saturated dives to 450 feet. Phase III includes two 12-day saturation dives to 600 feet again using the MK II DDS as in the first two phases. During the two dives the sea-floor construction and the salvage test programs will be conducted. Providing the first three phases are successful, and providing the modifications and improvements to the equipment and procedures for the first three phases have been completed, the fourth phase will be a 36-day habitat living experiment. You can see that orderly conduct of the first three phases and completion of necessary modifications at the end of each phase may well carry the habitat living portion of Sealab III into fiscal year 1971.

Mr. LIPSCOMB. Will you describe the deep ocean technology program for which you are requesting $6.6 million in fiscal year 1970?

Dr. FROSCH. This project was initiated in fiscal year 1968. It is a 12-year plan to generate and expand the base of technical knowledge required for the future Navy to adequately respond to whatever new deep ocean operational needs arise. The basic objective is to provide validated technological options for potential naval systems. Development is being conducted on pressure hull and buoyancy materials, propulsion systems, ocean floor construction systems, and so on.

Mr. LIPSCOMB. How will the fiscal year 1970 funds be used?

Dr. FROSCH. Fiscal 1970 funds will be used to pursue developments in vehicle and sea floor construction technologies. The effort includes work on titanium and glass hull materials, pressure resistant concrete structures, reliable electric drive systems and underwater power distribution systems. Developments will also be undertaken in improved lighting and navigation systems for manned and unmanned vehicles. Some work on instruments and equipments for sea floor construction will be done, and a sea floor construction experiment (Seacon) will be undertaken. An Opeval of the Curv III, the 7,000-foot cable controlled manned recovery vehicle, will be completed in fiscal 1970.

Mr. LIPSCOMB. How was the $9.1 million, provided in the last 2 fiscal years, utilized?

Dr. FROSCH. During the past 2 years, we have worked on development of electric drive systems, wet and dry electrical connectors and penetrators, and on preliminary designs for a thermal-chemical power system. We have initiated a comprehensive development program on glass and titanium.

We are conducting tests on underwater foundations, and have fabricated a diver operated chemical overlay system for bottom stabilization.

Development has been completed on the 7,000-foot cable controlled unmanned recovery vehicle, will be completed in fiscal 1970.

We have initiated development on other items such as a doppler sonar, a low light sensitive TV variable ballast system and so on.

INTERNATIONAL MILITARY HEADQUARTERS AND AGENCIES

Mr. LIPSCOMB. The fiscal year 1970 budget request for program-wide management and support totals $151.2 million, which is $14.5 million more than the fiscal year 1969 program. We have already discussed a good portion of this budget activity earlier.

Will you describe the new element in this budget activity entitled "International military headquarters and agencies," pointing specifically to what headquarters and agency personnel are involved, and how this relates to R.D.T. & E., Navy?

Dr. FROSCH. There is only one project in this program element. This project provides salaries and administrative support for a contingent of nine U.S. civilian scientific personnel assigned to the Saclant ASW Research Center, a NATO organization located at La Spezia, Italy. These personnel fulfill most of the U.S. commitments to the Center. The Center's mission is to provide scientific and technical advice and assistance to Saclant in the field of antisubmarine warfare, and to be responsive (in this field, through Saclant) to the re-

quirements of NATO naval forces. The Center may also render scientific and technical assistance to NATO nations requesting aid with antisubmarine warfare problems.

This project further provides for U.S. liaison support to the Center, and assistance to the Director of the Center, as feasible, in obtaining additional U.S. scientists on temporary short term loans. Assistance in obtaining equipment loans on request is also available to the Director.

Involved in the work performed under this project are: the Office of Naval Research, Washington: Office of Naval Research Branch Office, London: Office of the Chief of Naval Operations, and other elements of the Department of the Navy as appropriate.

Critical problems persist in the field of antisubmarine warware and fundamental research in nearly all pertinent scientific areas is required to extend understanding of the phenomena involved. The willing, cooperative effort of a portion of NATO's scientific talent, acting in concert, contributes significantly to the overall knowledge of antisubmarine warfare. To this end the Center is conceived to provide, through the sponsorship of Saclant, a setting with a suitable international scientific atmosphere responsive to guidance toward areas of research particularly related to the solution of antisubmarine warfare problems.

The scientific work of the Center is in the following general areas:

Research directed primarily toward detection, classification, and identification of submarines at sea with the major emphasis on underwater acoustics.

Research in oceanography, including physical oceanography and submarine geophysics, with enmphasis given to lines of research having potential application to antisubmarine warfare problems.

Operations research studies and investigations in support of NATO research efforts devoted to the development of improvement of antisubmarine warfare systems.

Discovering potentially profitable areas for exploration, to avoid unprofitable duplication of national efforts, and for the injection of a diversity of proficient scientific opinion.

Mr. LIPSCOMB. Why was this transferred to the Navy R.D.T. & E. budget from the military assistance program?

Dr. FROSCH. After an evaluation of the transfer proposal, it was determined that this element was more appropriately a program in support of U.S. Forces, therefore the change was made to more properly aline the funding responsibilities with military service functional assignments.

Mr. LIPSCOMB. What is meant by Saclant?

Dr. FROSCH. Saclant is the Supreme Allied Commander Atlantic. He is the NATO commander of a strategic area covered by the North Atlantic Treaty, the Atlantic Ocean Command. This area extends from the North Pole to the Tropic of Cancer and from the coastal waters of North America to those of Europe and Africa, including Portugal, except for the channel and the British Isles. The Supreme Allied Commander is Adm. Ephraim P. Holmes.

Saclant's peacetime responsibilities consist of preparing and finalizing defense plans, conducting joint training exercises, laying down training standards and supplying the NATO authorities with information on his strategic requirements.

The primary task in wartime of the Allied Command Atlantic is to insure security in the whole Atlantic area by guarding the sea lanes and denying their use to an enemy. Saclant has responsibility for islands in this area, such as Iceland and the Azores.

Mr. LIPSCOMB. Mr. Chairman, I would like to say for the record that this has been a very interesting hearing. It has been very productive, I believe. Dr. Frosch and his staff have answered the questions with utmost candor and have been helpful. I believe it has been very worthwhile.

Mr. MAHON. Thank you very much for your appearance here, and your cooperation.

I want to echo the words of Mr. Lipscomb with respect to your special assistance to us.

We stand adjourned.

TUESDAY, JUNE 10, 1969.

DEPARTMENT OF THE AIR FORCE

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION

WITNESSES

HON. GRANT L. HANSEN, ASSISTANT SECRETARY OF THE AIR FORCE (RESEARCH AND DEVELOPMENT)
JOE C. JONES, DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE (RESEARCH AND DEVELOPMENT)
JOHN B. WALSH, DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE (RESEARCH)
DR. WILLIAM L. LEHMANN, DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE (LABORATORIES)
DR. MICHAEL I. YARYMOVYCH, DEPUTY ASSISTANT SECRETARY OF THE AIR FORCE (REQUIREMENTS)
LT. GEN. MARVIN L. McNICKLE, DEPUTY CHIEF OF STAFF, RESEARCH AND DEVELOPMENT
MAJ. GEN. GEORGE S. BOYLAN, JR., DIRECTOR OF AEROSPACE PROGRAMS, DCS/PROGRAMS AND RESOURCES
MAJ. GEN. JAMES T. STEWART, VICE DIRECTOR, MOL PROGRAM OFFICE, DCS/RESEARCH AND DEVELOPMENT
MAJ. GEN. KENNETH SCHULTZ, SYSTEMS PROGRAM DIRECTOR, MINUTEMAN, AIR FORCE SYSTEMS COMMAND
BRIG. GEN. WILLIAM F. PITTS, DIRECTOR OF BUDGET, HEADQUARTERS, U.S. AIR FORCE
COL. F. J. HOERMANN, ASSISTANT FOR R. & D. PROGRAMING, DCS/RESEARCH AND DEVELOPMENT
COL. WILLIAM J. GROSSMILLER, DIRECTORATE OF AEROSPACE PROGRAMS, DCS/PROGRAMS AND RESOURCES
COL. R. E. HORNE, JR., DIRECTORATE OF DEVELOPMENT, DCS/RESEARCH AND DEVELOPMENT
COL. TIMOTHY I. AHERN, DIRECTORATE OF OPERATIONAL REQUIREMENTS AND DEVELOPMENT PLANS, DCS/RESEARCH AND DEVELOPMENT
COL. STUART H. SHERMAN, JR., DIRECTORATE OF OPERATIONAL REQUIREMENTS AND DEVELOPMENT PLANS, DCS/RESEARCH AND DEVELOPMENT
COL. ROBERT B. STEWART, DIRECTORATE OF DEVELOPMENT, DCS/RESEARCH AND DEVELOPMENT
LT. COL. STANLEY B. JARRETT, DIRECTORATE OF OPERATIONAL REQUIREMENTS AND DEVELOPMENT PLANS, DCS/RESEARCH AND DEVELOPMENT
MAJ. JOE E. SANDERS, DIRECTORATE OF OPERATIONAL REQUIREMENTS AND DEVELOPMENT PLANS, DCS/RESEARCH AND DEVELOPMENT

C. JACKOVICH, CHIEF, MISSILE AND SPACE SYSTEMS DIVISION, DIRECTORATE OF BUDGET, HEADQUARTERS, U.S. AIR FORCE
H. FINE, DIRECTORATE OF BUDGET, HEADQUARTERS, U.S. AIR FORCE
NORBERT G. PHILLIPS, DIRECTORATE OF BUDGET, HEADQUARTERS, U.S. AIR FORCE
DOUGLAS C. SINCLAIR, DEPUTY (COMPTROLLER), OFFICE OF THE ASSISTANT TO THE SECRETARY OF DEFENSE (LEGISLATIVE AFFAIRS)

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION, AIR FORCE

For expenses necessary for basic and applied scientific research, development, test, and evaluation, including maintenance, rehabilitation, lease and operation of facilities and equipment, as authorized by law; [$3,364,724,000] *$3,561,200,000*, to remain available until expended. (*5 U.S.C. 3109; 10 U.S.C. 174, 1581, 1584, 2271–79, 2352–54, 2386, 2663, 2672, 8012, 9503–04, 9532; 31 U.S.C. 649c, 718; 40 U.S.C. 523; 42 U.S.C. 1891–93; 50 U.S.C. App. 2093; Department of Defense Appropriation Act, 1969; additional authorizing legislation to be proposed.*)

DEPARTMENT OF THE AIR FORCE

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION

PROGRAM AND FINANCING (IN THOUSANDS OF DOLLARS)

Program by activities	Budget plan			Obligations		
	1968 actual	1969 estimate	1970 estimate	1968 actual	1969 estimate	1970 estimate
Direct:						
1. Military sciences	142,802	151,544	158,699	143,899	150,528	159,541
2. Aircraft and related equipment	761,728	472,595	668,014	793,433	478,356	652,817
3. Missiles and related equipment	952,559	938,148	976,903	950,643	946,283	976,318
4. Military astronautics and related equipment	1,013,398	1,196,595	1,067,973	1,046,575	1,147,253	1,072,738
7. Other equipment	277,193	383,665	385,166	282,902	389,104	388,733
8. Programwide management and support	278,098	290,777	309,445	277,505	289,211	308,153
Total direct	3,425,778	3,373,324	3,566,200	3,494,957	3,400,735	3,558,300
Reimbursable:						
1. Military sciences	17,741	21,550	21,000	12,388	25,214	22,995
2. Aircraft and related equipment	574	1,645	2,000	6,195	2,382	1,523
3. Missiles and related equipment	80,614	105,000	105,000	73,334	100,195	101,450
4. Military astronautics and related equipment	89,469	76,800	77,000	88,813	81,690	75,115
7. Other equipment	6,700	7,000	7,000	7,666	6,326	7,898
8. Programwide management and support	16,134	18,005	18,000	16,204	14,193	21,019
Total reimbursable	211,232	230,000	230,000	204,600	230,000	230,000
Total	3,637,010	3,603,324	3,796,200	3,699,557	3,630,735	3,788,300
Financing—Receipts and reimbursements from:						
Federal funds	−194,731	−228,000	−228,000	−182,247	−228,000	−228,000
Trust funds	−15,026			−31,324		
Non-Federal sources	−1,475	−2,000	−2,000	410	−2,000	−2,000
Unobligated balance available, start of year:						
For completion of prior year budget plans				−290,390	−198,011	−210,000
Available to finance new budget plans	−25,778	−25,000	−5,000	−25,778	−25,000	−5,000
Reprogram from (−) or to prior year budget plans	−31,761	39,400				
Unobligated balance available, end of year:						
For completion of prior year budget plans				198,011	210,000	217,900
Available to finance subsequent year budget plans	25,000	5,000		25,000	5,000	
Budget authority (appropriation)	3,393,239	3,392,724	3,561,200	3,393,239	3,392,724	3,561,200
Budget authority:						
Appropriation	3,240,000	3,364,724	3,561,200	3,240,000	3,364,724	3,561,200
Transfers from other accounts	153,239	28,000		153,239	28,000	
Appropriation (adjusted)	3,393,239	3,392,724	3,561,200	3,393,239	3,392,724	3,561,200
Relation of obligations to outlays:						
Obligations incurred, net				3,486,396	3,400,735	3,558,300
Obligated balance, start of year				1,505,291	1,191,243	1,191,978
Obligated balance, end of year				−1,191,243	−1,191,978	−1,298,278
Outlays				3,800,444	3,400,000	3,452,000

OBJECT CLASSIFICATION (IN THOUSANDS OF DOLLARS)

	1968 actual	1969 estimate	1970 estimate
AIR FORCE			
Personnel compensation:			
Permanent positions	268,166	286,152	288,600
Positions other than permanent	1,779	1,775	784
Other personnel compensation	4,993	5,065	4,916
Total personnel compensation	274,938	292,992	294,300
Direct obligations:			
Personnel compensation	269,693	285,792	287,100
Personnel benefits	20,902	22,572	21,533
Travel and transportation of persons	15,562	15,091	15,087
Transportation of things	5,976	5,985	6,126
Rent, communications and utilities	30,819	32,010	40,685
Printing and reproduction	1,812	1,907	1,955
Other services	3,068,124	2,938,185	3,079,410
Supplies and materials	49,803	55,177	57,773
Equipment	32,273	44,023	48,638
Subtotal	3,494,964	3,400,742	3,558,307
Deduct quarters and subsistence charges	7	7	7
Total direct obligations	3,494,957	3,400,735	3,558,300
Reimbursable obligations:			
Personnel compensation	5,245	7,200	7,200
Personnel benefits	422	549	544
Travel and transportation of persons	897	864	869
Transportation of things	248	906	906
Rent, communications, and utilities	6,571	11,311	11,311
Other services	177,817	194,424	194,470
Supplies and materials	11,356	9,959	9,900
Equipment	2,044	4,787	4,800
Total reimbursable obligations	204,600	230,000	230,000
Total obligations	3,699,557	3,630,735	3,788,300

PERSONNEL SUMMARY (IN THOUSANDS OF DOLLARS)

	1968 actual	1969 estimate	1970 estimate
Total number of permanent positions	27,783	27,808	27,621
Full-time equivalent of other positions	379	391	122
Average number of all employees	27,884	27,860	27,648
Average GS grade	9.0	9.0	9.0
Average GS salary	$10,357	$10,820	$10,824
Average salary of ungraded positions	$7,615	$7,958	$7,958

Mr. MAHON. This morning the committee will hear General McNickle present the Air Force budget request of $3,566 million for Research, Development, Test, and Evaluation (R.D.T. & E.) for fiscal year 1970.

Secretary Hansen, are you going to testify, also?

Mr. HANSEN. Yes, sir; Mr. Chairman.

Mr. MAHON. We welcome you before the committee and we will be very glad to hear you. Of course, General McNickle was before us earlier in connection with Air Force aircraft and missile procurement programs. How do you suggest we proceed, Mr. Secretary?

Mr. HANSEN. With your concurrence, Mr. Chairman, we will have the formal statement presented by General McNickle.

As you know, I am relatively new on my job. I will participate with him in answering your questions. I will respond to those questions which you address specifically to me, or those questions which I feel that I can answer from my own knowledge and experience to date.

(Discussion off the record.)

MANNED ORBITING LABORATORY (MOL)

Mr. MAHON. I understand from the Deputy Secretary of Defense that the MOL, the Manned Orbital Laboratory, is to be canceled.

TOTAL EXPENDITURES FOR MOL

General McNickle, how much money have we put into that project by way of expenditure, and how much by way of appropriations? Of course, all the money that has been appropriated has not been expended.

(Discussion off the record.)

General MCNICKLE. Approximately $1.1 billion.

Mr. SIKES. Spent or appropriated?

General PITTS. That is spent, sir. That is estimated expenditures to date.

Mr. SIKES. Over what period of time?

General MCNICKLE. From 1965, sir.

REASON FOR MOL CANCELLATION

Mr. MAHON. You have been telling us this is a very important project, a most important project.

We backed you and we have provided the funds, and now you pull the rug out from under the program. Does this demonstrate that we were wrong all the time, or else that you are wrong now. Why this change of course?

Mr. Secretary, can you comment on that?

Mr. HANSEN. Mr. Chairman, with your permission, might I read the statement prepared by Secretary Laird that addresses that question? It is about three pages.

Mr. MAHON. Why don't you read it to us?

Mr. HANSEN. Yes, sir. This is a statement for Secretary of Defense Melvin R. Laird.

The next item is the Manned Orbital Laboratory program. With the President's concurrence I have decided to cancel the Air Force MOL program. In making this determination we carefully evaluated the MOL program in relation to other priority defense requirements, as well as the urgent need to reduce defense spending now and in future years. You will recall that the primary objectives of the MOL program were to develop and test advanced equipment for both manned and unmanned space flight and to determine the extent of man's utility in space for National defense purposes. We were and still are confident that man's presence in orbit can enhance the effectiveness of equipment and speed its development for both manned and unmanned use in future systems. Man is unique in his talents, ability, and adaptiveness as recent NASA flights have clearly demonstrated, but the cost of putting and sustaining him in space is very high. Several factors contributed to our decision to cancel MOL:

One, in order to further reduce the defense budget significantly, it was necessary either to drastically cut back or terminate numerous small but important efforts or one of the larger, more costly programs.

Two, the development status of the MOL program is such that large annual investments are necessary to realize reasonable progress. Further, fiscal year 1970 reductions of any significance beyond those we have already made would reduce MOL activity to a sustaining level and still require several hundred million dollars.

Three, the potential worth of the unique experiments planned for MOL plus the information expected on man's utility in space for military purposes was not as valuable to the defense as the aggregate of other priority programs.

Four, since the MOL program was initiated, major advances have been made by both NASA and DOD in automated techniques for unmanned satellite systems. In the same period the DOD has accumulated much experience and operational capability in unmanned satellite operations for purposes such as communications, navigations, and meteorology. These have given us confidence that the most essential Department of Defense space missions can be accomplished with lower cost unmanned spacecraft. Not all of the $525 million previously requested for MOL in fiscal 1970 budget will be saved as a result of this cancellation. Sizable closeout costs will be involved. Additionally, we may wish to increase emphasis on certain DOD unmanned space activities. We have not yet sorted out all of the costs and possible actions and I ask the committee's indulgence in providing this information later.

Nevertheless, fiscal year 1970 savings of several hundred million dollars will accrue.

In addition, more than a billion dollars will be saved in fiscal years 1971 through 1974.

Approximately $1.1 billion has been spent to date on MOL. The hardware, technology, techniques, and understanding resulting from this investment will be of great value in future defense programs. DOD and NASA are also exploring the value to NASA of several advanced technologies from the MOL effort.

I wish to make two final points for the record. It should be clearly understood that termination is not in any sense an unfavorable reflection on MOL contractors. They have all worked very hard and have achieved excellent results. Likewise, MOL termination should not be construed as a reflection on the Air Force. The MOL goals were practical and achievable. Maximum advantage was being taken of hardware and experience from NASA and other Department of Defense projects, and the program was well managed and good progress was being made. Under other circumstances the continuance would have been fully justified.

Mr. MAHON. General McNickle, did you participate at all in this decision?

General MCNICKLE. No, sir.

Mr. MAHON. Were you aware that it was being considered?

General MCNICKLE. Yes, sir.

At the start it was a budget exercise and I did not think it was any different than the same kind of review that went on last year. This same kind of review came up last year and the MOL was thoroughly scrubbed at that time. That is what I thought was going on here until we got word to please submit additional data, and so on.

Mr. FLOOD. You never got a hint on that?

General MCNICKLE. That is right.

BENEFITS OBTAINED FROM MOL PROGRAM

Mr. MAHON. In the last 15 years DOD has canceled out before completion of development about $8 billion by way of various projects. MOL adds another $1.1 billion to that total. According to the statement, Secretary Hansen, not all of this will go down the drain, but that is standard procedure. Such a claim is in part to ease the blow to the taxpayer and the critic. Of course, there has to be some truth in that. You could hardly spend $1.1 billion without having some fallout or some side benefits to science or defense or some program.

Would that be correct?

Mr. HANSEN. Yes, sir, that is correct, but in this case something more specific has happened. I participated in a meeting with Secretary Seamans, and representatives of NASA, in which the Secretary told them that the Air Force was very disappointed that this program was being canceled, and that NASA was solicited to examine

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the assets of the program to see what might be used in the Apollo Applications Program. Specific things were discussed such as the services of certain trained astronauts, the waste management system, the flight suits, a number of specific things were discussed. The NASA people said that they would review the whole MOL program and ask for any of the things which they think would be directly applicable to their on-going plan.

Mr. MAHON. Do you think, any of you here who may be knowledgeable in this field, that the Air Force itself can reap some possible benefit with respect to weapons systems and programs from the MOL program?

General MCNICKLE. Yes, sir. I think there are a number of things that will be used on later systems.

I do not mean to infer that there will be a follow-on MOL or that the technology will necessarily be used in a space system. Personally, though, I think the MOL program is as good today as it was yesterday, or last year. It is just the decisionmakers in evaluating all of the programs, and coming to grips with all the problems, decided to cancel the MOL.

Mr. MAHON. As I understand it Mr. Packard takes the position that probably the need for the program is not as great now as it appeared to be at the time it was initiated. I assume that is correct?

General MCNICKLE. I do not know.

Mr. HANSEN. I guess there would be a certain amount of subjectiveness about that.

OTHER POTENTIAL PROGRAM CANCELLATIONS

Mr. MAHON. As we look into the future, Mr. Secretary—you are new here, more or less—what will be the next program that might be canceled? Is AMSA the next one?

General MCNICKLE. No, sir.

Mr. HANSEN. I would hope not.

Mr. MAHON. You think it may survive another couple of years?

Mr. HANSEN. I would hope that unless it was going to survive to complete the program that we would not start it. I think it should survive the full course.

If we anticipated that it would run some period of time involving large expenditures and then be canceled I would prefer that decision would be made now. You never get a value out of a program that is canceled in mid-stream which is really proportionate to the amount of money you have spent, because there are things in the program which cannot be utilized elsewhere.

Mr. MAHON. Sometimes programs are canceled because the state of the art is not such that the program can be carried to a successful and effective completion. That was true with the $1 billion nuclear-powered aircraft, and you can say it is true with several others.

Mr. HANSEN. Yes, sir.

Mr. MAHON. Others have been canceled for reasons having to do maybe with the international affairs or international politics or something. The SKYBOLT gets into this field to some extent.

As I understand it from you, Mr. Secretary, this program is being canceled not because it was not proceeding well, not because it was

not well managed, not because the state of the art was such that you could not achieve success, but it was decided that it had become a sufficiently low priority that it more or less had to go, especially in view of the monetary crunch.

Mr. FLOOD. You are the best witness that ever sat in that chair. You said that very well. He didn't.

Mr. MAHON. Will you comment on that, Mr. Secretary?

Mr. HANSEN. Mr. Chairman, my understanding is that the consideration in canceling the MOL program were exactly as you just stated.

Mr. FLOOD. Marvelous.

Mr. MAHON. Are there any questions on my right about the MOL?

SUDDEN RANCH FACILITY

Mr. SIKES. I would like to ask about one aspect only, and that concerns the Sudden Ranch in Southern California that was acquired a year or two ago at a very high price to support the MOL program. Possibly there is no one here who would know, but the question is, Is there now a requirement for this property or can it be placed back on the market and the Government retrieve at least some of its investment?

Mr. HANSEN. We are all still evaluating what we will do, but this particular point is one that I have discussed with General McNickle and with Secretary Seamans. Our present thinking is that the probability of use of that facility in unmanned programs is such that we are proposing that we would go ahead and complete the brick and motar construction. It is about 95 percent complete already and would be completed in a very short time. We would then mothball that facility for a period of time to permit us to evaluate the potential use of it in other unmanned or future manned programs. My presumption is that if that evaluation did not show any need, the facility would be declared surplus and disposed of through the regular surplus property procedure.

Mr. SIKES. I would like to have for the record, if it is not immediately available, the cost of the ranch and the cost of construction subsequent to its purchase.

General MCNICKLE. The cost of the ranch complex is $9.8 million.

Mr. SIKES. And the ranch itself.

General MCNICKLE. This was for the ranch $9.8 million.

Mr. MAHON. List all the costs, construction, acquisition, and so forth.

General MCNICKLE. Yes, sir.

(The information follows:)

The total amount paid by the Air Force for the Sudden Ranch property was $9,852,841. In an earlier transaction, we acquired the Scolari Ranch for $175,000. Approximately $91 million has been invested in construction of the MOL launch complex, which is almost complete. An additional $5 million has been funded for support facilities.

Mr. FLOOD. I can see where that makes sense if you are 95 percent completed on the bricks and motar for the Sudden Ranch complex, and you have the land. It costs a shocking amount to stop a project and then start it again. So if you are 95 percent complete I can see where it might make good business sense to go ahead and finish the thing even if you have to turn it over to GSA later on. But the way

you pleaded this case and it was stated so succinctly by your best witness, the chairman, this is a classic example where the operation was a success but the patient died. That is exactly what happened here.

Mr. SIKES. I presume that in the event the property were declared surplus, you would be able to salvage substantially the cost of the land itself but not of construction subsequent to the land acquisition, is that right?

General MCNICKLE. I would think the land would be worth even more at this time.

Mr. SIKES. How many acres are there?

General MCNICKLE. I do not have that information sir, I will provide it for the record.

(The information follows:)

ACRES ON RANCH PURCHASED FOR MOL PROGRAM

The Sudden Ranch property acquired contains 14,390 acres. The Scolari Ranch contains 500 acres.

Mr. FLOOD. Then I would expect as far as your budget is concerned the Air Force would have a bookkeeping deal made with GSA to protect what you have done. Could you do that? I don't see why not.

There ought to be some way in which the Air Force could bail itself out. If you turn this over to GSA, they could sell it to Joe Zilch.

General PITTS. That money reverts to the Treasury, sir, and is not returned to the Air Force.

Mr. FLOOD. I am talking about you. Do you still carry the red flag for the whole thing? That doesn't seem right.

General PITTS. Yes, sir.

Mr. FLOOD. Of course, you don't write the law. That is our fault.

OTHER POTENTIAL PROGRAM CANCELLATIONS

My problem with this thing, and I have been bothered about it—I only saw it in the paper—we went through pretty much exactly the same thing as far as the push, the crunch on the Jupiter, if anybody can remember that far back.

Most of you fellows were lieutenant colonels then. We went through that right here. The Air Force couldn't stand the Army having Jupiter, so the Air Force came in with Thor. We've got to have Thor. Nobody knew why except the Air Force could not stand these gold boys with the Jupiter. That belongs to the Air Force. So the Air Force being the Air Force got Thor and out went Jupiter. But there is no analogy with the MOL except the terrific performance given here. Let me tell you, John Barrymore would be a bum compared to the performances we saw here on that one. Then we get MOL and here she goes again.

General, you told us that last year the Air Force looked at MOL—I don't know what your exact words were—the classic terms are "very closely." Every department looks at things very, very closely. So last year the Air Force looked at MOL with the possibility that it would scratch it for apparently the same set of reasons you give us today. Nobody told us that and it did not happen.

The first I heard about it was from your lips right now. This is the Defense Appropriations Subcommittee, and the country is on fire

about this Defense budget. Believe me they are. Here we sit. We are the prize pigeons, we are supposed to know everything, but the Air Force did not take us into their confidence. Now they come in out of a clear blue sky and put us out into left field with dark glasses like mine. That is not baseball. That is not fair to us.

General McNICKLE. Mr. Flood, not only MOL took a good scrubbing last year, but every program.

Mr. FLOOD. I was going to ask you what else.

General McNICKLE. Every program we have.

Mr. FLOOD. You carefully review every year every program before you send it to OSD and OSD carefully reviews every item. That is a standard operating procedure. What I want to know now is what other programs last year did you look at as intensely and as carefully as you looked at MOL that almost got scratched but just didn't?

What programs that we don't know about now are we going to hear about next year? I know you look at everything carefully, but what programs came close, like MOL came close, that we don't know about?

General McNICKLE. I think the programs tend to be scrubbed more vigorously on the basis of size. The bigger they are, the harder they get scrubbed.

Mr. FLOOD. Name two.

General McNICKLE. The F–111 was one.

Mr. FLOOD. We knew about that.

Of course, you cannot read our minds, you do not know what we know. We know about that one. But can you guess one? I will settle for one. Can you guess one program that came as close as MOL from being scratched last year that nobody said a word about, and that not even the Flood spies heard about, and I have them all over the place. Just pick one good big fat one. Surprise us again.

General McNICKLE. FB–111.

Mr. FLOOD. We know about that. You are not going to tell me anyhow. I did the best I could. It is a good question and a lousy answer. You are not going to tell me.

They would take a star off your shoulder if you did.

Mr. MAHON. Let us proceed. We will put in the record at this point a letter addressed——

Mr. FLOOD. I want to say this, Mr. Chairman. I have absolutely no objection to having this program scrapped. Don't misunderstand me, and the savings made. I am for that. But what I do object to most strenuously is the underhand, secret, under-the-table way in which they did this by not taking into their confidence the Defense Appropriations Subcommittee which now looks very bad.

General McNICKLE. Mr. Flood, we did not cancel the MOL. The Air Force did not cancel the program.

Mr. FLOOD. By you I don't mean just the Air Force. I understand you did not. I want to make that clear.

I understand that.

Mr. SIKES. I think Mr. Flood has made a very pertinent observation. The merits of this action are not under discussion at the moment. I am not disposed to protest the action, but I do protest the fact that this committee was not apprised that this was under serious consideration.

POSSIBLE DUPLICATION BETWEEN NASA AND AIR FORCE SPACE PROGRAMS

Mr. ADDABBO. Mr. Chairman, if I may? General, in last year's hearings I went into quite a lengthy discussion with you and your other witnesses concerning the coordination and exchange of information between the Air Force and NASA relative to their laboratory space stations and the similarity between those two programs. At that time this committee was assured that there was complete coordination and exchange of information, and there was not duplication.

Now we find MOL being canceled. What assurances do we have that there is going to be better coordination and no duplication in the future; more reliable assurances than was testified to last year?

Mr. HANSEN. May I answer that question? You imply that as part of the reason for cancelation here that there is a duplication with the Apollo applications program, and to my knowledge—and I have been into it some—that is not so. The NASA people themselves, I think, would testify that in the coordination between the DOD and NASA on MOL and AAP one of the best coordinating groups is the Astronautics and Aeronautics Coordinating Board. So I do not think the implication that there was duplication and the MOL can be eliminated because of that, is a just observation.

Mr. ADDABBO. NASA has no program similar to MOL?

Mr. HANSEN. There are certain aspects that are similar, but the programs that are being run in a way that there was not duplication.

Mr. ADDABBO. Thank you.

ELEVENTH HOUR DECISION TO CANCEL MOL

Mr. SIKES. Mr. Chairman, let me proceed just a moment longer. On the day we received this notice of cancellation, without any prior discussion or warning from the Office of the Secretary of Defense, we are also receiving a statement by General McNickle on research, development, test, and evaluation requirements for the Air Force for fiscal 1970. Beginning on page 66 of that statement and extending through and into page 71 there is a statement about the Manned Orbital Laboratory. I feel that I have to quote one paragraph which says, "A very thorough review of the program was conducted by the Secretary of Defense in February which reaffirmed that the benefits to be derived from MOL justify its continuance. Furthermore, it was concluded that all of MOL objectives can be accomplished with a six- rather than a seven-launch program."

It appears, Mr. Chairman, that this is a very sudden decision and that even the military services are not kept very closely advised about what is happening.

Mr. FLOOD. Don't you fellows talk to each other over there anymore? Are you mad at each other, or what? We spend so much money on communications, billions of dollars on communications all over the world, except in the Pentagon itself.

General MCNICKLE. Sir, I know there was a lot of talk on this program. I was not privy to a lot of it, but there was a lot of talk and many papers were written prior to the cancellation.

Mr. MAHON. They pulled the rug out from under you at a most unpropitious moment.

General McNICKLE. Yes, sir; I am reading my statement at the present time.

Mr. MAHON. This gives ammunition for those who say that our Defense programs are loosely run and we need to do something to clean up the mess.

Mr. FLOOD. Do you mean there is a new crop of "whiz kids" down there besides "McNamara's Band."

Mr. HANSEN. Mr. Chairman, before I came over here this morning I had a chance to see a draft of what was then proposed to be a press release to be made about now, and in that draft the statement was made that the decision to cancel MOL had been reached by Secretary Laird with the approval of the President on Saturday. I am disturbed by the comment by Mr. Flood that he read about this in the paper. I have not seen anything about it in the papers.

I understand your concern.

Mr. FLOOD. Don't be disturbed by comments that I make about anything. I am just quoting Will Rogers. All I know insofar as testimony given here is what I read in the newspapers. I have to read the newspapers half the time to find out what is going on instead of learning it from my own witnesses.

Mr. HANSEN. From my own personal point of view I was aware that these discussions concerning the MOL program were taking place, and I had the impression that the resolution was to continue the program as planned. I was on a trip to the west coast over the weekend and was advised as you are.

Mr. FLOOD. Mister, you are so far down on the totem pole over there you, too, have to find out from my newspapers what is going on all the time. Don't get upset about that. You will get used to that.

Mr. MAHON. We will place in the record at this point a letter addressed to me as chairman by Mr. Packard. The third paragraph in that letter I would like to read.

I recognize the actions taken to date within the Congress to reduce defense spending in fiscal year 1970. In order to reduce the Department of Defense budget significantly, it was necessary either to drastically cut back numerous small development programs or one of the larger, more costly research and development undertakings. In view of all these factors, the MOL was selected for cancellation.

This may appear to be an effort on the part of the Secretary to imply that this is being done because of the pressures from Congress. That would seem unlikely.

In view of all these factors, the MOL was selected for cancellation.

When the Secretary comes up here we should ask him if this was a monetary decision or otherwise, and I also want the record to show—and this is the appropriate time to put it in the record—that insofar as I know Congress has not reduced at this session any defense appropriation for fiscal year 1970. We have not even completed our hearings.

I do not quite comprehend what is meant here; do you, Mr. Secretary?

Mr. HANSEN. Mr. Chairman, it is my understanding that the pressure financially on this program came from the Bureau of the Budget.

Mr. MAHON. I did want to single out that paragraph in the letter which I felt I should put in the record at this time. It would not be

fair to try to analyze the letter in too much detail at this time in view of the fact that Mr. Packard is not present before the committee. We expect to discuss that with him later.

(The letter follows:)

THE DEPUTY SECRETARY OF DEFENSE,
Washington, D.C., June 10, 1969.

HON. GEORGE H. MAHON,
Chairman, Committee on Appropriations, House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: This is to advise you that the Department of Defense has decided to terminate the Air Force Manned Orbiting Laboratory (MOL) program.

In arriving at this decision, a number of factors were considered. First, it is clear that the most essential Department of Defense space missions can be accomplished with lower cost unmanned spacecraft. Second, the potential worth of possible future applications of the experimental equipment being developed for MOL and the information expected from the flights on man's utility in space for military purposes, while worthwhile, did not equate in immediate value to the aggregate of other defense programs that would need to be curtailed to achieve similar spending reductions.

I recognize the actions taken to date within the Congress to reduce defense spending in fiscal year 1970. In order to reduce the Department of Defense budget significantly, it was necessary either to drastically cut back numerous small development programs or one of the larger, more costly research and development undertakings. In view of all these factors, the MOL was selected for cancellation.

It should be clearly understood that termination is not in any sense an unfavorable reflection on any of the MOL contractors. They have all worked very hard and have achieved excellent results.

Likewise, MOL termination should not be construed as a reflection on the Air Force. The MOL goals were practical and achievable; maximum advantage was being taken of hardware and experience from NASA and other Department of Defense space projects; and the program was well-managed and good progress was being made. Under other circumstances, its continuation would have been fully justified.

Attached is a copy of a public statement announcing cancellation.

Sincerely,

DAVID PACKARD.

GENERAL STATEMENT

Mr. MAHON. Now will you proceed with your statement?

General MCNICKLE. Mister Chairman and members of the committee: Today I have the pleasure of appearing before you to present the Air Force research, development, test, and evaluation program for fiscal year 1970. The program which I will be describing is the product of long and detailed negotiations between the Air Force and the Office of the Secretary of Defense. From an overall point of view, the final product represents a balanced program for 1970, which will permit us to progress in all of our mission areas. Further, it maintains a sense of continuity with last year's program; and equally important, it includes the funds necessary to start full-scale development on several new programs.

Before presenting the Air Force's proposed program for 1970, I would like to make a few introductory remarks on what I consider to be some of the more important aspects of research and development. The first point I would like to make is that research and development is not an end product; rather, it is the means of achieving new or improved capabilities. I mention this because it has become quite popular in recent years to refer to R. & D. in the aggregate and to cite how much of the Federal budget is allocated to it. The amount referred to is substantial—on the order of $16 to $17 billion—and it

seems to obscure the fact that this is only a total derived from many relatively small, individually justified programs.

The major segments that make up this total are often cast as being competitive, when in fact they are not. Taking the Air Force as an example, we do not compete with the other Federal agencies for a dollar share, or a percentage, of the total Federal R. & D. program. Quite the contrary, our requirement for R. & D. is a derived demand based on our need to achieve mission objectives in the national interest. While we rarely get all that we ask for, what we do get then becomes an input to that aggregate figure. The real competition is with the results of R. & D.—not the R. & D. itself, and the competitors are most often the Nation's real and potential enemies—not other Federal agencies.

The second point I would like to make concerns the importance of our R. & D. programs. In a somewhat oversimplified view, our current and future military strength can be measured by the answers to two questions: how much? and how good? The how much? deals with the size of our forces and is largely a question of numbers of people and procurement of equipment. It deals with the facts and specific projections which General McConnell presented to this committee in his posture statement, and the numbers of aircraft and missiles as outlined in my procurement statement. But the other question—how good?—is quite different and much more difficult to answer. It involves many judgments on relative merits, and it encompasses all of the uncertainties inherent in any view of the future. But difficult or not, that question must be answered; and the answer must be: good enough, by anybody's standard. And that, of course, is the function of our R. & D.: to focus creative imagination and human intelligence on the development of forces which will be good enough to cope with any enemy action and have the flexibility to adjust successfully to any uncertainty. We simply cannot accept being second best in a military showdown.

This brings me to my next point: how do we assure our forces are, and will be, good enough. In addressing the present we are dealing largely with the results of R. & D. supported by this committee, and accomplished in prior years on the basis of what we then thought today would be like. To this we can add a substantial measure of flexibility by making our present systems better through adaptations and modifications; and, indeed, we have been quite successful in Southeast Asia with quick reactions tailored to the situation. These include such systems as our very successful gunships, guided bombs and many of our electronic countermeasures. But clearly we cannot develop a new system to meet a new situation as it unfolds. It takes time, usually measured in years, to create and innovate, to make and test, and ultimately to field a completely new system. For the future, then, we must recognize the diversity of situations which could exist and we must be prepared for any eventuality.

Certainly we should be better prepared to cope with the more likely situations, and we can judge these in terms of intelligence estimates and what we see potential adversaries doing. We can see them expanding their ballistic missile force, and we can see them increasing the mobility of their conventional forces. We can note the rapid changes they can make in their Mediterranean fleet, and we can observe their

forces in the Indian Ocean, and their helicopter carriers and marines. We can view, with particular concern, the emphasis they have placed on new types of tactical aircraft, and we can see their tactical fighters being exported to many countries.

But at the same time we can point to near-term development programs which will increase our ability to deal effectively with this changing scene. In terms of strategic forces, we are making great progress with the multiple warhead Minuteman III; and the FB–111 bomber will soon be operational. At the same time, our general-purpose forces are receiving the F–4E and F–111, and they will soon be getting the A–7D. To round out our increased near-term capabilities, the first C–5A will be delivered to the Military Airlift Command this winter.

We can also see the Soviet bomber force flexing its muscles. Their inventory contains hundreds of medium and heavy bombers, and they are still building them. They are using new tactics and strategies. We also see their heavy bombers, armed with air-to-surface missiles, and we see them becoming ever bolder in approching the North American continent. In addition, we see them flying a large supersonic transport aircraft—the Tu–144.

But here again, we are ready to modernize our air defense forces with more capable interceptors and more effective warning and control systems. We have the technology to equip our interceptors with radars that can see out many miles and missiles that can reach out against low altitude bombers trying to sneak under our defenses. We would like to get this markedly increased capability into our present interceptors, or a new interceptor, but we need your support to do it. We are also developing new detection and control radars in the airborne warning and control system (AWACS) and the backscatter over-the-horizon radars. These latter two developments are progressing satisfactorily.

For the more distant and uncertain future we have to take an even broader view. Neither the Chinese Communists nor the Soviets are standing still; in fact, they are both searching for new future weapons and investing heavily in R. & D. The only prudent course, and the one we are proposing, is to be prepared to meet any serious eventuality. By prepared I mean we must have the technology or development programs underway now to achieve whatever new capabilities are needed, and to be ready to produce whatever quantities world conditions may dictate. This category includes strategic systems such as improved or advanced ICBM's, an advanced manned strategic aircraft (AMSA), and an improved air defense interceptor. It also includes such tactical systems as the F–15 air superiority fighter, the A–X close-air-support fighter, the tactical airlift light intratheater transport (LIT), and an advanced rescue system. How far we would go with production of these new systems is, as I indicated, subject to the realities of future world conditions—but we should certainly have all of these systems in an advanced phase of technology or development. And, they are all included to some degree in our proposed program for 1970.

So far, in treating the future I have limited my remarks to complete weapon systems, but I am sure you all realize that systems are an assemblage of many subsystems—each with its own technology.

While the relations between new systems and advanced technology can become quite involved, it is generally true that our next generation of systems—the ones beyond those that I have already mentioned—will have to be based on today's technology programs. As an example, the F–15 is going to be the finest air superiority fighter that we can design for the mid-1970's, but as we develop the F–15 we must also be working on new technology for engines, radars, and armaments which together with our F–15 experience will be the foundation for an even better fighter in the 1980's. Through this time-phased approach to new system developments, we are preparing ourselves to meet the needs of the next decade as they come into sharper focus. Hence, we view our entire technology program as both an investment in future capabilities and as an insurance policy which will pay off as future needs develop.

And now, Mr. Chairman, I would like to move into our program for 1970.

Fiscal Year 1970 Air Force R.D.T. & E. Program

The total Air Force research, development, test, and evaluation program for fiscal year 1970 is $3.566 billion. Of this amount, $3.561 billion requires new obligational authority (NOA) and $5 million is to be supported by appropriations from fiscal year 1969. The $5 million was appropriated for the advanced manned strategic aircraft (AMSA) in fiscal year 1969, but will partially finance the fiscal year 1970 AMSA program. In comparison with prior years, as shown on chart 1, the 1970 program does not represent a marked departure fom the levels that have prevailed in prior years. It is $29 million less than last year's request, and it is $193 million more than the currently approved 1969 program.

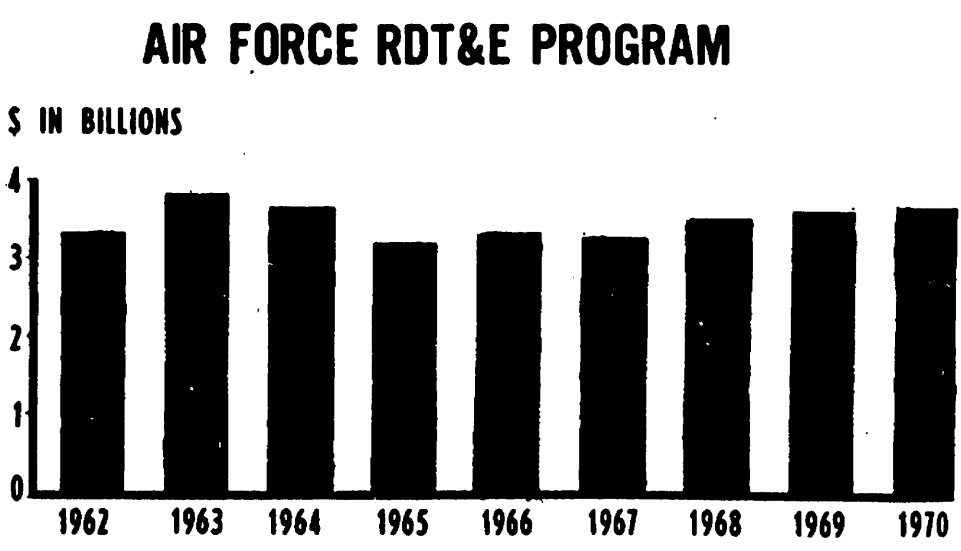


Chart 1

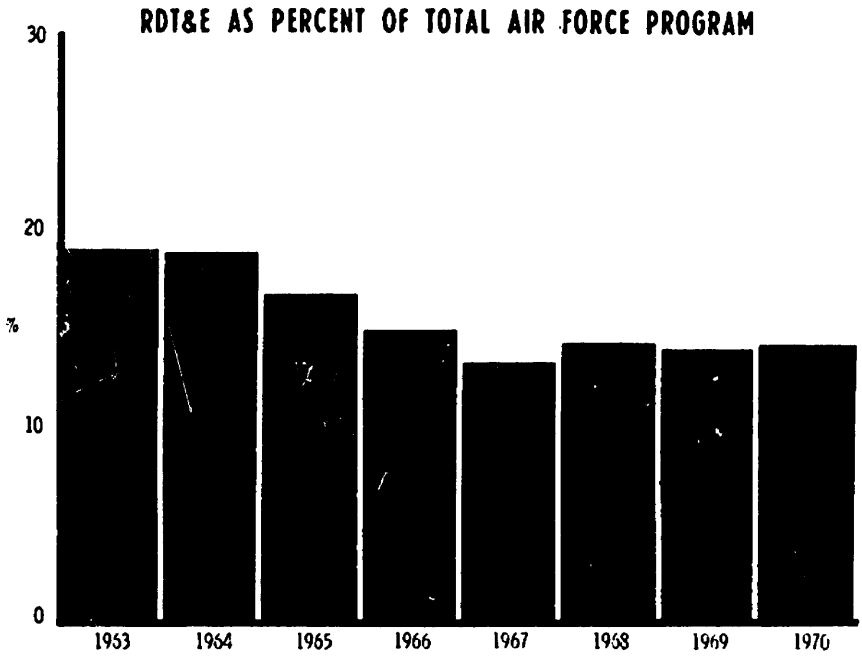


CHART 2

The percentage of Air Force money allocated to the R.D.T. & E. program, shown in chart 2, has declined appreciably since 1963, although it has been relatively constant since 1968. While some of the explanation for this situation is the growth of Southeast Asia requirements, the fact is that we have been doing less research and development, and it has been costing us more. There is very little that we can do to escape the increased costs which accompany the inflationary pressures on the entire economy; but we are, nonetheless, initiating several new and important programs in this budget with substantial long-term funding requirements. I will point these out during the course of my presentation.

The proposed fiscal year 1970 program, and the approved 1969 program, are shown in table I. They are grouped into the six budget activities that comprise the Air Force research, development, test, and evaluation program. In terms of change, there is a significant increase in our aircraft and related equipment activities which is partially explained by the relatively low level in fiscal year 1969, and by the increased requirements for manned aircraft development programs.

MILITARY SCIENCES

The first budget activity, shown in table II, is military sciences. It includes the Air Force's program in: The defense research sciences—commonly referred to as basic research; some of our applied research work; and activities in long-range and conceptual analyses. The general focus of these programs, which I will describe later, is on the more distant future. This is where we are probing to find what

is theoretically possible and operationally desirable. It is also where we pick and choose to match our scientific and technical capabilities against the demands of sophistication, complexity and the uncertainty of the future. We are requesting $158.7 million to continue these important activities in fiscal year 1970.

TABLE I.—FISCAL YEAR 1970 R.D.T. & E. BUDGET ESTIMATES

R.D.T. & E. PROGRAM, BY BUDGET ACTIVITY

[In millions of dollars]

	Fiscal year 1969	Fiscal year 1970
1. Military sciences	151.544	158.699
2. Aircraft and related equipment	472.595	668.014
3. Missiles and related equipment	938.148	976.903
4. Military astronautics and related equipment	1,136.595	1,067.973
7. Other equipment	383.665	385.166
8. Programwide management and support	290.777	309.445
Total	3,373.324	3,566.200

TABLE II.—FISCAL YEAR 1970 R.D.T. & E. BUDGET ESTIMATES

MILITARY SCIENCES (1)

[In millions of dollars]

	Fiscal year—	
	1969	1970
In-house laboratory independent research	5.000	5.300
Defense research sciences	90.772	94.873
Environment	10.450	11.000
Materials	23.650	25.787
Preliminary design/development planning	4.500	4.539
Innovations in education and training	.600	
Air Force Project Rand	15.000	15.600
Analytic services, Inc. (ANSER)	1.572	1.600
Total	151.544	158.699

DEFENSE RESEARCH SCIENCES

The Air Force's basic research work accounts for well over half of our "Military sciences" budget activity. This year we are requesting $94.9 million for research that encompasses those scientific disciplines which have proven to be relevant to our mission areas. This amount is a 4½-percent increase over this year and it will permit us to investigate specific subjects in the broad spectrum of fields shown in table III.

Table III.—Fiscal year 1970 R.D.T. & E. budget estimates, defense research sciences

General physics
Nuclear physics
Chemistry
Mathematical sciences
Electronics
Materials research
Mechanics
Energy conversion
Terrestrial sciences
Atmospheric sciences
Astronomy and astrophysics
Biological and medical sciences
Behavioral and social sciences

The overall objective of these programs is fourfold:

First, to pursue that basic research which we consider necessary for the Air Force, and which would not be accomplished without our support.

Second, to maintain an awareness of the basic research performed by others which could be useful in Air Force applications.

Third, to "couple" the results of research with the needs of technology.

And fourth, to provide access to the scientific community for quick reaction to urgent problems.

In addition, through our research projects at universities we are achieving a more distant objective by contributing to the development of the next generation of scientists and engineers. I mention this because in most cases we refer to our research projects as meeting the challenges and creating the possibilities of tomorrow. But we are also concerned with the step beyond, and that is an adequate supply of outstanding scientists and engineers with new and creative ideas to meet the challenges of the day after tomorrow. Many of these talented young people are at our universities today, and through our research projects they are becoming aware of the problems we must solve and how to solve them. Meeting this objective takes on even greater significance in the light of Soviet higher education—they have matched us stride for stride in doubling higher education enrollment in the past decade, and they are now turning out five times as many engineers as we are.

Achieving all of these objectives is the job of the Office of Aerospace Research operating through its own three laboratories and with institutions worldwide. Over the years this research has provided a vast array of significant accomplishments, many of which are contributing to the Nation's security today, and others which will find application tomorrow.

As an example, the forward-scatter over-the-horizon (OTH) radar which is now operating as System 440L, was born in one of our basic research laboratories. The forward-scatter OTH radar concept originated at the Air Force Cambridge Research Laboratories (AFCRL) in 1946, in fundamental studies of detecting artificial disturbances to the ionosphere. This pioneering work led to subsequent activities at AFCRL, as well as other Government and industry laboratories. By 1950, the Cambridge Research Laboratories were able to consider this phenomenon as a theoretical basis for long-range detection of missile launchings at distances of several thousand miles. Their continuing work on applications indicated that OTH radar warning times would be double those provided by the Ballistic Missile Early Warning System (BMEWS). And by 1960, they were able to start a demonstration program which led to the decision to undertake the present system which now has an operational capability.

The OTH radar is only one example of how our research laboratories have succeeded in developing and applying scientific discoveries. A look at another research facility—the Aerospace Research Laboratories (ARL)—provides a host of other examples such as new bomb

shapes for more accurate weapon delivery; new magnetic materials for computer memory cores; night vision techniques using both low-light level television and infrared devices; and blunt trailing edge supersonic compressor blades for propulsion at high speeds.

In still another example from the Aerospace Research Laboratories, our scientists have been able to develop the cadmium-sulfide solar cells as a source of electrical energy. The advantages of this cell over conventional silicon solar cells include flexiblity, weight reduction by a factor of 3, radiation resistance and lower cost. In terms of cost alone, the cadmium-sulfide cell reduces the price of an electrical power source in space from $350 per watt to only $50 per watt, and with the promise of only a few dollars per watt in mass production. Orbital flight tests and balloon tests are currently being made on these cells.

While I could add many more examples of return on our research investment, these provide some idea of the breadth and scope of our basic research programs. But before leaving this vital area, I would like to discuss one aspect of basic research which has attracted the interest of the Congress: The conduct of research abroad.

I believe there are some excellent reasons for continuing our limited support of foreign research. Perhaps the best reason is that we have no monopoly on good ideas. The United States is an excellent scientific competitor in virtually every field, but we are not the first to make every important discovery or breakthrough. While we can afford to be justly proud that our scientific community has been acclaimed with 40 percent of the Nobel prizes since World War II, we cannot afford to lose sight of the other 60 percent that went elsewhere. Obviously, we must maintain an awareness and understanding of what is going on in the rest of the scientific world—and this is one of the things we go by supporting research in foreign countries.

At the same time, we are mindful of the adverse effect of any "gold flow" on the balance of payments. For this reason the dollar outflow for Air Force research has been reduced substantially during the last 3 fiscal years, and we are reducing our support of foreign research in behavioral and social sciences. In addition, steps have been taken which will permit us to continue our foreign research without weakening the dollar. These steps include substantial cost-sharing arrangements, the use of "excess foreign currencies" and "barter funds," reverse flow from the purchase of American-made equipment, and the use of U.S.-flag carriers for travel.

Through these steps we are able to participiate in really worthwhile scientific investigations at only a fraction of their cost. In our cooperative cost-sharing contracts, the Air Force is paying only 37 percent of the costs, with the foreign institutions supplying the other 63 percent. In dollars, our fiscal year 1967 investments of $2.8 million worldwide research bought $7.6 million worth of scientific work. In addition, over one-half of our research investment is made with barter funds from the Commodity Credit Corporation, and half of the remainder is paid in U.S.-owned excess foreign currencies. The actual obligations, by country, are shown in table IV.

TABLE IV—FISCAL YEAR 1970 R.D.T. & E. BUDGET ESTIMATES, AIR FORCE SUPPORTED FOREIGN BASIC RESEARCH OBLIGATIONS

	Fiscal year 1966	Fiscal year 1967	Fiscal year 1968
Argentina	$71,000	$10,000	$73,000
Australia	238,000	141,000	263,000
Austria	81,000	64,000	60,000
Belgium	136,000	220,000	134,000
Bolivia	87,000	.....	.....
Brazil	9,000	74,000	8,000
Canada	826,000	365,000	461,000
Chile	76,000	33,000	51,000
Colombia	.....	.....	38,000
Denmark	3,000	1,000	3,000
Ecuador	.....	.....	8,000
Finland	43,000	10,000	.....
France	182,000	73,000	106,000
Germany	76,000	91,000	55,000
Greece	14,000	.....	7,000
India	.....	.....	22,000
Ireland	14,000	53,000	18,000
Israel	398,000	531,000	386,000
Italy	174,000	212,000	230,000
Jamaica	45,000	6,000	.....
Japan	31,000	42,000	33,000
Korea	6,000	7,000	.....
Lebanon	34,000	.....	27,000
Netherlands	33,000	.....	.....
New Zealand	.....	73,000	15,000
Norway	33,000	.....	22,000
Peru	55,000	30,000	16,000
Philippines	.....	24,000	12,000
Spain	32,000	41,000	53,000
Sweden	140,000	143,000	121,000
Switzerland	.....	10,000	13,000
Thailand	.....	.....	4,000
Uganda	15,000	.....	.....
United Kingdom	353,000	503,000	340,000
Uruguay	20,000	27,000	18,000
	3,225,000	2,784,000	2,597,000

At this point, it might be helpful to cite some examples of Air Force supported worthwhile scientific investigations. In one of our Swedish projects, scientists at the University of Uppsala have designed a technique to obtain more accurate position and distance information from ground observations of satellites. In one of our multinational projects, we have been working on the problems of jet propulsion for very high-speed flight. This work involves the collaboration of U.S. scientists with experts in this field in Spain, Germany, and the United Kingdom. In still another example, we have been working with one of the Max Planck Institutes in Germany, on a velocity-height measuring system that is now being tested in a high-resolution camera system at the Air Force Avionics Laboratory.

These examples, and many more, have convinced me that our foreign research program is extremely useful, and that it is a valuable adjunct to our much broader and comprehensive domestic program. Further, I believe it is paying its way in terms of value received, and with full recognition of the importance of minimizing gold flow.

MATERIALS

In an area closely related to basic research, we are requesting $25.8 million to continue our applied research and advanced development of new materials. Our program in this field combines the outstanding competence of our in-house laboratory—the Air Force Materials Lab-

oratory at Wright-Patterson AFB, Ohio—with the capabilities of industrial research staffs and nonprofit institutions.

This work has been extremely productive in making available new and exciting materials with a host of applications. In one case, the laboratory has successfully developed woven and knitted fabrics which are nonflammable in air and burn very slowly in an environment of pure oxygen. There is almost no limit to the possible uses for this fabric and we are now using it in the final design of clothing for the Manned Orbiting Laboratory (MOL) flight crews. As a result of NASA tests on materials furnished to them by the laboratory, several items in the Apollo 8 command module were made of this new fabric. They included the crew restraint system, in-flight exerciser, tether lines, and lacing cords.

Keeping others informed of our progress in science and technology minimizes the possibility of unproductive duplication and is an important part of our basic and applied research programs. An example of this coordinated approach is the development of a high-performance lubricant for the sensitive gyro bearings that are a vital part of our guidance systems. The Materials Laboratory and Pennsylvania State University perfected such a lubricant which was then produced by a member of the petroleum industry. The lubricant is now being evaluated in a cooperative test program by the Massachusetts Institute of Technology, the Naval Research Laboratory, and our own Materials Laboratory.

Another of our high-potential materials programs—one that really qualifies as a breakthrough—is the filament composite technology. Our work on boron and carbon composites has progressed to the point that we have a separate program element, managed by the Air Force Materials Laboratory, for the advanced development of this technology (aerospace structural materials in the aircraft and related equipment budget activity). Structural parts are being designed, fabricated, and tested for aircraft, helicopters, reentry vehicles, and jet engines. They include F–111 tail sections, CH–47 helicopter rotor blade sections, C–5A wing slats, and advanced fighter wing structures.

We are also applying this technology in jet engine applications. We have recently started a joint laboratory program with the objective of employing advanced composite materials in current and future engine designs. Through the combined efforts of the Materials Laboratory, and the Aero-Propulsion Laboratory, we will evaluate these new materials in the compressor and turbine sections of an engine. We expect that the use of composite materials could reduce the weight of present-day engines by one-eighth; and if we used them from the beginning of engine design, we anticipate a weight reduction of one-fifth could be achieved. Further, lighter engines would permit lighter aircraft and better performance. While we are pursuing these applications, we are also reducing the costs of these new materials.

PRELIMINARY DESIGN/DEVELOPMENT PLANNING

Before leaving the "Military science," budget activity, I would like to comment on our program for preliminary design/development planning. This program consists of two parts that are really quite separate. The first deals with a variety of preliminary design and

planning activities for new or improved weapon systems as reflected by the program title, whereas the second is concerned with design criteria for technical facilities.

The largest part is for some 20 different analyses and investigations which are prerequisite to system development. They examine operational mission areas in depth, and support the preparation of proposals to correct deficiencies and improve capabilities. As these proposals gain acceptance, they become individual program elements. Representative projects for the fiscal year 1969 program are shown in table V. A description of one of them (the last on the table) provides an indication of the type of work that is involved:

SUPPORT ANALYSIS FOR TACTICAL WEAPONS SYSTEMS

An analysis to assess the military utility and cost of tactical offensive and defensive forces. Mathematical methods and relationships will be developed to determine fighter aircraft effectiveness, and kill and loss rates, for friendly and enemy aircraft using various tactics. The contract will also require an analysis of tactical transport concepts for the initial deployment, and subsequent resupply, of ground assault operations.

TABLE V.—*Fiscal year 1970 R.D.T. & E. budget estimates, preliminary design/development planning activities (fiscal year 1969)*

Preliminary design for a tanker
Concept for a combat support aircraft
Mission analysis for continental U.S. air defense
Computation support for weapon system development
Analysis support for strategic weapon systems
Improvement of vulnerability calculations for aircraft
Advanced post-boost vehicles
Support analysis for tactical weapon systems

The second and smaller part—amounting to about $700,000—provides for detailed examinations of various elements of our test facilities. As many of you are aware, all of our weapons require extensive testing in order to assure confidence in their operations, and to identify and correct deficiencies early in the development and procurement cycle. Over the past two decades, we have done reasonably well in this respect, but in recent years we have found some of our system capabilities outdistancing our ability to test and verify performance. This is also an area where the Soviets have been outdistancing us with substantial outlays for new and sophisticated test facilities.

As a step in alining our test facility requirements with our new weapon systems, we have initiated a series of engineering studies of the type shown in table VI. One of these studies—the electronic countermeasures (ECM) systems integration and evaluation facility—responds to the lesson we have learned in Southeast Asia on the importance of effective and reliable electronic countermeasures. There is no longer any question that countermeasures can be extremely effective and that they make a significant contribution to the success of our air operations. Yet, to gain that effectiveness, countermeasures should be tested and demonstrated in a realistic environment before they are committed to combat. The purpose of the countermeasure facility analyss is to define the design criteria for providing a realistic environment and suitable evaluation systems.

TABLE VI.—Fiscal year 1970 R.D.T. & E. budget estimates, design criteria for technical facilities

Hypervelocity high density shock tunnel
V/STOL aircraft test facility
Universal aircraft flight simulator
Testing activities data processing applications
R. & D. laboratory for flight control
Electronic countermeasures systems integration and evaluation facility

The projects in preliminary design and devleopment planning are, in a sense, research on air operations, weapon systems and facilities. This is where we are able to free ourselves from old analyses and outdated ideas, and seek and refine the basic truths involved in the conduct of our operations. Our approach is scientific with subtle analysis, rigorous thought, and precise reasoning. Our results are as good as we can make them. It is, as the budget activity title suggests, military science.

AIRCRAFT AND RELATED EQUIPMENT

As I indicated earlier, the development of manned aircraft is a very important part of our overall R.D.T. & E. program and one that is receiving considerable emphasis. With the $668 million proposed program for fiscal year 1970, which includes $5 million carried over from 1969, we expect to work on the programs shown in table VII. These funds will permit us to achieve near-completion of the F–111, A–7, and C–5 development programs, and initiate full-scale development on essentially new programs. These include the F–15 air superiority fighter, the advanced manned strategic, aircraft (AMSA) and the specalized close air support aircraft—the A–X. We also have the airborne warning and control system (AWACS) which is an aircraft system carried in the other equipment budget activity. One new aircraft, which we had planned to have in development, has been postponed for the time being. That is the light intratheater transport (LIT). Deferring development on this aircraft was difficult, but it was based on the magnitude of the funding requirements for 1970 and beyond, the relative priorities of other arcraft programs, and the need for additional flight control and propeller technology. We are, however, continuing to work on the needed technology areas for a new light intratheater transport.

TABLE VII.—FISCAL YEAR 1970 R.D.T. & E. BUDGET ESTIMATES, AIRCRAFT AND RELATED EQUIPMENT (2)

[In millions of dollars]

	Fiscal year 1969	Fiscal year 1970
FB-111 squadrons	——	——
SR-71 squadrons	——	——
A-7 squadrons	——	——
F-111 squadrons	——	——
RF-111 squadrons	——	——
Aerial targets	——	——
C-141 airlift squadrons	——	——
C-5 airlift squadrons	——	——
Aerospace flight dynamics	——	——
Aircraft propulsion subsystem integration	——	——
Advanced aircraft navigation	——	——
Light intratheater transport	——	——
Flight vehicle subsystems	——	——
Advanced fire control/missile technology	——	——
Advanced reconnaissance and target acquisition capability	——	——
Aerospace structural materials	——	——
Hypersonic vehicle technology	——	——
V/TOL engine development	——	——
Advanced avionics	——	——
Advanced turbine engine gas generator	——	——
Advanced manned strategic aircraft (AMSA)	——	——
Subsonic cruise armed decoy	——	——
National clear air turbulence program	——	——
CONUS air defense interceptor	——	——
Close air support weapons	——	——
Advanced rescue system	——	——
VTOL aircraft (US/FRG)	——	——
F-15A	——	——
Adverse weather aerial delivery system	——	——
A-X aircraft	——	——
Aircraft equipment development	——	——
Total	472.595	668.014

ADVANCED MANNED STRATEGIC AIRCRAFT

This year, I am pleased to report that we have received approval to proceed with the development of an advanced manned strategic aircraft—the AMSA. Over the past 5 years, we have studied this program from virtually every angle. We have looked at the AMSA in terms of a mixed force of bombers and missiles. We have considered it in terms of its fundamental mission—getting bombs on target. We have examined the benefits to be achieved with penetration aids, and we have made detailed analyses of the defense environments which could confront new bomber forces in the seventies and beyond. We carefully weighed all of these factors, and we have now reached agreement to start a full-scale engineering development program for AMSA in fiscal year 1970.

Under this agreement we will proceed to select a system and integration contractor and a propulsion contractor for the development and production program. The development program will be paced with a series of performance milestones to demonstrate progress and establish technical confidence as we proceed into each succeeding phase of development. The decision to proceed with production will remain flexible with implementation being based upon technical progress in the development program. This approach will permit a more explicit determination of production decisions at a later date.

The AMSA, as we see it, will be a four-engine bomber capable of supersonic speeds at either high or low altitude. It will have a gross weight of 350,000 to 400,000 pounds and will be able to deliver very large payloads to great distances. The internal weapons bay will permit us to carry large nonnuclear munition payloads. The aircraft design will be such as to reduce the probability of detection. We are also incorporating other survival and penetration characteristics such as short takeoff and landing to permit widespread dispersal, provisions for decoy and defense missiles, and electronic countermeasures. In this way we expect the AMSA will be an effective weapon system across a wide spectrum of possible conflict situations.

The fiscal year 1970 budget contains $100.2 million for development of the AMSA. Our current schedule calls for issuing the request for proposals (RFP) to industry in May, development contract award in November 1969, and first flight in 1973. Further, if all subsequent decisions are favorable, we should have an operational capability with this new bomber in 1976. In addition, the 1970 R.D.T. & E. program also includes money for three other developments which could be used with the AMSA: the subsonic cruise armed decoy (SCAD); the short range attack missile (SRAM); and the strategic bomber penetration program. The latter two—SRAM and strategic bomber penetration—are carried in the missiles and related equipment budget activity, and are described later.

F–111 A AND D, RF–111D, AND FB–111A

The F–111 is expected to be an excellent aircraft for long-range penetration and precision attack in hostile territory. The F–111 has demonstrated new capabilities for tactical strike aircraft which have long been needed but never achieved by other aircraft. Most notable among these is the low-altitude penetration capability with terrain following radar. This permits weapon delivery at night and in adverse weather. In addition, the aircraft is capable of short field takeoffs and landings, supersonic penetration at low altitude, extensive loiter time in the target area, and high speed at altitude.

The limited combat evaluation in Southeast Asia, in 1968, demonstrated an accurate self-contained blind bombing capability. At night, against poorly, defined targets in undeveloped areas of North Vietnam, the F–111A blind bombing system demonstrated high potential target destruction capabilities. Weapon delivery accuracy is expected to increase as we gain additional experience. Unfortunately, three aircraft were lost during the Southeast Asia evaluation and the wreckage of only one has been found. In that case, the evidence indicated that the loss was caused by a foreign object restricting movement of the flight control linkage. The other two losses may have been caused by the failure of a weld on the horizontal tail actuator—a problem which became apparent during the investigation of a domestic aircraft accident. Later in the year, fatigue testing indicated that the wing carry-through structure should be strengthened. We are testing "fixes" to correct these difficulties, and we are modifying the operational fleet.

One of the major parts of the F–111 development program is the Mark II avionics systems. This system will further improve bombing

accuracy, add all weather air-to-air capability, decrease navigation errors and permit detection and attack of moving vehicles. Flight tests, begun in May of last year, have demonstrated the feasibility of the various operating modes of the system. A major improvement was shown in the detection of fixed man-made targets and the moving target system detected and tracked moving vehicles for attack.

Testing on propulsion, air loads, stability and control, and advanced avionics will continue through this year and on into 1970. Air Force testing will also include work on the release of weapons and certification of the aircraft in its various configurations. We are requesting $73.7 million to continue this F–111 work.

The deep penetration characteristics of the F–111A's and D's should be matched with a reconnaissance aircraft of similar capabilities. We plan to develop the RF–111D to satisfy this requirement. The RF–111 will use the latest in sensor technology to gather intelligence data for a variety of missions from close air support to deep penetration. It will exploit our advanced development programs in forward looking radar, integrated display systems, and improved navigational systems; and it is expected to provide a significant increase in tactical reconnaissance capability. We are requesting $15 million to continue the RF–111D prototype development started in fiscal year 1969, and to support the engineering of aircraft modifications sensors and ground support equipment.

The bomber version of the F–111—the FB–111A—is being developed to replace some of the aging B–52C's through F's. This aircraft will be capable of performing strategic air operations over enemy territory from bases in the United States. With its high speed and small radar reflecting surface, the FB–111A should have improved penetration capabilities. Further, the bombing and navigation system—which includes a star-tracking compass, doppler radar, inertial guidance, and a digital computer—promises to improve radar weapon delivery accuracies by at least a factor of two over current strategic systems. In recent tests, conducted at Elgin Air Force Base, Fla., the FB–111 demonstrated excellent bombing accuracy at low altitudes.

Another major activity in the FB–111 development program is the significantly improved TF–30 turbofan engine which will be used primarily in the F–111D. Through redesign of several key engine sections—such as the turbine, the compressor, and the nozzle—the new engine will provide a takeoff thrust of 25,000 pounds which is a 25-percent increase. This engine—designated the TF–30–P–100—is expected to increase the single engine rate of climb substantially and increase the low level speed with a 20,000-pound bomb load, under tropical conditions.

Development and testing of the FB–111A is proceeding satisfactorily. An FB–111 engine-airframe prototype has been undergoing flight tests for approximately 1½ years and a Strategic Air Command (SAC) crew is now flying an FB–111A at the Air Force Flight Test Center. In addition the combination of an FB–111 and the new short range attack missile (SRAM) is also undergoing flight test as described under missiles and related equipment. We are requesting $84.9 million for the FB–111 in our proposed program for 1970. Of this amount, $36.5 million is for development of the new P–100 turbofan engine.

F–15

One of our highest priority objectives of recent years has been to develop an air superiority fighter to combat the MIG's, and their successors, in the mid-seventies and beyond. We have started the engine development program for such a fighter in cooperation with the Navy, and we now have three aircraft manufacturers working on the fighter itself. The aircraft companies are under contract to design the best possible single-seat, twin-engine fighter for air-to-air combat. We call this fighter the F–15.

While the F–15 designs are not yet complete, we do have a good idea of their general characteristics. With the take-off weight of the F–15 in the 40,000-pound class, the thrust-to-weight ratio will be very good. This high thrust-to-weight ratio, in combination with a much lower wing loading than we have had in recent fighters, will provide acceleration and maneuverability better than anything flying today, or that we can foresee on either side of the Iron Curtain. This performance will assure the close-in maneuvering ability necessary for winning air battles and maintaining air superiority.

For armament, the F–15 will carry a complementary array of weapons consisting of a high rate of fire cannon, new "dogfight" missiles for use against maneuvering targets at short range, and longer ranger all-weather air-to-air missiles. The cannon could be a new development which is similar to our existing gatling gun, but with higher muzzle velocity for greater accuracy and improved hitting power. This new gun would use ammunition that is caseless; that is, the propellent itself forms the case and is expended during firing. The short range, or "dogfight" missile will have a short minimum range but it will also be able to reach out several miles under some conditions. The new gun development is carried in a separate program in the other equipment budget activity, and the short range missile is carried separately in the Missiles and related equipment budget activity. The longer range missile will be an improved version of the Sparrow.

We are requesting $175.1 million in the 1970 program to complete contract definition and to initiate full-scale development, in December 1969, of the F–15 air superiority fighter with an initial operational capability currently scheduled for 1975.

A–X

In order to provide additional close air support for highly mobile Army units in the 1970's, we plan to develop the A–X aircraft. This new attack fighter is expected to be relatively simple and rugged, and it is being designed for the specific purpose of providing our ground forces with close air support. It would be able to replace the A–1 and A–37 which were pressed into this role to meet Southeast Asia requirements.

We see the A–X as a twin-engine, turboprop aircraft with the ability to operate from short, forward area airstrips. Our concept emphasizes operational flexibility with a wide range of tradeoffs available between fuel load and ordnance. For example, we would expect the A–X to be able to take off from a short forward runway—one

very close to the forward edge of the battle area—with a large ordnance payload, fly out on a short radius mission, and loiter for hours in the combat area. Where a longer runway is available, the aircraft should be able to carry more than double the ordnance payload on a longer radius mission, and still loiter for hours. Ease of maintenance, reliable communications tailored to the combat environment, and simple, low-cost navigational and armament equipment will all be part of this aircraft. A very significant feature of the A–X will be its unusually high level of survivability in the face of concentrated enemy antiaircraft weapons. This will be achieved through such design features as extensive fuel system protection, dual manual flight controls, and heavy armor.

We now are in the process of completing our development plan for the A–X, with development scheduled to begin in fiscal year 1970. We are requesting $12 million to start the A–X development program in 1970.

CONUS AIR DEFENSE INTERCEPTOR

As a part of our air defense modernization, we are proposing the development of a missile and fire control system for our interceptor force. This equipment would take advantage of the Navy's Phoenix system development, as well as our own work in this area, and would improve significantly the interceptor's ability to "see" and destroy bombers at any altitude—but especially at low attitudes.

We have demonstrated the technology to increase radar and missile effectiveness. Through our earlier work on advanced interceptors—primarily the YF–12A—and the Phoenix work, we know that we can more than double the present high altitude radar detection range. We can increase our detection ranges by a substantial factor against targets trying to penetrate at low altitudes. We also demonstrated a new air-to-air missile capable of seeking and destroying bombers at long ranges.

Incorporating these new advances into an interceptor aircraft requires that the new radar be designed—or "sized"—to fit into the interceptor. In addition, the new missiles—the AIM–47's—are about 12 feet long and weigh over 800 pounds; installing these missiles on an interceptor also requires engineering designs for major modification.

We are requesting $18.5 million in our 1970 program to continue the development of the new missile/fire control system combination, and to undertake the engineering to put this equipment in a modern interceptor.

Missiles and Related Equipment

The missiles and related equipment budget activity covers a wide range of developments in systems and technology, as well as the operation of two test ranges. The proposed fiscal year 1970 program is $976.9 million which compares with the 1969 program of $938.1 million, as shown in table VIII. Of these amounts, over one-fifth is allocated for the operation of the Eastern and Western Test Ranges. The remaining funds are divided between intercontinental ballistic missiles (ICBM's) and air-launched missiles on a three-for-one basis. Because of the diversity in size and application of the various missiles, I have treated the ICBM programs and their related technology, and then turned to the shorter range missiles.

TABLE VIII.—FISCAL YEAR 1970 R.D.T. & E. BUDGET ESTIMATES

MISSILES AND RELATED EQUIPMENT (3)

[In millions of dollars]

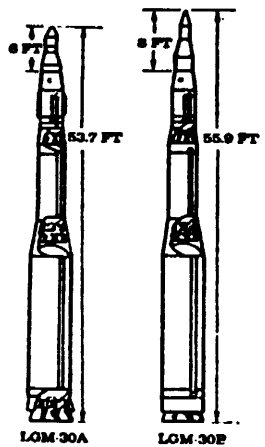
	Fiscal year 1969	Fiscal year 1970
Short-range attack missile	——	——
Minuteman squadrons	——	——
Minuteman integrated command and control system	——	——
Nike targets	——	——
Advanced weapons and applications	——	——
Rocket propulsion	——	——
Advanced air-to-surface missile guidance technology	——	——
Air-launched missile propulsion	——	——
Tactical air-to-ground missile X-3	——	——
Advanced ICBM technology	——	——
Short-range tactical air-to-air missile	——	——
Advanced ballistic reentry system	——	——
Strategic bomber penetration	——	——
Tactical air-to-ground missile (Maverick)	——	——
AIM 4-D growth	——	——
Hard rock silo development	——	——
Western test range	——	——
Eastern test range	——	——
Total	938.148	976.903

MINUTEMAN

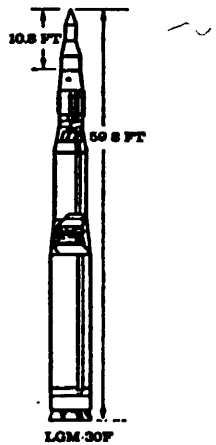
The Minuteman development program is now focused on improvements for the Minuteman II, completion of development on the Minuteman III, and work on the Minuteman integrated command and control system. The Minuteman II work is primarily concerned with the Mark 1A penetration system. This system is carried with the reentry vehicle. We are planning flight tests of the Mark 1A system.

Most of the 1970 Minuteman work will be done on the development of Minuteman III and its Mark 12 reentry system. This work is continuing on schedule and we expect to achieve an operational capability on schedule. This missile system, with the capability of deploying multiple independently targeted reentry vehicles (MIRV's) will introduce a new dimension of flexibility into the strategic missile forces. The MIRV's give a single Minuteman III missile the ability to attack separate targets, or to concentrate all Mark 12 reentry vehicles on a single target. The first Minuteman III was launched on August 16, 1968.

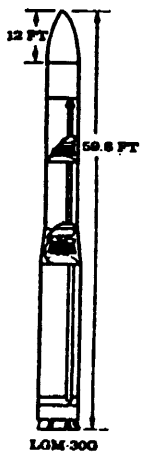
The fiscal year 1970 program contains $339.4 million to continue the Minuteman III development and flight test program and $20 million to continue to the development of Minuteman integrated command and control system (MICCS). This system will provide the capability for memory augmentation, controlled flexible response, and possible use on the Minuteman/Safeguard integration system.



Minuteman I



Minuteman II



Minuteman III

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HARD ROCK SILO DEVELOPMENT

We have also determined that we can improve the deterrent effectiveness of our Minuteman III force by making them more difficult targets for any enemy to destroy. To achieve this objective, we are developing superhardened launch and control facilities to be sited in rock sufficiently hard to provide a significant increase in the overpressure needed to destroy a single facility. These new launch facilities are being designed to withstand both high overpressures and associated nuclear effects. The design of the launch control will provide even greater hardness. Concurrently, development is underway to satisfy the demanding command and control survivability requirements which are inherent with these extremely hard facilities. These new facilities are also being designed to have the dual capability of accommodating a larger payload advanced ICBM at a later date.

We are requesting $50 million in this budget to continue engineering development of the facilities. As part of this program we will fabricate a full-scale prototype silo and is associated ground equipment to demonstrate—by high explosive simulation tests (HEST)—the extreme hardness levels which are required.

ADVANCED ICBM TECHNOLOGY

In addition to the dual capable Hard Rock Silo development program, we are also working on the more critical, long leadtime items for the development of an advanced ICBM system at some future time. The technology from the Self-Aligning Boost and Reentry (SABRE) program has been incorporated with other guidance technology to provide a basis for developing an advanced guidance system. The other technology activities in this program are concentrating on the development of an advanced post boost propulsion system and the definition of an advanced post boost vehicle. We are requesting $20 million to continue the development of those technologies which will assure a future capability to deploy an advanced land based missile system.

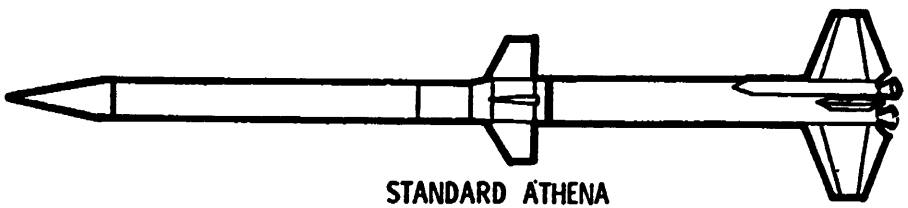
ADVANCED BALLISTIC REENTRY SYSTEM (ABRES)

The development and testing of advanced reentry systems and penetration aids is the objective of the Department of Defense's Advanced Ballistic Reentry Systems (ABRES) program. The Air Force is the executive agency for this continuing program and the funds for its support are in the Air Force budget. However, the program provides development and test services for the Navy's Polaris and Poseidon missiles and some Army reentry work, in addition to basically Air Force programs. It is also closely associated with the Air Force's Nike Targets program which supports the Army. The technologies for MIRV, chaff and decoys—all of which are being used in the Minuteman III missile system—were initially demonstrated in the ABRES program.

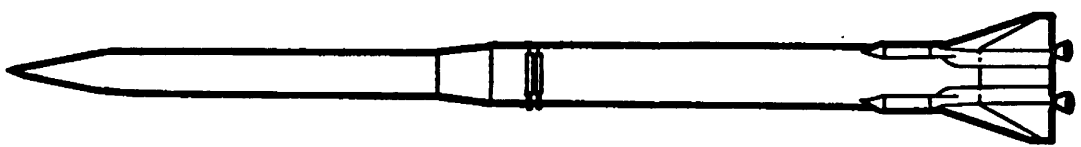
The program continues to concentrate on the development of reentry shapes and designs, and penetration aids and techniques. The results of this work will be used to assure the effectiveness of future reentry vehicle which may have to face sophisticated ballistic missile defense environments. To accomplish this end, the ABRES program encompasses a wide variety of tasks and experiments. One of the current projects is the development of hardened reentry vehicle technology applicable to small, lightweight reentry vehicles. Full scale flight tests of an advanced technology version of a small reentry vehicle is planned. We are also continuing work on other advanced reentry concepts.

In carrying out these tasks and projects, the ABRES program employs both subscale and fullscale flight testing. The subscale tests have been very successful in using the Athena boosters in launches from Green River, Utah, into the White Sands Missile Range in New Mexico. We plan to build on this successful experience in fiscal year 1970, with the introduction of a new and bigger Athena—the Athena H. The Athena H will have a payload capacity four times as large as that of the current Athena. In addition, full scale reentry flight tests will continue from the Western Test Range using surplus missile boosters which are no longer required in the operational inventory. Additional Athena and Atlas booster flights are scheduled for fiscal year 1970. We are requesting $121.4 million to continue the ABRES program in 1970.

COMPARISON OF ATHENA VEHICLES



STANDARD ATHENA



ATHENA H

SHORT RANGE ATTACK MISSILE

The Short Range Attack Missile (SRAM), which I mentioned in conjunction with the AMSA and the FB–111, has progressed into the test phase. This guided, nuclear-armed missile will increase our confidence in successfully attacking targets in the presence of sophisticated defenses. It is being developed for our bombers to use in supressing defenses in their path and to destroy primary targets as well—and without exposing the bombers to the enemy's defenses.

The SRAM test program is now well underway. It has been paced by the solid rocket motor which experienced some difficulties last year, but which now appear to be corrected. Recent static firings of motors have been very sucessful. Dummy SRAM drops from the internal rotary launcher and the external wing pylons of a B–52 bomber have paved the way for the first live missile launch from the B–52. In addition, internally mounted dummy SRAMs have been dropped from an FB–111 aircraft in preparation for the first live missile launch from the FB–111. We are requesting money for the SRAM development program, in this budget activity, to continue the SRAM development test program, and the engineering for the modification of the B–52 G and H squadrons with SRAM equipment.

STRATEGIC BOMBER PENETRATION

We are also investigating other ways to facilitate penetration of enemy aircraft defenses. The Strategic Bomber Penetration program will investigate various concepts including the use of bomber defense missiles (BDM) on the bomber force—primarily the AMSA, but also on the B–52's.

We are requesting $3 million to continue our bomber defense missile analyses and to continue our examination of bomber penetration techniques. These activities are expected to provide the performance and cost data which are prerequisites for the development of any bomber penetration system.

MAVERICK

We are also developing a much shorter range air-to-surface missile for tactical applications. This new missile—called the AGM–65A, or Maverick—is a rocket-powered, television guided weapon designed to attack small hard tactical targets such as tanks and field fortifications. It will be carried by such tactical aircraft as the F–4, the A–7, and the F–111.

Development of this missile is well underway with most of its characteristics determined. It will be about 8-feet long, 1 foot in diameter, weighing less than 500 pounds, and suitable for external mounting. However, it will be able to deliver a focused high explosive warhead at various ranges and it can also be launched during supersonic flight. Its automatic television guidance provides the missile with the ability to track its target after launch without any further reference to its parent aircraft. We expect very high accuracies with this missile.

Fiscal year 1969 is the peak development year on this program in terms of R.D.T. & E. funds. We are requesting $39.6 million for Maverick development in fiscal year 1970.

SHORT RANGE TACTICAL AIR-TO-AIR MISSILE

Our experiences in tactical air-to-air encounters have indicated that guns, short range missiles, and long range missiles contribute to achieving and maintaining air superiority. The short range tactical air-to-air missile—the AIM–82A—is being developed to fill the gap between guns and longer range missiles.

We plan to start this missile development program in the middle of this year with two or more contractors defining the weapon. Then, in fiscal year 1970, we plan to have two contractors engaged in a competitive development program. This latter phase will end in a fly-off demonstration to be followed by selection of the better missile for subsequent production. We are requesting $14 million for this program in 1970.

MILITARY ASTRONAUTICS AND RELATED EQUIPMENT

The 1970 proposed program for military astronautics and related equipment is $1.1109 billion, which is essentially the same level as in 1969. This is about one-third of our total Air Force R.D.T. & E. program from fiscal year 1970. The programs that constitute this budget activity are shown in table IX, where it can be seen that the Manned Orbiting Laboratory (MOL) accounts for one-half of the funds requested. In addition to that very important program, we are also requesting funds in this budget activity for new advances in satellite communications—both point-to-point and tactical, and a new approach to ballistic missile defense to be funded under "Defense subsystem development and demonstration."

DEFENSE SATELLITE COMMUNICATIONS SYSTEM

The initial defense satellite communications system has been operational since the middle of 1967. It presently consists of 26 low-power satellites in near synchronous equatorial orbit; 25 of these satellites are regularly scheduled for communications. The success of this initial program has been the basis for a more advanced global point-to-point satellite communications system.

TABLE IX.—FISCAL YEAR 1970 R.D.T. & E. BUDGET ESTIMATES

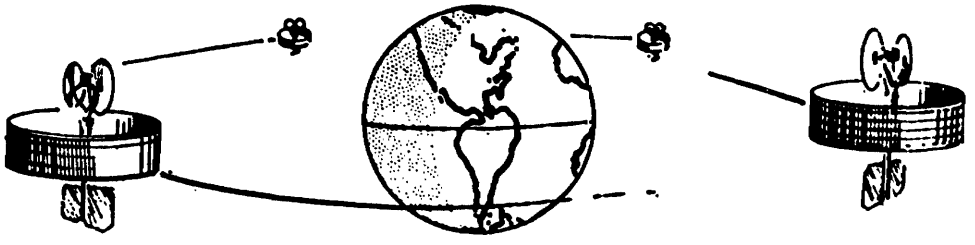
MILITARY ASTRONAUTICS AND RELATED EQUIPMENT (4)

[In millions of dollars]

	Fiscal year—	
	1969	1970
Program 949	——	——
Program 417	——	——
Defense satellite communication	——	——
Special activities	——	——
Satellite control facility	——	——
Titan III space booster	——	——
Manned orbiting laboratory	——	——
Aerospace biotechnology	——	——
Aerospace propulsion	——	——
Aerospace avionics	——	——
Space studies	——	——
Advanced space power supply technology	——	——
Space experiments support	——	——
Satellites, balloons, and rockets	——	——
Advanced space guidance	——	——
Space object surveillance tracking and identification	——	——
Advanced liquid rocket technology	——	——
Defense subsystem development and demonstration	——	——
Tactical Satellite communications	——	——
Spacecraft technology and advanced reentry tests	——	——
Expandable structures	——	——
Satellite system for precise navigation	——	——
Advanced satellite secondary propulsion system	——	——
Space relay and data management	——	——
Advanced sensor technology	——	——
Graphitic reentry materials	——	——
Arnold engineering development center	——	——
Aerospace	——	——
Total	1,136.595	1,067.973

The advanced system, called phase II, will use up to four high-power satellites in stationary equatorial orbits. These new satellites will weigh almost 10 times as much as the present satellites and they will have many times the effective radiated power to earth stations. They will also provide a narrow beam capability which will permit even higher effective radiated power. The role of the Air Force in this program is to develop and launch the satellites and operate assigned ground terminals for the Defense Communication Agency. We are requesting $20.8 million in our 1970 program for satellite development and testing.

PHASE II CONCEPT



SATELLITES IN SYNCHRONOUS EQUATORIAL ORBIT

TACTICAL SATELLITE COMMUNICATIONS

Since late 1965, the Air Force has been participating in the joint service Tactical Satellite Communications program. The purpose of this program is to explore and demonstrate the use of satellites to satisfy selected tactical communication needs of the military services. The concept employed here is to place much of the power and complexity of the communications system in the satellite, thereby permitting the tactical use of relatively lightweight and mobile terminals on aircraft, jeeps, trucks, and ships. The satellites and the airborne terminals for this program are the responsibility of the Air Force.

All three of the satellites involved in this program are now in orbit and operating. The first of these—LES–5—is a spin-stabilized, solar-powered satellite that has been in a slowly drifting orbit since mid-1967. All of the services, and some of our NATO allies, have used this satellite in a variety of communications tests and experiments. The Air Force placed the second of these communications satellites—the LES–6—in a synchronous equatorial orbit in September 1968. The LES–6 is fixed above the Galapagos Islands (off the west coast of Ecuador and directly south of Chicago). It differs from the LES–5 in that it is 10 times more powerful and is in stationary orbit. The military services are now using the LES–6 for additional testing.

The final step in the space segment of the Tactical Communications Satellite program was to place the 1,600-pound advanced satellite—TACSAT—into a synchronous orbit in February 1969. TACSAT I and LES–6 will now be used by the services for extensive tests. On the basis of data obtained from these tests, an operational system will be defined. We are requesting $8 million for the TACSAT program to complete the evaluation and to start work on the operational tactical communications satellite.

MANNED ORBITING LABORATORY

The Manned Oriting Laboratory (MOL) program has the objectives of developing manned and unmanned defense-oriented space equipment, and determining the full extent of man's utility in space for defense purposes. The basic MOL vehicle, and its two-man crew, will be the test bed to accomplish these objectives by conducting experiments with complex equipment in near-earth orbits. Based on previous experience with both manned and unmanned space systems, we believe that from the beginning MOL will perform support functions whose values will justify program costs.

The basic development approach is to take maximum advantage of equipment, subsystems, and technology which have already been developed. The use of the modified Gemini spacecraft is perhaps the best example, but there are many others. They include building on the Gemini and Apollo astronaut suit technology, for the MOL pilot full pressure suits; use of space packaged foods of the type developed by the Army and NASA; adaptation of the Apollo fuel cell for MOL applications; and use of the Apollo attitude control electronics technology.

In a typical MOL mission, the two-man crew will be launched into orbit inside a Gemini B spacecraft attached to the laboratory. In or-

bit, the pilots will move into the laboratory through a hatch in the Gemini heat shield. Once in the laboratory, the crew will take off their space suits and perform their experiments in a "shirt-sleeve" environment. After 30 days, they will prepare for their return to earth by getting back into the Gemini B, detaching it from the laboratory, and reentering the earth's atmosphere for an ocean landing and recovery. The laboratory will reenter separately and is expected to burn up in the process. The MOL launches will take place at Vandenberg Air Force Base, Calif., and the Air Force Satellite Control Facility at Sunnyvale, Calif., will control and track the flights through its worldwide network of ground stations.

We have made considerable progress in the MOL program since the President directed its development in 1965. All of the major components of the MOL system are under development. Mockup and structural test assemblies of the laboratory and experimental modules have been completed and the fabrication of components has begun. Successful static test firings of the first stage engine of the Titan IIIM have also been conducted. The launch complex construction is almost complete.

A very thorough review of the program was conducted by the Secretary of Defense in February which reaffirmed that the benefits to be derived from MOL justify its continuance. Furthermore, it was concluded that all of the MOL objectives can be accomplished within a reduced launch program. The revised plan consists of two hardware qualification launches to qualify the Titan IIIM/Gemini B structural hardware, and four 30-day manned flights. The elimination of one flight was made possible by the current maturity and increased knowledge of manned spaceflight, which makes us confident that we can meet our objectives.

By slightly extending the launch intervals, we have protected the option of economically adding launches to the program, if this proves desirable. Between now and that decision point, we will have gained additional technical data and knowledge.

The revised plan also lowers the estimate of the total program cost and reduces the fiscal year 1970 requirement from $576 million to $525 million. Our current schedule provides for the first unmanned launch in early 1971 and the first manned flight in early 1972.

SPACE EXPERIMENTS SUPPORT PROGRAM

Our space technology programs are producing many new approaches for a variety of applications, but they must be proven in a space environment. Frequently these new approaches and experiments do not justify the expense of being placed in orbit by their own booster. In 1965, we established the space experiments support program (SESP) to provide space flight support for Defense experiments that do not have any other means of being placed in orbit. The purpose is to get the most use out of every booster. This program is responsible for reviewing and selecting competing experiments and for procuring launch vehicles and spacecraft for the experiments. It also takes care of launch scheduling and the purchase of launch services. The first SESP launch took place in June 1967, orbiting two satellites—one Army and one Navy.

This program also takes advantage of very high priority programs, which must be placed in order, but which do not fully use the payload capability of their launch vehicles. In those cases, this support program provides for the assignment of payloads to use space that is available aboard the launch vehicles of other space programs. An example of this type of Titan IIIC which was launched on May 23 and carried three secondary satellites into orbit. Another example is a multipayload flight with an Army satellite aboard a NASA Nimbus B launch. We are requesting $19.3 million to continue the space experiments support program in 1970.

ADVANCED SPACE GUIDANCE

The advanced space guidance program addresses the problem of providing precise pointing information to various satellite sensors. This problem is expected to become increasingly important as new sensors are developed for use aboard spacecraft. The primary task for this program in 1970 is the continued development of the space precision attitude reference system (SPARS). This system consists of a star sensing device, a gyro reference, and remote optical alinement equipment. We are starting the fabrication and functional testing of a SPARS prototype system with 1969 funds, and we expect to complete the prototype system and prepare for flight testing with the $7 million requested in 1970. Flight tests are planned for mid-1971, and early 1972.

GRAPHITIC REENTRY MATERIALS

The new graphitic reentry materials program is closely related to the ABRES program which I described under "Missiles and related equipment," The program will develop hardened graphitic materials and will provide heat shields and nose tips for flight demonstration under the ABRES program. This promising new technology will continue the materials and design technology initiated under the aerospace structural materials program and it will continue to be managed by the Air Force Materials Laboratory at Wright-Patterson AFB, Ohio. We are requesting $2 million to initiate this program in fiscal year 1970.

ARNOLD ENGINEERING DEVELOPMENT CENTER

The Arnold Engineering Development Center (AEDC) at Tullahoma, Tenn., is shown at table IX as unfunded in fiscal year 1970. This reflects a decision to operate the Arnold Engineering Development Center under the "Air Force industrial fund" whereby the programs which use the AEDC facilities will provide the funds for their operation. However, there is a new program called Arnold Engineering Development Center Testing Technology, which is carried in the "Other equipment" budget activity, to provide for the costs of developing testing technology at the center. We are requesting $4.5 million for that program in 1970.

OTHER EQUIPMENT

The "Other equipment" budget activity includes complete support systems as well as major subsystems which will later be incorporated into full-scale weapon systems. Most of the support systems involve electronic surveillance or communications. They include programs such as backscatter over-the-horizon (OTH) radars, intelligence systems, command and control systems, and communications systems. The major subsystems are concerned with new guns for the F–15 and A–X, and penetration aids for aircraft.

The proposed program for fiscal year 1970 includes $400 million for "Other equipment." This is slightly more than $384 million for 1969, as shown in table X, and represents the net effect of a large number of increases and decreases. The largest single increase is for the airborne warning and control system (AWACS).

AIRBORNE WARNING AND CONTROL SYSTEM

The airborne warning and control system (AWACS) is a program which will permit us to place the essential elements of detection and control into an aircraft. Such a system offers many advantages for both our tactical forces and our air defense. It would be completely mobile and capable of rapid worldwide deployment. Once deployed in a tactical role, it would function as the nerve center for achieving and maintaining air superiority and for directing tactical air forces in an extended battle area. In the air defense role, AWACS aircraft would be used in conjunction with over-the-horizon radars, and the improved interceptors—which I described earlier. In this role, the AWACS would have a considerable advantage in not being a geographically fixed target.

The AWACS radar is the most demanding part of this system in terms of technology. It must be able to pick out moving targets, such as bombers attempting to penetrate at low altitude, and display them clearly for the airborne crew.

The aircraft is also an important part of the AWACS. What we are looking for is a large aircraft that can be modified to carry all of the AWACS equipment and a crew of 20 to 40 people.From our evaluation of available aircraft, either the DC–8 or the 707 jet transport could be suitably modified to handle the system and provide an on-station altitude of 30,000 to 35,000 feet. On-station endurance on the order of 7 hours minimum could be obtained, and we plan to be able to increase this with inflight refueling.

The 1970 program includes $60 million for the AWACS. This amount will permit us to continue the radar developments and to initiate system development.

CONUS OVER-THE-HORIZON BACKSCATTER RADAR

In my treatment of the "Military sciences," I traced the evolution of over-the-horizon (OTH) radar from its early beginnings in our basic research program to the System 440L. This early research has also led to another type of OTH radar—called "backscatter"— which should be able to detect aircraft and missiles off our coasts.

TABLE X.—FISCAL YEAR 1970 R.D.T. & E. BUDGET ESTIMATES, OTHER EQUIPMENT (7)

[In millions of dollars]

	Fiscal year 1969	Fiscal year 1970
Stragetic Air Command communications and control networks (SACCON)	———	———
PostAttack Command and control system (PACCS)	———	———
UHF-Emergency Rocket Command system (ERCS)	———	———
Special purpose communications	———	———
Airborne warning and control system	———	———
Conus over-the-horizon radar	———	———
Over-the-horizon radar system	———	———
Tactical air control system	———	———
Defense Communications Planning Group	———	———
Cryptologic activities	———	———
100TH Strategic Reconnaissance Wing	———	———
Technical sensor collection	———	———
Clear sky	———	———
Mapping, charting, and geodesy	———	———
Intelligence data handling system	———	———
National Military Command systemwide support	———	———
Air Force communications	———	———
Traffic control, approach, and landing system (TRACALS)	———	———
Air cargo materials handling	———	———
Conventional munitions	———	———
Ground electronics	———	———
Human resources	———	———
Overland radar technology	———	———
Over-the-horizon radar technology	———	———
Tactical air control and landing devices	———	———
Advanced devices	———	———
Advanced Tactical Command and control capability	———	———
Satellite communications terminals—Tactical	———	———
Airborne satellite communications terminals—Strategic	———	———
Loran D	———	———
Advanced Airborne Command post (AABNCP)	———	———
High energy laser program	———	———
Triservice lightweight tactical radar	———	———
Base security	———	———
Reconnaissance/intelligence exploitation	———	———
Conventional weapons	———	———
Biological warfare/chemical warfare program	———	———
Penetration aids for manned aircraft	———	———
Simulator for air-to-air combat	———	———
Integrated control/tactical displays	———	———
Civil engineering technology	———	———
Aeronautical Chart and Information Center	———	———
Integrated communications-navigation-identification	———	———
Tactical information processing and interpretation	———	———
Air traffic control radar beacon system/air identification mark XII system	———	———
Joint advanced tactical command, control and communications program	———	———
Tactical jamming system	———	———
Electronic warfare systems	———	———
Life support system	———	———
Chemical-biological equipment	———	———
Other operational equipment	———	———
Light weight precision bombing system	———	———
Intelligence/reconnaissance equipment	———	———
Systems survivability	———	———
Armament/ordnance development	———	———
Improved aircraft firefighting equipment	———	———
Improved aircraft gun system	———	———
Sentinel mist	———	———
Arnold engineering development center testing technology	———	———
Test instrumentation	———	———
Information analysis center	———	———
Electromagnetic compatibility analysis center	———	———
Lincoln laboratory	———	———
Mitre	———	———
Aircraft navigation system verification	———	———
Total	383.665	385.166

The continental United States (CONUS) OTH backscatter radar program is developing this technique to be an integral part of our modernized air defense. In its simpler form, the OTH backscatter radar will be able to detect aircraft at ranges of several thousand nautical miles. However, by increasing the number of transmit beams,

and making other design changes, OTH backscatter radars could also detect submarine launched ballistic missiles (SLBM's).

We are requesting $3 million in our 1970 R.D.T. & E. program to start development on this detection system. The direction this work takes is dependent upon the decision, yet to be made, on the additional cost for an SLBM capability.

SENTINEL MIST

Sentinel Mist is the new designation for the FPS–95 radar. This high power radar system was developed under the Technical Sensor Collection program in prior years, and is also based on the technology produced in earlier OTH radar programs and the basic research work I mentioned earlier. It is a backscatter over-the-horizon (OTH) radar system. We are requesting $13.6 million to complete the installation and begin operational testing of the radar.

SPECIAL PURPOSE COMMUNICATIONS

For several years we have been working on ways to insure the survivability of the Strategic Air Command's communications systems. The Special Purpose Communications program is developing Very Low Frequency (VLF) radio equipment to complement other communications and provide a reliable means of communicating over long distances during and after a nuclear attack. We plan to equip SAC's airborne command post aircraft with these new VLF transmitters and receivers and also with a very long trailing wire antenna. In addition, we will install VLF communications facilities in key control centers on the ground.

The first generation of transmitters, receivers, and trailing wire antennas have been developed and we are in the process of testing the airborne equipment. We are also transferring the VLF ground stations to SAC. With the $5 million requested in 1970, we will continue the test program and the development of improved signal processing equipment.

IMPROVED AIRCRAFT GUN SYSTEMS

Our tactical air warfare experiences continue to validate the requirement for improved aircraft gun systems. This year we have initiated a new program to concentrate on the development of a gun for aerial combat, and another gun for close air support work. The aerial combat gun is being developed primarily for air superiority fighters such as the F–15. Its unusual feature will be a caseless round with attendant weight savings. We have already achieved single shot firings of a caseless round and we have designed and fabricated a model gun mechanism. We expect to be able to demonstrate trouble-free, automatic firing of the combined caseless round and gun system in the very near future.

We are also working on a new air-to-ground gun system for use against a variety of targets such as personnel, armored vehicles, and hard point targets that are blast sensitive. While the design characteristics for this gun have not been fully established, we are considering a large caliber with a high muzzle velocity to achieve the effectiveness

we need. This year we plan to start engineering development on this system, and we would expect to use it on the A–X close air support aircraft. We are requesting $10 million for the development of these improved gun systems.

AIR FORCE HUMAN RESOURCES LABORATORY

The Air Force Human Resources Laboratory, which appears as a new program in 1970, is, in effect, a regrouping of personnel and training research projects. It is being assembled from various activities of the Aerospace Medical Division to focus attention on the benefits to be derived from greater productivity of our most important resource—people. This Laboratory will bring together such related activities as methods and techniques for flying training and technical training, the use of learning machines and computer-aided instruction, and performance evaluation techniques and personnel selection processes. We are requesting $4 million in 1970 for the operation of this Laboratory. This amount is about $1 million more than contained in the 1969 program.

PROGRAMWIDE MANAGEMENT AND SUPPORT

In a continuing effort to improve the management of our R.D.T. & E. program, we have revised the structure of the programwide management and support programs for fiscal year 1970. The four existing programs—command and base operations; development, acquisition, and test management; aeronautical systems engineering group; and exploratory development management have been consolidated into two new programs called development and test support and acquisition and command support. Table XI identifies the individual organizations included under each of these programs. A major improvement resulting from this new structure is the consolidation of all of the funds for operation and management of each of these organizations into a single program element instead of dividing them between two elements.

TABLE XI.—FISCAL YEAR 1970 R.D.T. & E. BUDGET ESTIMATES

PROGRAMWIDE MANAGMENT AND SUPPORT (8)

[In millions of dollars]

	Fiscal year	
	1969	1970
Development and test support	121.600	125.821
Flight Test Center	——	——
Missile Development Center	——	——
Special Weapons Center	——	——
Armament Development Center	——	——
Acquisition and command support	168.952	182.950
Aeronautical Systems Division	——	——
Electronic Systems Division	——	——
Space and missile organization	——	——
Aeromedical Division	——	——
Office of Aerospace Research	——	——
Headquarters, Air Force Systems Command	——	.474
International Military Headquarters and agencies	.225	.200
International cooperative R. & D	——	——
Total	290.777	309.445

The increased requirements for support of these activities in fiscal year 1970, provide primarily for the cost of the civilian pay raise which became effective on July 1, 1968. The fiscal year 1969 cost for this pay raise is not included in the amounts shown for that year, but will be added by a reprograming action later in fiscal year 1969. The increase also reflects the provision for procurement of standard electronic equipment for research and development activities which were previously provided under the "Other procurement" appropriation.

The development and test support program and the acquisition and command support program include the pay for civilian personnel at these major research and development activities. These funds are also used for travel, transportation, rents, utilities, contract services, and supplies and equipment for military and civilian personnel. The levels of military and civilian personnel planned for these Air Force activities in fiscal year 1970, are somewhat lower than in fiscal year 1969.

The international military headquarters and agencies program, which appears as a "new start" in fiscal year 1970, is in reality a transfer of accountability from the military assistance program (MAP) to the R.D.T. & E. program. The funds in this program pay for the salaries and allowances of the U.S. representatives at the Supreme Headquarters Allied Powers Europe (SHAPE) Technical Center which is located at The Hague in the Netherlands. This Technical Center provides SHAPE with operations research and systems analysis capabilities which are applied to such SHAPE problems as force structures, command and control, and communications. The United States supplies about one-fifth of the scientific and engineering effort for which $474,000 is requested in fiscal year 1970.

The international cooperative research and development program is somewhat less in 1970, than it is in 1969. The funds in this program facilitate the mutually beneficial flow of technology between the Air Force, our allies, and other countries in the free world.

Conclusion

This completes my description of the various budget activities, Mr. Chairman; but before proceeding with your questions I would like to make a concluding observation. The Air Force R.D.T. & E. program which I have proposed to you today is big by almost any standard. It amounts to $3.566 billion to be paid for by all of us. While it is not the biggest Air Force R.D.T. & E. budget, and while it will not buy as much as several earlier budgets, it is an amount which will pay for our essential new systems and their supporting technology.

There are, of course, several programs we would like to have—and could profitably use—which are not included in this proposed program. The Air Force request to the Secretary of Defense amounted to a $4.2 billion program. That amount was examined, analyzed, and adjusted on a program-by-program basis as negotiations took place over a matter of months. It was then reexamined by the new administration. In the end, we arrived at the figure of $3.566 billion. I believe, Mr. Chairman, that the $3.566 billion program I have presented today will

permit the Air Force to develop those systems which are so necessary to the Nation's security, and indeed, its survival.

Mr. Chairman, and members of the committee, this concludes my prepared statement. I will be most pleased to respond to your questions at this time.

FISCAL YEAR 1970 R.D.T. & E. BUDGET ESTIMATES

[In thousands of dollars]

	Military sciences	Aircraft and related equipment	Missiles and related equipment	Astronautics and related equipment	Other equipment	Program-wide management and support	Total
Program I, strategic forces		87,920	452,108	73,719	73,800		687,547
Program II, General purpose forces		91,837			22,700		114,537
Program III, intelligence and communications		2,200		794,568	33,000		829,768
Program IV, airlift forces		34,202			3,000		37,202
Subtotal (operational systems development)		216,159	452,108	868,287	132,500		1,669,054
Program VI:							
Research	100,173						100,173
Exploratory development	36,787	30,819	36,180	103,742	52,421		259,949
Advanced development	4,539	210,919	166,912	71,244	60,300		513,914
Engineering development		210,117	92,300		89,535		391,952
Management and support	17,200		229,403	24,700	50,410	309,445	631,158
Subtotal (program VI)	158,699	451,855	524,795	199,666	252,666	309,445	1,897,146
Total, Air Force R.D.T. & E. program	158,699	668,014	976,903	1,067,973	385,166	309,445	3,566,200

Mr. SIKES. The budget amounts mentioned in your statement require modification in light of the MOL program cancellation.

General MCNICKLE. Yes, sir; but they will probably be revised.

VARIOUS USES OF BERRYLIUM

Mr. FLOOD. Are you still conducting R. & D. in berrylium?

General MCNICKLE. Yes, sir.

Mr. FLOOD. For what purpose? Airframes—anything else, fuel?

General MCNICKLE. Where we can take advantage of its characteristics, as in brakes.

Mr. FLOOD. Exotic fuel.

Mr. HANSEN. On Berrylium additives to fuel we have stopped work. I would like to introduce Dr. Lehmann who handles our research program. He might answer that.

Dr. LEHMANN. You asked about the fuel?

Mr. FLOOD. First fuel, exotic fuel.

Dr. LEHMANN. There was a program at the Rocket Propulsion Laboratory.

Mr. FLOOD. I know there was. What about it today?

Dr. LEHMANN. It is still continuing at a modest level but the large-scale tests have been stopped.

Mr. FLOOD. What about the metal for airframes?

Dr. LEHMANN. Yes, sir; we are still looking at that for lightweight structure for airframes.

UNFUNDED PROJECTS OF SIGNIFICANCE

Mr. SIKES. Thank you very much, General McNickle. Yours has been a very well prepared presentation and the committee appreciates the detail shown in the document. I am interested in your statement that there are several programs that you would like to have and could profitably use which are not included in the program.

Which ones are those that are of real significance in your opinion?

General MCNICKLE. Sir, in light of the MOL cancellation today, may I submit my revised views for the record?

Mr. SIKES. Very well, including information about costs.

(The information follows:)

The significant Air Force programs which could use additional fiscal year 1970 R.D.T. & E. funding are:

Fiscal year 1970

[Dollars in millions]

Defense subsystem development and demonstration $24

The DSDD is an advanced development program which will provide test data and design requirements ———. The fiscal year 1970 funding of $12.9 million results in the Air Force flying ——— launches to flight test the ——— sensor and guidance electronics ———.

The additional funding of $24 million would provide the earliest and most economical demonstration of ——— nonnuclear kill against reentry vehicles. A total of ——— flight demonstrations are planned, with the first to occur in ———. This will allow the Department of Defense to obtain maximum results from funds expended to date on this program and its predecessor, program 922.

Advanced ICBM technology $24

An additional $24 million is required for advanced ICBM technology in order to begin the competitive design phase of an advanced hardened missile guidance system development. Such a system would provide an order of magnitude increase in nuclear hardness and a ——— improvement in guidance system accuracy, as compared to Minuteman III. An advanced guidance system, as part of an advanced post boost vehicle, in a critical and pacing item constraining the future development of an advanced ICBM.

The Air Force is seriously concerned over the trend of the survivability and range/payload capabilities of the land-based strategic missile force vis-a-vis that of the Soviet Union. In our best judgment, an advanced ICBM should be developed to counter this threat.

Advanced sensor technology $7

Seven million dollars is needed for advanced sensor technology in order to develop a means for making accurate ——— measurements ———

Dual capable Minuteman $16

The dual capable Minuteman missile provides an option for using the Minuteman missile in either its present mission as an offensive weapon or as an extended range interceptor defending against reentry vehicles: $6 million is required to complete preliminary design studies associated with modifying existing Minuteman missiles; $10 million is needed to begin development of the components which will make the Minuteman missile dual-capable; this development includes fusing, guidance, targeting, and command and control integration.

AX aircraft $7.4

Because of the requirement for studies on size, survivability and all weather support, the Air Force cannot substantially speed up the contract definition phase or initial operating capability of fiscal year 1973. However, $1.4 million can be used beneficially for some acceleration of airframe and engine development and $6 million to accelerate the larger caliber gun development program.

NEW DEVELOPMENTS ENTERING INVENTORY DURING PAST YEAR

Mr. SIKES. In the time period of the past year since your predecessor, General Holzapple, presented the Air Force's fiscal 1969 budget for R.D.T. & E. to the committee, what new weapons or equipment of significance have been added to the operational inventory of the Air Force through the efforts of the R.D.T. & E. program. Do you have a list of those?

General MCNICKLE. Yes, sir.

Mr. SIKES. Will you run through them briefly at this point and provide details for the record?

General MCNICKLE. In general, Mr. Chairman, most of these are either ECM or munitions for Southeast Asia. There are fuzes and WAAPM. The latter provides a very effective air-delivered, anti-personnel mine field.

Mr. SIKES. It is understandable that the public and, indeed, the Congress, would be interested in what we have been getting for roughly $3.5 billion a year, which has been appropriated for this work for a number of years. You would anticipate there would have been some exciting new major developments.

General MCNICKLE. The C-130 gunship II is an outstanding example of such developments. Another is our laser-guided bomb. It consists of a standard bomb from inventory, a new tail fin assembly, and a new nose with the guidance system. ———.

Mr. FLOOD. How about laser as a weapon in its own right?

General MCNICKLE. ———.

Mr. SIKES. This is impressive? You mentioned the C-130 gunship. All that involved was mounting some machineguns in a C-130 aircraft. It is not a very expensive, or far-reaching development, although a useful one.

It does make the work of this committee more difficult when there are not more significant items of accomplishment to point to.

General MCNICKLE. Sir, one of our more impressive developments was the Phase I Defense Satellite Communications System which we launched from the Eastern Test Range.

Another is our modification to the MSQ blind bombing radar system which is now deployed in Southeast Asia. It enables us to drop bombs on tactical targets at any hour of the day or night, and independent of the weather.

Our over-the-horizon radar——

NEW WEAPONS ADDED TO INVENTORY THROUGH R&D EFFORTS

Mr. SIKES. I suggest you provide a listing of the significant new items. Indicate the development cost of each item and the degree to which it is superior to the predecessor item. Do not include in this list weapons which you anticipate completion of during the current fiscal year or items completed previous to March of last year when General Holzapple appeared.

(The information follows:)

Description	Month	Development cost
C-130 Gunship II. Side-firing C-130 for night close support and interdiction missions. Has 20 mm. guns and ability to acquire targets at night and to deliver fire solely through the use of the sensors and fire control system.	September 1968.	$700,000
F-111 aircraft. Task force deployed to Takhli AB, Thailand for operational missions.	March 1968.....	1,439,000 000
AIM-7E-2 Sparrow missile. An improved air-to-air missile with greater manuever-ing capability and a reduction in the minimum launch range.	May 1968.....	Navy [1]
OV-10 aircraft. 2 engine turboprop forward air controller aircraft. Provides signifi-cant improvement in response time, maneuverability, increased visibility, and can return fire.	July 1968.....	2,000,000 [2]
AGM-12E standoff cluster missile. Air launched missile designed for flak suppres-sion by release of BLU-26 and BLU-36 (antipersonnel) bomblets.	October 1968...	100,000
F-4E aircraft. F-4D aircraft modified with J79-GE-17 engines and an M61 20mm. nose gun. Will provide significantly improved air-to-air capability and enhance air-to-ground capability.	.....do.....	
Black spot aircraft. C-123 A'C equipped with multiple sensors for night interdiction. New capability with sensors plus area munitions.	November 1968.	12,000,000
MUNITIONS		
SUU-42/A dispenser. Externally-mounted 8-tube dispenser for delivering various types of sensors/flares from F-4 aircraft. New capability.	March 1968.....	586,000
SUU-41 dispenser. A device for dispensing Gravel mines from high-speed aircraft. New capability.	April 1968.....	924,000
Chemical weapon BLU-52. A BLU-1 Napalm tank filled with riot control agent (CS-2). Used as area denial and harrassment weapon. New capability.	.....do.....	10,000
FMU-72/B fuze. Long delay fuze ——— settings from ———. Has safety features not in predecessor.	December 1968..	837,000
FMU-56/B fuze. A proximity fuze using radar doppler principle to provide selectable heights of burst ———. Height of burst can be present for delivery at varying altitudes to provide operation flexibility.	July 1968.....	2,590,000
Long-duration target marker LUU-1/B. Target marker which burns for 30 minutes and provides 3 selective colors (red, purple, or green) and is visible at 5 miles day or night. Great improvement over Army grenades previously used.	August 1968..	79,000
WDU-4A/A 20 grain flechette rocket warhead. Improved antipersonnel weapon. New capability.	September 1968.	100,000
CBU-46 (SUU-7+BLU-66). Jungle bomblet in 19-tube dispenser. New Capability...	February 1969..	400,000
CBU-42 SUU-38/BLU-54 30-day WAAPM. Antipersonnel mine. New capability.....	March 1969.....	6,470,000
M-731 strike film viewer. A device for use by photo interpreters to improve speed and accuracy in analyzing aerial photographs.	July 1968.....	$4,000
Mobile color film processing facility (EN-75). A device for providing automatic proc-essing of color photography in response to SEAOR 51.	March 1969.....	2,976,000,000
ELECTRONIC COUNTERMEASURES		
QRC-335A seed sesame. A system installed on F-4 and RF-4 aircraft which provides automatic ECM against ——— band radars ———. Later model, QRC-335-4, deployed April 1969, provided capability against X band radars ———.	April 1968.....	2,030,000
ALQ-71 ECM pod. An improved, podmounted ECM system with more effective hori-zontal and vertical antennas and a higher power magnetron with a frequency range ———.	March 1968.....	1,000,000
QRC-359. Improved capability for ALT-16 jammer. ———.....	.....do.....	160,000
QRC-354-Receiver. A VHF receiver designed to detect the presence of ———. New capability.	March 1969.....	721,000
QRC-370 lightweight chaff. An improved radar countermeasure for use on EB-66 aircraft. Provides lower rate of descent, larger area of coverage and faster dispersal than previous chaff employed.	May 1969.....	50,000
IMPROVED ATTACK CAPABILITY		
Laser-guided bomb. M-117 and MK-84 bombs modified with a laser seeking capa-bility which homes in on reflected laser energy for improved accuracy. New capability.	March 1968.....	2,100,000
Electro-optical guided bomb. MK-84, 2,000-lb. GP bomb modified with a device for optical homing on designated targets. Response to SEAOR 100. New capability.	February 1969..	3,185,000
COMMUNICATIONS COMMAND AND CONTROL		
Defense satellite communications system (DSCS) phase I. The final payload of 8 spacecraft for the DSCS was launched from the ETR on June 13, 1968. These 8 communication satellites completed deployment of phase 1 of the DSCS. The 100-pound spin stabilized solar powered satellites are essentially the same as the 18 satellites previously orbited in 1966 and 1967.	June 1968.....	53,500,000
Deployable automatic relay terminal and commando shackle relay. Transportable ground station with a single ADR antenna capable of receiving, processing and displaying the data being relayed through EC-121R, or Pave Eagle, sensor relay equipment from sensor fields containing up to 150 Igloo White type sensors. The DART is presently operating with the commando shackle relay. The commando shackle relay is a shelter containing EC-121R relay equipment and situated ——— in South Vietnam. Sensor data is relayed ——— to the DART at Ben Hoa SVN. New capability.	November 1968.	2,080,000
TPS-50 radars. Equipment is used at Tan Son Nhut Airport to detect low-flying aircraft. Significant improvement due to transportability and rapid rate of de-ployment.	August 1968....	200,000

See footnotes at end of table.

Description	Month	Development cost
Map overlays for mobile GCA units. Developed in response to SEAOR 161 to provide improved all-weather operations. New capability.	April 1968.....	1,000
AN/GPA-129 video mapping group. Generates map information from an overlay for mixing with radar information at a display console. SEAOR 54. New capability.	April 1969.....	50,000
AN/PRC-72 radio. Multimode manpack radio operating in HF, VHF, and UHF for use by tactical air liaison officers. Greatly improved due to increased frequency range and portability.	February 1969..	25,000
MSQ-77 modifications. Improvements in ground-based radar which will provide increased bombing accuracy under conditions of night and low visibility.	January 1969...	2,600,000
K-300 A/I automatic satellite picture recorder. Provides weather stations with automatic picture transmission recording capability for improved dissemination of weather data. Response to SEAOR 120 (class V modification). New capability.	January 1969...	50,000
Rapidly deployable antenna mast. An experimental lightweight, transportable antenna mast for use with the RVN direct air request net to provide improved communications in remote areas. New capability.	January 1969....	14,000
PERSONAL LIFE SUPPORT		
Improved body armor. Improved individual equipment used by aircrew on low altitude missions for protection from small arms fire. Provides increased protection by larger area coverage.	April 1968.....	16,000
Radio set URC-64. 4 channel aircrew survival radio to provide better communications between downed personnel and rescue aircraft. Has 20 percent more range. Added volume control and 4 selectable frequencies not on previous unit.	August 1968....	1,000,000
Pararescue transceiver helmet. A helmet equipped with a bone-conducting microphone and radio to permit improved communications between rescue helicopter and personnel conducting rescue operation. New capability.	May 1969.....	223,000
SURVEILLANCE		
440L, OTH radar system. Achieved interim capability on ——— for detecting U.S.S.R. ICBM launches. Provide real time warning to NORAD Combat Operation Center. New Capability.	March 1968.....	35,300,000
AN/FPS-85 phased array radar. For use in the Spacetrack System. It performs the multiple functions of satellite detection, tracking, identification and data collection concurrently on a maximum of 200 targets in its coverage.	December 1968..	78,000,000
OPERATIONAL SUPPORT		
Palletized mail systems. Containers designed to carry 1,600 pounds of high-density mail (95 cubic feet volume). 4 containers can be carried on 1 463L pallet which permits a C-130 to carry 35,500 pounds of mail, as compared with 10,000 pounds without the containers. New capability.	May 1968.....	6,000
Cargo buffer stop. Devices to provide 4-G forward restraint for use with container delivery system on loads up to 35,000 pounds in C-130 aircraft. SEAOR 71. New capability.	May 1968.....	25,000
Fast fix cement. Material developed for use in repairing runways damaged by rocket or artillery attacks. New capability.	.....do.....	25,000
C-130 ramp kit. Modified C-130 unloading ramp to provide rapid unloading capability. New capability.	June 1968.....	25,000
Aircraft arresting barrier (BAK-13). Provides an all weather, rapid-cycling, bi-directional arresting capability for all century series fighters. Great improvement in installation time and cycling.	.....do.....	500,000
Mobile electronic weighing system (A/M 37-U2). A system which will weigh and compute the centers of gravity position of wheeled vehicles, cargo aircraft, and all cargo loads that are compatible with the 463L cargo system. SEAOR 82. New capability.	August 1968....	1,000,000
Cargo airdrop release gate. A pyrotechnic device used to cut the AFT restraint webbing of airdrop cargo just prior to release. New capability.	October 1968...	25,000
Hydraulic flow comparator. A device for preventing the loss of hydraulic fluid in the event a line is ruptured or broken. The comparator sense the difference in flow between the supply and return lines furnishing power to an actuator and closes off the line when the flow becomes excessive. New capability.	December 1968..	150,000
Jet turbine oil. A new jet turbine engine oil (MIL-L-7808), increased engine oil drain time in SAC fleet from 300 hours (using its predecessor) to 600 hours. This represents a savings to SAC alone of $3,000,000/year.	October 1968...	300,000
Maintenance free aircraft battery. Maintenance for 3 to 5 years. Its predecessor required maintenance vary 30 to 90 days at a cost of tens of millions of dollars.	June 1968.....	700,000
JP-7 jet fuel. JP-7 jet fuel, developed for the SR-71 aircraft in-house. It is saving the Air Force $3,000,000/year in fuel cost over the previously used fuel.	.....do.....	50,000

COMPLETED DEVELOPMENTS NOT YET OPERATIONAL

Mr. SIKES. I would like to have you list separately the new items which have completed development but which are not yet in the hands of our field forces in operational quantities.

(The information follows:)

	Month	Quantity
AIRCRAFT AND MISSILES		
Hunter 1 system. A C-130 aircraft equipped with battlefield illumination and multiple sensors for night recce/strike missions. Response to SEAOR 50.	August	1
AGM-78B standard arm missile. An air-to-surface antiradiation missile with seeker capability in ———.	do	25
MUNITIONS		
MLU-32/B99 Briteye flare. A 5,000,000 candlepower flare which burns for 5 minutes/ response to SEAOR 36.	do	2,400
FMU-26B/B fuze, Multipurpose. A fuze with impact, short delay, and timed airburst functions, compatible with nose and tail fuze wells of all bombs which have standard 3 in. fuze wells.	November	88,000
BLU-31/B land mine. An air deliverable ——— land mine with ——— explosive weight. Response to SEAOR 94.	June	———
CBU-33 Antivehicle land mine. A subsurface mine delivered from a dispenser for use against tanks and vehicles/will penetrate ——— ins. of mild steel. Response to SEAOR 130.	June	20
LUU-2/B flare. A 2,000,000 candlepower flare which burns for 2 minutes. Replaces MK-24 and MK-25 flares. Response to SEAOR 36.	August	2,000
Incendiary ammunition. 7.62mm. incendiary and API ammunition for use with side-firing gunships.	July	200 000
RECONNAISSANCE		
AR-109A viewer-printer. A combination direct/rear projection viewer which provides capability to view a single image in both modes at the same time. Response to SEAOR 158.	June	1
Camouflage detector. A handheld monocular viewing device which provides real-time camouflage detection.	September	5
Infrared data link. (Compass sight) a system of 1 RF-4C sensor A/C, one 5-B7 relay A/C, and 1 ground station with near real-time readout of infrared reconnaissance data. Response to SEAOR 45.	do	2
Black Crow sensor for gunship II. A device for detecting truck traffic ———	do	———
Step and repeat printer. A device for providing continuous enlargement of photographs at a rate of 2,000 to 3,000 prints per hour. Response to SEAOR 104.	June	8
Model 1150 incinerator. A device for economical destruction of photographic film and other classified material. Response to SEAOR 120.	July	6
ELECTRIC COUNTERMEASURES		
AN/APR-35. A radar signal receiving set with panoramic and analysis display for use on F105F Wild Weasel aircraft.	September	4
QRC-345/AAQ-4 IR countermeasure. A system for providing EB-66 aircraft with protection against infrared seeking missiles.	August	20
QRC-384 miniaturized noise jammer. L-Band radar countermeasure for installation in F-105, F-4, and RF-4 aircraft.	do	75
NAVIGATION		
Improved terrain following system for RF-4C. Modification to the APQ-99 Forward Looking Radar to provide an improved capability response to SEAOR 105.	do	120
Tactical landing system (AN/ARN-97 and AN/TRN-27). A lightweight precision approach aid capable of being installed by a combat control team for use at austere bases. Response to SEAOR 78.	July	500
Lightweight Tacan (AN/TRN-26). A small size lightweight mobile tacan for use in austere locations which will provide bearing, range, and station identification information. Response to SEAOR 119.	do	9
IMPROVED ATTACK CAPABILITY		
F-4C Laser Bombing Syst (AN/AVB-1). An improved tactical visual air-to-ground weapon delivery system. Response to SEAOR 64.	November	4
KMU-370/B laser guided bomb kit. A field installed laser guidence unit for use with the M-118 3,000 pound bomb.	June	20
F-4D/APX-81 System. A means of providing friendly and enemy IFF Transponder interrogation and reception to reduce the need for visual recognition/identification.	October	8
COMMUNICATIONS, COMMAND AND CONTROL		
AN/PRC 66 radio set. A lightweight portable UHF transceiver. Operates on self-contained batteries and weighs 10 pounds. Response to SEAOR 140.	August	95
Increased Capability for Rapcon and GCA. Modifications to existing facilities at ten SEA sites for improved traffic handling. Response to SEAOR 163.	June	10
RF fence—GCA radar. An installation at Phan Rang AB, SVN, to eliminate ground interference and provide improved radar operation.	August	1

See footnotes at end of table.

	Month	Quantity
TRN-17 Antenna. A redesigned TACAN antenna which provides improved TACAN operation.	June	14
EC-121 modification. Improvements in current EC-121 equipment to provide better surveillance ———. Response to SEAOR 62.	September	3
PERSONAL LIFE SUPPORT		
Survival Kit Gas Mask. An emergency device to protect downed crewmembers when tear gas is used to suppress enemy action during rescue operations. Response to SEAOR 144.	June	50
Multiple target autodirection finder AN/ARD-19. A system for determining location of downed personnel by providing direction finding information using signals from emergency radio. ——— returns may be plotted simultaneously. Response to SEAOR 46.	November	85
HH-53B limited night recovery system Low light level television to be installed in rescue helicopter for improved night rescue. Response to SEAOR 114.	June	6

[1] Navy.
[2] By Air Force (other by Navy).

Terminated R. & D. Projects

Mr. Sikes. What research and development efforts of significance have been canceled or terminated in the time period since our hearings on this subject last year, other than the MOL which was discussed earlier?

AGENA–D MISSILE

Mr. Hansen. I have some personal familiarity with at least one of these.

The Agena–D program, an improved capability version of the upper stage Agena, was canceled.

Mr. Sikes. For what reason?

Mr. Hansen. As the development progressed, it became apparent that it was going to cost a lot more than the original estimates and a reexamination of the requirements yielded the belief that for the improvement represented in relationship to the cost, it just simply wasn't worth continuing.

LIST OF TERMINATED R. & D. PROJECTS

Mr. Sikes. In each illustration I would like for you to provide for the record the total cost of development and the canceling cost, if known.

(The information follows:)

Terminated R. & D. Projects

The total cost of developing the X–15 was $210.5 million. The B–70 total development cost was $1.47 billion. The total Agena D improvement program cost was less than $7.2 million.

The X–15 program was completed and terminated with no termination costs. The scope of the B–70 program was changed so that no separate cost for termination was identified. There are no termination costs associated with the Agena D improvement program.

Mr Sikes. What are some of the others?

Mr. HANSEN. There are but two others of which I am aware. The B-70 program and the X-15 program.

You have mentioned the MOL.

BENEFITS RECEIVED FROM X-15 PROGRAM

Mr. SIKES. The X-15 program made considerable contributions, did it not?

General PITTS. Yes sir, it did.

Mr. SIKES. Provide any benefits received during the period these programs were in operation.

(The information follows:)

The X-15 program made the following contributions during its life cycle:

1. Demonstrated that the pilot, given the proper displays and information, can fly rocket powered vehicles on space trajectories with great accuracy.

2. Weightlessness and the high heart rates associated with this type of flying produced no difficulties.

3. The X-15 research in hypersonic aerodynamics proved that there was excellent agreement between low temperature wind tunnel test data and actual hypersonic flight data.

4. Turbulent heat transfer is another problem area where great uncertainty existed before the X-15 program. The measured flight data showed a marked departure from available predictions, averaging about 35 percent lower. This significant difference has stimulated the development of new prediction methods and new wind tunnel investigations.

5. Many valuable lessons were learned in design of the primary structure and in local heating problems effecting the secondary structure.

6. The X-15 has also performed as a reuseable carrier for a variety of high altitude scientific experiments. It permitted full recovery of the equipment, recalibration, and repeated flights where needed.

Following are a few specific examples of some of the major technological contributions the XB-70 Flight Research Program has made in increasing our knowledge of the supersonic flight environment:

1. Flight dynamics and stability and control

(*a*) Validation of aerodynamic prediction techniques which account for the effects of aeroelasticity.

(*b*) Compliation of control usage and airplane response parameter data.

(*c*) Correlation of ground based simulator data with airborne data.

(*d*) Validation of predicted aircraft performance techniques.

(*e*) Development of instrumentation calibration methods.

2. Handling qualities

(*a*) Validation of proposed handling qualities criteria for large transport aircraft.

(*b*) Identification of specific piloting problems associated with high-speed flight (i.e., altitude control, lateral-directional control) and terminal area operations (i.e., optimum glide slope, flare height).

3. Engine inlet compatibility

(*a*) Investigation of internal high-speed shock wave systems and associated variable geometry and controls.

(*b*) Turbulent inlet flow measurements.

(*c*) Spillage drag tests.

4. Validation of aerodynamic load prediction techniques

5. High speed friction measurements and pressure distribution data

6. Noise pollution measurements to support the national sonic boom program

7. Dynamic response

(*a*) Vehicle response measurements relative to high altitude turbulence, landing loads, and normal operation.

(*b*) Evaluation of structural-mode suppression subsystem.

The Agena upper stage space vehicle has been used by both the Air Force and NASA for a variety of space missions. The Agena D improvement program was to have developed a better propulsion system in order to increase the vehicle payload and maneuvering capability.

Because this improvement program was canceled before any significant hardware was built, the contribution of this program to the field of propulsion technology is minor. This program accomplished specialized tasks associated with the Agena vehicle engine design/analysis, fuel tests, development of a thrust chamber assembly, gas generator, valves and controls, and a turbine assembly.

PROPORTION OF R. & D. FUNDS DEVOTED TO STRATEGIC AND TACTICAL WARFARE

Mr. SIKES. What proportion of your fiscal year 1970 request relates to strategic warfare and what part to tactical warfare? Do you have that immediately available?

General PITTS. 29.2 percent for strategic, sir. About 12.6 percent for tactical.

Mr. SIKES. There have been times when the Air Force has been criticized for overemphasis on strategic problems and not enough attention to tactical developments. Do you think that would be a valid criticism of the current budget?

General MCNICKLE. Sir, I am not sure overemphasis is the word. The cost of developing our strategic deterrent forces has certainly been greater over years than we have spent on the tactical side: and the need for a credible deterrent force has had an extremely high national priority. If we had it to do all over, I think we would still have focused on the strategic forces first.

Mr. SIKES. What was the percentage last year and the year before?

General MCNICKLE. I will submit that for the record, Mr. Sikes, but I should caution that percentages can be misleading here since the strategic systems are much more expensive than the tactical systems.

(The information follows:)

	Fiscal year	
	1968, percent	1969, percent
Strategic	25.0	25.6
Tactical	10.8	10.1

R.D.T. & E. PROGRAM COST INCREASES

Mr. SIKES. On cost overruns, what programs in R.D.T. & E. have experienced significant cost increases over and above the amount estimated in the hearings last year?

MINUTEMAN MISSILE

General MCNICKLE. During the fiscal year 1969, Minuteman was up $8.4 million, which reflects a program revision—would you like the reason, Mr. Chairman?

Mr. SIKES. Yes.

General MCNICKLE. The Minuteman increase reflects the revision of cost estimates primarily on the guidance and control systems, and airborne and ground hardening.

SHORT-RANGE ATTACK MISSILE (SRAM)

The SRAM program was up $92 million. This increase provides for the necessary engineering changes on the propulsion system, for overruns, and for the increased costs associated with the flight test delays with the F–111.

F–15 AIRCRAFT

The F–15 increased $38.5 million, reflecting firm contractor costs for initial engine development and contract definition. Earlier estimates were based on parametric studies.

MAVERICK AIR-TO-GROUND MISSILE

Maverick increased $19 million in 1969 but this resulted from the deferring of phase II engineering development of the missile from 1968 to 1969.

TRACALS

TRACALS increased $28 million. This resulted from the realization that the TPN–19 had to be developed. Funds were transferred from procurement for this purpose.

FB–111 AIRCRAFT

The FB–111 increased $13.7 million, reflecting actual progress made to date projected through the remainder of 1969, based on contractural obligation percentages.

SUBSONIC CRUISE ARMED DECOY (SCAD)

SCAD increased $4 million. This provided for establishement of new advanced development programs and the supported concept design studies for subsonic air-launched missiles.

Mr. SIKES. Complete that for the record.

(The information follows:)

There were seven R.D.T. & E. programs which experienced significant cost increases during fiscal year 1969. The costs shown below are the increases from the fiscal year 1969 President's budget after congressional reductions were reflected versus the latest approved reprograming request.

Program	Changes in fiscal year 1969 program (in millions)	Reason
Minuteman	+$8.4	Reflects increased costs associated with providing guidance system survivability against a newly identified phenomenon of a nuclear environment.
SRAM	+92.0	Required for necessary engineering changes to the propulsion system and overruns incurred by the contractor and his subcontractors; also this increase provides for costs associated with flight test delays of FB-111/SRAM.
F-15	+38.5	Reflects firm contractor costs for initial engine development and contract definition; earlier costs were based on parametric studies.
Maverick	+19.0	Increased costs in fiscal year 1969 resulted from the deferral of phase II engineering development of the AGM missile from fiscal years 1968 to 1969.
TRACALS	+28.0	It was determined that the AN/TPN-19 ground control approach (GCA) system could not be bought directly with procurement funds, but that directives required that the first 2 models for testing had to be bought with R.D.T. & E. funds. Accordingly, $28,000,000 was reprogramed from the investment account.
FB 111	+13.7	Funds reprogramed from the F-111 and RF-111 programs to reflect the actual progress made to date projected through the remainder of fiscal year 1969, based upon contractual obligations and expenditures.
SCAD	+4.0	This increase provided for the establishment of a new advanced development program to support concept and design studies of a subsonic air-launched missile which will have attack and decoy capabilities needed to increase the survivability of the B-52, F-111, and AMSA aircraft.

Fiscal Year 1969 R.D.T. & E. Program Reductions

Mr. Sikes. What programs have proven to be less costly than had been anticipated?

General McNickle. F–111 went down $17.7 million. The light intratheater transport (LIT) was reduced $14 million and Hard Rock Silo was reduced $13 million. These are not actual decreases in program costs, they are reductions in the 1969 program.

Mr. Sikes. These are fiscal year costs. Have there been any programs which were shown to be less costly than you had anticipated, total programs?

General McNickle. No major programs, Mr. Sikes.

Original Air Force R.D.T. & E. Budget Request

Mr. Sikes. What was the request of the Department of the Air Force to the Secretary of Defense for this appropriation for fiscal year 1970?

General Pitts. Air Force requested $4.2 billion, sir. That was revised by the Secretary of Defense's office to $4.3 billion; and the Johnson administration reduced that OSD number by $700 million to a figure of $3.599 billion.

Mr. Sikes. In the January budget?

General Pitts. Yes. The Nixon administration subsequently made a net reduction of some $33 million to take the budget down to our present figure of $3.566 billion. That was a net of some increases and some decreases.

Major Program Changes to Fiscal Year 1970 Air Force R.D.T. & E. Budget

Mr. Sikes. Were there any major program changes in the various budgets?

General Pitts. Yes, sir.

Mr. Sikes. Outline those for the record.

(The information follows:)

	Dollars in millions
Research	−3.4
Exploratory Development	+10.0
Advanced Development	−133.9
AMSA	+15.2
SCAD	−12.9
CONUS air defense interceptor	−14.5
LIT	−7.0
Advanced ICBM technology	−27.0
Short-range tactical air-to-air missile	−29.0
Advanced reentry vehicle	−10.0
Strategic bomber penetration	−8.0
Space experiment support	−12.0
Defense subsystems demonstration and test	−18.1
Tactical satellite communications	−5.0
Advanced airborne command post	−2.6
Other advanced development	−3.0
Engineering Development	−123.2
Advanced rescue system	−16.5
F-15	−10.2
A-X	−37.1
Hard rock silo	−38.0
Advanced ICBM system	−27.0
Other engineering developments	+5.6
Management and support	−51.2
Operational systems	−480.4
SRAM	+16.7
Special projects	−10.0
MOL	−40.7
AWACS	−60.0
FB-111	−43.2
F-111A	−21.3
C-5A	−30.7
F-12	−99.9
Minuteman/MICCS	−69.2
Program 949	−.8
Program 417	−6.3
Air command	−6.9
Other operational systems	−108.1
Total reduction	−701.1

Adequancy of Air Force Fiscal Year 1970 R.D.T. & E. Budget

Mr. Sikes. Do you consider, Mr. Secretary, the budget presented to Congress to be adequate to provide the technological effort to maintain the position of superiority of the Air Force?

Mr. Hansen. I think it is very difficult, really, to measure what it takes for superiority. I think you have to look at one type of weapon at a time. I don't think that this budget makes us superior—in fact, I am sure it doesn't make us superior in every area, but I do think that it is a balanced program that gives us an adequate capability in each general area to be able to take on the problems that are assigned to the Air Force.

Mr. Sikes. Does the budget as presented have your complete support?

Mr. HANSEN. Yes, sir.

Mr. SIKES. General McNickle, what are your comments on the question?

General MCNICKLE. Mr. Chairman, I agree with the Secretary. We would like, of course, more money, but I support the entire program, as I have presented it.

Mr. SIKES. Mr. Secretary, would you pinpoint some of the areas in which you feel we will not achieve or continue to hold superiority?

SUPERIORITY OF CERTAIN SOVIET AIRCRAFT

Mr. HANSEN. Well, for example, we know from some of the aircraft displays that the Russians are considerably ahead of us in heavy lift helicopters. They have a much greater capability than we do.

At the present time we believe they are ahead of us in some of the capabilities of their fighters, such as the Mig–21 and the Foxbat. We are hoping to be able to overcome that with the F–15. We expect to, if that program continues as planned.

Mr. SIKES. Will there be a time gap when the Russians will possess better aircraft in that category than we possess?

Mr. HANSEN. Yes, sir: I think they will.

Mr. SIKES. In what anticipated period of time?

Mr. HANSEN. ———.

Mr. SIKES. What other examples can you provide?

General MCNICKLE. ———.

Mr. SIKES. What time gap do you anticipate in this development?

General MCNICKLE. Four years.

Mr. SIKES. Are there others?

General MCNICKLE. They have a supersonic transport which is at the present time of questionable value to their armed forces. However, it does have national prestige aspects to it.

Mr. SIKES. A supersonic transport?

General MCNICKLE. Yes, the TU–144, but we are not aware of a military application for their SST at this time.

Mr. HANSEN. It indicates a level of technological capability.

Mr. SIKES. What are some of the areas in which we clearly excel the Russians?

SUPERIORITY OF U.S. WEAPONS

General MCNICKLE. I think we have a better strategic missile capability, both submarine and land-based, than the Russians. I think that we have a better bomber in the B–52 and B–58 than they have, and the technology that goes along with the strategic force. I believe the C–5, C–141, and C–130 represent a much better transport capability than the Russians have.

Mr. HANSEN. I don't think they have anything comparable to the F–111.

MAJOR REPROGRAMING ACTIONS DURING FISCAL YEAR 1969

Mr. SIKES. I would like to have you summarize for the record at this point the major reprograming actions, including both increases and decreases in this appropriation made during fiscal year 1969 to this date?

(The information follows:)

MAJOR R. & D. REPROGRAMING ACTIONS FOR FISCAL YEAR 1969

[In millions of dollars]

OSD R-2 No.	Program	Approved by Congress	Change	Revised program
69-90	FB-111A	49.000	+13.700	62.700
69-73	F-111	117.300	−12.020	105.280
69-90	F-111		−5.680	99.600
69-90	RF-111	11.500	−5.500	6.000
69-30	Light intratheater transport	15.000	−10.000	5.000
69-39	do		−4.000	1.000
69-30	Advanced tactical fighters (F-X)	30.000	+15.450	45.450
69-39	do		+9.600	55.050
69-87	do		+13.480	68.530
69-30	Subsonic cruise armed decoy	0	+4.000	4.000
69-13	Short range attack missile	43.300	+39.990	83.290
69-39	do		+10.400	93.690
69-83	do		+41.600	135.290
69-83	Minuteman	413.400	+8.400	421.800
69-30	Hard rock silo development	38.000	−13.000	25.000
69-30	TAC AGM (Maverick)	25.000	+19.000	44.000
69-13	Airborne warning and control system	75.000	−28.290	46.710
69-30	do		−1.710	45.000
69-39	do		−5.200	39.800
69-25	Traffic control and landing system	0	+28.000	28.000
69-87	do		−9.980	18.020
69-90	do		−2.520	15.500
	Total		(+105.720)	

CLASSIFIED AND WAGE BOARD PAY INCREASES

Mr. SIKES. Are there any other major reprogramings under consideration in the Pentagon at this time which involve this appropriation, other than MOL?

General PITTS. Yes, sir, we have a reprograming action Air Force No. 69–10 currently in the mill, Mr. Sikes. That is approximately $9.2 million. That provides for the balance of the classified and wage board pay increases. The total pay raise is some $13.9 million. The reprograming action will pick up $9.2 million of that raise and the other $4.7 million is being furnished with reprograming flexilibity by the Air Force.

Mr. SIKES. Any others?

General PITTS. No, sir.

TRANSFERS TO AND FROM FISCAL YEAR 1970 R.D.T. & E. PROGRAM

Mr. SIKES. What transfers were made to or from this appropriation in fiscal year 1969?

General PITTS. We had two transfers into this appropriation, both of them from the "Other procurement, Air Force" appropriation. One for $28 million, and that was to fund the two prototype models of the TPN–19 radar. It was determined by the Office, Secretary of Defense, that these were properly funded in the R. & D. program because they were prototype models; so we transferred that money from other procurement into R.D.T. & E. The other transfer was for $50 million from the Other Procurement appropriation into the R.D.T. & E. appropriation to cover increases in the SRAM missile program and the Minuteman program.

Air Force R.D.T. & E. Program Compared With That of Soviet Air Force

Mr. Sikes. Insofar as your intelligence estimates provide such information, tell us how the amount that you are requesting for R.D.T. & E. for the Air Force compares with the amount the Soviets are spending in this area.

Mr. Hansen. I would like to answer that, Mr. Chairman. I spent some time looking into that. I asked that same question when I came into my present position. We simply don't have a breakdown of the Russian expenditures from which we can determine that. If you take all of their military R. & D. and their space programs, which they don't separate, and put that together, the dollar equivalent of that, as best I can find out, is very close to the dollars that are being spent in this country for the same things. Now, I believe that represents a larger portion of their gross national product.

Mr. Sikes. That would indicate a larger effort by the Soviets in this field than we are making.

Mr. Hansen. In proportion to their overall economy.

Mr. Sikes. That is what I mean.

Mr. Hansen. Yes.

SOVIET WEAPON SYSTEM PRIORITIES

Mr. Sikes. What weapons do they seem to be stressing most, if you can determine that?

Mr. Hansen. Well, they are certainly stressing the buildup of their ballistic missile force. They are stressing their fighter capability. They have put quite a lot of emphasis on their space program in those types of unmanned gadgets which have a usefulness in a military sense.

Mr. Sikes. Do the Soviets have anything approximating the MOL?

Mr. Hansen.———.

NEW OPERATIONAL SOVIET AIRCRAFT

Mr. Sikes. Tell us what new weapons the Soviets' Air Force has placed in its inventory, its operational inventory, in the past year?

Mr. Hansen. I don't know exactly at what point you really consider that the weapon is operational. I feel that since ——— the Foxbat airplane ——— that it is either at or very near——

Mr. Sikes. That is about as close as we can determine, not knowing more about their procedures.

Mr. Hansen. I think we have to assume if it is not operational, it is getting very close.

Mr. Sikes. Are there other weapons in the same category?

General McNickle. They have a fighter called the Flagon that is now in their inventory.

Mr. Sikes. What do we know about the capabilities of each of those?

General McNickle. The Foxbat is in some respect similar to our F–12A. The Flagon is an advanced interceptor. About ——— Flagons are now operationally deployed.

Mr. SIKES. Would that put it in the same category as the F–111?

General MCNICKLE. It would be more like the F–4.

They have a new jet transport, the TU–154 which we call the Careless.

Mr. HANSEN. They have a new helicopter. I went through the Army's review of that and they described at least one new helicopter they have put in the inventory and they have started deployment of the SS–13 ICBM.

General PITTS. In connection with the helicopters, they have deployed a helicopter carrier into the Mediterranean ———.

Mr. HASSEN. ———.

Mr. SIKES. Supply for the record some information on the characteristics of each of those, and any others we have not discussed.

(The information follows:)

CHARACTERISTICS OF NEW WEAPONS IN SOVIET INVENTORY

The Harke, currently the world's largest operational helicopter, is a flying crane developed from the Soviet Hook heavy transport helicopter ———.

The MIG–21/Fishbed is a single-place turbojet fighter, which originally entered service in 1960. ———.

The Flagon A is a Sukhoi designed twin turbojet interceptor which entered operational service in 1967. ———.

The Soviet supersonic transport, the TU–144/Charger, was the first supersonic transport to fly (December 1968). It will probably cruise at about twice the speed of sound and carry over 120 passengers. ———.

The TU–154/Careless is a new Soviet medium-sized passenger trijet, with a configuration similar to that of the Boeing 727, and can carry 158 passengers to a range of 2,500 nautical miles at an average cruise speed of 460 knots.

The SS–13 is the first deployed Soviet solid-propellant ICBM. ———.

The Moskva is a Soviet helicopter carrier, which was first deployed in the Mediterranean in 1968. It is about 600 feet long with possibly a 25,000 ton displacement and can carry at least 30 helicopters. The Moskva's operation to date has emphasized its antisubmarine warfare capabilities, but it may also have amphibious assault and command ship functions.

PERFORMANCE OF NEW AIR FORCE DEVELOPMENTS NOW IN VIETNAM

Mr. SIKES. How well have the new weapons and equipments which the Air Force has sent to Vietnam performed?

General MCNICKLE. I mentioned the C–130 gunship. They have done exceedingly well.

The C–119, which we have also made into a gunship because we didn't have enough C–130's, has also deployed. ———. They are also doing very well.

———. I think it is especially noteworthy that these are adaptations of our present inventory aircraft.

There is an AC–123 called Blackspot. We have two of those. ———.

Mr. SIKES. Complete that listing for the record, and also give us a listing of new items which have been highly successful in performance and new items which have not lived up to expectations.

(The information follows:)

PERFORMANCE OF NEW WEAPONS AND EQUIPMENT IN VIETNAM

The following items of new equipment have been highly successful in Southeast Asia:

AIRCRAFT AND MISSILES

C–130 gunship II aircraft.
C–123K blackspot aircraft.
OV–10 reconnaissance/strike aircraft.
F–4E aircraft.
AIM–7E–2 air-to-air missile.
AGM–12E stand-off cluster missile.

MUNITIONS

SUU–42/A dispenser.
SUU–41 dispenser.
Chemical weapon BLU–52.
FMU–72B long-delay fuze.
FMU–56/B proximity.
LUU–1B long-duration target marker.
WDU–4A/A 20 grain flechette rocket.
CBU–46 jungle bomblet.
CBU–52 wide area antipersonnel bomblet.

IMPROVED ATTACK CAPABILITY

Laser guided bomb (KMU–351/B).
———.
———.

COMMUNICATIONS, COMMAND AND CONTROL

Deployable automatic relay terminal.
Map overlays for mobile GCA units.
AN/GPA–129 video mapping group.
AN/PRC–72 radio.
MSQ–77 bomb directing radar.

PERSONAL LIFE SUPPORT

Improved body armor.
Foliage penetration flares.
Personnel lowering device.
SRU–22/P marker panels.
URT–33 personal locator beacon.

OPERATIONAL SUPPORT

Palletized mail system.
Aircraft arresting barrier.
Mobile electronic weighing system.
Hydraulic flow comparator.
Jet turbine oil.

The following items of new equipment have not lived up to expectations:

COMMUNICATIONS, COMMAND AND CONTROL

TPS–50 radar.

PERSONAL LIFE SUPPORT

URC–64 emergency radio.
Pararescue transceiver helmet.

OPERATIONAL SUPPORT

Fast fix cement for runway repair.
Cargo airdrop release gate.

The record should show that new items of equipment are thoroughly tested in the continental United States and must demonstrate desired performance prior to shipment to Southeast Asia. Items of equipment failing to perform satisfactorily undergo further development efforts. An example of this policy is the recent cancellation of the shipment of BLU-31/B land mine to Southeast Asia after extensive tests revealed several deficiencies. In cases where further development efforts are considered unproductive, the projects are canceled and the funds are reprogramed to more promising developments.

Necessity for Modification Program

Mr. Sikes. On the modifications, in discussing the funding of the Air Force procurement appropriations, note was taken of the very large sums requested for various modification efforts. To what extent are these modification efforts due to a failure, or partial failure in the development program?

General McNickle. We have a figure for 1969 and 1970 of $40 million to correct deficiencies discovered during the test program. This type of modification is due to long development cycles. Most of the funds are used to give additional capability.

Mr. Sikes. These would be illustrations of improvements to a system rather than corrections of the weaknesses?

General McNickle. Yes, sir, the latter are improvements.

Mr. Sikes. Have there been those where your modification was to correct a weakness or deficiencies?

General Pitts. I can give a rough percentage figure of about 6 percent of our aircraft modification funds which go into this correction of deficiencies, sir.

Mr. Sikes. Provide a listing of some of those for the record.

(The information follows:)

List of Modifications To Correct Deficiencies in Aircraft

FISCAL YEAR 1968

Aircraft	*Item*
RF-4C	Aerospace ground equipment for central air data computer. Refrigerator unit valve.
F-4E	APR 36/37 radar homing and warning. Aerospace ground equipment for central air data computer.
C-141	All Weather Landing System (AWLS) (kits and installation). Update seven flight simulators.
F-111	KU band beacon (radar homing beacon for tanker hookup). ECM (track breaker—microwave detecting).

FISCAL YEAR 1969

F-4E	APR 36/37 radar homing and warning. GFAE kits for APR 36/37.
C-141	Update eight flight simulators.
F-111	Incorporate rounds reposition in the ammo handling system. Revise interface response between fuel quantity fuel distribution light. Install fire detection system. Improve aerial refueling capability. Incorporate improved penetration aids. Provide improved weather operation for terrain-following radar.

Mr. Sikes. Could you name some of those now?

General Pitts. The wing carry-through box failure in the F-111 is an example.

MODIFICATIONS TO NEW EQUIPMENT IN THE INVENTORY

Mr. SIKES. It seems the modifications begin almost as soon as the weapon is placed in inventory. Is that a realistic necessity?

Mr. HANSEN. It think it is a function of how long it takes us to do things. We make a commitment to production considerably ahead of time and then something comes along, either a change in the threat, or the planned utilization of the weapon or new technology or something, and by then the production is far enough along that we decide to go ahead and let it run through and then cycle them back through and put the modifications in.

Mr. SIKES. This committee has supported that concept but is this an admission of an inherent weakness in the program in that we don't figure these things during the developmental stage and they have to be built into the weapon or the item after it has really been completed and is delivered?

Mr. HANSEN. I think I would have to state that to a limited extent it is that, but I think it is more the fact that it takes quite a long time to build these things and all during that time it is possible for new things to come along, either considerations of usage, or new materials, or better ways of doing things, where you simply couldn't have thought of that before you started no matter how smart you were.

I think the only way you could really stop the procedure of building something and then modifying it would be to be able to build it very quickly so there wasn't much time in between for these other things to surface.

I think it is a function of the fact that our technology is a very rapid moving thing and also our ideas as to how systems will be employed is moving very rapidly.

The F–111, for instance, was conceived for a different role than that for which it has been ultimately developed. The same is true of the B–52 and the C–130 and so on.

General PITTS. I think General McNickle spoke to this committee under the Aircraft Procurement appropriation pertinent to this point. That is the fact that a lot of our mods result from getting the items in the hands of the user; and that pilots who fly the plane will find deficiencies or recommend improvements that will enable him to carry out his mission better. This results in modifications to an aircraft.

EFFECT OF CONCURRENT DEVELOPMENT AND PRODUCTION

Mr. SIKES. That is a good point.

Now, quite probably you can save significant sums if we initiated a policy of having less concurrency in development and production of new weapons systems, but would we lose valuable time if that were the case?

Mr. HANSEN. I think it is the concept of the present administration to remove the high degree of concurrency that we have had in the past. We would argue that, really, you hurry and as you run into these problems and are set back, you are really not ahead as much as you thought.

It is a matter of a calculated risk. If you have concurrent development and production because the initial operational capability date is extremely important to you, you take the calculated risk that you

won't run into troubles and if you don't you are ahead for that. But, if you do, you may not even be as well off as you would have been if you had had a more phased program.

It is our belief that, on balance, we have run into that situation more than we have the one where we took the calculated risk and it really paid off.

Mr. SIKES. The committee will resume its discussions at 2 o'clock.

AFTERNOON SESSION

MEASURE OF VALUE RECEIVED FROM R.D.T. & E. INVESTMENT DOLLARS

Mr. MAHON. Mr. Secretary, when one evaluates what has been accomplished by the vast billions that are spent by the Defense Department in a given year, he wonders whether or not we are getting our money's worth. This morning we discussed with you the question of just what you had been able to accomplish in the past year. It seems to me that the responses to these questions are rather—I don't know whether you would say unsatisfactory—they are certainly not very exciting or very promising. We spend a lot of money and we keep a lot of people on the payroll, everybody eats, but to prove that tremendous forward leaps have been made in military programs is something that would hardly be possible based upon the information we get from our witnesses.

Mr. HANSEN. Mr. Chairman, I understand what you are saying. The thing we discussed this morning was what programs that have been taken out of the R. & D. category and put into operational usage during the last year, and there is quite a list of them which we will submit for the record.

Mr. MAHON. We will have a look at those.

(Clerk's note. The list referred to appears on p. 369.)

Mr. HANSEN. The statement is made there is really not anything in there that is very exciting. I am inclined to agree with that.

Mr. MAHON. The word I was grasping for was unimpressive.

Mr. HANSEN. Yes, satisfying from the point of view of the R. & D. money that has gone into it. I think research and development has to be looked at with a long view. There is much more than just what is put into operation or put into production in a given year. It is what progress is being made in programs that are not at either one of these milestones. What kind of seeds are being planted for the future and what kind of harvest has been reaped in the past.

If you look back over many years and see supersonic aircraft and radar development and ballistic missiles and things like that, they are very rewarding things. If we look at some of the things that are coming along now, like the future potential of laser beams, ——— some of the possibilities of satellite surveillance and things of that nature, I think there are concepts in R. & D. that are equally exciting for the future potential extension of capability to equipment like radar which is now in our active inventory.

Mr. MAHON. I think the feeling is among many, and to some extent I share this feeling, that while we have done a lot of spectacular things in the field of technology and weaponry over the past 25 years,

or more, we more or less have had a rather long drought and we have not done anything spectacular lately, particularly in the field of major weapons. Of course, the space effort of NASA has been quite spectacular. It has been quite a leap forward. It has been something that has a landmark characteristic. But there have been no real big landmarks in the last few years in the military area, as I see it.

Mr. HANSEN. Mr. Chairman, I agree that the nature of research is that it seems to sort of progress by spurts and plateaus. There have been studies made of research progress over a very long period of time, hundreds of years and that seems to be the tendency of it. As far as the space program is concerned, I agree with you on that. I think you have to recognize the fact that the Air Force has had a fairly significant role in that, too. We are very proud of things like our communications satellites, and specifically the tactical communications satellite which is now being tested.

EFFECT OF CAMPUS UNREST ON AIR FORCE R.D.T. & E. PROGRAM

Mr. MAHON. I do not want to belabor this question. Let us come to campus unrest. Have any more colleges and universities refused to take your classified grants or contracts?

Mr. HANSEN. Any more, you ask?

Mr. MAHON. Yes.

Mr. HANSEN. I am aware of two cases. MIT suspended their willingness to take up new contracts pending the report of the Pounds Committee which made a study of this issue. This committee released its report about a week or 10 days ago. As a result of its findings and recommendations, MIT lifted their suspension on accepting contracts. So there is one case where a university decided to withhold acceptance of contracts and subsequently indicated a willingness to go ahead. The other case that I am aware of is at Stanford where the on-campus laboratory refused to accept additional contracts but instead administratively they have agreed to transfer that work to the Stanford Research Institute which has been made separate from the university.

To my knowledge no other universities have refused to accept military research contracts.

As a matter of fact, in the Pounds Committe they did say that they thought it was proper for MIT to do military research work, but they felt for the long run they ought to build up the research work that they do in the nondefense fields.

Mr. FLOOD. What about George Washington, University?

Mr. HANSEN. Has George Washington University refused, is that what you are asking, sir?

Mr. FLOOD. I am asking you.

Mr. HANSEN. To my knowledge they have not.

Mr. FLOOD. Harvard?

Mr. LIPSCOMB. You are just talking about the Air Force.

Mr. HANSEN. Yes, sir; I am talking strictly Air Force.

Mr. MAHON. Can you broaden that to cover the Defense Department?

Mr. HANSEN. No, sir; I am unable to speak for the other services, Mr. Chairman.

Mr. MAHON. In general has the campus unrest which has often had an antimilitary flavor had a detrimental effect on your basic research effort?

Mr. HANSEN. I do not think we can really point to any place where it has so far. We are very worried about the general attitudes that are there and how this might affect us in the long run, and specifically as to whether or not people that are talented in our areas of interest or who have the potential to become talented would maybe shy away from doing this because of some ostracism—the fact that this would appear a wrong thing to their peers. We are very much concerned about that. We have discussed a number of possibilities. One is doing more work in-house. Another one is having more capability along those lines in the FCRC's, which I am personally against. Another thing is related to the Themis program, where there are a very large number of universities in the country and a relatively small number of them that are doing research work.

It seems to me if there are other universities where the administration, the faculty, and the students are interested in doing this kind of work and have the capability for it, we should encourage them to do that in order to broaden our base so that we will not be as susceptible to damage to the program because certain people are not interested in doing defense research anymore.

FEASIBILITY OF AN EFFECTIVE ANTIBALLISTIC MISSILE DEFENSE

Mr. MAHON. Are there any questions on campus unrest? If not, as the service primarily responsible for the technical development of the ICBM's, do you, General McNickle, feel that the development of an effective antiballistic missile system is feasible within the current state of the art?

General MCNICKLE. Yes; I think proof of that is what we have been able to do with our space programs. They show we have great capability. If we decided we wanted to, we could go ahead and do it. I think unquestionably that we can. But exactly when, and on what timetable—I would say that might be questionable, but to be able to say we can do it; yes, sir.

Mr. MAHON. In other words, you think we can perfect a defense against the ICBM?

General MCNICKLE. Yes, sir; I think there will continue to be give and take between offense and defense; the offense is a little ahead now and you have to do something to it——

Mr. FLOOD. Wait a minute, he said perfect. Didn't you hear him say perfect?

General MCNICKLE. Yes; we could perfect a system for a specific point in time. However, as time moves on, then either the offense or defense will go out ahead, and we would have to make some changes.

Mr. MAHON. We have not been able to perfect an absolutely airtight ironclad defense against the penetration of bombers and other aircraft. Do you foresee that we could develop a totally effective defense against the ICBM?

General MCNICKLE. If totally effective means stopping all incoming warheads I think there will always be some that would get through under any circumstances that you talk about, sir.

Mr. FLOOD. Your answer is no?

Mr. MAHON. Yes, Mr. Secretary.

Mr. HANSEN. May I also respond to that?

When you say perfect and relate it to the technology, my personal opinion is that the state of the art of technology would permit us to make a system which would assure that no incoming ICBM warheads would get through. As to whether or not that would be economically feasible for the country in terms of how many radars you had to have and how hard they had to be, how many missiles you had to have and how many had to be on the alert, there is a question in my mind that way.

CAPABILITY OF SOVIET UNION TO PERFECT AN ABM DEFENSE

Mr. MAHON. I would like to turn this around.

Do you think that our major opponent nations around the world, such as the Soviet Union, would be able to perfect a defense against our intercontinental ballistic missile?

Mr. HANSEN. I think if we stood still eventually they would be able to. I think if we are doing what we are supposed to be doing, and our ABRES program is doing that, we will be a step ahead of them so just at the point where they are able to defeat our present capability we develop a new capability.

Mr. SIKES. Aren't you giving us credit for more ability than our opponents, and isn't that always a dangerous thing to do?

Mr. HANSEN. Your question is a very good one. Am I not crediting us with more capability than I credit the Russians with?

Mr. SIKES. Isn't that always a dangerous thing when you talk of defense?

Mr. HANSEN. It is a very dangerous thing if we do that, yes. Yes, I think that point is very well taken.

Mr. SIKES. I hope you are right but I would not want to sleep on it.

Mr. FLOOD. You know it is not.

Mr. HANSEN. I think the fact is that our ability from a state of the art point of view to perfect a system would tend to be frustrated by the enemy's ability to field the new threat somewhat short of our perfection of our ability to counter the previous threat. I guess I should stand to have the record show that I had more sober thoughts on what I previously said.

CAPABILITY OF PENETRATING SOVIET ABM DEFENSE

Mr. MAHON. Mr. Secretary, do you believe that the penetration aids which we have as of the present time can or could defeat the Soviet ABM system?

Mr. HANSEN. I think utilizing the penetration aids that we have available and under development now we could get a very significant portion of our warheads through. I am sure their system would catch some. But I think the question is——

Mr. FLOOD. The chairman said defeat. You have a habit of not hearing. He said defeat this time. Defeat is the key word.

Mr. HANSEN. I guess I would have to ask you to define for me how you visualize the word "defeat."

Mr. FLOOD. How do you visualize it?

He asked the question. Defeat is the word.

Mr. HANSEN. I guess defeat would be to render ineffective their defense, and I would have to say that if you got enough through to do the damage that you wanted to do, you would then have defeated their defense, and in that sense I think the capability which we have through the ABRES program would be able to accomplish that objective.

Mr. MAHON. Are you rather confident of that, Mr. Secretary?

Mr. HANSEN. Yes, sir.

Mr. MAHON. General McNickle, what is your thought on that?

General MCNICKLE. Yes, sir. ———.

AIR FORCE USE OF CONSULTANTS IN R.D.T. & E. PROGRAM

Mr. MAHON. Compare the number of consultants used in fiscal 1969 with the number in fiscal 1968 and 1967.

What has been your record on that, General Pitts?

(The information follows:)

The Air Force had about 50 R. & D. consultants receiving compensation during fiscal year 1967 and 1968, and 57 in 1969. A small number of additional consultants also served without compensation (WOC), or were listed as active but did not consult.

COST OF CONSULTANTS

Mr. MAHON. Compare the costs of consultants in fiscal years 1967, 1968, and 1969.

(The information follows:)

Estimated costs of Air Force R. & D. consultants for the past 3 fiscal years were:

Fiscal year 1967	$130,000
Fiscal year 1968	140,000
Fiscal year 1969	165,000

PROJECTED USE OF CONSULTANTS IN FISCAL YEAR 1970

Mr. MAHON. What is your projected use of consultants in fiscal year 1970?

(The information follows:)

For fiscal year 1970, it is estimated that about 55 consultants will work some 1,700 days for approximately $160,000.

USE OF FCRC EMPLOYEES AS CONSULTANTS

Mr. MAHON. To what extent do you use employees of Federal Contract Research Centers with which you contract as consultants?

(The information follows:)

Employees of Federal Contract Research Centers are used very sparingly and without compensation as Air Force research and development consultants.

USE OF FACULTY MEMBERS AS CONSULTANTS

Mr. Mahon. To what extent do you use faculty members of colleges and universities as consultants at the same time they are working under Air Force research grants or contracts?

(The information follows:)

Four faculty members of colleges and universities serve on the Scientific Advisory Group of the Office of Aerospace Research in addition to working under Air Force research grants or contracts sponsored by our defense research sciences program. Although not consultants in our normal usage of the word, there are also four members of the Air Force Scientific Advisory Board who have active research contracts, but one of these serves on the Scientific Advisory Board without compensation.

AVERAGE DAILY RATE OF PAY FOR CONSULTANTS

Mr. MAHON. What has been your average daily rate of pay for consultants in fiscal years 1967, 1968, and 1969? What average rate is projected for fiscal 1970?

(The information follows:)

The average daily rate of pay for consultants in fiscal years 1967, 1968, and 1969 is estimated at $85, $86, and $89 respectively. An average rate of about $96 is projected for fiscal year 1970.

AVERAGE YEARLY AMOUNT PAID CONSULTANTS

Mr. MAHON. What has been your average yearly amount paid to individual consultants in each of these 3 years?

To what extent were people classed as consultants in order to keep them on the payroll and avoid the personnel reductions imposed by the Revenue and Expenditure Control Act?

(The information follows:)

The average yearly amount paid to individual R. & D. consultants who receive compensation is estimated to be $2,500 for fiscal year 1967, $2,700 for fiscal year 1968, and $2,890 for fiscal year 1969.

No personnel were classified as R. & D. consultants in order to keep them on the Air Force payroll and avoid personnel reductions imposed by the Revenue and Expenditure Control Act.

AIR FORCE R.D.T. & E. FACILITIES

Mr. MAHON. With respect to facilities, what new Air Force R.D.T. & E. facilities were opened in fiscal year 1969? Are any proposed in fiscal year 1970?

General PITTS. No new R. & D. establishments have been opened and none closed, sir. There have been some expansions at existing establishments.

Mr. MAHON. What about proposed openings for 1970?

General PITTS. I would like to turn to our director of programs, General Boylan, for the answer to that question.

General BOYLAN. Mr. Chairman, I have no information specifically on the opening of new R. & D. installations in fiscal 1970. There will be, as in each year, modifications and improvements at the existing laboratories and test facilities.

Mr. MAHON. What sums are included in the fiscal 1970 budget for facilities to be closed during the fiscal year?

(The information follows:)

No sums were initially included in the fiscal year 1970 budget for facilities to be closed.

PROPOSED EXPANSIONS OR IMPROVEMENTS TO R.D.T. & E. FACILITIES

Mr. MAHON. What major expansions or improvements of Air Force R.D.T. & E. facilities are planned in fiscal year 1970? What was done in 1969 in this regard?

(The information follows:)

FISCAL YEAR 1970 R.D.T. & E. FACILITIES MCP

Arnold Engineering Development Center, Tenn.: Hypersonic gas dynamics wind tunnel (addition)
Brooks AFB, Tex.:
    Research Laboratory (addition)
    Human Resources Laboratory
Edwards AFB, Calif.: Aircraft traction evaluation systems
Eglin AFB, Fla.:
    Data Collection Theodolite Station
    Electronic research radar facility
Griffiss AFB, N.Y.: Electronic Research Laboratory, microwave
Holloman AFB, N. Mex.: Research Data Center (addition)
Kirtland AFB, N. Mex.:
    Laser Optics Science Laboratory
    Survivability/Vulnerability Simulation Laboratory
Los Angeles AFS, Calif.: Data Computation Center (addition and alteration)
Vandenberg AFB, Calif.:
    Space launch complex (alterations)
    Power and environmental systems facility
    Technical operations facility
Western Test Range: Missile Instrumentation Station
Westover AFB, Mass.: Special Projects Facility (addition and alterations)
Wright-Patterson AFB, Ohio:
    Computer Science Center
    Science Laboratory, materials
Arnold Engineering Development Center, Tenn.:
    Propulsion-engine test cell (alteration)
    Propulsion-engine test cell (addition)
Brooks AFB, Tex.: Science Laboratory Aeroenvironmental
Eastern Test Range:
    Antigua Island—Missile Communication Station (addition)
    Ascension Island—Missile Communication Station (addition)
    Cape Kennedy—Missile Communication Station (addition)
    Cape Kennedy—ITL Launch Complex (alterations)
    Malabar—Missile Communication Station (addition)
Eglin AFB, Fla.:
    Data Collection Theodolite Station
    Test complex surveillance and control system facility
Green River, Utah: Missile launch test facility
Griffiss AFB, N.Y.: Electronic Research Laboratory, computation
Holloman AFB, N. Mex.:
    Guidance flight line complex
    Test track building
L. G. Hanscom Field, Mass.:
    Special Laboratory, computation
    Van deGraaff Cobalt Laboratory (addition)
Satellite Control Facility, Calif.: Satellite Control Center (addition)
Vandenberg AFB, Calif.:
    Equipment Test Laboratory
    Space launch complex (alterations)
Wright-Patterson AFB, Ohio: Reconnaissance systems integration and evaluation facility

IN-HOUSE R.D.T. & E. FACILITIES

Mr. MAHON. With respect to in-house facilities, what in-house facilities are supported from this appropriation?

General MCNICKLE. Would you like them for the record?

Mr. MAHON. Yes.

(The information follows:)

Cambridge Research Laboratory (CRL), Cambridge, Mass.
AF Office of Scientific Research (AFOSR), Rosslyn, Va.
Frank J. Seiler Laboratory (FJSL), Colorado Springs, Colo.
Aerospace Research Laboratory (ARL), Wright-Patterson AFB, Ohio.
Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio.
Air Force Weapons Laboratory (AFWL), Albuquerque, N. Mex.
Air Force Rocket Propulsion Laboratory (AFRPL), Edwards AFB, Calif.
Aerospace Medical Division (AMD), Brooks AFB, San Antonio, Tex.
Air Force Aero Propulsion Laboratory (AFAPL), Wright-Patterson AFB, Ohio.
Air Force Avionics Laboratory (AFAL), Wright-Patterson AFB, Ohio.
Air Force Armament Laboratory (AFATL), Eglin Field, Fla.
Rome Air Development Center (RADC), Rome, N.Y.
Human Resources Laboratory (HRL), Brooks AFB, Tex.
Air Force Western Test Range, Vandenberg AFB, Calif.
Air Force Eastern Test Range, Patrick AFB, Fla.
Satellite Control Facility, Los Angeles, Calif.
Arnold Engineering Development Center, Tullahoma, Tenn.
Electromagnetic Compatibiliy Analysis Center, Annapolis, Md.
International Military Headquarters and Agencies, The Hague, Netherlands.
Air Force Flight Test Center, Edwards AFB, Calif.
Air Force Missile Development Center, Holloman AFB, N. Mex.
Air Force Armament Development Test Center, Eglin AFB, Fla.
Air Force Special Weapons Center, Kirtland AFB, N. Mex.
Aeronautical Systems Division, Wright-Patterson, AFB, Ohio.
Electronics Systems Division, Hanscomb AFB, Mass.
Space and Missile Systems Organization, Los Angeles AF Station, Calif.
Headquarters, Office of Aerospace Research, Rosslyn, Va.
Headquarters, Systems Command, Andrews AFB, Md.
Air Force Materials Lab (AFML), Wright-Patterson AFB, Ohio.

COST OF SUPPORTING IN-HOUSE FACILITIES

Mr. MAHON. Please advise how does the cost of supporting these installations in fiscal year 1970 compare with the amount for fiscal 1968 and 1969?

(The information follows:)

[In thousands of dollars]

	Fiscal year—		
	1968	1969	1970
Aerospace Medical Division (AMD) Brooks AFB, San Antonio, Tex	19,209	19,410	18,025
Air Force Aero Propulsion Laboratory (AFAPL), Wright-Patterson AFB, Ohio	5,284	5,636	5,700
Air Force Avionics Laboratory (AFAL), Wright-Patterson AFB, Ohio	7,645	9,900	10,338
Air Force Armament Laboratory (AFATL), Eglin Field, Fla	3,869	4,500	6,658
Rome Air Development Center (RADC), Rome, N.Y	18,022	19,200	19,500
Human Resources Laboratory (HRL), Brooks AFB, Tex	(1)	(1)	2,990
Air Force Western Test Range, Vandenberg AFB, Calif	59,421	58,516	68,465
Air Force Eastern Test Range, Patrick AFB, Fla	162,363	151,501	160,938
Satellite Control Facility, Los Angeles, Calif	22,003	29,300	37,200
Arnold Engineering Development Center, Tullahoma, Tenn	42,556	42,000	[2] 4,501
Electromagnetic Compatibility Analysis Center, Annapolis, Md	185	675	700
Cambridge Research Laboratory (CRL), Cambridge, Mass	20,816	23,916	25,101
Air Force Office of Scientific Research (AFOSR), Rosslyn, Va	1,621	1,779	1,898
Frank J. Seiler Laboratory (FJSL) Colorado Springs, Colo	270	462	481
Aerospace Research Laboratory (ARL), Wright-Patterson AFB, Ohio	6,297	7,026	7,393
Air Force Materials Laboratory (AFML), Wright-Patterson AFB, Ohio	6,214	6,600	7,287
Air Force Flight Dynamics Laboratory, Wright-Patterson AFB, Ohio	11,598	12,230	19,311
Air Force Weapons Laboratory (AFWL), Albuquerque, N. Mex	4,103	5,110	5,445
Air Force Rocket Propulsion Laboratory (AFRPL), Edwards AFB, Calif	8,700	8,385	10,380
International Military Headquarters and agencies, The Hague, Netherlands			474
Air Force Flight Test Center (AFFTC), Edwards AFB, Calif	30,529	32,461	33,424
Air Force Missile Development Center, Holloman AFB, N. Mex	25,081	22,730	23,259
Air Force Armament Development Test Center, Eglin AFB, Fla	51,318	52,118	54,471
Air Force Special Weapons Center, Kirtland AFB, N. Mex	13,940	14,291	14,667
Aeronautical Systems Division, Wright-Patterson AFB, Ohio	71,236	74,918	76,848
Electronics Systems Division, Hanscom AFB, Mass	28,682	28,400	33,059
Space and missile systems organization, Los Angeles AF Station, Calif	28,237	28,500	30,443
Headquarters, Office of Aerospace Research, Rosslyn, Va	3,100	3,100	3,187
Headquarters, Systems Command, Andrews AFB, Md	21,281	29,308	34,678
Total	673,580	691,972	716,871

[1] Previously included in Aerospace Medical Division.
[2] AEDC began operations under the Air Force industrial fund on July 1, 1969. Fiscal year 1970 program consists of in-house research and development to improve the status of wind tunnel and other testing technology including improvements.

Some of the major changes in fiscal year 1970 versus the fiscal year 1969 program and the primary reason for same are:

Air Force western test range increase of $9,949,000 in fiscal year 1970 is primarily for support of Minuteman III testing on the range.

Air Force eastern test range increase of $9,437,000 is associated with instrumentation for a ship in support of the Navy Poseidon program.

Satellite control facility increase of $7,900,000 is primarily associated with effort formerly funded under the special activities program.

Air Force Flight Dynamics Laboratory increase of $7,081,000 is to cover cost of testing at Arnold Engineering Development Center (AEDC) under the service funding concept which becomes effective at AEDC with the start of fiscal year 1970.

International Military Headquarters and Agencies was formerly funded under the military assistance program (MAP) appropriation.

Headquarters, Systems Command net increase of $5,370,000 is associated with the depot maintenance industrial funding that was formerly funded for under other appropriations.

Fiscal Year 1969 Unexpended Balance

Mr. Mahon. This is the total package.

How does your currently estimated unexpended balance for fiscal year 1969 differ from the estimate given the committee when you appeared last year?

General Pitts. There is a reduction of some $460.5 million, Mr. Chairman.

That derives from the fact that in the 1969 budget there was a figure of $1,867,500,000 and in the 1969 column of the 1970 budget it was reduced to $1,407 million.

UNOBLIGATED BALANCES FISCAL YEAR 1963-68

Mr. MAHON. Will you please for the record supply the answer to this question? Submit at this point a listing of the original estimates of unobligated balances for fiscal 1963 through 1968 and the actual amount unobligated at the end of each of those fiscal years. Put that in the record, but without resorting to figures, what has the experience been in general.

General PITTS. Generally we have improved, sir. From 1963 there has been an improvement from an increase in unobligated balances above the amount estimated by some $261.2 million to 1968, which is our last actual figure, when our actual unobligated balance was $272 million lower than was estimated.

(The information follows:)

[In millions of dollars]

Fiscal year	Original estimate unobligated balance	Actual unobligated	Difference
1963	263.0	524.2	+261.2
1964	175.0	476.2	+301.2
1965	291.3	401.4	+110.1
1966	279.2	447.1	+167.9
1967	410.0	316.2	−93.8
1968	495.0	223.0	−272.0

FISCAL YEAR 1969 UNEXPENDED BALANCE

Mr. MAHON. How accurate does your original estimate of the amount which will remain unexpended at the end of fiscal 1969 seem to be? This is June, what does it look like now?

General PITTS. I believe the original estimate was high, sir.

Mr. MAHON. You mean the estimate of obligations?

General PITTS. No, sir; of unexpended balances. That decrease in the estimate from last year that I spoke about, that $460,500,000 results from two factors. One was a congressional reduction in 1969 of some $222 million.

Mr. MAHON. Elaborate on that for the record.

General PITTS. Yes, sir; I will.

Mr. MAHON. You are talking about the Revenue and Expenditure Control Act, and other factors.

General PITTS. Yes, sir.

(The information follows:)

The decrease of $460.5 million in estimated unexpended balances at end fiscal year 1969 reflects primarily the effects of the congressional reduction of $222 million (about $130 million of expenditures), and a decrease of $389 million (about $330 million of expenditures), in unexpended balances brought forward from prior years resulting from an increase in rate of expenditures during fiscal year 1968 resulting from improved program management.

Mr. MAHON. What was the estimated unexpended balance presented to the committee last year and the total that you estimate that the unexpended balance at the end of fiscal year 1969 will be?

(The information follows:)

The estimated unexpended balance at the end of fiscal year 1969 presented last year in the fiscal year 1969 budget was $1,867.5 million. This compares with a revised estimate for fiscal year 1969 of $1,407 million as presented in the fiscal year 1970 budget. This is a reduction of $460.5 million.

TOTAL AVAILABLE FOR EXPENDITURE IN FISCAL YEAR 1970

Mr. MAHON. Including the amount anticipated to be unexpended at the end of fiscal 1969, and if the Congress grants the full budget request for 1970, what will the total amount available for expenditure be in this appropriation in fiscal 1970?

General PITTS. That total would be about $4.96 billion, sir. That derives from two figures: $3.561 billion of 1970 NOA and $1,407,000,000 of unexpended carryover from prior years.

SOURCE OF EXPENDITURES BY FISCAL YEAR

Mr. MAHON. Will you submit for the record an analysis of your estimated expenditures for fiscal 1970 showing the source of the expenditure by appropriation year?

General PITTS. Yes, sir.

(The information follows:)

ANALYSIS OF ESTIMATED EXPENDITURES FOR FISCAL YEAR 1970

Estimated expenditure by fiscal year during fiscal year 1970

Fiscal Year:	*Millions of dollars*
1970	2,063.9
1969	1,189.4
1968	112.7
1967	41.8
1966	23.5
1965	11.3
Fiscal year 1964 and prior years	9.4
Total	3,452.0

RATE OF EXPENDITURE OF R.D.T. & E. FUNDS

Mr. MAHON. What would be the effect of a limitation in the law which would make funds appropriated for R.D.T. & E., Air Force, available for expenditure for not to exceed 5 years rather than having them remain available until expended?

What part of the R.D.T. & E., Air Force, funds are not expended during the first 5-year period?

General PITTS. In answer to the first part of that question, sir, it would not have a substantial effect on this account, because this account expends some 93 or 94 percent of its money in the first 2 years. So, during the last 3 years of that 5-year program expenditures would be comparatively small amounts. In this respect I do not think we would object to a 5-year limitation on fund availability.

If I could add one thing, sir, it would take away a little flexibility that Congress has allowed us in reprograming those prior year funds between program years.

RECOUPMENT OF PRIOR YEAR FUNDS

Mr. MAHON. What has been your recoupment experience thus far in 1969 and what is your estimated recoupment experience in 1970?

General PITTS. We have recouped some $15,484,000 in 1969 from prior years, made up of $6 million from 1968 and a sum of $9,484,000 from prior years.

PERCENTAGE OF NEW OBLIGATIONAL AUTHORITY EXPENDED IN SAME YEAR APPROPRIATED

Mr. MAHON. Will you provide a tabulation showing the percentage of new obligational authority expended in the same year it was appropriated? Will you provide this by fiscal years since 1963?

(The information follows:)

[Dollar amounts in thousands]

Fiscal year	NOA	Expend (first year)	Percent expended
1963	3,697,592	2,504,594	67.7
1964	3,540,584	2,466,077	69.6
1965	3,175,300	2,053,552	64.7
1966	3,219,889	1,813,337	56.3
1967	3,171,750	1,932,104	60.9
1968	3,393,239	2,349,943	69.2

CIVILIAN PERSONNEL SUPPORTED BY R. D. T. & E. APPROPRIATIONS

Mr. MAHON. What is the total number of civilian personnel to be supported in this appropriation for fiscal year 1970? How does this compare with the 3 previous fiscal years?

General PITTS. In 1970, sir, an average of 27,648, and that compares with the 3 previous years, 1969, 27,860; 1968, 27,884; and 1967, 28,173, a slightly downward trend.

APPARENT LEVEL OF EFFORT FUNDING

Mr. MAHON. Secretary Hansen, do these figures tend to show that we propose to maintain an establishment of say about 27,000 people and spend a certain amount of money year in and year out? We just look upon this as a sort of institution to maintain. Do we tend to look upon this as being necessary regardless of productivity that may come about as a result of the expenditure? Is this the reason why we are able to demonstrate less and less at the end of each year? Just what

has actually been accomplished by these vast expenditures in R.D.T. & E.? That is several questions in one.

Mr. HANSEN. I do not think, in my own view, that I could confirm the observation that we are producing less and less. I certainly agree that the numbers of civilian man-years involved in R.D.T. & E. over a 4-year period are so close from year to year that it looks like a level-of-effort type of thing. I do know that is not the way we develop our fund request. We look at it program by program and evaluate the merit of that program in terms of its relevance to what we view as the needs to carry out our Air Force mission, and then total those up and we get these kinds of numbers.

Mr. MAHON. Surprisingly, it comes out every year at just about the same number of people and dollars.

Mr. HANSEN. I think there are leveling influences that make it do that. As was previously stated by General McNickle, the Air Force looks at what it wants to do, and I guess this has always turned out to be more than would sell; therefore it gets trimmed back to a point where it bears a relationship to the previous year's efforts. This, in effect, tends to kind of make us operate on at least a financial level-of-effort basis.

REDUCTION IN MAN-YEARS

General MCNICKLE. Sir, there was a reduction in fiscal year 1969 of about 840 man-years below the number shown in last year's President's budget for fiscal year 1969. There is about an 800 man-year reduction in the military this year in research and development.

Mr. SIKES. Are you reducing any civilians?

General MCNICKLE. No, sir. There was an 840 civilian reduction last year from planned manning levels.

Mr. MINSHALL. How many total man-years do you have in your effort?

General MCNICKLE. About 27,000.

Mr. MINSHALL. What you mentioned is just a drop in the bucket.

SUPPORT OF WAR IN SOUTHEAST ASIA

Mr. MAHON. What part of the $3.5 billion which you are requesting for fiscal 1970 is to fund programs directly in support of the war in Southeast Asia?

General PITTS. Roughly $95 million, $94.9, Mr. Chairman.

Mr. MAHON. That is for work which is closely related to the war now going on in Vietnam. Is that what you mean?

General PITTS. Yes, sir. It is for such things as the Defense Communications Planning Group, ———.

Another would be the traffic control and landing system. Basically, these R. & D. expenditures are for aircraft equipment and development, armament and ordnance development, and these kind of things that are directly relatable to the Southeast Asia War.

Mr. MAHON. Out of $3.5 billion only $95 million is closely related to the war effort.

General PITTS. Directly, yes, sir; indirectly, there are other amounts. Directly relatable to Southeast Asia, $95 million.

REDUCTION IN R.D.T. & E. SUPPORT OF SOUTHEAST ASIA

Mr. MAHON. You are not spending, relatively speaking, very much money on the war from the standpoint of R.D.T. & E., it would appear.

Mr. HANSEN. That amount is like half what it was last year, and I think reflects our belief that we are coming nearer to the end of that from the point of view of the research and development type activity that it takes to support it.

We all hope, and have reason to be a little optimistic about the fact that if we were to start a development now for that war it would not make it in time. We hope it would not.

Mr. SIKES. Did that influence the amount that is being used or that is to be used in this budget on directly related Southeast Asia expenditures?

General MCNICKLE. Yes, sir.

Sir, it is normal also that at the start of the year the estimate for Southeast Asia is low. During the year additional items will be identified and the amount has historically almost doubled.

It was about $175 million last year. I agree with Secretary Hansen, if we cannot deliver within 2 years, we do not count it as contributing to Southeast Asia. Of course, a lot more of our R. & D. is extremely useful in Southeast Asia, but it is not specifically for Southeast Asia and is not included in these amounts.

Mr. MAHON. We hope that this testimony, when read several months hence, will seem even more pertinent than it does now.

Mr. HANSEN. I hope so, too, Mr. Chairman.

OTHER MAJOR PROGRAMS RELATED TO SOUTHEAST ASIA

Mr. MAHON. List any other major programs having to do with the R.D.T. & E., Air Force, in Southeast Asia?

(The information follows:)

The major programs in fiscal year 1970 are:

		Millions
2.80.12.F	Defense communications planning group	$19.0
6.42.12.F	Aircraft equipment development	11.2
6.47.05.F	Electronic warfare systems	8.0
6.47.08.F	Other operational equipment	9.7
6.47.10.F	Intelligence/reconnaissance equipment	4.0
6.47.12.F	Armament/ordnance development	9.8
6.58.05.F	Development and test support	6.8

SOUTHEAST ASIA SUPPORT COMPARED WITH PREVIOUS YEARS

Mr. MAHON. How does the amount for support of the war in Southeast Asia compare with the similar function in the previous two fiscal years? Put that in the record, please.

(The information follows:)

The 3-year comparison is:

R.D.T. & E. support:	*Millions*
Fiscal year 1968	[1] $153.6
Fiscal year 1969	[1] 173.6
Fiscal year 1970	94.9

[1] Fiscal year 1968 and 1969 figures are actuals and reflect reprograming actions into the SEA account during the year. The fiscal year 1970 figure is the budget number which will probably show an increase as reprograming actions are experienced.

Mr. MAHON. Are there any areas of which you are aware in which new weapons are needed for the war in Southeast Asia and are within the state of the art of development which are not included in your program?

Mr. HANSEN. No, sir.

FEDERAL CONTRACT RESEARCH CENTERS (FCRC's)

Mr. MAHON. With respect to Federal contract research centers, last year, for the first time in several years, the committee did not place a specific limitation on funds to be spent with Federal contract research centers. In the report on the bill, the committee made it clear that this action was being taken with the understanding that this activity would be carefully watched and that increases in funding of the Federal contract research centers would be noted in the hearings this year.

FISCAL YEAR 1969 FCRC FUNDING

What increases in funds for Federal contract research centers, either in the amounts in line items directly in support of the centers or in other line items of which a part of effort was allocated to the Federal contract research centers, are proposed in fiscal 1970 compared with fiscal 1969? What does that look like?

General PITTS. In 1969 we show a decrease in our estimate of $1 million, sir.

Within the total ceiling there are some increases covering anticipated cost-of-living increases, but the current total Air Force estimate is approximately $1 million less than we estimated last year.

FCRC FUNDING INCREASE IN FISCAL YEAR 1970

Mr. MAHON. How does that compare with the 1970 figure?

Mr. HANSEN. The proposed increase in fiscal 1970 is $5.4 million over the estimated actual expenditures for fiscal 1969.

ACTUAL FCRC FISCAL YEAR 1969 FUNDING COMPARED WITH ESTIMATE

Mr. MAHON. How do the actual amounts programed for the various centers in fiscal 1969 compare with the amounts presented to the Congress in the justifications last year?

Please put that in the record.

General PITTS. I have the figures. You are talking about the 1969 column?

(The information follows:)

[In thousands of dollars]

	Fiscal year 1969 program in fiscal year 1969 budget	Fiscal year 1969 program in fiscal year 1970 budget
Aerospace Corp.	70,170	72,122
R.D.T. & E.	56,150	64,456
Missile procurement	14,020	7,666
Lincoln Laboratory	29,000	29,200
R.D.T. & E.	29,000	29,200
Applied Physics Laboratory, John Hopkins University	655	589
R.D.T. & E.	655	589
MITRE Corp.	27,000	27,250
R.D.T. & E.	22,955	19,925
Other procurement	4,045	6,725
Operation and maintenance	0	600
Rand Corp.	15,740	15,202
R.D.T. & E.	15,740	15,202
ANSER	1,500	1,572
R.D.T. & E.	1,500	1,572
ECAC	4,500	4,500
R.D.T. & E.	4,500	4,500
Research Analysis Corp.	150	150
Operation and maintenance	150	150
Cost of living ceiling	2,900	0
Total, FCRC	151,615	150,585

REASON FOR FCRC FUNDING INCREASE IN FICAL YEAR 1970

Mr. MAHON. The justifications on page 11 show an approximate increase in funding for Federal contract research centers of approximately $5.4 million, which you have just referred to earlier. I wish you would give us the justification for this increase.

(The information follows:)

The $5.4 million increase in fiscal year 1970 is attributed mainly to increases in the funding at Aerospace, MITRE, RAND, and ANSER, in recognition of the rising costs of living. The increase, with the exception of MITRE's effort required for the joint continental defense systems integration planning staff (JSIPS), is required to cover anticipated cost of living increases in order to maintain, but not exceed, the fiscal year 1968 levels of technical personnel at these centers.

INCREASE IN FCRC TECHNICIAN MAN-YEAR COSTS

Mr. MAHON. In general, has there been any increase in costs at the Federal contract research centers above and beyond that which would be reflected in your increased budget request?

For example, are you paying any more per technical man-year in fiscal 1970 than you paid in fiscal year 1969?

Mr. HANSEN. Yes, sir; we are.

Mr. MAHON. Are you getting comparable levels of work effort in the two fiscal years so that the dollar comparisons are also reasonably accurate workload comparisons?

Mr. HANSEN. I think if you adjust the dollar levels for the cost of living increase of 4 or 5 percent, then the answer is yes. The dollars should accurately reflect the work that we obtained.

Mr. MAHON. Do you mean you are getting less for your money?

Mr. HANSEN. Yes, sir. I mean that wages, and fringe benefits, the sum of those costs which make up the cost per member of the technical staff is increasing and the man's productivity is not increasing proportionately in my judgment.

PROJECT THEMIS

Mr. MAHON. Will you provide for the record a tabulation indicating the estimate in fiscal 1970 for Project Themis and the amount programed for Themis in each of the years since the inception of the program.

Mr. HANSEN. You want that for the record?

Mr. MAHON. Yes.

(The information follows:)

THEMIS ESTIMATE, FISCAL YEAR 1970 VERSUS PRIOR YEARS

The Air Force segment of the Themis program is as follows:	*Millions*
Fiscal year 1967	$5.3
Fiscal year 1968	8.0
Fiscal year 1969	8.48
Fiscal year 1970	10.1

EVALUATION OF PROJECT THEMIS

Mr. MAHON. Can you give the committee an evaluation of the Themis program as far as the Air Force is concerned. We had some discussion here with other services about this. Have you had enough experience with the program to know whether or not it is a valuable part of the Air Force R.D.T. & E. effort?

Mr. HANSEN. I have with me today Dr. Bill Lehmann, who is a member of my staff, who handles this program, and I would like for him to answer the question except for the generality that in my view the trouble we are having in the universities today emphasizes the importance of Themis as a way that we can broaden the capability and therefore have a wider selection of universities which we can depend on to do our work.

If I might ask Dr. Lehmann to comment on your basic question.

Mr. MAHON. Very well.

Dr. LEHMANN. Sir, first of all, let me preface my comment by the fact that the Themis program is now in the third year. For a research program to become fully productive takes some time. Yes, there has been productivity. In the first year of operation through September 1968 there were about 65 papers published in the professional journals. There were about 30-odd technical reports that came out. We had a number of cases where some of our universities in the Themis program contributed to our more applied research organizations. For example, Louisiana State University, working on the application of digital and

analog computers to applied problems, found that our armament lab at Eglin Air Force Base had a direct use for their capability. The armament lab at Eglin then let another contract with LSU to do calculations and war gaming on air-to-air combat and air-to-surface missiles.

Similarly, Kansas State University has worked with the aeromedical lab on such matters as the effect of heating on a pilot in his confined cockpit.

Similarly, the Illinois Institute of Technology, in their V/STOL work, worked with the flight dynamics labs. Thus, there are many laboratories that have benefited from the product of the Themis program. In total my answer is that, yes, this is productive.

Also, this represents a capability which did not formerly exist. There are new universities which are contributing to the Air Force which were not making the same contribution in prior years.

IMPROVEMENT IN QUALITY OF PROPOSALS

Mr. SIKES. Would you say it has reached the limit of its usefulness?

Dr. LEHMANN. No, sir, I do not think we are at that point yet. In the first year, many of the proposals were prepared so fast that they were not really well thought out. We are now seeing the quality of these proposals improve as time goes on. The satisfaction of the Air Force with the average quality of these Themis research, and we only canceled one out of 27 research contracts, indicates that this is a very valuable source. As time goes on, we believe many of these universities will be able to compete effectively with the prestige universities, with the major centers of excellence today.

Mr. SIKES. Do you think Themis is necessary in order to attract the competence and abilities of the smaller schools?

Dr. LEHMANN. I think without it you would have far less than you do, sir. I think the thing comes out like this: Many times we will have a principal investigator at an outstanding university, and he has a No. 2 man. The No. 2 man breaks loose and goes off to a good but less well known university. Without this Themis emphasis, the research would tend to go to the established leaders; Themis is a very important element in helping an unknown researcher make his mark. We are finding, as our experience grows, that we can profitably avail ourselves more of the people in the lesser known universities.

Mr. SIKES. I yield to Mr. Lipscomb.

COST OF PROJECT THEMIS

Mr. LIPSCOMB. How much did you have in the program for fiscal 1967?

Dr. LEHMANN. That was the first year. I think it was $5.1 million or rather $5.3 million. That was the first year.

Mr. LIPSCOMB. You know that for fiscal 1967 through fiscal 1969 we have apparently invested through the Air Force about $22 million in the program?

Dr. LEHMANN. You are right, sir.

Mr. LIPSCOMB. You are asking for another $12.3 million for fiscal year 1970.

Dr. LEHMANN. No, sir, it is $10.1 million for 1970. The plus $2 million goes to the joint service electronics program which was included with the research program at universities. It is $10.1 for Themis in fiscal year 1970. The university research program in documents submitted to you included the joint service electronics program.

Mr. LIPSCOMB. So you are really reducing your Themis request?

Dr. LEHMANN. No, the Themis request is the same. The university program as reflected in the budget submission includes Themis and the Air Force part of the joint services electronic program.

Themis is at the same level as programed, sir.

Mr. LIPSCOMB. You mentioned that you are spreading this work around in your Themis program to the smaller universities.

Dr. LEHMANN. I should not necessarily say smaller because some of the universities are larger.

Mr. LIPSCOMB. Ones that have not participated in Government programs before.

Dr. LEHMANN. The ones that have not participated in the Department of Defense program which have by and large not been available where we have had a minor relationship with them.

SHOULD PROJECT THEMIS BE ADMINISTERED BY NATIONAL SCIENCE FOUNDATION?

Mr. LIPSCOMB. We have gone into this in great detail with previous witnesses on other programs, and I am still of the view, Mr. Chairman, that this program belongs in the National Science Foundation or someplace of that nature where they could coordinate the vast number of Federal programs and attempt to eliminate duplication or waste between programs. I just think it belongs some other place for efficient administration.

Dr. LEHMANN. Are you asking for a statement of what the services get out of Themis that they would not get if it were administered by the NSF?

Mr. SIKES. Why don't you give us that.

Dr. LEHMANN. The laws of physics are the same for the National Science Foundation or the Atomic Energy Commission or the Department of Defense. There is no magic in this business.

Mr. FLOOD. You mean something that goes up must come down.

Dr. LEHMANN. That is right. It is the same with Russian science, American science, DOD science, and AEC science. We use what the NSF develops, and the NSF and the scientific community of this country use what comes out of Defense research. When I say we use the science developed by NSF, that means our scientists and our engineers build upon that science—and who are our scientists and engineers? They are in-house people, they are military "bluesuiters" and Air Force civilians and they are university contractors—all those who are part of our total Air Force scientific team.

Mr. FLOOD. I think you miss my point. Does that law apply to budgets in the DOD?

Dr. LEHMANN. What goes up must come down.

Mr. SIKES. Not yet.

Dr. LEHMAN. That is for your decision.

Mr. LIPSCOMB. It is just starting to work.

Mr. MINSHALL. "What we get must be spent," would be better.

Dr. LEHMANN. I cited several cases. I cited the case of Louisana State University working with the Armament Lab; the case of Kansas State University working with the Aeromedical Lab and so on and so on. These are interrelationships that developed which would have not come about if it were not for an Air Force program as distinct from an NSF program. It is not because we wouldn't use the NSF program but rather because we would not have people who are intimately involved in science without an Air Force program. That is sort of the business. And you must not forget that the answers to some of our most pressing problems, for example, how to get a Minuteman missile which will take more nuclear radiation without being destroyed, will not arise by just going out and building more Minuteman missiles. The answer will have to come out of basic research because we do not now know how to do this.

Mr. LIPSCOMB. You mean you are not ready to spend that $50 million request in the budget.

NUMBER OF PERSONNEL ADMINISTERING PROJECT

Mr. LIPSCOMB. How many people do you have in your shop, civilians and military, working on Project Themis, in analyzing the requests and the projects?

Dr. LEHMANN. We have Col. Pete Luke, and his deputy who are two Air Force members of the DOD Steering Group on Project Themis. After that we treat each project on an individual basis. We have 27 projects under Project Themis that are Air Force funded, plus three that we monitor. I estimate roughly this is a total of something like one or two man-years, but it is drawn from about 30 different scientists and a little effort from each.

Mr. LIPSCOMB. Does the funding for your office come out of the Project Themis funds or is that separately funded?

Dr. LEHMANN. No, sir. All the Themis funding goes to the universities. The rest of our 6.1 program pays for the people monitoring Themis.

JOINT SERVICE ELECTRONICS PROGRAM (JSEP)

Mr. LIPSCOMB. What is this addition you have under the university program?

Dr. LEHMANN. Sir, it is not a new addition. It has been there for many years. It was included in the university program in the budget by decision of D.D.R. & E. this past year.

It is the joint service electronics program. There are about seven or eight universities throughout the country, Illinois, MIT. I could provide that for the record. These universities which have a rather extensive electronics program across the board or many fields of electronics. It has been one of our most productive programs. It is at least 7 or 8 years old.

Mr. LIPSCOMB. Where was it funded before the university program?

Dr. LEHMANN. It was under Defense Research Sciences, but it was not separately identified. It was included in the electronics line. If you

will notice, the electronics line in your budget was something like $8 million in 1968 and then dropped to about $6.3 in fiscal year 1970. If we had included the JSEP in that line instead of the university program, the electronics line would have been $8.4 million in 1970 and the university program $2 million less. That is where it shows in the figures you have, sir.

Mr. LIPSCOMB. Is the Air Force the only one that contributes to this?

Dr. LEHMANN. No, sir; that is a triservice program. The Army and Navy also contribute to the joint service electronics program.

Mr. LIPSCOMB. Are all services handling it through the university program?

Dr. LEHMANN. I believe that is the case. I think that was the decision by D.D.R. & E. I am not positive on that. I would have to verify that for the record. All I can speak for is the Air Force.

PARTICIPANTS AND COST OF JOINT SERVICE ELECTRONICS PROGRAM

Mr. LIPSCOMB. I do not believe the Navy showed up that way. Would you list for the record the universities that participate in the joint service electronics program, and also the total cost of the program?

Dr. LEHMANN. Yes, sir.

(The information follows:)

The joint service electronics program (JSEP) was funded at $6,014,000 in fiscal year 1969, with the Air Force funding $2,005,000 of the total. For fiscal year 1970, $6,600,000 is budgeted for the JSEP, with the Air Force's portion amounting to $2,300,000. In fiscal year 1970 the program will be administered under the university program by the Air Force as well as the Army and Navy. Universities associated with the program are: Harvard University, Massachusetts Institute of Technology, Columbia University, Stanford University, University of California (Berkeley), Polytechnic Institute of Brooklyn, University of Texas, University of Illinois, University of Southern California.

PROJECT THEMIS

Mr. LIPSCOMB. Are you participating through Themis in any joint efforts, such as in the program or project entitled "Research on Research"?

Dr. LEHMANN. There is the Case Western Reserve. That is jointly supported by the Army, Navy, and Air Force.

Mr. LIPSCOMB. How much do you have in that program, $100,000?

Dr. LEHMANN. The annual expenditure is about $200,000 per year, and I think we are one-third, one-third, one-third, although I am not positive.

Mr. LIPSCOMB. Are there any other joint Themis projects you have with the other services?

Dr. LEHMANN. I think that is the only one that is joint tri-service. We monitor some ARPA funded programs.

Mr. LIPSCOMB. Have you had any meaningful consultation with the directors of the program called "Research on Research" during the past year?

Dr. LEHMANN. I personally?

PROJECT THEMIS ACCOMPLISHMENTS

Mr. LIPSCOMB. They must be doing the work for somebody. I am trying to locate some projects that have accomplished something and can be testified to.

Dr. LEHMANN. Some work in this area has been used in some of our education programs, such as the air university's professional military education program, such as the Air Force Institute of Technology program on systems management and systems engineering. Those are the only two I know of directly.

I could check that.

Mr. LIPSCOMB. You are not personally aware of any meaningful conferences they have had?

Dr. LEHMANN. I think these two I have cited are meaningful; yes, sir.

Mr. LIPSCOMB. Do you know those to be a fact?

Dr. LEHMANN. I know our people have incorporated some of the ideas coming out of such research into some of their curriculum.

Mr. LIPSCOMB. For the record, you can cite the accomplishments of the "Research on Research" program as far as the Air Force is concerned.

Also, the meaningful conferences that were held and so forth.

(The information follows:)

RESEARCH ON RESEARCH PROGRAM—CASE WESTERN RESERVE UNIVERSITY THEMIS PROJECT

Title: "Program of Research on Research Management" (monitored by Army Research Office).

EXAMPLES OF ACCOMPLISHMENTS

1. Twenty-five technical papers have been presented at seminars and at various scientific and technical meetings. Five examples follow:

(*a*) Dean, B. V., "A Research Program on the Management of Research and Development," 1968 Joint National Meeting of Operations Research Society of America and the Institute of Management Science, San Francisco, Calif., May 1–3, 1968.

(*b*) Kranzberg, M., "The Disunity of Science-Technology," Sigma Xi National Lectureship, midwest tour: University of Toledo, Albion College, Grand Valley State College, April 1968.

(*c*) Kranzberg, M., "Technology the Civilizer," Western Michigan University, January 17, 1968.

(*d*) Mantel, S. J., Burton V. Dean, et al., "Research Project Cost Distribution and Budget Forecasting," presented at the XV TIMS international meeting, Cleveland, Ohio, September 13, 1968.

(*e*) Reisman, Arnold, "Unification of Engineering Economy: The Need and a Suggested Approach," a paper presented on the Genesys TV network, University of Florida, February 9, 1968, and at the short course on "Recent Developments in Operations Research," Case Western Reserve University, Cleveland, June 5–7, 1968, and the invitational workshop "Economics of Engineering Systems" UCLA, June 24–July 3, 1968. Forthcoming in the "Proceedings" of the latter two conferences, and in the Engineering Economist, fall 1968.

2. Twelve papers have been published in scientific journals. Five examples follow:

(*a*) Dean, B. V., *Evaluating, Selecting, and Controlling R&D Projects*, American Management Association, Research Study 89, June 1968.

(*b*) Kranzberg, M., "The Disunity of Science-Technology," *American Scientist*, 56, 1 (spring 1968), 21–34.

(*c*) Kranzberg, M., "The Transfer of Technology, Imitative or Innovative?" in Daniel L. Spencer and Alexander Woroniak (eds.), *The Transfer of Technology to Developing Countries* (New York, Frederick A. Praeger, 1967), pp. 30–34.

(*d*) Kranzberg, M., "The Public—and the Scientists too—Discover Science," Scientific Research, VII, 8 (Apr. 15, 1968), pp. 21–24.

(*e*) Kranzberg, M., "Toward a Better University," *University Bulletin*, Brigham Young University, XXIII, 45 (July 8, 1968).

3. Fourteen technical reports have been prepared. Five examples follow:

(*a*) Corwin, B. D., "On the Application of Current Techniques for Single and Multi-Project Scheduling with Limited Resources to R&D Projects," C.W.R.U., O.R. Dept., Tech. Memo., September 1968.

(*b*) Bushnell, J. L., et al., "An Annotated Bibliography on the Management of Research and Development," C.W.R.U., O.R. Dept., Tech. Memo 100, March 1968.

(*c*) Chidambaram, T. S., "Optimality of Full Funding Strategies in R&D Allocation Problems," C.W.R.U., O.R. Dept., Tech. Memo 102, January 1968.

(*d*) Davis, J. Bruce, "Annotated Bibliography on Methods for Evaluating Research Projects," C.W.R.U., O.R. Dept., Tech. Memo 105, April 1968.

(*e*) Chidambaram, T. S., "Some Preliminary Results on the Budget Decrement Problem," C.W.R.U., O.R. Dept., Tech. Memo., 106, May 1968.

4. Four papers have been accepted by journals for publication:

(*a*) Layton, Edwin, "The Engineer and Business," in Robert Perrucci ed., The Engineers and the Social System (Wiley, scheduled to appear in the fall 1968).

(*b*) Kranzberg, M., "The Real Problems of Innovation," The President's Forum, American Management Association (forthcoming).

(*c*) Kranzberg, M., review of J. J. Brown, Ideas in Exle: A History of Canadian Invention, in Candian Historical Review.

(*d*) Taft, Martin I., and Reisman, Arnol. "On a Computer-Aided System Approach to Personnel Administration," a paper presented at the short course on Recent Developments in Operations Research, C.W.R.U., Cleveland, Ohio, June 5–7, 1968. Forthcoming in the "Proceedings" of the short course. Also to be presented at the winter annual meeting of the American Society of Mechanical Engineers, and in the Engineering Economist, fall 1968.

5. Advisory assistance has been provided on three defense problems:

(*a*) Project Torque, Colonel Stick, USAF, R. & D. programing, July 15, 1968.

(*b*) Project Torque, allocation algorithm, Mr. R. Jurick, Mr. A. B. Nutt. Flight Dynamics Laboratory, Wright-Patterson Air Force Base, July 31, 1968.

(*c*) Resource Allocation in Multi-Project Laboratories, L. Roepcke, R. Phillips, USAMC, July 1968.

F–111D Aircraft Engine

Mr. Flood. I would like to refer back, General, to your statement. You spoke of the installation of new engines in the F–111D at some length.

General McNickle. Yes, sir.

Mr. Flood. That is all very well, but our experience teaches us that down through the years whenever you install a new engine in an existing airframe there immediately follows an expensive modification of the aircraft.

You carefully avoided that here. Is this the rare bird in which you install a big new round fat engine in the existing airframe and not spend anything to modify the aircraft? That is something new.

General McNickle. These are improvements in the internal configuration of the TF–30 engine. It is still a TF–30 and there is no change in the exterior of the engine which would require a modification of the aircraft.

Mr. Flood. It is a modification of the engine, itself?

General McNickle. Yes, sir.

Mr. Flood. You used the term in the statement "new engine." A new engine usually means to me a lot of money to modify the aircraft. I am never sure which comes first, the chicken or the egg.

General McNICKLE. I am sorry, I did not make that clear. It is not a new engine in that sense. It is an updating of the present engine—a new version of the TF–30 with a significant increase in thrust.

SPARROW AIR-TO-AIR MISSILE

Mr. FLOOD. Then it is not what I thought. On page 40 you speak of the short-range missile, the Sparrow. Is that ——— miles of which you speak dead ahead? On page 40 you depict a diagram which has quite a fan from point to point. What do you mean by ——— miles—dead ahead, or does it include much more of a fan?

Is ——— miles just a straight line?

General McNICKLE. It is dead ahead, the range falls off as the missile maneuvers from straight ahead.

Mr. FLOOD. What is the mileage covered by the arc of the fan? That is a lot more, is it not?

General McNICKLE. No, sir; actually, as the missile moves to the extremes of the fan and the range reduced.

Mr. FLOOD. It would not be material. It would not be ——— miles to the end of the fan and ——— miles dead ahead.

General McNICKLE. No, sir.

Mr. FLOOD. It is just ——— miles plus a little here or there?

General McNICKLE. It is ——— miles maximum.

Mr. HANSEN. It is ——— miles that the missile flies.

MAKE-UP OF CHAFF CLOUDS

Mr. FLOOD. On page 46, you speak of chaff. What kind of chaff are we using in this one? What is the nature of the chaff? What is it made of?

General McNICKLE. Sir, I will have to check that.

Mr. FLOOD. I have been with chaff since we started with little silver threads. Then we went to all sorts of things. Tin foil was the first thing. What is the sophisticated chaff? I am amazed you would not know that.

Mr. HANSEN. What it is made of?

Mr. FLOOD. Yes.

We have had all kinds of chaff. This is the most sophisticated thing.

General McNICKLE. ———.

Mr. FLOOD. ———.

Gneeral McNICKLE. Yes, sir.

Mr. FLOOD. That will do. ———.

Gneeral McNICKLE. Yes, sir.

Mr. FLOOD. That is enough.

CLOSE AIR SUPPORT TACTICS

Mr. FLOOD. During the Korean war, you will recall, we had some very unhappy experiences with ground strafing by jet aircraft in close ground support to troops on the frontline. Very unsatisfactory, especially close up against hard points; small, strong points, double machinegun emplacements; concrete emplacements with grenade throwers and what-not, right in front of the infantry. We called in you

fellows with jet aircraft for ground strafing. It never worked out. Very unsuccessful. Very unsatisfactory close up.

Now you tell me you are going to do this with the Maverick with F–4A's—page 56 of your statement. What magic has taken place in your development of ground support tactics close up? If I am a company commander and I have ahead of me, close up, a strong point that is holding me up and I call you in, why are you going to be any better with jet aircraft and the Maverick air-to-ground missile than you were in Korea?

General McNickle. Mr. Flood, we had some problems early in the Southeast Asia war also, but we have worked those out with the Army through the use of the forward air controller arrangement. We have forward air controllers on the ground, as well as in the air, and I think that the Army would probably be the first to say that they have no hesitation now in calling in Air Force close air support any place they need it. The Maverick, while it will be a very precise weapon, is not intended for close air support. It is primarily a tank and hard point killer.

Mr. Sikes. On the question Mr. Flood asked you, the answer is simple. The new aircraft is not a jet; it is a prop-driven aircraft designed specifically for the support of troops, close air support of troops.

General McNickle. Yes, sir. The proposed close air support aircraft, the A–X, would be a turboprop aircraft.

Mr. Flood. I know that, but I am talking about jets.

General McNickle. We are using jets in Southeast Asia now and we are strafing and putting the bombs in very, very close whenever the situation dictates. The Army has no hesitation calling for them.

Mr. Flood. If the Army is satisfied, I am.

General Boylan. And Napalm.

General McNickle. I think the Army will verify it.

Mr. Flood. Napalm should work.

General Boylan. It is the whole combination. The airplane itself is vastly improved. The delivery systems, and certainly our training to operate in the close support role. All of these have paid great dividends.

Mr. Flood. If the Army is satisfied, that is all I am concerned about.

General Boylan. They would be our best witness.

Astronautics Vis-a-Vis Military Astronautics

Mr. Flood. What is the difference between the term astronautics and military astronautics? What is so peculiar about military astronautics vis-a-vis the term astronautics?

Mr. Hansen. I would venture an opinion on that. In military astronautics, you would be using a particular environment technology for a military purpose. Let's say, for example, that you have a satellite which is looking toward the sky for a scientific purpose like the OAO. This is an astronautical thing. If you turned it around and had it look at the ground to observe things that were of military interest, then that would be military astronautics.

Mr. Flood. It is like trying to pick up a handful of quicksilver. It is a good try. You get "A" for effort. It is not clear.

Nobody else is probably interested, but me, but you might include a better definition in the record.

I know what astronautics is, but I don't know what military astronautics is.

Mr. HANSEN. Astronautics is the science of space flight and then military astronautics would be that particular branch of the science of space flight which deals with matters which are peculiarly utilized for military purposes.

Mr. FLOOD. That place of yours is infested over there with people who could out-O. Henry at any time.

Mr. HANSEN. In a lot of cases, they are the same really, if that is what you mean——

Mr. FLOOD. That is what I thought.

Mr. HANSEN. For instance, if you are talking about a star-tracker, for space navigation, that is the same as an element of astronautics, whether it is tracking a spacecraft on its way to the moon or whether ——.

TACTICAL SATELLITE COMMUNICATIONS PROGRAM

Mr. FLOOD. I read in the paper within the last 2 or 3 days—I am sure you did as well—a story to the effect that somebody has perfected this. You mentioned earlier in the day you were engaged in this kind of thing. The story had to do with the fact that somebody in R. & D. some place is developing a project which will permit the GI in the front line, if he has the right gimmick on his back, by satellite, to take commands right from the President's bedroom or something. Are you doing this?

Mr. HANSEN. I read that. That is the tactical communications satellite. It provides a communication relay facility by which any two points that are within view of that satellite and have the proper transmitter and receiver can communicate.

Mr. FLOOD. The President is going to direct a platoon sergeant around a pillbox.

Mr. HANSEN. I think that is some reporter's license as to what might be done with it.

Mr. FLOOD. What is it, exactly?

Mr. HANSEN. I think it would be obviously impractical to establish something for the field soldier to communicate with the President.

I think what this says is that the capability would be there if they wanted to do that.

Mr. FLOOD. What it said was, in many, many cases, and, of course this is true, operations on the line are retarded or don't develop as they should because communications becomes a can of worms, and that this is one way for somebody to jump over the can of worms to the frontline.

Mr. SIKES. I submit that is because they have too many systems now.

Mr. FLOOD. That might be.

They didn't say who is doing this. Your R. & D. Are you doing it or is somebody else?

Mr. HANSEN. The Air Force is doing this in R. & D.

Mr. FLOOD. What are you doing?

General MCNICKLE. The Army is developing the ground stations.

Mr. HANSEN. It is a joint service program. The ground station portion of the program is being developed by the Army.

Mr. FLOOD. This is a ground station according to the story and when it is perfected this lone GI with the proper piece of hardware on his back could use it. Do you propose to have 2.5 million ground stations? What is it?

General MCNICKLE. It takes three men to the pack, but it has the capability of long-distance communications.

Mr. FLOOD. By way of satellite?

Mr. HANSEN. The system provides the capability so that from a transmission point to any other point which can also see that same satellite, you can have transmission to a receiver which could be in a truck, in a ship, in an airplane, or a man pack——

Mr. FLOOD. You mean if a division was having trouble getting through to the company it could talk via satellite to get through to the company?

Mr. HANSEN. Yes, sir. He could talk to the satellite and the satellite would relay it back to the company.

Mr. FLOOD. This is mighty good if you can work it out. That might be one of the new things that the chairman was asking about earlier.

Mr. HANSEN. Yes, sir.

MAJOR NEW RDT & E PROGRAM STARTS FOR FISCAL YEAR 1970

Mr. SIKES. What are the major new program starts included in the fiscal year 1970 request?

General MCNICKLE. The major ones will be B-1 (AMSA), F-15, the AWACS; the A-X; and CONUS Air Defense Interceptor which is a technology line.

I would point out that most of these are aircraft and the reason there are so many aircraft here is that we have had a drought over many years and the average Air Force airplane is now over 9 years old. I should also point out that most of these programs are new in the sense that they are taking on a major new orientation in fiscal year 1970.

Mr. SIKES. I recognize the problem and I sympathize with you in your efforts to overcome this deficit.

COMPARISON OF NEW STARTS WITH LAST FISCAL YEAR

How does the number of significant new starts in the fiscal year 1970 program compare with other recent programs?

General MCNICKLE. There are a few more this year. Last year we had Defense Satellite Communications System, Maverick and Hard Rock Silo.

REIMBURSABLE PROGRAM

Mr. SIKES. I would like you to discuss the reimbursable program estimated at $230 million. What are the principal sources of reimbursable obligations and what programs of significance are involved?

General PITTS. The program for 1970 amounts to some $230 million, Mr. Chairman. The principal item that makes that up is the reimbursement from the National Aeronautics and Space Administration, NASA. That is made up of two items: support provided by

the Eastern and Western Test Ranges, and Arnold Engineering Development Center, and boosters for various launches. Other principal sources involve other U.S. Government agencies. We are talking here in the Office of the Secretary of Defense, of offices such as the Advanced Research Projects Agency; Defense Atomic Support Agency, and then all other U.S. Government agencies such as the Federal Aviation Administration, Atomic Energy Commission, and Federal Communications Commission. These reimbursements amount to some $39.8 million and cover various work done and services provided by the various Air Force research and development activities.

The sum of $41.6 million is associated with reimbursements from the Army for such things as work on radar technology, boosters for the Sentinel program; support of the Nike X program; $23.9 million of reimbursements are from other Air Forces appropriations and miscellaneous accounts. For example, we are reimbursed from our O. & M. military family housing, redistribution and marketing, commissary surcharges and foreign military sales accounts. Those are the principal items.

Coordination of Research

Mr. Sikes. With respect to coordination of research, in what way does the organization of the Air Force reflect your activities in trying to utilize scientific research which has been funded by the other military services and by the civilian agencies of the Government?

Mr. Hansen. I will start that answer. We do make a very great effort to make sure somebody else isn't already doing it before we start and also to make sure that we make use of what other people do.

I can cite one example from my personal experience where I was formerly responsible for a test site at Point Loma in California. The cliff was chipping away and falling into the ocean and we were afraid we were going to lose our test stand. We found there were available some soil stabilization techniques that had been developed in Army research which were applied there. The last I heard the test stand was still there.

There are the scientific advisory panels of three services who invite participation at their meetings in each case from the other services. We have, of course, the communication link through D.D.R. & E. who are trying to see to it that we are coordinated. In the MOL program a very great deal of the research involved in that, of course, came out of NASA.

On our F-15 program, for instance, we are worried about engine inlet conditions and things like that where we are using heavily the research from NASA's Lewis Research Center. I think if you wanted more examples——

Mr. Sikes. You might provide them for the record.

(The information follows:)

Utilization of Scientific Research Funded by Other Services and Departments

Because of the Air Force's wide range of interests, we must keep abreast of a variety of scientific areas, many of which are supported by non-Air Force agencies. Our research program is coordinated with industry through review of industrial independent R. & D. programs by our own scientists. Symposia, scientific meetings, and scientific publications allow us to receive information on other scientists' activities.

Army programs.—Air Force personnel selection and classification had its beginnings as a part of the Army Air Force program before there was a separate Air Force. Techniques have advanced greatly since then, and the Air Force has been a leader among the military services in these areas. Vaccines developed by the Army at Fort Detrick and Walter Reed have proven most beneficial in affording protection to all of the services and to civilian laboratory personnel involved in research on certain rare diseases. The Army Limited War Laboratory at Aberdeen Proving Ground, Md., on energy spectrum of weapon muzzle flashes, has provided information related to the selection of sensors for infrared gunfire locating devices, now under development by the Air Force Avionics Laboratory. With Air Force funding, the Army Waterways Experiment Station, Greenville, Miss., compiles data on soil structure behavior under dynamic landing for aircraft design criteria. The joint services electronics program involves $8 million from the three services (Air Force portion is $2 million) which is combined with other support at universities to benefit us with broad base electronics research work about $15 million.

Navy programs.—Navy is a member of the joint services electronics program, mentioned above. The Office of Naval Research supported the Pennsalt Chemicals Corp. for years on synthesis and structure of organometallic compounds. Some of these compounds are of interest to the Air Force Weapons Laboratory as potential shielding materials for nuclear weapons. The Naval Research Laboratory developed techniques on antenna scanning used by our BMEWS (Ballistic Missile Early Warning System) radars. Some interesting work on isolation and confinement in the Navy Sealab was applicable to the Air Force MOL program.

National Science Foundation (NSF) programs.—The NSF provides major support to mathematics research. When such research advances to a stage where application to Air Force problems becomes feasible, the Air Force Office of Scientific Research provides additional support for specific purposes. An example is recent research in differential topology, used in global analysis, elliptic differential operators, and the solution and application of differential equations. Differential games, involving pursuit and evasion and applicable to evading a surface-to-air missile, is based upon work sponsored by NSF and the Navy.

Industrial R. & D. programs.—Polyethelene films used in large high-altitude balloons were largely developed and compounded by industry. Examples are X-124 film developed by Ethyl Visk Queen Co. and Strato-Film developed by Winzen Corp. Research sponsored by Firestone Rubber Co. resulted in a reticulated polyurethane foam to reduce the probability of gas tank explosions in automobile accidents. Foam of this type is used in our aircraft fuel tanks to suppress explosions when the tanks are struck by incendiary projectiles. A whole new series of solar cells, infrared detectors, and discreet frequency light meters is being researched by the Air Force Cambridge Research Laboratories. This program resulted from a discussion of a new organic radical compound, TCNQ, in a Du Pont publication reporting on their research. Composite materials research, including some prototype hardware, in Air Force programs are based on Bell Telephone Laboratories scientists work in 1952 on single crystal whiskers of great strength, with the concept of dispersion strengthening introduced a few years later by International Nickel Co. Bell Labs, using its own funds, sponsored basic research which led to an ion implantation technique in silicon. Bell licensed Texas Instruments to develop the technique into a workable vidicon tube, presently used in the forward looking infrared (FLIR) system for Gun Ship II and Tropic Moon III aircraft.

NASA programs.—The Air Force is probably the largest user of technical information developed by NASA in this country. In the case of the F–15, for example, NASA has been conducting aerodynamic configuration and weight estimation tests at their Langley, Va., facility, engine air inlet tests at their Ames, Calif., facility, and engine stability tests at their Cleveland, Ohio, facility. Their entire technical program contributes to areas of Air Force interest.

FAA programs.—The FAA supersonic transport (SST) development is also contributing considerable to the Air Force research and development program. The Air Force is currently using engine-demonstration hardware which was developed by the SST program and now surplus to that program for tests on advanced turbine power extraction techniques. The SST quarter-scale engine air inlet is also being used jointly by the FAA and the Air Force in the development of technical information of interest to each agency.

Army weather research.—In July 1964 an Army engineer conceived a method for local dispersal of warm fog (i.e., fog temperature above 32° F.). The idea is

to fly a helicopter just above a deck of stratus or fog; the downwash from the rotors, being from the drier air above, is forced into the fog drying it out and dissipating it in the local area. After the publication of the results of Army experiments, the Air Force's Cambridge Research Laboratories conducted further experiments. As a direct result of these efforts, two downed airmen in Southeast Asia were rescued by helicopters using this technique.

Degradation of Weapons Due to Exposure in Vietnam

Mr. Sikes. On exposure of weapons, last year we discussed briefly the degradation of some of our newer weapons due to their exposure in combat in Vietnam. There would be other problems due to timing.

After the enemy had seen certain weapons operate for a while, he was able to devise counters to them. Can you tell us of any instances in the past year in which the enemy has been able to effectively downgrade some of our weapons through his ability to devise counters, or defenses against them?

Mr. Hansen. I think it was a little bit earlier than the last year, but one of the major things that happened is that he found we didn't have a night capability, or a bad visibility capability, he would operate during the periods when he knew that we weren't in a position to counter that operation.

I am not aware of any case within the last year where the capability of our weapons has been downgraded by a change in the tactics or operations of the enemy.

General McNickle. There are three areas where we are concerned. We have no adverse effects yet, but we have indications that they are picking up the air-dropped sensor, but so far they haven't exploited them.

The portable radios that our pilots carry for use if they are shot down, could be very troublesome if the enemy had and used them. We don't have any instances where they have used them, but we have gone to multichannels and worked out codes to avoid trouble. We don't know what surprises they might be planning up in the North where they have all that air defense, but we are sure they are keeping busy.

New Enemy Weapons

Mr. Sikes. Has the enemy shown, or utilized any new weapons which were developed in China or the Soviet Union or in Eastern Europe, like Czechoslovakia?

General McNickle. No, sir; we haven't seen any recently.

Mr. Sikes. Nothing new?

General McNickle. We saw a few of the later model Migs come in a year ago, but nothing since then.

Mr. Flood. I heard they had some new fancy antiaircraft weapons probably Czechoslovakian.

Mr. Sikes Will you check your records on that?

Mr. Lipscomb. It would be worth looking at, General.

General McNickle. We should be able to tell from the firings. We will submit that for the record.

(The information follows:)

NEW ANTIAIRCRAFT WEAPONS USED BY NORTH VIETNAM

No newly developed communist antiaircraft weapons have been shown or used by the North Vietnamese in Southeast Asia in recent years. The Soviet 23 mm. antiaircraft gun—which is new to Southeast Asia—was confirmed in the North Vietnamese inventory during ———.

Mr. SIKES. Have you noted an improvement in quality or effectiveness of enemy weapons in Vietnam in the past year?

General MCNICKLE. I don't know of any qualitative increase but there have been quantitative increase.

MILITARY SCIENCES

Mr. SIKES. Under military sciences, the request before the committee is $158.7 million. I would like a comparison with this amount of the amount programed for this purpose for fiscal years 1963 through 1965.

(The information follows:)

Budget for Military Sciences (1963–69)

	Thousands
Fiscal year 1963	$122,145
Fiscal year 1964	151,122
Fiscal year 1965	161,440
Fiscal year 1966	150,690
Fiscal year 1967	159,408
Fiscal year 1968	142,802
Fiscal year 1969	147,357
Fiscal year 1970	158,699

COLLEGES AND UNIVERSITIES IN MILITARY SCIENCES PROGRAM

Mr. SIKES. I would like to know how many colleges and universities in the United States and in foreign countries are involved in the military sciences program at this time or at the time of your most recent date for which you have this information. You can list those for the record.

(The information follows:)

The military sciences program in fiscal year 1969 included 286 U.S. and foreign universities. This total included the following:

United States:

Auburn University
University of Alabama
University of Alaska
Arizona State University
University of Arizona
California Institute of Technology
San Diego State College
Stanford University
University of California, Berkeley
University of California, Los Angeles
Colorado State University
University of Colorado
University of Connecticut
Yale University
Catholic University
George Washington University
Georgetown University
Howard University
Florida State University

University of Florida
Emory University
Georgia Institute of Technology
University of Hawaii
Illinois Institute of Technology
Purdue University
University of Notre Dame
Iowa State University
Kansas State University
University of Kentucky
Louisiana State University System
Tulane University
University of Maryland
Harvard University
Massachusetts Institute of Technology
Tufts University
Michigan State University
University of Michigan
University of Minnesota
University of Mississippi
University of Missouri, Columbia
Montana State University
University of Nevada
Rutgers State University
Stevens Institute of Technology
Adelphi University
Cornell University
New York University
Polytech Institute of Brooklyn
Yeshiva University
Duke University
Wake Forest University
Case Western Reserve University
Ohio State University
University of Cincinnati
University of Dayton
Oklahoma State University
University of Oregon
Pennsylvania State University
University of Pittsburgh
University of Rhode Island
University of Tennessee
Rice University
Texas A. & M. University
University of Texas, Houston
University of Utah
University of Vermont
University of Virginia
University of Washington
University of Wisconsin

Foreign universities:

Argentina:

Universidad National de Cordoba
Observatorio de Fisica Cosmica

Foreign universities—Continued
- Australia:
  - University of Sydney
  - University of Melbourne
- Austria:
  - University of Vienna
  - Innsbruck University
- Belgium:
  - Von Karman Institute of Fluid Dynamics
  - University Libre de Bruxelles
- Bolivia: San Andres University
- Brazil:
  - University de São Paulo
  - Comissao Nactional de Actividades Espacia
- Canada:
  - University of Alberta
  - University of Toronto
  - McGill University
  - Laval University
- Chile:
  - University de Chile
  - Catholic University of Chile
- Colombia: University Nacional de Colombia
- Denmark: Technical University of Denmark
- Finland: Technical University of Helsinki
- France:
  - Universite de Paris a la Sorbonne
  - University of Lyon
- Germany:
  - Max Planck Institute
  - Technische Hochschule, Munchen
- Greece: University of Athens
- India: University of Calcutta
- Israel:
  - Weizman Institute of Science
  - Hebrew University
  - Tel-Aviv University
- Italy:
  - University of Rome
  - University of Degli Studi di Pisa
  - University of Milan
- New Zealand:
  - University of Aukland
  - Victoria University
- Norway: University of Oslo
- Sweden:
  - Royal University of Uppsala
  - Gateborgs Institutet
- United Kingdom:
  - University of Manchester
  - Oxford University
  - University of Sussex
  - University of Glasgow
  - Queens University, Belfast
  - University of Hull

OTHER PARTICIPANTS IN MILITARY SCIENCES PROGRAM

Mr. SIKES. In addition to the colleges and universities involved, how many profitmaking firms and how many nonprofit organizations other than colleges and universities are participants in your military sciences program? You can list those for the record.

(The information follows:)

In 1969 there were, excluding universities, approximately 720 commercial and nonprofit contractors participating in the military sciences program. This figure includes:

COMMERCIAL FIRMS

McDonnell Douglas Corp.
Marquart Corp.
American Society for Metals
International Harvester Co.
Philco-Ford Corp.
Avco Corp.
Boeing Co.
Standard Pressed Steel Co.
Johns-Manville Products Corp.
NCR Co.
Aluminum Co. of America
Monsanto Research Corp.
Belfour Stulen, Inc.
Whittaker Corp.
Shell Chemical Co.
Minnesota Mining and Manufacturing Co.
Celanese Corp.
Olin-Mathieson Chemical Corp.
Optics Technology, Inc.
Hitco, Inc.
Fabric Research Laboratories, Inc.
W. R. Grace and Co.
American Oil Co.
Perkin-Elmer Corp.
ManLabs, Inc.
Advanced Metals Research Corp.
Systems Research Labs, Inc.
Brush Beryllium Co.
General American Transportation Corp.
Astro Research Corp.
Crucible Steel Co. of America
McPherson Instrument Corp.
Space Data Corp.
Photo Metrics, Inc.
Adcole Corp.
Vitro Corp. of America
Accumetrics Corp.
Digi-Data Corp.
GCA Corp.
Melpar, Inc.
Signatron, Inc.
Computer Research Corp.
Chromalloy American Corp.
Applied Logic Corp.
Bolt-Beranek-Newman
American Optical Co.
Control Data Corp.
Logicon, Inc.
Space Sciences, Inc.
Ewen Knight Corp.
Thomas, A. S., Inc.

NONPROFIT ORGANIZATIONS

Midwest Research Institute
University of Dayton Research Institute
Mellon Institute
New York University Research Foundation
IIT Research Institute
Battelle Memorial Institute
Stanford Research Institute
Educational Research Corp.
System Development Corp.
Franklin Institute
Drexel Institute of Technology
Cornell Aeronautical Laboratories
Lowell Tech Institute Research Foundation

IN-HOUSE LABORATORY INDEPENDENT RESEARCH

Mr. SIKES. On "In-house laboratory independent research," you are requesting $5.3 million, which is an increase of $300,000 above last year's amount. Can you give the committee any examples of recent useful effort under this program?

Mr. HANSEN. If you will permit, I would like to ask Dr. Lehmann to answer that since this is his area of cognizance.

Mr. SIKES. The committee encourages you to use backup witnesses. That is what they are here for.

RECENT ACCOMPLISHMENTS IN V/STOL RESEARCH

Dr. LEHMANN. Some of the things that have come up in the research program have been thrust augmentation work in the aeronautical research lab. This is a different approach to a V/STOL aircraft.

Mr. SIKES. Tell us something about that. We have been talking about VTOL and V/STOL for 25 years around here with very little to show for it. Tell us what you mean.

Mr. FLOOD. The British and the Germans quit their program, didn't they?

Dr. LEHMANN. The British have the Harrier.

Mr. FLOOD. I understood they had stopped their program.

Dr. LEHMANN. The ARL concept I refer to is a different approach. The British approach takes some jet engines and either draws the air in here and diverts it so you shoot it down or they tip the engine so that instead of pulling you forward it pulls you up.

Mr. FLOOD. There is nothing new about that.

Dr. LEHMANN. That is the ordinary VTOL concept. The ARL concept——

Mr. FLOOD. Don't tell me you are going to use all three of them.

Dr. LEHMANN. Oh, no. In this concept you take air at a high pressure and blow it out very fast. Then you have some ducts here wherein you entrain the ambient air, and by mixing the low-speed air with the high-speed air coming from the compressor, you now get a net increase in the thrust.

Mr. FLOOD. You keep up those gestures, mister, and you will take off and fly yourself.

Dr. LEHMANN. Anyway, that is the approach that they use in here, mixing the low-speed ambient air with the high-speed air coming out of the compressors. The concept that they have, instead of looking like propellers which tilt up, looks more like a flying venetian blind. It is a new approach. It is one we are investigating and considering whether to try for a prototype demonstration. Whether we will or not, we have not yet decided.

Mr. SIKES. Isn't the Harrier a first cousin to this concept you are speaking of?

Dr. LEHMANN. Sir, the Harrier is basically the jet which is deflected. This is a different approach and it has been done on a research laboratory scale.

As I should have pointed out, it is basic research. It is done in a laboratory. They have a rig where they have run a number of experiments. The experiments look encouraging enough so that they want to continue on with them.

Let me cite another one that came up.

"COMBAT TRAP" BOMB

You are familiar with some of the early work on Combat Trap, which was a 10,000-pound bomb used to clear a helicopter landing zone in South Vietnam. Some of that was funded in its early stages by the laboratory director's funds. This is one of the uses of the lab director's funds. When you get new work coming in that wasn't thought of at the time you went through your formal programing, the

lab director individually has the authority to take some dollars and put them on a project to get it going fast.

They did that. They got other funds coming in later to support, but in something like 90 days they were ready to go with that 10,000-pounder in clearing out trees and jungle.

SOLAR FORECASTING

I have some notes here. Let me point out there is the work on solar forecasting. That work was supported out of CRL, the Cambridge Research Laboratory.

We had an improved image intensification device which was supported by the laboratory director's funds.

OTHER EXAMPLES OF IN-HOUSE RESEARCH

Mr. SIKES. You can provide additional information for the record if you have other examples that you think are significant.

(The information follows:)

EXAMPLES OF RECENT USEFUL EFFORT ON IN-HOUSE RESEARCH

As a research management tool, the Air Force in-house independent research program (IDF) has provided Air Force Cambridge Research Laboratories (AFCRL) with a means of stimulating research efforts to better meet Air Force systems research requirements and technology needs. Project 6690, Aerospace Density, was proceeding at a lesser rate of progress until IDF support was provided to develop and fly new accelerometer instrumentation special low-altitude density-sensing satellites. Today, the project is one of the most active at AFCRL, providing vitally needed low-altitude density data to the Air Force Systems Command Space and Missile Systems Organization. Project 8668, Space Environment Observing and Forecasting Techniques, was launched and given adequate IDF support so that today AFCRL is well on its way to providing the Air Weather Service and its user agencies with the space forecasting techniques needed to conduct Air Force space operations and systems development.

The Avionics Laboratory developed a transmitter and power amplifier which provided the first airborne high-power microwave transmitter. Utilization of this X-band transmit system has positively demonstrated the feasibility of airborne satellite microwave communications and has pointed up technical areas requiring refinement or further development.

Under the IDF-funded portion of an Air Force Armament Laboratory project, the contractor completed the guidance and control kit design to adapt Hornet components (from the earlier portion of this program) to attach to and provide television guidance for a 2,000-pound bomb. The design goal was a kit to provide automatic television contrast-guidance homing for the MK-84 2,000 pound bomb. In the case of large hard targets, this should provide an effectiveness not available with any other conventional weapon at any cost. The flight test program, completed in January 1967, produced eight successful flights, two failures caused by the missile, and two inconclusive tests.

The Aero Propulsion Laboratory conducted a research program to provide a means of rapidly identifying batch-to-batch differences in synthetic lubricants to assure quality control and to determine undesirable chemical changes which may occur during storage.

This research showed that differential thermal analysis (DTA) and thermogravimetric analysis (TGA) are excellent techniques for rapidly obtaining the thermal and oxidative stability characteristics of lubricants. Consequently, DTA and TGA have considerable value for use as a batch control technique. Incorporation of DTA and TGA methods into military lubricant specifications for quality control purposes is planned. Effort under this contract has been completed and is reported by AFAPL-TR-68-26, "Development of Batch Control Techniques for Synthetic Lubricants Using Thermoanalysis."

This program is continuing to optimize DTA and TGA techniques for use as test methods for determining differences in the oxidation and thermal stability of synthetic lubricants, as well as to define and measure kinetic and chemical mechanisms of oxidative and thermal degradation. Successfully developed TGA and DTA methods will provide a significant improvement in the performance of synthetic turbine lubricants through much improved quality control.

Under a 1966 Aerospace Research Laboratories LDF program with Clevite Corp., research was conducted on the mechanism of the photovoltaic effect in high efficiency thin film cadmium sulfide solar cells, and improvements in providing cells for testing were also made.

Three environmental tests of the flexible cadmium sulfide film cells have been conducted utilizing Office of Aerospace Research (OAR) satellites placed in orbit in the radiation belts. The most recent vehicle OVI–13 was placed in orbit April 6, 1968. Recent test data indicate a loss of only some 6–8 percent in short circuit current after more than 500 orbits, or about 2,000-hour life at about 60°–70° C., and the cells are continuing to function normally even in the Van Allen belt environment. More extensive tests are planned. The use of these radiation resistant thin film cadmium sulfide cells for large power systems should provide equivalent power to weight ratios and be more economical than ever advanced silicon cells.

The Materials Laboratory director's funds provided for the continuation of a high temperature fuel tank sealant development program. Sealants being developed offer maximum potential for solving the critical integral fuel tank sealing problem associated with mach 2.5 or higher military aircraft where aerodynamic heating will push fuel tank temperatures to 500° F. or more. Currently available polysulfide or fluorosilicone sealants are inadequate for maintenance free, lifetime performance of current aircraft such as the F–111 and SR–71, and others on the drawing board such as FX.

LIST OF IN-HOUSE LABORATORIES AND THEIR FUNDING

Mr. SIKES. For the record tell us how many in-house laboratories participate in the program and how the funds are allocated among them.

Is the increase of $300,000 based upon inflation or on any other factor?

Mr. HANSEN. The $300,000 is inflation. The list of the laboratories and the funds allocated we will supply for the record.

(The information follows:)

LIST OF LABS AND FUNDS ALLOCATED

Laboratory director funds supplied in fiscal year 1969 to Air Force laboratories were:

Laboratory	*Funds*
Air Force Cambridge Research Laboratory	$780,000
Air Force Aerospace Research Laboratory	320,000
Air Force Rocket Propulsion Laboratory	460,000
Air Force Weapons Laboratory	460,000
Air Force Flight Dynamics Laboratory	425,000
Air Force Aeropropulsion Laboratory	425,000
Air Force Avionics Laboratory	425,000
Air Force Materials Laboratory	425,000
Air Force Armament Laboratory	300,000
Air Force Human Resources Laboratory	135,000
Air Force Aerospace Medical Research Laboratory	200,000
Rome Air Development Center	450,000
6571st Aeromedical Laboratory	35,000
School of Aerospace Medicine	100,000

VALUE OF IN-HOUSE LABORATORY INDEPENDENT RESEARCH

Mr. SIKES. Is in-house laboratory independent research, something which is probably nice to have and provides some return but which is of a reasonably low priority? Would you consider it low priority?

Mr. HANSEN. I wouldn't. I would consider it to be high priority. It is one of these things where the results are maybe not quite as tangible as a piece of hardware going out of a factory door, but I believe very strongly that when you shut off this type of capability that eventually you will wake up to the fact that new ideas aren't being generated and developed. I don't think that we can get along without either the universities or the in-house laboratories or the industrial complex as sources of those ideas.

The in-house laboratories are a little more strongly motivated to develop solutions to rather specific problems, I think, because of the closeness to the rest of the military organization. I think they are an essential part of the research program.

METHOD USED IN EVALUATING PROGRAM

Mr. LIPSCOMB. Mr. Secretary, you have mentioned all of these different groups that do basic research, write reports and make studies. Have you had an opportunity to determine how you evaluate all the reports and studies and what happens to them after you get them? Have you looked around to find out how many are filed away in file drawers untouched? This is of concern. With so many studies, analyses, and projects going on, I don't know how you have enough help to evaluate them or even read them.

Mr. HANSEN. I understand your concern. I have looked into the matter on a fairly limited basis. In each case there is a person who is responsible for that particular research study and whose responsibility includes the disseminating of the results of that research to the people to whom it would be meaningful. If you will look at a typical research report, there will be a distribution list on the back of it where copies have gone all over to various organizations who might make use of the information.

Now, your question might be, when you are in that organization and this report comes in, what do you do with it? Do you just put it away in a file or do you have somebody review it to see if it might be useful to what you are doing? Within my own experience in industry, where we got these reports, we would always have someone who was cognizant of that particular area and responsible for the work in it look the report over to see whether or not there was anything in there that would be useful to us.

Mr. LIPSCOMB. This is of concern because we keep putting resources into these programs. As you can tell from the testimony so far, it is pretty hard to put an evaluation on a program because nobody really has enough information to spell out what has been accomplished. Yet we see right here in-house laboratory independent research, $5.3 million, and then Defense Research Sciences, $94.8 million.

Mr. HANSEN. Well, researchers are very——

Mr. LIPSCOMB. Prolific?

Mr. HANSEN. They are very jealous of the prerogative they have to publish the results of what they are doing and give it a very wide dissemination. If there is a problem, it is not in the research, or not spreading the word around on what he is doing. The problem would be in whether or not he is spreading it to the right people and whether the people that he is spreading it to are picking it up and using it.

Mr. LIPSCOMB. I understand their right to publish but you are buying something for the Air Force. That is really why you are putting your money into it.

Mr. HANSEN. Yes, sir.

Mr. LIPSCOMB. The question is, how do you get results out of what you are buying? You haven't been there long enough to really answer all these questions, but do you have enough people to effectively evaluate these studies and reports to see that they are not all waste, that they at least get seen, read, evaluated, and used?

Mr. HANSEN. Well, Dr. Lehmann has been there for several years. I would like him to answer that question.

Dr. LEHMANN. There is the quote that the best person to decide what kind of research ought to be done is the researcher and the next best person is the supervisor and the next best person is the Laboratory Director—Then you stop getting "next best" and start getting "worse," and the worst man is the vice president for research. You are familiar with that quote, I am sure.

Mr. HANSEN. I don't believe it.

Dr. LEHMANN. The dissemination of individual results is not done in the Pentagon. The results, the dissemination of results is done on a scientist-to-scientist basis and a scientist-to-engineer basis. We have an Air Force science and engineering symposium each year in the fall where people from the entire Air Force get together. We have meetings between our laboratories and our product divisions. There is much effort made in getting information, getting results, getting ideas out of the researchers into the minds of the users, and into something where it does the Air Force some good.

Now, for our part here in the Pentagon, we are doing overall evaluation, looking at these programs based upon publications, patents, and specific products of the research.

The AFSC laboratories each year send over a list of the 10 most wanted research items to the Air Force Office of Aerospace Research and that organization responds to those 10 most wanted research items. They tell them what they are doing. They tell about ideas they have. It is at that working level that the interchange really takes place.

We observe that interchange. If we don't think it is enough, we put the pressure on. If it is right, we encourage it and we try to foster it.

There are many products that have come out of this research. Like tubes for low-light-level TV or like perchboro carbon, new chemical compounds. We can go through a list on these products and if you like, sir, we can provide that for the record. These are the visible demonstrations of what we get from the research and how it later gets picked up into Air Force systems.

PROJECT HINDSIGHT

Are you familiar with Project Hindsight, sir? That was a study that was done——

Mr. LIPSCOMB. Yes; I have been sitting here a long time, Doctor. What we are talking about is doing away with some waste and inefficiency and making use of the American taxpayers' dollar without running it down the drain, just because some researcher wants a program.

Dr. LEHMANN. Yes, sir; and that is exactly what we are trying to do.

Mr. LIPSCOMB. That is all we are trying to do?

Dr. LEHMANN. Yes, sir.

Mr. LIPSCOMB. Project Hindsight that is in your field, I suppose?

Dr. LEHMANN. Hindsight was the study which said, for example, "How do we get from a C–130 to a C–141 transport aircraft?"

"How much was it worth to us, and how much did it cost us in research dollars to get there."

Mr. LIPSCOMB. How much did it cost?

Dr. LEHMANN. I don't have the exact numbers. But the payoff was like a factor of 10 to 1. That is, you have about 10 times more gain in operating capability than in the cost to develop it.

Mr. LIPSCOMB. Was that an in-house laboratory independent research project?

Dr. LEHMANN. No, sir.

Mr. LIPSCOMB. How did you finance that?

Dr. LEHMANN. No, sir; that was out of D.D.R. & E., sir.

Mr. LIPSCOMB. Yes; but how did you finance it?

Dr. LEHMANN. That was in-house.

Mr. LIPSCOMB. Sure it was in-house.

Mr. FLOOD. The point Mr. Lipscomb is making is that we find out that year after year, item after item on R. & D., hindsight is better than foresight when it comes to money in R. & D.

Dr. LEHMANN. Some of the research results in rescuing downed pilots in Southeast Asia, too. It is important that we recognize that it is basic and the applied research which is paying off like that.

METHOD USED IN EVALUATING PROGRAM

Mr. LIPSCOMB. We are not insinuating or saying all research is bad or wasteful. We know that you have accomplishments. What we are trying to determine is how you weed out the no-good, time-consuming, no-result, wasteful expenditure of public dollars.

Dr. LEHMANN. When we find there are no results, sir, we cut it out.

Mr. LIPSCOMB. That is what we are talking about.

Mr. FLOOD. Which came first, the chicken or the egg? That is the kind of question we will get.

Dr. LEHMANN. Yes.

Mr. LIPSCOMB. This discussion started when we asked you how you could look at all the reports that come in to see how efficiently you are allocating these resources. But you, perhaps, believe that you have unlimited funds, that you can give out any kind of research contract you want, and there is no need to evaluate the results.

Dr. LEHMANN. Oh, no, sir. We are very much aware of the limitations.

HOW DUPLICATION OF RESEARCH IS AVOIDED

Mr. ADDABBO. On page 13 of your statement you indicate there are certain studies being made by other military departments. Is there any coordination between and among other departments to make sure there are not specific studies which are being duplicated?

Mr. HANSEN. Yes, sir. That comes about in two ways. The person who wants to start something is responsible to ascertain that it isn't already going and then D.D.R. & E. has a very, very major effort to prevent duplications. An example that slipped through us was that the Air Force wanted some food research work done and this work was already programed to be done in the Army, so DOD just pointed out to the Air Force that it was something we couldn't do, that it was the Army's job.

Mr. FLOOD. That was several years ago.

Mr. HANSEN. No, sir; that is since I came on board.

Mr. FLOOD. That has happened before on exactly the same subject.

BEHAVIORAL AND SOCIAL SCIENCE STUDIES

Mr. ADDABBO. What are some specific studies being made under "behavioral and social science studies" mentioned on page 13 of your statement?

List them for the record.

(The information follows:)

SPECIFIC STUDIES UNDER BEHAVIORAL/SOCIAL STUDIES

I. RESEARCH ON AIR FORCE HUMAN PERFORMANCE (PSYCHOLOGICAL SCIENCES)

(a) *Personnel and training.*—The Air Force is continually concerned with questions that involve the effective use of personnel. These problems include the selection of persons who are equipped by their aptitudes, abilities, and experience to perform Air Force jobs. This research program is designed to supply basic data on human capabilities that will bear on these problems. Research is directed toward improving selection, classification, and assignment procedures; the designing of more efficient training techniques; understanding of short- and long-term memory and learning and retention processes. Examples are:

Principal investigator	Institution	Title
Ericksen, S. C.	University of Michigan	Development of Computer-assisted Instruction.
Lumsdaine, A. A.	University of Washington	Improvement of Learning Capabilities.
Noble, C. E.	University of Georgia	Human Selective Learning.
Robinson, J. A.	University of Louisville	Transformation and Organization of Memory Processes.
Sklansky, J.	University of California	Training Theory.

(b) *Human engineering.*—This area of research is concerned with improving the design of Air Force material to match human operational capabilities and to minimize difficulties in equipment operation. Data are provided on psychological measurement of man's skills, perceptual ability, man-machine information processing. Examples are:

Principal investigator	Institution	Title
Kelley, C. R.	Dunlap & Associates	Predictive and Adaptive Processes in Man and Machine.
Klingberg, C. L.	Boeing Co	Image Quality and Information Extraction Performance.
Nickerson, R. S.	Bolt Beranek & Newman, Inc	Ability of Human Subjects to Control the Timing of Simple Responses.
Tanner, W. P.	University of Michigan	Mechanisms for Improving Human Visual and Auditory Skills.

II. RESEARCH ON HUMAN INTERACTION IN AIR FORCE OPERATIONS (SOCIAL SCIENCES)

(*a*) *Organizational effectiveness, motivation, and performance under stress.*—The Air Force has had a longstanding interest in the problems of improved leadership and management of its crews and units of all sizes including complex organizations with unique missions such as research laboratories. Air Force crews and work units are required to operate in many unusual and stressful environments. The following studies bring the analytic capabilities of behavioral scientists to bear on the problems and processes that affect the operations of military organizations. Others increase our understanding of the social and psychological effects of stress on crew behavior, and organizational effectiveness in crisis situations. Examples are:

Principal investigator	Institution	Title
McGrath, J.	University of Illinois	Social and Psychological Aspects of Stress.
Obermayer, R.	Bunker-Ramo Corp	Comparative Study of Control and Feedback Techniques.
Zander, A. F.	University of Michigan	Desire for Group Achievement: Origin and Effects.

(*b*) *Research on Air Force operational environments.**—The Air Force is prepared to operate in all parts of the world and to coordinate its activities with foreign allied forces with which it may be associated in training, civic actions, military assistance, or in the conduct of joint operations. The research in this area supports these activities and also provides information on populations, leaders, and political-military relations of countries that might be engaged in military actions against the United States or its allies. Examples are:

Principal investigator	Institution	Title
Grusky, O.	University of California (Los Angeles).	A Comparative Analysis of Military Career Patterns.
Sebeok, T. A.	Center for Applied Linguistics	Research To Improve Language Training (Western Europe).

Effect of Campus Unrest on Research Program

Mr. Addabbo. What effects have the college riots had on your research projects at the various colleges, and have any projects been canceled at these colleges?

General McNickle. No, sir; none of our research projects have been canceled, but riots are hardly conducive to research.

Effect of On-Going Research Programs on Need for ABM Defense

Mr. Addabbo. The Hard Rock Silo development is mentioned on page 49 of your statement, the satellite surveillance system is mentioned on pages 64 and 65, and the back-scatter, over-the-horizon radar is discussed on page 74. In view of the promise these programs hold and the moneys being requested for them, why do we still need an ABM system?

General McNickle. I would like to answer that for the record. They are interrelated but it is pretty complicated.

*All contracts listed above have been funded to completion from fiscal year 1969 and earlier funds. None have been planned for renewal and all will be completed by June 30, 1970.

(The information follows:)

If our policy was to launch our land-based offensive forces based on warning from the satellite surveillance and over-the-horizon radar programs, we would not need an ABM system to protect these forces. While such a policy is reasonable for bombers, it is not desirable for our Minuteman force. We therefore must have the capability for the Minuteman force to absorb a surprise attack with sufficient survivors for retaliation. A workable ABM system would provide the option to ride out an attack, while insuring that the required number of Minuteman missiles survive for retaliation.

General BOYLAN. These things aren't individual pieces where if you follow one or the other you get the same result. They are all part of our basic responsibility to provide the very best within the capabilities this Nation can possess. Each has something to offer to the total environment.

The defense of the strategic defensive system, the Hard Rock Silo, for example.

Mr. ADDABBO. Is not the ABM supposed to be a defense for our strategic offensive forces?

General BOYLAN. It certainly is. From what I know about this configuration, I believe it will make a significant contribution to the overall defense of our strategic posture.

Mr. FLOOD. Apparently this point has not been made clear enough in this whole ABM debate.

We have been talking about it for several years, but among all these experts who are now debating this thing from one end of the country to the other, and in the Congress, apparently too few have stressed the point that it is a defensive system to protect our offensive system, if and when necessary.

Mr. HANSEN. I think I can answer most of that question right here. You spoke of the satellite surveillance and the over-the-horizon radar. These are warning devices, early warning devices which enhance the capability of an ABM system by giving more lead to the knowledge that something is coming. The Hard Rock Silo provides the capability that if the screen that the ABM puts up has some stuff come through it, you will still have the capability to withstand that and retaliate. So these are all things which complement the ABM system, enhance its capability or sweep up after it, but do not replace it. If you had all those things put together, the only thing of those three that really provides a protection for your strategic force in the ability to withstand the first strike and still have the capability to retaliate.

Mr. ADDABBO. Once you have the satellite surveillance and the over-the-horizon radar, wouldn't you be better off releasing your offensive——

General MCNICKLE. If you were sure.

Mr. ADDABBO. Sure of what is coming? What good is a surveillance system if we are not sure what is coming toward us and from where?

General MCNICKLE. It provides warning and permits us to react.

———.

One advantage of the bomber is that we could actually launch them and then, if it was some meteorological phenomena, or some airplane that was lost, we could recall the planes. Once you let the missiles go, they are gone.

Mr. FLOOD. I member two very, very, very, very bad things on launching bombers. Awfully bad.

Mr. ADDABBO. Can't you always destroy a missile in the air before it strikes?

Mr. HANSEN. No, sir.

DEFENSE RESEARCH SCIENCES

Mr. MAHON. You are requesting $94.8 million for "Defense research sciences," an increase of $4.1 million over the $90.7 million for 1969. What amounts have been spent in this area since 1963? Supply that for the record.

(The information follows:)

Amounts spent since fiscal year 1963 for defense research sciences

Fiscal year:	
1963	$73,500
1964	74,000
1965	81,800
1966	84,400
1967	88,500
1968	87,000
1969	[1] 90,800

[1] Estimated.

REASONS FOR INCREASE IN FISCAL YEAR 1970

Mr. MAHON. What is the basis for the increased request this year?

General PITTS. Mainly cost of living increases.

Mr. MAHON. Explain the remaining increased cost, will you?

General PITTS Yes, sir.

(The information follows:)

REASONS FOR INCREASE FOR FISCAL YEAR 1970 DEFENSE RESEARCH SCIENCES

The request for fiscal year 1970 for the defense research sciences is $4.1 million greater than in fiscal year 1969. Of this total, cost of living increases account for $3.7 million. This amount, first prorated across all the subelements, was then adjusted between subelements to account for needs in specific areas of investigation. An additional amount, approximately $400,000, was requested to provide for important investigations in several areas, primarily in the largest subelements, general physics and atmospheric sciences. Areas of increased emphasis include:

GENERAL PHYSICS

***a.* Ultraviolet research. Additional support for an electron storage ring with a radiation intensity 10 times greater than any other facility will provide for use of this high energy device for studying the solid state properties of material surfaces and for calibrating ultraviolet detectors.**

***b.* Crystal growth. Integrated circuit technology is based upon the availability of very pure, reproducible crystals. Added effort will be devoted to investigations of improved methods and new materials for manmade crystals. Areas of particular interest are new materials capable of being grown for desired electronic detection and radiation hardness properties.**

ATMOSPHERIC SCIENCES

***a.* Solar eclipse—1970. Support is needed to take advantage of an opportunity to measure atmospheric and solar parameters within the United States during a solar eclipse. Ground-based and airborne measurements will be made including spectroscopic and atmospheric reaction rate observations.**

***b.* Data reduction. Added effort is required to obtain orbital density data from two very successful satellite experiments. This data is of direct interest to several Air Force satellites.**

COMPARISON WITH NATIONAL SCIENCE FOUNDATION PROGRAM

Mr. MAHON. How does the Defense Research Sciences Program request for fiscal year 1970 compare in dollars and in the number of universities and colleges which participate, with the program of the National Science Foundation? Who is qualified to speak in that area? Supply it for the record.

General PITTS. I can give that to you, sir.

The National Science Foundation has some 300 universities or colleges funded in that program at $250 million and the Air Force Office of Scientific Research provides for some 186 universities at $43.3 million.

FOUR BASIC PURPOSES OF DEFENSE RESEARCH SCIENCES

Mr. MAHON. In your statement on page 14 you list four basic purposes of the Defense Research Sciences effort. Can you assign a dollar value to each one of these objectives? How much of the $94.8 million do you expect to spend in each one of the four areas mentioned? Supply that for the record.

(The information follows:)

A dollar value cannot be assigned to each of the four basic objectives since each of the projects in the defense research sciences program contributes toward each of these objectives. A basic research project necessary to the Air Force, also provides, through necessary interface with the scientific community, an awareness of basic research done by others and a ready access to the scientific community. The "coupling" of the needs of technology and research is provided for by the interface between the Air Force research contract monitor and the project's principal investigator.

PRINCIPAL BENEFIT OF PROGRAM

Mr. MAHON. Is the principal benefit of this program probably reflected in your statement that "Through our research projects at universities we are achieving a more distant objective by contributing to the development of the next generation of scientists and engineers"?

Mr. HANSEN. I would say that isn't the principal benefit. It is a secondary benefit. The programs are selected on the basis of their relevance in terms of the subject content of the program. I think that this contributing to the development of the next generation is a very important secondary benefit, but we don't do it just for that. If they are not doing something which makes a worthwhile contribution to the program, we wouldn't sponsor them.

NUMBER OF PERSONNEL ADMINISTERING PROGRAM

Mr. MAHON. How many Air Force, military, and civilian personnel are engaged in the selection of colleges and universities for grants and contracts?

General MCNICKLE. There are 50 military and civilian personnel.

Mr. MAHON. Where is this actually performed?

General MCNICKLE. In Arlington, Va., in the Air Force Office of Scientific Research.

PROCEDURES FOLLOWED IN ALLOCATING FUNDS

Mr. MAHON. Supply for the record a statement setting out the procedures which are followed in the allocation of these funds.

(The information follows:)

PROCEDURES IN ALLOCATING FUNDS FOR UNIVERSITY GRANTS

The contract/grant program supported by the Air Force through the AFOSR is selected from unsolicited proposals. The funds are allocated to proposals in the physical sciences, engineering sciences, environmental sciences, and the life sciences based on the relevance to the Air Force mission, scientific merit, competence of the scientist, availability of funds. Selections are made by Air Force scientists, sometimes with assistance from independent evaluating groups of experts in a particular area.

IN-HOUSE VERSUS CONTRACTED RESEARCH

Mr. MAHON. What part of the Defense Research Sciences effort is in-house in the Air Force and what part is with colleges, universities and nonprofit organizations?

(The information follows:)

In fiscal year 1969, defense research sciences funds were allocated as follows: In-house, $31.0 million, 34 percent; colleges and universities, $43.3 million, 48 percent; nonprofit, $1.6 million, 2 percent.

MATERIALS RESEARCH PROGRAM

Mr. MAHON. You are requesting $2.6 million for "Materials research." Throughout the Defense budget there is a number of programs in the area of materials research.

PROGRAMS ORIENTED TOWARD SPECIFIC OBJECTIVES

Are your materials research programs oriented toward specific objectives? If they are, what are those objectives, please?

Mr. HANSEN. Our materials programs are each oriented toward a specific objective, such as providing a material which will have higher strength, or a material which will provide a given strength at lower weight, or a material which will provide a level of strength under serious environmental conditions like high heat flux.

Mr. MAHON. You can elaborate for the record.

(The information follows:)

The "Materials research" subelement under the "Defense research sciences" program element (P.E. 61102F), conducted partly by the Aerospace Research Laboratories and partly by the Air Force Materials Laboratory, is a basic research program which is concerned primarily with the investigation of the nature of the kind of materials in which the Air Force is interested. It is oriented toward broad classes of materials rather than toward specific materials or specific applications.

The objective of the Air Force Materials Laboratory's exploratory development program in materials (P.E. 62102F), on the other hand, is to develop new and improved materials for aerospace application, provide a central Air Force agency knowledgeable in all materials areas, and provide a quick reaction capability to solve operational problems involving materials technology application. Examples of the goals of this program are: Improved structural materials for use at temperatures from cryogenic (very low) to over 4,000° F.; materials resistant to combinations of conditions such as corrosion, erosion, stress, radiation and vibration; coatings to protect materials from severe environments; elastomeric (rubberlike) materials; and lubricants.

Perhaps the clearest example of the difference in the kind of work done under the two programs is the effort in polymer research and development. In the basic research program, effort is directed toward synthesizing new polymers which have desirable properties such as high temperature resistance and chemical stability. In the exploratory development program, effort is directed toward developing those polymers into elastomeric (rubberlike) materials, adhesives, lubricants, plastics, fibers, or other materials for application in aerospace systems.

Our advanced development programs, P.E. 63211F, "Aerospace structural materials," and P.E. 63425F, "Graphitic reentry materials" take the development a step further towards the application of a specific material or small group of materials to aerospace vehicles. In addition to the further development of the materials, these programs involve the design, fabrication, and test of representative systems components. The aerospace structural materials program is concerned with the development of high strength, very stiff composite materials of boron or graphite filament combined with plastic or metal and applying them to aircraft and engines. Under the graphitic reentry materials program, graphitic materials are being developed for use in nose tips and heat shields. These programs are conducted by the Air Force Materials Laboratory in close cooperation with the other laboratories and systems divisions concerned (e.g., AF Flight Dynamics Laboratory, AF Aero Propulsion Laboratory, Aeronautical Systems Division, Space and Missile Systems Office).

RECENT PROGRAM ACCOMPLISHMENTS

Mr. MAHON. Can you point out any recent use which has been made in Air Force weapons systems of information developed in this part of the materials research effort?

Mr. HANSEN. Yes. In the weight control programs on airplanes, such as the F–111. There is a wing section on the F–111 now fabricated out of new material that was fairly recently developed in the research program.

Mr. FLOOD. Are you doing any lighter-than-air research?

Mr. HANSEN. Not that I am aware of.

Dr. LEHMANN. We have a few balloons but that is just to get payloads up to high altitudes.

Mr. FLOOD. I mean the old dirigibles.

Mr. HANSEN. No, sir.

ATMOSPHERIC SCIENCES PROGRAM

Mr. MAHON. Can you give the committee some of the highlights of your atmospheric sciences program for which you are requesting $14.7 million?

Dr. LEHMANN. The composition of the atmosphere, the ionosphere, and the effects of the atmosphere upon things like optics, like radiation going through it, like electromagnetic propagation through it, like nuclear effects in the atmosphere. Those are the highlights of it, sir. I can elaborate on those and I can supply more for the record.

Mr. MAHON. You are speaking in rather broad terms. Can you zero in on more specific things or are you able to do that now?

Dr. LEHMANN. I could in some cases, sir.

Let's say for example one of our major operational problems is the problem of radar blackout if you have a nuclear detonation above the earth's atmosphere. What has happened here is that the nuclear radiation ionizes part of our atmosphere which then prevents radar from penetrating through that. It bounces the radar back.

Now, how long that radar blackout lasts depends upon, first of all, how much ionization the radiation produces, how long these ions last, how long it takes them to recombine, how they diffuse out. This is one example of the kind of thing that our Air Force Cambridge Research Lab in this environment works on.

Mr. MAHON. Essentially it means how many "ions" you have in the fire?

Dr. LEHMANN. Yes, sir.

REASON FOR COST INCREASE IN FISCAL YEAR 1970

Mr. MAHON. The fiscal year 1970 request is almost a $1 million increase above the current year. State for the record why the increase.

(The information follows:)

The Atmospheric Sciences subelement of the Defense Research Sciences program was funded at $13,858,000 in fiscal year 1969. The $970,000 additional requested for fiscal year 1970 includes approximately $565,000 to cover cost of living increases. The remaining funds are requested to provide for increased efforts in several important areas. these include:

(a) *Solar Eclipse 1970.*—An unusual opportunity to measure atmospheric and solar parameters during an eclipse will occur in March 1970. Since the path of totality will cross the southeastern United States a concerted effort will be made to obtain ground and aircraft measured solar and atmospheric data concerning solar processes and their effect on our environment.

(b) *Data Reduction.*—The results of three very successful experiments will require additional support to provide for the reduction and analysis of data. The OV 1-15 and OV 1-16 density satellite experiments were designed to determine the atmospheric density in regions of interest to USAF satellites, and the micrometeorological field experiment obtained data on the effects of the earth on the atmosphere and the processes therein. The results of these experiments are expected to provide basic information about our atmosphere.

BEHAVIORAL AND SOCIAL SCIENCES PROGRAM

Mr. MAHON. What is the basis for your request of an additional $608,000 in this behavioral and social sciences program? What efforts are identified with it? Who can tell us something about this? Is this some kind of program to keep somebody employed who wants to work in this field? Why the increase and what additional is going to be done with the increase? What have been some of the recent achievements in the beavioral and social sciences area as a result of your expenditures?

Dr. LEHMANN. With regard to the first question, sir, about two-thirds of the $608,000 was programed to go into additional work in the human performance area.

Now, by human performance I mean how does a pilot perform in his plane with the instruments he's got? How good is he at picking up targets on the ground? How well can he stand the heat and the confinement? How does he learn? How do we train him? How do we educate him? These are factors in human performance.

The other $200,000 was programed to go into the human interaction area. How do men work together? What makes an officer want to stay with the Air Force? How do I decide what tasks to assign a man? How do I prepare him for the possibility that he may be captured and interrogated? How do I give him some background on how prisoners of war are treated?

Mr. MAHON. May I interrupt to ask, do you maintain that these studies relate to practical and specific questions, such as you have been asking here?

Dr. LEHMANN. Yes, sir.

Now, sir; I should add that since the time the President's budget was submitted to you which reflected a $2.6 million level, our needs have been reviewed and we found that we had higher priority needs in other areas. It turns out to be in electronics and work with lasers. Consequently we now plan to spend only $2,200,000. I repeat that was because of higher priority requirements that we felt we had in the areas I mentioned.

EXAMPLES OF PROGRAM ACCOMPLISHMENTS

Now, I did not cite the kind of payoffs that we have, which is your second question. If I am too long winded on this, I can supply it for the record, or I can supply it here.

For example, we have done a simple little thing like putting a TV camera in a cockpit looking down on a pilot and his instruments so the TV camera sees what the pilot sees while he is going through pilot training. After he has gone through a maneuver he comes back on the ground and he gets instant replay. He sits down with his instructor and the instructor, in a calmer environment says, "Here is what you did. That was wrong. That was right."

That is one of the little things that has come out of this kind of program.

Another thing we are working on in this area, in our total effort on human performance, is the business of simulation. For example, the airlines are upgrading trained pilots for the 747 jumbo jet. They are only using something like 5 hours of actual flying time. All the rest of the time is in a simulator. We are planning similar things in undergraduate pilot training.

Mr. MAHON. Let me ask you to identify the particular study concerned with observing the behavior of a student pilot by means of a television camera.

Dr. LEHMANN. That was carried out by our human resources laboratory. I think that particular one happened to be an exploratory development program.

Mr. MAHON. Check that for the record, will you?

Dr. LEHMANN. All right, sir.

Mr. LIPSCOMB. Did that television camera above the pilot come out of the behavioral and social sciences program?

Dr. LEHMANN. It is part of our behavioral and social science effort in total. Whether it is the basic research or the applied research, I will have to check that for the record, sir.

(The information follows:)

This is part of the applied research. It started as part of the exploratory development program and then moved into the advanced development program as the feasibility and value of the approach was established.

Mr. LIPSCOMB. Do you have a list of the contracts that were awarded in fiscal year 1966 and fiscal year 1969, for behavioral and social sciences research?

Dr. LEHMANN. Yes, sir; I brought that along.

Mr. LIPSCOMB. Could we take a look at it, Mr. Chairman?

Mr. MAHON. Yes.

Dr. LEHMANN. Here is a complete listing as reported out by the Management Informatiion System of OAR.

Mr. LIPSCOMB. What is this?

Dr. LEHMANN. I must have given you the wrong one. I am sorry, here is the one I should have given you.

"STUDY OF COGNITIVE AND EFFECTIVE ATTITUDES" BY DR. HENRY TAJFEL

Mr. LIPSCOMB. Doctor, you could tell us what happens to this Air Force contract, EOAR-4-66, "Technical Monitors' Evaluation of Performance on Tajfel Grant." Do you know about this one?

Dr. LEHMANN. No, sir; I am afraid I do not.

Mr. LIPSCOMB. It involved a study grant done by a professor, a Dr. Tajfel.

Dr. LEHMANN. Where was he?

Mr. LIPSCOMB. He started at Oxford and went out to Stanford and then ended up in Brussels, I believe. The "Study of Cognitive and Effective Attitudes." That is an Air Force grant.

Dr. LEHMANN. I believe that one is terminated, but I can check it for the record.

Mr. LIPSCOMB. It was delivered November 4, 1968, less than 8 months ago, so it is rather new.

Dr. LEHMANN. A new grant?

Mr. LIPSCOMB. Maybe you can tell us what use was made of this study after you check the record. The findings say, "The findings described above point toward the need for further intense research into the development of national attitudes in children for reasons which are both theoretical and practical nature." I know it is unfair to pick out a contract like this on a study and try to have you evaluate it here, but for the record I would like to know what happened to this study, what use it is put to, and where it is now.

Mr. FLOOD. That sounds like pediatrics.

Dr. LEHMANN. Yes, sir; I think it is best to check that one out and supply it for the record.

(The information follows:)

BEHAVIORAL SCIENCE/AF CONTRACT EOAR-4-66/TAJFEL GRANT

MAJOR TAJFEL PUBLICATIONS SUPPORTED BY AFOSR GRANT EOAR-4-66

The results of these studies are included in the following publications: (1) A chapter entitled "The Formation of National Attitudes" published in Problems of Interdisciplinary Relationships in the Social Sciences, M. Sherif, editor.

(2) "Social and Cultural Factors in Perception." In Lindzey, G. and E. Aronson (eds.); Handbook of Social Psychology, 1967.

(3) "Cooperation Between Human Groups," Eugenics Review, 1960.

These publications are in the open scientific literature and the final summary report is available through the Defense Documentation Center (AD #678167).

Tajfel participation in Air Force meetings and other forms of consultation:

January 1967, Air Force supported conference on research needs for developing countries, Chicago, Ill.

Spent 6 months at the Institute for Advance Studies, Stanford University. While there he consulted with Dr. Howard Vollmer who was doing Air Force sponsored research on matters of organization and leadership.

What is the Air Force interest and use of this research?

The Air Force is interested in outstanding basic research in fields that give promise of improving Air Force performance in the future. The Tajfel research relates to other research programs being carried on in the United States that deal with the development of loyalty and identification with organizations. It is possible that research of this type may find ultimate application in the development of instruments for screening unreliable people from critical assignments. More immediately the work is applicable to programs aimed at the development of individual motivation and morale of military units. The results of this study will also contribute to a better understanding of the commitments of youth who form the manpower pool from which U.S. military men must be recruited.

Dr. Tajfel's publications are in the technical libraries at Air University and at the personnel research division (now part of the Human Resources Laboratory). They have contributed to the curriculum and research efforts of Air Force officers in training at the Air War College and the Air Command and Staff College.

Mr. LIPSCOMB. The evaluator of the study was Dr. Charles E. Hutchinson; maybe he is around?

Dr. LEHMANN. No; Dr. Hutchinson is on a 2-month leave.

Mr. LIPSCOMB. With a grant?

Dr. LEHMANN. No, sir; out on his own on annual leave.

Mr. FLOOD. He picked the right time to go.

Dr. LEHMANN. By the way, I am a physicist, and not a psychologist.

Mr. MAHON. We will stand adjourned until 10 a.m. tomorrow.

WEDNESDAY, *June 11, 1969.*

Mr. MAHON. The committee will resume its hearings with the Air Force. Mr. Sikes will again chair the committee for most of the morning, if not all the morning, as I have other commitments.

Mr. SIKES. Mr. Lipscomb.

"STUDY OF COGNITIVE AND EFFECTIVE ATTITUDES" BY DR. HENRY TAJFEL

Mr. LIPSCOMB. Mr. Chairman, we might start with the report on that one study we discussed yesterday and learn how they are using it.

Dr. LEHMANN. Yesterday you asked me to find out how the Air Force has used the study "Study of Cognitive and Effective Attitudes" by Dr. Henry Tajfel who at that time was at Oxford University. The contract was let in fiscal year 1966. The wording of the title is a little hard to understand. The subtitle I use in my mind now is "How do young people recognize and develop loyalty to their country?"

This work was started in 1966. The work was supposed to have been completed in 1968. Unfortunately the principal investigator, Dr. Tajfel, had two heart attacks. For that reason the contract was extended on a no-cost basis. The final report was submitted last year. I would simply like to report what kind of results come from Dr. Tajfel's work.

He published a chapter entitled "The Formation of National Attitudes," published in a book "Problems of Interdisciplinary Relationships in the Social Sciences."

He published a chapter on social and cultural factors and perception in the Handbook of Social Psychology in 1967. He published a book "Cooperation Between Human Groups" in the "Eugenics Review," which took part of the work that he had done.

In 1967 he participated in an Air Force conference on research needs for developing countries. While he was out at Stanford University, he consulted with Dr. Vollmer, who is an Air Force grantee at Stanford University working in matters of organization and leadership.

This, sir, is the report that I provide to you, as to what has come from this particular——

UNABLE TO IDENTIFY SPECIFIC USE MADE OF THE STUDY

Mr. LIPSCOMB. After the study was transmitted to the Air Force, then where was it distributed within the Air Force for the attention of those interested? What happened to the study?

Dr. LEHMANN. We do have the publications in the Defense Documentation Center where it is available to the public, in the technical libraries of the Air University, and in the Personnel Research Division of the Human Research Laboratory. I was unable to find any specific use that was made of this research.

I would point out that also in gathering some of the kinds of contributions that have come from research in this field, you frequently will find that the contributions today came from research of 10 years ago. This may or may not contribute to things in the future. It is in the libraries and it is with the Personnel Research Division of the Human Resources Lab.

NOT THE TYPE OF RESEARCH AIR FORCE SHOULD BE FUNDING

Mr. LIPSCOMB. Without being critical of this study or this man's work, is this the type of research that the Air Force should be putting their resources into?

Mr. HANSEN. I don't think so. Based on what I have heard, it seems to me that the relevance here is rather distant. I will certainly take steps in my tenure in this job to try to see to it that these are screened more severely so that we do not support things which have a relevance which is as obscure as this one is, as I understand it.

FEASIBILITY OF REQUESTING FUNDS AFTER UNSOLICITED PROPOSALS RECEIVED

Mr. LIPSCOMB. We have gone over this many times but for years the committee has been put in the position of picking out a title and looking into it as one of the bad examples of the spending of military resources for studies that really don't have any relevance to the military. These are unsolicited proposals that come before you for evaluation.

When the services come to the committee for funds, they usually come with a program that isn't in existence. They don't even know what they are going to use the funds for. Why wouldn't it be practical to take your unsolicted proposals and bring them to the committee when you come up to justify your request and get your funds on that basis? Why couldn't we do it that way? In other words, develop the program and then come to us for the funds?

Mr. HANSEN. I believe I am correct in saying that we don't have in our hands today all of the unsolicited proposals that we would screen to determine what we would spend the fiscal year 1970 money on. We

have to say to you, "We want this money to do these sorts of things, of which the past is the only example we have, but the past, based on examples like this, is one that we would expect to improve on."

Mr. LIPSCOMB. Build up your proposals for a year and then bring in the program.

Mr. HANSEN. My offhand impression is that it seems it would take away a lot of the flexibility if these had to be organized to the point where we bring them here and say, "These specifically are the things that we want to do, and we wouldn't change that."

This transfers the decision point for these research studies from our Office of Scientific Research to the Congress.

Mr. LIPSCOMB. Not at all. You will then come to us with a program instead of just a request for funds.

As it is now when you give us something to look at, it almost doesn't mean a thing because too often you don't necessarily go ahead with the program as submitted. It is merely illustrative.

Mr. HANSEN. Are you saying to support the request for fiscal 1970 we should be saying we want to continue the studies in given areas and that we have as our candidates at the moment new studies with the following titles; in addition then we want some ∞ percent, unspecified, to allow for consideration of things that would come in during the year—something of that general nature, is that what you are saying?

Mr. LIPSCOMB. I am looking for a better way to apply the limited resources that we have available for studies in basic research. If you keep expending them in studies which do not produce reports which realistically assist the Air Force to accomplish its mission, if it is say only an unrelated social study that can be made any place else in the Government, well then you are going to keep getting cut in your funding program.

It is not only the Air Force. This applies all across the board in military research. I think it is nonproductive for us each year to keep pointing up the type of study that was just explained here.

OTHER STUDIES OF QUESTIONABLE VALUE

I have another one here entitled "Political Functions of the Military in the Middle East and North Africa."

Some other agency perhaps, but I can't account for the Air Force making such a study.

I could go through the book given us yesterday and ask questions on such studies as "Persuasive communication and functional organization," "Stimulation studies of communication behavior under stress," "Criteria for design of new forms of organization," "Desire for group achievement, origin and effect."

Do you see what I mean? It is wrong to go through and just pick out titles. "Behavior norms, Japanese and American youth." You just don't have that kind of resources either available to you or personnel who can analyze the studies.

Here is a report submitted today that just went into the file. I just think you ought to make better use of your resources.

Mr. HANSEN. I certainly would agree with that.

As you read those titles, it certainly seems to me that it is possible for there to be significant relevance in some of those subjects.

Mr. LIPSCOMB. Pardon?

Mr. HANSEN. I say, as you read the list of titles it seems to me it is very possible for there to be significant relevance under some of those subjects. I think it is our job to try to push in the direction of that, but research, by its very nature, has to be at least loosely structured. Perhaps three-quarters of it doesn't really come up with much, but the other quarter of it is valuable enough to justify the whole program. If we knew in advance what the least productive three-quarters was, it could be cut out before initiation. However, we don't really know this. Sometimes unlikely titles turn out to be research that has significant value.

I agree with you that it is possible to screen these areas of work harder, and that we should do this.

Mr. LIPSCOMB. Over all the years that we have asked questions on these studies, we were always able to come up with the ones that have just been put in the file and not used.

Mr. HANSEN. I certainly agree that that is bad.

Mr. LIPSCOMB. You can go back and—Doctor, you can check the record and see what we have pulled out. This gets to be an expensive exercise in futility.

Dr. LEHMANN. Are you interested in those which did not go in the files and were used?

NEED TO STOP WASTE AND INEFFICIENCY IN RESEARCH STUDIES

Mr. LIPSCOMB. Those are the ones we are buying. What we are trying to do is stop waste and inefficiency in the Air Force.

Dr. LEHMANN. Yes, sir; but like the library situation, sir, you don't know which books you are not going to use, but those that you do have to use are essential.

Mr. SIKES. You should be able to screen those that you are not likely to use.

Dr. LEHMANN. Yes, sir; we are screening more carefully, and there have been policy changes so that most of these areas dealing with foreign cultural affairs are being terminated and phased out.

TERMINATING BEHAVIORAL SCIENCES STUDIES IN FOREIGN COUNTRIES

Mr. LIPSCOMB. Is the Air Force doing the same as ARPA in this regard, canceling out all behavioral sciences done overseas?

Dr. LEHMANN. From the information I have, sir, that would appear to be the case.

Mr. LIPSCOMB. Are you going to take the same position in that regard as ARPA?

Dr. LEHMANN. From the information I have on the contracts to be terminated, it would appear that is the case.

Mr. HANSEN. I guess we are not that familiar with what ARPA is doing.

Mr. LIPSCOMB. ARPA is going to announce to this committee that they are no longer going to contract for any overseas behavioral science research.

TOO MANY IRRELEVANT STUDIES IN PAST YEARS

General McNICKLE. I am now the approval authority for the Air Force studies you are talking about. I have not approved any and don't intend to approve any Air Force sponsored behavioral science research to be done overseas.

I agree with you that too many of these studies have not been relevant in the past, I do propose, though, that a lot of our problems have been with the use of nondescriptive titles. But I also intend to cut down the amount of money used for those that seem less relevant. I would like to propose that we can work out something with the committee in some way of satisfying your needs.

Mr. SIKES. Follow that up with the committee staff and let's see what can be arrived at.

ENVIRONMENTAL STUDIES

Under exploratory development, you are asking for $11 million for environmental studies. This is an increase above the $10,450,000 programed for fiscal year 1969, and the $9,566,000 in 1968. Why must there be any increase in this area?

General McNICKLE. Mr. Chairman, it is primarily a cost-of-living increase, but we also have some new projects.

ENVIRONMENTAL PROGRAM STUDY PROJECTS FOR FISCAL YEAR 1070

Mr. SIKES. Spell those out for the record and also for the record tell us how many individual contracts or grants are involved in this environmental study program.

Each of the projects appears to have been funded in all 3 fiscal years. Does this mean that you don't complete any projects in this area?

Mr. HANSEN. That is not true. I think we have to distinguish between projects and tasks within projects. In general, a project is an area of interest within which specific tasks are accomplished, and as one task is completed, another would be started. The total of the project is generally more than a 3-year project, but the tasks within are less. I have a list here of examples of tasks which would be completed in the fiscal year 1970 and the tasks to be started.

Mr. SIKES. Submit that for the record.

(The information follows:)

TASKS IN THE ENVIRONMENT PROGRAM TO BE COMPLETED IN FISCAL YEAR 1970

Title	Project	Task
Advanced aircraft atmospheric sensing techniques	6020	04
Airborne gravity meter and gravity instrumentation research	7600	05
Theoretical electromagnetic studies	7601	01
Temporal electromagnetic studies	7601	02
Electromagnetic rocket observations	7601	03
Electromagnetic satellite observations	7601	04
Numerical analysis (dynamic aspects of the geomagnetic field)	7601	05
Instrumentation (to measure magnetic fields)	7601	06
Solar winds studies	7601	07
Albedo measurements	7621	05
Upper atmosphere dynamics and structure	7635	06
Statistical techniques (atmospheric circulation)	8628	04
AFCRL observatory program	8668	03

TASKS WHICH WILL BE STARTED IN FISCAL YEAR 1970

Dynamical properties of the magnetosphere	7601	08
Ionospheric electrical and magnetic studies	7601	09
Magnetospheric electrical and magnetic studies	7601	10
Characteristics of seismic sources	7639	01
Site location	7639	09

Mr. SIKES. How much of the $11 million requested will be spent in Air Force facilities?

Mr. HANSEN. None of that. That all goes out in contracts.

Mr. SIKES. How did the amount requested in fiscal year 1969 for "environment" compare with the amount actually programed in fiscal year 1969?

General PITTS. $12 million was requested, Mr. Chairman, and $10,450,000 was programed.

IMPACT OF MOL CANCELLATION

Mr. DAVIS. Part of this work, as I understand it, has been related to MOL, so I assume that since the decision was made to cancel MOL, there will be a revision of this program?

Mr. HANSEN. To the extent it is directly coupled to MOL, that would have to be true: yes, sir.

Mr. DAVIS. In the analysis that we can anticipate, will those reductions be specifically pinpointed so we can relate those individual items to the MOL program?

Mr. HANSEN. Yes. I think any place where we have an item in here which is directly and exclusively in support of MOL it has got to go. We haven't really had a chance to dig through here and altogether analyze this—in fact, we haven't even had a chance to start that analysis yet.

Mr. SIKES. Has anyone undertaken an intensive review of this entire area?

General MCNICKLE. The MOL project office has started working with the contractors to work out the cancellation effort and identify all the bits and pieces that are supported. However, I believe that most, if not all, of the activity specifically for the MOL was funded out of the MOL account.

Mr. SIKES. What about items that are direct MOL line items? Is there a review constantly in process or periodically in process on those?

General McNICKLE. Those items that are affected by the cancellation, no matter where they are, will be identified.

MATERIALS RESEARCH

Mr. SIKES. Under "Materials" you are requesting $25,787,000 for exploratory development in materials. This compares with $23.6 million in fiscal year 1969, and $20.1 million in fiscal year 1968. Why is this subject area continually increasing in cost? This is obviously more than an inflationary increase.

General McNICKLE. That is an effort to recover some of the drastic cut which was made in the fiscal year 1968 program. Actually, it was reduced to $20.1 million from $26.1 in 1966, and $25.1 in 1967, so there was a deep valley in there which hurt our programs.

Mr. SIKES. What programs did it hurt?

General McNICKLE. Several important areas were scaled back and, in our estimation, too much. Nondestructive tests, coating for materials, and refractory metals were eliminated or reduced to a level that we thought was too low.

Mr. SIKES. I would be glad to have you provide for the record some additional support.

General McNICKLE. We would be happy to do so, Mr. Chairman.

Mr. SIKES. I don't think you have given us much assurance of need. You say you are trying to recoup reductions, but that is not a justification of need. Add whatever you want.

General McNICKLE. We will.

(The information follows:)

The increase in the funding for the materials exploratory development program in fiscal year 1970 is required for the following reasons.

In general, the cost of research and development increases by about 6 percent per year due to higher costs for services, supplies, and equipment.

Specifically, because of previous funding reductions, certain important efforts which could not be accomplished and which are urgently needed for our future defense posture are now being implemented. Examples are: development of improved slurry silicide coatings for columbium sheet for aircraft gas turbine applications; advanced stability characterization of coated refractory alloys for reusable reentry vehicle applications; improved reinforced plastic backing for ceramic faced armor; jet engine compressor blade erosion resistant coatings development; development of methods and procedures to determine the degree of fire resistance of fluids and lubricants in support of the Air Force survivability and reliability requirements for aircraft; characterization of available insulations for lifting reentry vehicle use; development of improved graphite for reentry vehicle use through new material and processing approaches; critical evaluation of methods for the prevention of catastropic failure of materials in aerospace systems; advanced lightweight armor for combat aircraft; development of radar absorbing materials for use at temperatures up to 2,000° F., development of single crystals of rare earth transition element intermetallic compounds for improved permanent magnet materials; fabrication and testing of molded aircraft plastic drop tanks for A-7 aircraft; and generation of design data for new structural materials. It is especially urgent that effort on design data acquisition be increased because the availability of adequate design data is a determining factor in the early application of new and improved materials to areospace systems.

Finally, materials technology becomes increasingly complex as systems requirements become more demanding and as the relatively easy problems get solved. The more difficult problems cost more to solve, not only because they require more effort, but also because they require both the development and use of increasingly more sophisticated, and therefore, more expensive equipment and instrumentation.

AIR FORCE MATERIALS LABORATORY

Mr. SIKES. What is the justification for the increase from $6.6 to $7.3 million for the Air Force Materials Laboratory operation?

Mr. HANSEN. That effort is all in-house, so it is strictly an increase in the salaries and fringe benefits for the people, plus the cost of the material and supplies that they need to operate at the same level.

NUMBER OF MATERIALS RESEARCH CONTRACTS

Mr. SIKES. How many individual contracts or grants were involved in the materials effort under "Exploratory development"?

Mr. HANSEN. We don't use grants in this area. There are approximately 440 contracts.

Mr. SIKES. What part of this effort is done with industry, what part with nonprofit organizations, and what part with colleges and universities?

Mr. HANSEN. The majority are with industry. Would you like the exact numbers?

MATERIALS RESEARCH CONTRACTORS

Mr. SIKES. You can provide for the record the exact number in each category.

(The information follows:)

Of the 440 contracts in the materials exploratory development, 275 are with industry, 100 are with not-for-profit institutions, and 65 are with universities.

NEW MATERIALS DEVELOPED FOR AIRCRAFT STRUCTURES

Mr. SIKES. In the statement which was presented you said that structural parts are being designed, fabricated, and tested from new materials developed in this program. Is the cost of designing, fabricating and testing the structural parts mentioned included in the project or under various weapons systems projects?

Mr. HANSEN. As I understand your question, it is really both places. The materials research brings the materials up to the point where the design data is available so that within a specific project they can then pick it up at that point and develop the fabrication of particular parts or usages for that program.

Mr. SIKES. So that it could be both, or either?

Mr. HANSEN. Yes, sir; that is right. If you had the case where you were just doing work on a material to get it ready for a class of applications but nothing specific, it would be in research; if the research were completed and you were just kind of picking it out of a handbook for a specific application, it would be in the program. If it were somewhere in between, it would be in both areas.

Mr. SIKES. There have been specific instances recently of fairly major structural parts of aircraft being fabricated from new materials. List those for the record and indicate from what source the funding of this work was done. I think it was done primarily from a line item for that particular aircraft.

Mr. HANSEN. One particular example would be the experimental boron fiber reinforced composite wing sections which were designed, fabricated, and installed on some F–111's as part of the aerospace

structural materials advanced development program. That is the only example like that that I can think of offhand.

Mr. SIKES. Has there been one on beryllium also?

Mr. HANSEN. In connection with the C–5A programs, I could refer that question to Mr. Jones of my staff.

Mr. JONES. There have been programs of this nature which would develop or do develop not only the application of new materials to aircraft structures, but also the fabrication techniques to put them into composite, complex structures within the airframes. The boron fibers is one example, on the F–111. We have parts on the C–5 and parts on aircraft engines made up in that program.

The beryllium program was another example in which the Government did fund the fabrication of parts and also fabrication techniques for some engine parts, for some aircraft parts, and actually have flown some tail sections in F–4's which were beryllium.

PARTICIPATION OF CONTRACTORS IN NEW MATERIALS TESTING

Mr. SIKES. This has been touched on to some extent, but I want to be more specific: To what extent do airframe manufacturers and jet engine manufacturers design, fabricate and test various structural parts made of new materials as a part of new aircraft development programs?

Mr. HANSEN. They would have to do whatever was required to carry out their program and would hope that the necessary fundamental work had already been done so they could pick it up and take it from there. If the fundamental work hadn't been done it would have to be included as part of this program and then airframe and engine manufacturers would adapt it to their particular problems and requirements.

Mr. SIKES. What would be the situation if an aircraft manufacturer had available the benefit of the Government research on new materials but elected to conduct his own research, either because he didn't have confidence in the Government's research, or because he wanted to make a profit on the cost of his operation in this field?

I understand that has happened.

Mr. HANSEN. Is your question related to what would happen in relationship to the allowability——

Mr. SIKES. What is the Government's attitude in a case of that kind? Do you attempt to put your foot down and tell him to take advantage of what the Government has already done in order to save the Government that amount of money, or do you let him repeat the test in his own shop and collect from the Government for the duplication of research which has already been done by the Government?

Mr. HANSEN. I am sure that as a principle we would try to prevent his unnecessarily duplicating something that had already been done. If he were to be able to make a case for the fact that previous test results were not adequate for his particular problem, and that they needed to be repeated under different circumstances or conditions, we would approve that.

When we have a large program package, where he is going to do certain work that is rather broadly stated, but is necessary to achieve an objective which is specifically stated, then I think we have got to

allow him some latitude for his judgment in how he has to solve the problem which is specifically stated.

GOVERNMENT'S RIGHT IN CONTRACTOR-DEVELOPED NEW MATERIALS

Mr. SIKES. Would an aircraft manufacturer, as an example, who obtained an Air Force exploratory development contract relating to a promising new material, have a considerable head start on his competitors if the new material is successfully developed? In other words, what rights does the Government have to materials technology developed under this program? Is the technology available to all competitors on a new aircraft?

Mr. HANSEN. There are several questions there.

Would he have an advantage? I would say that he would have a temporary advantage.

Mr. SIKES. That is understandable. What rights does the Government have to materials technology which a contractor develops under this program?

Mr. HANSEN. The Government has full rights to the technology and that technology is made available to his competitors through reports and other data. However, he would have the right to commercial usage, but not any exclusive right for military or Government contract uses.

CONTRACTOR SHARING OF NEW MATERIALS DEVELOPMENT COST

Mr. SIKES. Does the Government pay 100 percent of the cost of exploratory development efforts or is it required that Air Force funds be matched with company funds when contracts are given in this area?

General MCNICKLE. There are times when the contractor will put up some money if he wants to expedite the program, but the usual policy is we should pay for work which we ask the contractor to do.

Mr. HANSEN. I think the reason behind that is the fact that presumably we have hired the work done because we need the product. The greatest control to assure that the work gets done in accordance with the Government requirements to provide the desired product is to pay for it. If there is a cost-sharing, we have to depend on his good graces to come across with the part of it which he is paying for because he is under no contractual obligation to do that.

AVERAGE LENGTH OF MATERIALS RESEARCH CONTRACTS

Mr. SIKES. In what periods of time does the Government normally contract with an organization in the area of exploratory development on materials?

Mr. HANSEN. These contracts vary in length. I think if you were to take an average period of time, based on the contracts where I have been on the receiving end rather than on the giving end, it runs around 1 to 2 years. I think some of them are quick jobs that support a particular problem and might be as short as 2 or 3 months. Some run as long as 3 or 4 years.

General McNickle says there is a 2-year average.

CONTRACTORS FOR AEROSPACE LUBRICANTS RESEARCH

Mr. SIKES. With what organizations do you contract in the area of aerospace lubricants?

General MCNICKLE. This is not normally done with oil companies. They are chemical companies and universities. I have a list of them if you want it.

(The information follows:)

The contractors for work in aerospace lubricants are: Midwest Research Institute, Kansas City, Mo.; MMM Corp., Minneapolis, Minn.; General Electric Co., Valley Forge, Pa.; Rennselaer Polytechnic Institute, Troy, N.Y.; American Oil Co., Whiting, Ind.; Penn State University, State College, Pa.; Phoenix Chemical Co., Chicago, Ill.; University of Dayton, Dayton, Ohio.

RESEARCH COORDINATION BY AIR FORCE MATERIALS LABORATORY

Mr. DAVIS. In your justifications you refer to coordination maintained at laboratory level on research in metallic materials. By "laboratory level," do you mean the Air Force Materials Laboratory or the individual laboratories in which the work is carried out?

Mr. HANSEN. We mean the Air Force Materials Laboratory. We set them up as the custodian of excellence and knowledge in the particular field and then depend on them to tie this together.

Mr. DAVIS. Are they the mangement agent for not only all three branches of the military service, but also for the Atomic Energy Commission and NASA in this field of research?

Mr. HANSEN. No, they are not the mangement agency, but we charge them with the responsibility to be cognizant of all national developments. I just got through reviewing a report of the program plan for one of the laboratories in the Air Force. One of the things we ask them to do is show in each fairly specific area in which they operate all of the money that is being spent in that area nationally by the three services, the AEC, and NASA. We also ask them to make an estimate of the industrial research and development funds that are being spent in that area.

Also, there is a section of their plan in which they tell us the specific meetings they have attended, trips they have made and things they have done to coordinate and be cognizant of the activities in those other areas.

So, while they don't have an authoritative, or management responsibility, they are required as part of the justification of their program, to demonstrate their cognizance of all of these efforts, and the analysis by which they have assured that their effort fits in with everything else in a nonduplicative fashion.

Mr. DAVIS. Are you referring to the Air Force Materials Laboratory at Wright-Patterson when you refer to the laboratory?

Mr. HANSEN. No, sir. The specific example that I was just discussing was the Air Force Flight Dynamics Laboratory, but that is just because that is fresh in my mind. I reviewed it a couple of days ago but a similar procedure exists for the materials laboratory.

Materials research work is done in a very large number of places around the country. Each major industrial organization has some sort of materials function.

Mr. DAVIS. My question related to research in metallic materials. You have indicated that we have work in this area done not only by the armed services, but by NASA and by the Atomic Energy Commission. Then you state that the project is managed by the Air Force Materials Laboratory at Wright-Patterson. Now, when you use that term "is managed," that means managed for not only the Defense Department, but for NASA and Atomic Energy?

Mr. HANSEN. In the budget book on page 19 where it speaks of the management of the program by the Air Force Materials Laboratory, this means the management of the Air Force effort for the Air Force. This is not management in a national sense for all agencies. This strictly refers to the Air Force, but as part of managing the overall materials program for the Air Force, we charge these people with the responsibility to have cognizance of what else is going on and a program plan which will not overlap with others.

Mr. DAVIS. There is similar language on page 25 that I happen to be looking at, but it seems to be quite similar language relating to metallic materials specifically.

Mr. HANSEN. Here again, the same explanation applies, that they are the manager of the project described by this program element for the Air Force. There are, however, some areas where DOD has assigned overall management to one service. For instance, the ABRES program is a triservice effort assigned to the Air Force. As another example, we mentioned yesterday the food program assigned to the Army for all three services.

This is not in that category. Each of the services to the extent required has its own materials function, with a very strong effort to coordinate so there is not duplication.

Mr. DAVIS. That is the thing I was getting at and I am not sure I have made myself clear.

It states that coordination is maintained "at laboratory level." Now, that specifically refers to the Air Force Materials Laboratory at Wright-Patterson, not to the individual laboratory in which work might be done on research in metallic materials.

Mr. HANSEN. That is my understanding.

Mr. JONES. If I could respond to that, sir, coordination at the laboratory level is intended to mean that the Air Force Materials Laboratory at Wright-Patterson will coordinate, on technical committees, with the NASA laboratories, with the AEC laboratories, and with the other service laboratories who are doing similar work. There is a requirement on the part of the Secretary, before he will authorize a research program, that it be certified that there has been, through technical committee coordination, a collaborative review, to insure no duplication.

The coordination is between Air Force laboratory—in this case, the Air Force Materials Laboratory—and the other governmental agency laboratories at the technical laboratory level.

Mr. DAVIS. But there has been no designation then of the Air Force Materials Laboratory as the managing agent for the Government as a whole in the field of metallic research?

Mr. JONES. No, sir.

Mr. DAVIS. That is all, Mr. Chairman. Thank you.

ALUMINUM OXIDE RESEARCH

Mr. LIPSCOMB. On page 23 of the justification book it speaks of aluminum oxide. Is there anyone who can explain the value of aluminum oxide and what was gained and accomplished in this program? Or you can do it for the record.

Dr. LEHMANN. Yes, sir. Aluminum oxide is Al_2O_3. It is commonly called sapphire, or if it is pink, ruby. It is next in hardness to diamond—very hard, strong, and brittle. You can make single crystals of this and grow them. You can then take these fibers of aluminum oxide and imbed them in aluminum. If you do that, you get the higher strength of the aluminum oxide in the direction of the fibers. It is like fiberglass. In fiberglass you get the high strength of the glass fibers themselves in the direction you desire and then it is bound together by the matrix, say a polyester resin. The aluminum oxide crystal has very high strength and when imbedded in the aluminum metal matrix you get a stronger material than plain aluminum for a given weight. This has potential application at higher temperatures, for aluminum oxide is a high-temperature material. So you have then the possibility of its use in turbojet compressor blades or other applications where you want light weight, high strength, and good temperature performance.

Mr. LIPSCOMB. Can you give some other examples of its use? Is it for aircraft? Space?

Dr. LEHMANN. Yes. It has use in aircraft where there is high temperature performance or light weight. I cited the compressor blades of the turbojet engine. There is also a possibility of use in structural materials where there is high temperature. The aluminum oxide by itself is an insulator and can be used in radomes and antenna windows.

Mr. LIPSCOMB. Is this a process and a use that is generally known throughout the industry?

Dr. LEHMANN. The use of reinforced materials, such as fiberglass, is generally known. The process for making continuous, single crystal aluminum oxide filaments is new.

Mr. LIPSCOMB. Was it developed by the Air Force?

Dr. LEHMANN. Yes, the work was originally done by the Air Force on contract. This research has involved the development of improved techniques to get crystals with greater strength and greater uniformity. The research that is going on now is primarily in processes used to produce the aluminum oxide and in the kind of treatment given to the aluminum oxide so that it is wet by aluminum.

The fundamental material properties have been well known for many years.

Mr. LIPSCOMB. Has any of the research in aluminum oxide been classified? Is it of a classified nature?

Dr. LEHMANN. There are some classified applications, I believe. Aluminum oxide is also used for laser materials. The ruby laser is aluminum oxide.

Mr. LIPSCOMB. For the record, could you give a list of the classified uses of aluminum oxide?

Dr. LEHMANN. A list of the classified uses?

Mr. LIPSCOMB. Or what uses of Aluminum oxide is under consideration.

Dr. LEHMANN. All right, sir.

(The information follows:)

Aluminum oxide in various forms is used in military devices or materials applications for which the performance or the use of the device or material is classified.

In general, the physical and chemical properties and the materials technology of the aluminum oxide itself are not classified. However, the materials behavior under certain operational environmental conditions may be classified.

Examples of classified uses are:

LASERS. Aluminum oxide (as ruby) is used as the laser material in some laser devices. The purpose and performance of some of the devices are classified.

ARMOR MATERIALS. Aluminum oxide, either opaque or transparent, is used as the facing (hard) material in composite armor materials consisting of a hard facing, a softer, shock absorbing material, usually a plastic, and a backing material such as a glass fiber reinforced plastic. The ballistic performance of such composite materials is classified.

VACUUM TUBES. The specific application of aluminum oxide within these devices is classified.

MICROELECTRONIC DEVICES. Aluminum oxide is one of the standard substrate materials for microelectronic circuits. Some microelectronic devices are classified because of their use and performance, but not because they contain aluminum oxide.

NOSE TIPS. As a ceramic material, aluminum oxide can be used in nose tips for reentry vehicles. Its performance under the operational environmental conditions may be classified, depending on the classification of the system in which it is used.

OTHER USES OF ALUMINUM OXIDE

Mr. MINSHALL. Before we get too far away from the aluminum oxide discussion, I would like to ask Dr. Lehmann a question.

Dr. Lehmann, you mentioned classified uses of aluminum oxide. Could you give us a better feel for that?

Dr. LEHMANN. I didn't mention classified uses. Mr. Lipscomb asked are there classified uses, and I believe that there are.

Mr. MINSHALL. You don't know them off the top of your head though?

Dr. LEHMANN. I don't think of anything specific.

Mr. MINSHALL. What use would the Soviet Union be making of aluminum oxide?

Dr. LEHMANN. The same kind of uses we could, sir. First, higher performance and higher strength material; second the lasers, and third, ceramic coatings for materials.

Mr. MINSHALL. It could be used for both civilian and military?

Dr. LEHMANN. Yes, sir. Its greatest attractiveness is for military use, because in the military use you typically want to engineer the most performance into a material and engineer all the weight out. In a civilian application, you are usually not that critical and you can add plenty of weight in so you don't have to go to the high-performance materials; you can use lower cost, heavier material.

Mr. MINSHALL. You mentioned two military uses, radomes and reentry vehicle antenna windows. What other uses are there for these materials?

Dr. LEHMANN. I cited compressor blades in turbojet engines.

Mr. MINSHALL. Some of those can be supplied for the record. What other military uses might be included?

Dr. LEHMANN. The high-temperature aspects of reentry vehicles could also be included.

We will supply the information for the record.

(The information follows:)

The continuous filaments of single crystal aluminum oxide newly developed by the Air Force Materials Laboratory are as strong and stiff as high-strength, high-stiffness boron and graphite filaments used in the advanced composites being developed and applied under the advanced development program on aerospace structural materials. They, therefore, have essentially the same potential for use in lightweight aircraft and engine structural components. In addition, because of their dielectric properties, they can be used as radome and antenna window materials. Further composite development and low-cost process development are needed.

Aluminum oxide in another form is a ceramic with potential use in high-temperature applications such as nose tips. It is also useful in either opaque or transparent form as an armor material.

It has some application in vacuum tubes. It is used as a substrate material in microelectronic devices.

In the form of ruby, it is used as a laser material.

As sapphire it is used in jewel bearings.

Less pure grades of aluminum oxide, of course, are widely used in cement and in abrasives. The largest use is as the raw material for the production of aluminum metal.

PRELIMINARY DESIGN/DEVELOPMENT PLANNING

Mr. SIKES. Referring to preliminary design/development planning, why was the "studies and analyses" program changed to "preliminary design/development planning?

Mr. HANSEN. We felt the preliminary design/development planning was a little more descriptive of what is actually done and pins it down a little bit more.

Mr. SIKES. What part of the effort in this area was accomplished by the Air Force in-house?

Mr. HANSEN. None of it. This line item is all contract work. There is supporting in-house work done but this item covers work to be contracted.

STUDIES PLANNED FOR FISCAL YEAR 1970

Mr. SIKES. What are some of the major plans or designs or studies or analyses which are planned for fiscal year 1970? You apparently use various terms.

Mr. HANSEN. Shall I read the titles of some of them?

Mr. SIKES. Provide them for the record.

(The information follows:)

The following is a tentative list of efforts that will be supported by this program element. This program element is purposely designed to be flexible in order to rapidly adjust to changing priorities.

Analytic and computational support for strategic and tactical weapons system development; antiaircraft artillery effectiveness analysis; analysis of weapon delivery systems; precision pointing and tracking from aircraft; preliminary design for post boost vehicle; application of extended range nuclear aircraft; preliminary design of imagery transmission systems for strategic use; study of improved electronic warfare capability; tactical command and control capability; and design criteria for technical facilities and test support.

MISSION ANALYSIS FOR SPECIAL AIR WARFARE

Mr. SIKES. In the justifications, you refer to mission analysis for special air warfare as a part of the fiscal year 1970 planned program. What does this involve?

Mr. HANSEN. Let me give you a specific example planned for fiscal year 1970. It is called missile and space defense of the United States. This is a study that would be done partly in-house and partly supported by contracts and it involves the formulation of a concept which involves the capability of the 949 satellite system to both detect missile launches off the launch pad, and forecast their trajectory and combine those data with long wavelength infrared (LWIR) midcourse tracking. For long range potential we can consider the possibility of something like a laser beam disabling device for a system concept which could track a ballistic missile from a space-based defense system and kill it over the country it was launched from instead of waiting to kill it at the terminal end.

This is an example. This is a very imaginary concept and it is probably fairly far out, but it is the sort of thing we should be thinking about in order to make sure that the things we are developing would be suitable building blocks for such a system.

Mr. SIKES. Let me see if I understand your answer. Are you saying that this visualizes the possible use of aircraft against space vehicles?

Mr. HANSEN. ———.

Mr. SIKES. Who will perform this effort?

Mr. HANSEN. This is an in-house guided effort which would be supported by specific studies by various contractors. I cannot say which contractors they have in mind to bring into it, but it would be contractor-supported studies guided by an in-house study.

General BOYLAN. Mr. Chairman, with specific reference to your——

Mr. SIKES. I am talking about "Mission analysis for special air warfare." Is that what you are talking about?

Mr. HANSEN. No. I am talking about one titled "Missile and space defense of the United States."

General BOYLAN. The Secretary has given you an example of mission analysis in the area of space missile defense.

In the special air warfare mission analysis, as you will recall, the Air Force initially developed special air warfare capabilities in the early sixties. This was a relatively minor effort; at that time we called it COIN or counterinsurgency. Shortly after that, with the advent of the U.S. involvement in Vietnam, we found it necessary to apply airpower at the lowest end of the spectrum of sophistication.

Since 1964 various weapons systems have been committed to Vietnam in special air warfare activities.

This mission analysis will examine the experience we have gained over the last 5 or 6 years, identify those elements that have indicated the greatest efficiency and economy, and through this process pin down promising concepts that the Air Force should exploit in planning for future special air warfare forces. As the Secretary indicated, this analysis will be in-house with some contractor support.

Mr. SIKES. Who will perform the work?

General BOYLAN. It is my understanding that the effort will be in-house with possibly some support in certain areas by contract. I am uncertain of that last point and may I correct the record?

Mr. HANSEN. General Pitts has a list of the people that will support that study.

General PITTS. General Boylan is right. It is in-house primarily, supplemented with contracts with electronic and aircraft firms, Bell Aerospace Systems, Kaywood Schiller in Chicago, our Federal contract research centers, some universities, and research consultant organizations.

PRELIMINARY DESIGN FOR A TANKER

Mr. SIKES. One of the items listed in your statement under this heading is, "Preliminary design for a tanker." Is the Air Force considering the development and procurement of a new tanker aircraft?

General MCNICKLE. This is a study to determine which would be the best way to go if a new tanker should be needed. One consideration was the possibility of using a C–5, or another larger cargo type of airplane. The study is in process now and it is for a tanker sometime in the future.

This relates to the KC–135 and it is not an immediate problem.

General BOYLAN. As you know, the average age of the tanker is just under 9 years at the present time.

Mr. SIKES. Is it contemplated you will be able to install fuel tanks, et cetera, in existing off-the-shelf aircraft?

General MCNICKLE. That is one of the possibilities, using a C–5 with a tank.

PRELIMINARY DESIGN FOR AN ADVANCED INTERCEPTOR

Mr. SIKES. How much money is involved and who will be the contractors in the proposed study of a preliminary design for an advanced interceptor.

General MCNICKLE. There is $200,000 to support this. It is to look at those tasks that would have to be addressed no matter what kind of advanced interceptor we might have. North American-Rockwell and Hughes are involved in the avionics and fire control.

Mr. SIKES. What do you expect to accomplish with this study?

General MCNICKLE. We hope to keep our advanced interceptor concepts up to date and compatible with available technology so whenever a decision is made for an advanced interceptor we will have fresh data and can go ahead.

ADVANTAGE TO AEROSPACE CONTRACTORS CONDUCTING SUCH STUDIES

Mr. SIKES. When you contract with a large weapons manufacturer for advanced studies of this type, do you buy the bias toward certain kinds of design of that particular contractor to a large extent?

Mr. HANSEN. There is a possibility of that. That is one of the reasons why these kind of studies normally go to two or more companies that are considered to be the best in this kind of business. We generally hope to get alternate approaches to the solution of the problem. I think we would have to acknowledge that once we select a particular concept and decide we are going to go ahead with that, the company that has already studied that concept tends to have a leg up.

Mr. SIKES. How do you guard against that? Obviously a contractor could use these studies to encourage the Air Force to buy his own type of aircraft.

Mr. HANSEN. One of the ways we guard against it is to make the study results available to all the contractors that would propose on the system, and allow them enough time in submitting their proposals so that they can examine the results of all study contractors in the matter.

Mr. SIKES. Should a study of this type be made in-house at Wright-Patterson, for instance?

General MCNICKLE. A number of them are, Mr. Chairman. However, we need to look at more possibilities and get the best ideas that we can find.

We also have NASA involved so we do have a nonpartisan, so to speak, look at these areas.

RAND CORPORATION

Mr. SIKES. Under the Rand Corp., what is the requirement for a $600,000 increase for fiscal 1970?

General MCNICKLE. Cost of living increase, Mr. Sikes.

Mr. HANSEN. Four percent for cost of living in order to retain a constant manpower level.

STUDY OF "MANAGEMENT AND TERMINATION OF GENERAL WAR"

Mr. SIKES. One of the examples listed of the current year Project Rand program is, "Management and termination of general war." Has this study been completed?

Mr. HANSEN. That study has not been completed.

Mr. SIKES. When is it expected that it will be completed?

Mr. HANSEN. My understanding is that the completion of that study is about 2 months off.

Mr. SIKES. What are some of the objectives of this study? Give us that for the record and tell us how long it has been in operation and what it costs.

(The information follows:)

BACKGROUND OF MANAGEMENT AND TERMINATION OF GENERAL WAR

This project is concerned with the feasibility of controlling general war and imposing restraints on collateral damage incurred in counterforce operations. Implications for force design, force procurement, basing policies, and force targeting are under exploration.

The project has been in existence since January 1964 and since January 1, 1968—when cost accounting by project was initiated—has cost $35,100.

EXAMPLES OF COMPLETED RAND STUDIES OF VALUE

Mr. SIKES. What do you consider to be the most valuable Rand studies completed in the year since we heard the Air Force on this appropriation last?

Mr. HANSEN. They made a study for us on tactical bombing accuracy, and one on sortie rate and surge capability of tactical fighter aircraft. Rand took a leading coordinating effort with the services to work on survivability of aircraft. They also made a study of VLF-LF communications in a nuclear environment which was of joint interest to the Navy and the Air Force.

Mr. SIKES. I would like for you to pick up two or three major studies and tell the committee about something of their importance, their recommendations and how these studies were utilized in the Air Force.

(The information follows:)

EXAMPLES OF BACKGROUND USE OF RAND STUDIES

1. TACTICAL BOMBING ACCURACY

Rand has continued to help the Air Force achieve better tactical bombing accuracy. As an example, Rand personnel worked closely with the Air Staff and PACAF on the first combat use of the F-111A, and figured largely in the decision to analyze F-111A bomb impacts for the 18-day combat period. The results of the analysis led to a number of Rand suggestions for changes in operational procedures for the F-111A to exploit fully its combat capabilities. At the request of the Air Staff, the suggestions were briefed to PACAF, and PACAF is taking appropriate steps for implementation. In another action related to the F-111A, Rand has recommended two possible improvements, or a combination of them, to achieve greater radar bombing accuracy. One improvement is to add a higher resolution radar to the aircraft's present bombing system. A study by General Dynamics has confirmed a preliminary Rand finding that the addition of such radar is practicable. The other improvement, which Rand suggested through its participation in an Air Force study at the AFSC west coast facility, is a correlation bombing technique. This is a technique in which the bombing aircraft matches the radar image of a target under attack with a reference radar picture previously obtained by aerial reconnaissance or simulation. The Air Force is currently evaluating the relative cost and effectiveness of each of the proposed improvements, as well as the cost of using both improvements together.

2. AIRCRAFT SURVIVABILITY

This study involved the survivability of close support aircraft subjected to small arms ground fire. Specifically it has demonstrated the value of increased protective structure and proper placement of critical components and contributed directly to the Air Force specification of requirements for new close support aircraft. The A-X and F-X programs and some Naval Air Systems Command projects reflect the impact of the Rand studies. Furthermore, these studies figured directly in DOD's formation of an ad hoc committee to review survivability measures for aircraft and tracked vehicles.

Rand's work has been extended to consider survivability in the general tactical environment, not only for close support and interdiction aircraft but also for theater airlift vehicles. Particular attention has focused on techniques for suppressing fuel fires and explosions. As a direct result of this Rand effort, the Air Force in recent months has programed over $150 million for a modification program incorporating some of these techniques into aircraft now in service. This modification program includes the F-4, F-105, F-111A, A-1, A-7, OV-10, C-130, and helicopters. Modification of additional aircraft is under study.

Rand has organized and cosponsored with D.D.R. & E. a symposium which brought together senior management and staff personnel from OSD, the military departments, the FAA, and industry. A follow-on meeting on this important subject is scheduled for early next year.

3. RAND-TAC SYSTEMS

The Rand-TAC system is an improved system of data collection and analysis that evolved from a series of Rand-assisted Air Force field tests. It yields superior data for computer simulation models and, in particular, makes it possible to inject into analysis the interactions among the functions of operations, maintenance, and supply at the base level.

This past year Rand trained the Air Force evaluation team for the Combat Dragon* field exercise in the use of the Rand-TAC System. The training was done in the United States before the team's departure for Southeast Asia.

Combat Dragon is now regarded by many Air Force and DOD officials as a benchmark of excellence for weapon system evaluation. This is significant because one of Rand's primary objectives in developing improved analysis methodologies is to have the Air Force acquire the expertise necessary to apply them without continual assistance from Rand personnel. In this case, through Rand

*An evaluation of the close air support version of the AT-37.

assistance, the Air Force has its own team of officers with competence in a relatively sophisticated computer-assisted analysis technique, and this team is imparting its knowledge to other Air Force personnel. Furthermore, the Air Force is continuing to expand and improve the basic Rand-TAC System. As an example, the operations-maintenance-supply interactions that occurred in the Southeast Asia F-111A operational experience.

RAND STUDIES OF LITTLE OR NO VALUE

Mr. SIKES. What part of the studies of the Rand Corp. have not been of much value to the Air Force?

General MCNICKLE. Sir, last fall the Air Staff examined all of the 178 studies going on at Rand. Four of those studies were of little or no value to the Air Force and we recommended to Rand that these be terminated. Rand canceled two of them and reduced the effort by one-half on the other two, with one of these being reoriented.

Mr. MINSHALL. What were these four studies?

General MCNICKLE. Hydrocraft and human engineering were two of them.

Mr. MINSHALL. When was that initiated?

General MCNICKLE. Sir, I do not have that information. I will put it in the record.

Mr. MINSHALL. How much was spent on it?

General MCNICKLE. I will have to furnish that also.

(The information follows:)

INITIATION AND COST OF HYDROCRAFT AND HUMAN ENGINEERING STUDIES

The hydrocraft study was initiated in February 1961, and the human engineering study was initiated in March 1959. A third project, bureaucratic decisionmaking, was initiated in April 1966. This project has been reduced in level of effort by 50 percent and reoriented to place emphasis on military organizations. The fourth study, game theory, was initiated in December 1966 and has been reduced in level of effort by 50 percent.

Since January 1, 1968—the date cost accounting by project began—the following actual costs for each of these four projects have accumulated:

Hydrocraft	$99,300
Human engineering	34,500
Bureaucratic decisionmaking	235,500
Game theory	197,500

General MCNICKLE. The one that was reoriented was bureaucratic decisionmaking. One that had the level of effort reduced was game theory.

Mr. SIKES. You paid Rand to do that?

Mr. MINSHALL. That is what I want to know; who started all this monkey business?

General MCNICKLE. The genesis of these four studies is something I will have to submit for the record.

Mr. MINSHALL. Is this some of McNamara's doing?

General MCNICKLE. Rand is used not only by the Air Force but also by the DOD.

Mr. MINSHALL. That was not my question.

Was this some of McNamara's ideas?

General MCNICKLE. I do not know how it started.

Mr. SIKES. Has the study of bureaucratic decisionmaking been reoriented since the 20th of January?

General MCNICKLE. Yes, sir.

TOO MUCH FREEDOM BY RAND IN SELECTING STUDY AREAS

Mr. SIKES. How much freedom is given to Rand to select their own areas to be studied?

Mr. HANSEN. In my opinion too much.

Mr. SIKES. The committee has some concern about that. Is this something that you will look into and tell us what you plan to do in the future on this?

Mr. HANSEN. I have been looking into that. I can tell you right now that we plan to reorient the Rand effort to more specific areas that are assigned to them and to have a lesser degree of freedom in initiating studies on their own.

LIST OF RAND STUDIES

Mr. MINSHALL. Mr. Chairman, I think it would be helpful to this committee if we had a complete list of all of these programs that Rand is in on.

Mr. SIKES. The 178 studies. Yes; provide that for the record.

Mr. MINSHALL. Just because there are a lot of them, we should not pass over them and say there are too many to look at.

Who initiated them, how much did they cost, what did they accomplish, and what use has been made of them, if any?

I think these things would be very helpful.

Mr. HANSEN. We can certainly furnish that. But I wonder if I could ask a question in clarification of your request, Mr. Minshall.

Mr. MINSHALL. Yes, sir.

Mr. HANSEN. We can get the list of the Rand studies, when they were initiated and what has been spent on them rather quickly. It is going to take us quite a bit more time to put in this fourth column that you talked about, which is what we have used them for or what we have done with them or what our analysis is of the value.

Would you like for us to wait until we have all four or would you like to get a preliminary submittal of the list and when we initiated and the cost and then have us follow that up?

Mr. MINSHALL. I think so we will have it for this printed record. That is my concern. I don't want it next year.

Mr. HANSEN. I am thinking it might take us 2 or 3 weeks to analyze 178 studies in-house if we have not already done it.

Mr. MINSHALL. You must have it somewhere. This is what amazes me.

General BOYLAN. The majority of these will be easy to correlate with the person who requested and the person who uses it.

Mr. MINSHALL. The reason I asked for it is that I thought you had it readily available in the files.

General MCNICKLE. Also, the Rand studies are not all for the Air Force.

Mr. HANSEN. All these studies are not for the Air Force.

Mr. MINSHALL. That is what we should know.

Mr. HANSEN. We have to identify each and find out who wanted it.

I think we could get this done within a couple of weeks if that is all right.

Mr. MINSHALL. We are going to be here until Christmas so there is plenty of time.

Mr. HANSEN. I have the message.

Mr. LIPSCOMB. We have another series of hearings on R.D.T. & E. after we finish with you.

General MCNICKLE. A year ago there was an attempt made by the Air Force to reduce Project Rand by a small amount.

Mr. MINSHALL. I do not intend for you to have Rand make a study of their studies and give them another project. I think you should do this in-house.

General MCNICKLE. Yes, sir, we are.

(The information follows:)

PROJECT RAND RESEARCH PROGRAM

[Amounts in thousands]

	Initiated by	Starting date	Amount[1]
INTERNATIONAL POLICY ISSUES			
Nuclear proliferation	Rand	March 1965	$188.9
U.S. security interests and alternatives in Asia and Africa:			
Asian security issues (PR)	do	Aug. 1968	75.2
Japanese rearm nuclear and space programs	do	Nov. 1968	28.3
Chinese military and foreign policy	do	January 1956	150.0
U.S. security interests and alternatives in Europe:			
European security issues (PR)	do	October 1962	164.7
Soviet military and foreign policy	do	June 1953	310.6
U.S. security interests—General:			
Military representation in U.S. missions	do	September 1967	54.4
Policy relevant technology—1970's and 1980's	do	October 1968	2.8
MILITARY PLANNING, PROCUREMENT, SUPPORT, AND OPERATIONS—STRATEGIC			
Strategic concepts:			
Strategic studies formulation and synthesis	do	February 1968	143.5
Strategic concepts and doctrines	do	September 1963	209.7
Strategic counterforce, World War II	do	December 1964	58.7
Management and termination—general war	do	January 1964	35.1
NU-OPTS participation and support	AF	August 1968	207.3
Deterrence	Rand	April 1969	7.8
Strategic forces:			
Forces for strategic war fighting	do	September 1965	153.4
Alternative damage-limiting systems	do	November 1967	130.9
Cost support-strategic studies	do	November 1968	36.3
Missile systems:			
Strategic missile force study	do	June 1962	369.6
Strategic systems and concepts	do	December 1961	53.2
Vulnerabilities-strategic systems	Joint	January 1967	168.7
Strategic missile basing	do	February 1967	95.7
Enduring survival	AF	January 1968	68.8
Space defense and penetration	Rand	June 1958	29.6
Adaptive ballistic missile defense	do	July 1968	37.6
Manned aircraft systems:			
Bomber study	do	May 1966	123.5
Chemical and biological warfare defense study	do	March 1964	46.0
Space options and operations:			
Space operations	do	September 1961	235.8
Special space studies	AF	December 1968	5.2
TACTICAL			
Policy and force structure:			
Tactical studies formulation and synthesis	Rand	February 1968	228.3
Air power effectiveness—SE ASIA	AF	October 1967	545.9
Air support of ground forces:			
TAC air study-battlefield operations	Rand	January 1964	322.7
Improved tactical navigation/weapon delivery	Joint	November 1967	78.6
Improved equipment for FAC/SCAR	AF	November 1968	18.1
Air Superiority: TAC air study—air superiority operations	Rand	January 1964	214.7
Air interdiction:			
TAC weapon delivery accuracy	do	February 1966	85.6
Restriction of infiltration	AF	August 1967	303.9
LOC interdiction MDL/applications	AF	September 1968	16.2
Strategy of interdiction	Rand	February 1969	57.2
Tactical penetration and survivability:			
Defense tactical aircraft—SAM's	do	February 1966	38.2
Tactical penetration aids	AF	January 1967	49.0
High-survivability aircraft	Rand	December 1966	41.8

See footnote at end of table.

PROJECT RAND RESEARCH PROGRAM—Continued

(Amounts in thousands)

	Initiated by	Starting date	Amount[1]
TACTICAL—Continued			
Supporting tactical studies:			
Cost support—TAC studies program	Rand	January 1964	9.5
Gaming support for tactical air studies program	do	do	47.3
USES—emplaced fields of sensors	do	August 1968	85.0
TAC RECCE cost performance	AF	July 1968	118.9
Maintenance concepts/inertial NAV-system	AF	December 1968	41.6
Aerial suppression of S-A weapons	Joint	May 1969	0
Counterinsurgency: Military and nonmilitary aspects of economic competition	Rand	September 1960	19.4
Command and control and related systems:			
Command and control in general war	do	September 1965	115.9
RECCE-X	AF	December 1967	168.9
Command and control/limited nuclear operations	Rand	January 1966	20.0
Postwar recovery: Recovery from thermonuclear war	do	January 1967	8.3
Mobility—transportation:			
TAC airlift study	Joint	August 1966	99.6
V/STOL intratheater transport	AF	April 1968	36.4
MAC vulnerability	AF	June 1968	34.7
Transportation, inventory requirements	AF	November 1966	33.9
MAC scheduling options study	Joint	April 1967	107.5
Terminal facilities, operations	do	do	129.4
Civil air fleet augmentation	Rand	do	32.2
Support and maintenance:			
Initial support planning	AF	July 1962	48.4
TAC aircraft logistics-operations interactions	AF	June 1966	23.0
Project Pacer Tack	AF	September 1967	34.5
Forecasting maintenance personnel requirements	AF	July 1961	50.7
Maintenance manpower requirements	Rand	June 1968	60.8
Aircrew requirements	Joint	do	19.6
Reliability estimation	Rand	do	28.4
Recoverable item stockage policy	AF	do	111.5
EOQ stockage policy	Rand	do	47.2
War reserve stockage policy	AF	do	10.5
AF depot activities	Rand	April 1968	124.0
Project Ace	AF	October 1967	44.5
Maintenance information requirements and analysis	Rand	July 1957	189.1
LP-IV integrated maintenance management	do	December 1959	248.9
LP-IV maintenance control systems	do	June 1968	216.1
LP-IV maintenance analysis	do	do	185.0
Data processing research	Joint	April 1959	114.7
Simscript II	Rand	September 1968	140.6
Planet	Joint	October 1968	13.5
Support to AFLC center	AF	January 1968	247.7
MAC field test support	Joint	June 1968	40.5
ADC supply support	AF	do	2.2
MAC en route support equipment study	Joint	October 1968	84.2
Logistics support/deployed AF units	AF	April 1969	28.6
C-5A MADARS subsystem	AF	October 1968	41.1
R. & D. procurement and management techniques:			
Research/development planning	Rand	February 1955	106.0
The AF R. & D. process	AF	June 1968	21.5
USAF R. & D. program content	AF	September 1968	117.8
Weapons system acquisition	Rand	October 1966	118.6
Incentive contracting experience	do	June 1968	3.3
Procurement profit policy	Joint	do	71.1
Contract pricing and market behavior	Rand	do	36.7
Characteristics of defense procurement	do	do	50.7
Competition and licensing	do	do	33.6
Procurement strategies for weapons acquisition	do	do	.2
Government equipment policy	AF	do	3.2
Management info and control systems	Joint	May 1962	108.6
Evaluation-management information systems	Rand	August 1967	8.0
Advanced logistics system design model	AF	October 1968	142.3
Scheduling theory	Joint	June 1968	10.0
Financial implications of Air Force commitments and programs	AF	January 1956	33.2
Costing techniques assistance to USAF	AF	September 1966	124.5
Personnel and manpower:			
AF personnel and manpower research	Rand	August 1966	196.4
Pilot procurement and training	AF	May 1967	289.4
Medical auxiliary personnel	Rand	October 1967	151.2
USAF airmen training and retention	Joint	June 1968	57.1
USAF officer career structure	do	do	29.2
Military manpower procurement	Rand	December 1968	44.2
USAF manpower utilization and impact of cross-training	do	June 1968	46.8
Systems for AF education and training	do	July 1968	190.9
AFIT doctoral program	AF	April 1969	0

See footnote at end of table.

PROJECT RAND RESEARCH PROGRAM—Continued

[Amounts in thousands]

	Initiated by	Starting date	Amount[1]
TACTICAL—Continued			
Intelligence:			
Trends in Soviet science	Rand	June 1953	58.4
Intelligence	do	December 1961	57.1
Soviet cybernetics technology	do	September 1964	103.3
Intelligence-recce studies	do	March 1966	18.8
SCIENCE, TECHNOLOGY, METHODOLOGY—NATURAL SCIENCES AND TECHNOLOGY			
Physics and electronics:			
Fluid mechanics	do	June 1953	176.7
Guidance and control	do	do	210.0
Physics	do	do	135.3
Physical and quantum electronics	do	do	164.5
Radar, ECM and signal processing	do	June 1960	111.8
Communications and propagation	do	December 1961	136.1
Electromagnetic compatibility	do	do	97.3
Weapon characteristics and effects:			
Nuclear weapons effects	do	June 1953	207.2
Impact and blast phenomena	do	June 1959	144.3
Radioactive fallout	do	June 1953	49.9
Armament	do	May 1959	38.1
Environmental sciences:			
Geophysics	do	June 1953	219.4
Atmospheric radiation	do	April 1968	91.8
Cloud physics and weather control	Joint	March 1960	105.2
Military environment	Rand	June 1968	195.1
Structure/dynamics of 20 to 120 kilometers atmosphere.	do	January 1964	60.2
Aerospace mechanics:			
Flight mechanics	do	May 1959	98.2
Propulsion	do	June 1953	269.1
Aircraft design	do	May 1959	214.6
Space vehicle design	do	do	166.0
Lifting vehicle technology—R. & D./applications	Joint	August 1965	73.7
USAF-FRG aerodynamics program	do	June 1968	89.5
Rain erosion of hypersonic vehicles	Rand	do	76.6
ABM penetration	AF	February 1967	119.7
Aircraft systems: Aircraft operations	Rand	April 1959	35.3
Missile and space systems:			
Nonvertically launched missiles	do	March 1967	62.4
Orbital basing study	do	April 1967	13.9
Remotely manned systems	do	August 1968	98.6
Range instrumentation	Joint	September 1968	50.8
Materials, structures, and manufacturing techniques:			
Materials and structures	Rand	June 1953	115.2
Composite materials	AF	April 1966	88.4
Basing technology and design:			
Base design	Rand	May 1969	35.0
Basing technology	do	February 1960	104.5
Human engineering: False-pseudo color	do	June 1968	68.6
Biological science: Mathematical-chemical models of physiological systems.	do	March 1965	244.1
SOCIAL SCIENCES			
Political studies: Role of the military in Indonesia	do	October 1960	72.3
Economic studies:			
Sino-Soviet economic potential	do	February 1955	195.8
Economics	do	September 1960	128.0
Organizational behavior and decision theory: Bureaucratic decisionmaking.	do	April 1966	247.9
Arms control research	do	October 1962	0
MATHEMATICS AND ANALYTICAL METHODS			
Mathematics:			
Mathematics	do	June 1953	254.2
Dynamic and linear programing	do	do	50.0
Game theory	do	December 1966	197.0
Combinatorics	do	May 1968	233.5
Logic and automata	do	do	141.8
Probability and statistics	do	do	83.5
Computational mathematics	do	do	43.2
Information and data systems:			
Cybernetics data-research	do	January 1960	246.9
China data retrieval	do	September 1968	23.6
Computer programing study	do	May 1962	361.2
Computer systems studies	do	do	89.8
JOSS-II	do	February 1966	26.5
Computer graphics—Stereo display	do	February 1968	49.7

See footnote at end of table.

PROJECT RAND RESEARCH PROGRAM—Continued

[Amounts in thousands]

	Initiated by	Starting date	Amount [1]
MATHEMATICS AND ANALYTICAL METHODS—Con.			
Linguistics:			
Linguistics: Linguistic research	Rand	December 1956	303.2
Analysis methodology:			
Cost estimating methods and factors	do	June 1953	483.6
Engineering science	do	May 1957	154.9
Systems analysis	do	September 1957	20.1
System sciences	do	June 1968	136.7
Policy evaluation methodology	do	December 1958	170.8
Simulation techniques	do	December 1960	83.2
Methodology for international security studies	do	February 1967	52.1
SPECIAL ASSISTANCE, PROGRAM			
Special assistance:			
Special assistance—project Rand	Joint	November 1961	317.0
Rand military exercise/test advisory group	Rand	May 1968	29.9
AFSC cost analysis training	AF	September 1960	.6
JCS munitions effectiveness support	AF	April 1968	121.7
Program formulation:			
Program development (Project Rand)	Not a research project		
Project formulation (Project Rand)	do		
Liaison: Foreign and liaison assignments	Joint	June 1953	468.9

[1] These costs are accumulative since Jan. 1, 1968, when cost accounting by project was initiated.

Examples of Recent Project Rand Research That Have Produced Important Pay-Offs

1. AIRCRAFT SURVIVABILITY

This study involved the survivability of close support aircraft subject to small arms ground fire. Specifically it has demonstrated the value of increased protective structure and proper placement of critical components and contributed directly to the Air Force specification of requirements for new close support aircraft. The A–X and F–X programs and some Naval Air Systems Command projects reflect the impact of the Rand studies. Furthermore, these studies figured directly in DOD's formation of an ad hoc committee to review survivability measures for aircraft and tracked vehicles.

Rand's work has been extended to consider survivability in the general tactical environment, not only for close support and interdiction aircraft but also for theater airlift vehicles. Particular attention has focused on techniques for suppressing fuel fires and explosions. A modification program is incorporating some of these techniques into tactical aircraft now in service.

Rand has organized and cosponsored with D.D.R. & E. a symposium which brought together senior management and staff personnel from OSD, the military departments, the FAA, and industry. A follow-on meeting on this important subject is scheduled for early next year.

2. RAND–TAC SYSTEM

The Rand-TAC system is an improved system of data collection and analysis that evolved from a series of Rand-assisted Air Force field tests. It yields superior data for computer simulation models and, in particular, makes it possible to inject into analysis the interactions among the functions of operations, maintenance, and supply at the base level.

This past year Rand trained the Air Force evaluation team for the Combat Dragon* field exercise in the use of the Rand-TAC system. The training was done in the United States before the team's departure for Southeast Asia.

Combat Dragon is now regarded by many Air Force and DOD officials as a benchmark of excellence for weapon system evaluation. This is significant, because one of Rand's primary objectives in developing improved analysis methodologies is to have the Air Force acquire the expertise necessary to apply them

*An evaluation of the close air support version of the AT–37.

without continual assistance from Rand personnel. In this case, through Rand assistance, the Air Force has its own team of officers with competence in a relatively sophisticated computer-assisted analysis technique, and this team is imparting its knowledge to other Air Force personnel. Furthermore, the Air Force is continuing to expand and improve the basic Rand-TAC system. As an example, the system currently is being used for the evaluation of the operations-maintenance-supply interactions that occurred in the Southeast Asia F-111A operational experience.

3. ANALYSIS OF AIR/GROUND WARFARE (CLOSE-SUPPORT)

Rand has been studying battlefield operations in depth for several years. The objective is to understand and quantify the influences of air power on ground combat. One technique has been to develop a detailed mathematical computer model of the interactions between weapon systems such as air and artillery and the performance of companies and battalions in a dynamic fire-fight situation. The current version of this model, which has undergone a number of recent refinements, is called Fast-Val II. With this model it is possible to predict changes in the outcome of fire fights as a function of the number, type, targeting, and planning of artillery and air strike support.

Within the past year it was possible to test Fast-Val II against an actual combat situation. From Marine Corps after-action reports, the model was used to simulate the Khe Sanh battle of April-May 1967. There was a close correlation between the outcome predicted by the model and the actual outcome. On the basis of this correlation it appears possible within reasonable limits to predict the outcome of combat situations generally. Results so far also suggest that the model can predict quantitatively the supporting fires, both air and artillery, necessary in various situations to shift the battlefield balance in favor of friendly forces.

Rand is continuing to refine its battlefield operations model and plans to test it against further combat situations. In particular, they are working with the active official cooperation of the Marine Corps to collect detailed data on additional combat actions to obtain further validation of the model. Just-completed fieldwork resulted in the collection of Marine and also Army data which will be utilized. It seems clear that studies along this line will continue to lead to better means of comparing and evaluating tactics and munitions.

4. COMPUTER-BASED GRAPHICS

This is a continuation of the very successful Joss development. Joss is a relatively low-cost time-sharing system in which the user communicates directly with a computer in simple English and algebraic expressions. Fifteen Joss terminals are installed in various Air Force and DOD facilities in order to provide military and defense personnel an exposure to this new mode of computer use. All terminals receive computer power via telephone or teletype circuits from a machine at Rand.

A similar total-system approach to interactive man-machine communications is now being followed in the development of a system to permit remote time-shared access to computers through graphical input-output devices. Efforts to exploit computer-based graphical capability have been inhibited in the past by the high cost of prototype user consoles. Rand conceived and developed a relatively low cost input device—the Rand Tablet—several years ago, and is designing and implementing an interactive, multiple-access total system. Now being assembled for experimental use at Rand, this video graphics system uses consoles which incorporate components and techniques developed by the television industry to reduce the unit cost of terminals.

The new graphics system will offer the user a complete spectrum of computer-based graphical capability. He can use it simply to display large amounts of textual information of analytical curves, or he can have the full interactive processing power of a large computer. Rand's Grail (Graphical Input Language) system, which is just being completed, will be incorporated into the software which supports the graphical terminals. Grail permits the user to construct and describe the flow charts used in computer programing. Communication to the computer is via the stylus of the Rand Tablet, and the user gestures to the machine with natural hand motions. For example, he sketches rectangular boxes,

circles or diamonds freehand; he letters in block print; he eradicates an item by the natural motion of erasure. The Grail software automatically maintains several levels of detail beneath the flow charts which the user constructs; hence, upon completion of his work, he has a ready-to-run computer program automatically produced.

5. SORTIE RATE ANALYSIS AND THE SURGE CAPABILITY OF TACTICAL FIGHTER AIRCRAFT

As a result of the Southeast Asia field exercise Rapid Roger (in which Rand participated intensively), the Air Force Chief of Staff directed an examination of the impact on force structure of increasing tactical fighter sortie rates from their current level over a range of substantially higher rates. At his request, Rand contributed extensively to the examination, in structuring the study and in assisting in the analysis and preparation of the final report. Rand's participation also included use of its Samsom II simulation model at Santa Monica.

As a result of the sortie rate analysis, the Chief of Staff directed a significant increase in the sortie rate planning factor for the entire tactical fighter force, and has initiated another series of planning and programing actions in the Air Staff addressing the increase resource equirements that will be generated by the higher sortie rates.

The results indicate that, in an emergency, tactical fighter forces (the F–4 portion at least) are capable of very high close support sortie rates (from 4 to 6 sorties per day) on a temporary basis, and that recovery from such surge operations can be made quite rapidly provided that sufficient docks are available and some cross-training is performed in advance.

6. TACTICAL BOMBING ACCURACY

(Clerk's note: Description of this study is classified.)

7. VLF–LF COMMUNICATIONS IN NUCLEAR EVIRONMENTS

(Clerk's note: Description of this study is classified.)

8. RECCE–X

(Clerk's note: Description of this study is classified.)

9. COMPARISON OF Ge:Hg AND In Sb DETECTORS FOR THERMAL RECONNAISSANCE

This study, initiated at the suggestion of the Air Staff in 1967, relied heavily on basic research in physical and quantum electronics. At that time the infrared community was strongly divided as to which detector would be superior for reconnaissance, since indium antimonide (In Sb) yields superior contrast with hot spots while mercury-doped germanium (Ge:Hq) detectors yield a higher signal-to-noise ratio, and hence, better detection of unheated targets on the basis of shape.

The study showed that it was not appropriate to measure sensor performance by the usual "contrast" expression used heretofore. A more appropriate "detectability" criterion was evolved, which incorporates detector responsivity, detector noise, and background clutter, permitting the evaluation of detector excellence for reconnaissance as a function of target temperature, size, and the nature of background clutter. More importantly, it was found that the observed apparent superiority of In Sb detectors in detecting hot spots essentially stemmed from using scanner resolution which favored these detectors. If the resolution is selected so as to optimize the performance of each detector (by standardizing the clutter-to-noise ratio), the Ge:Hq detector is found to be superior both for terrain mapping and the detection of normally encountered hot spots. (In Sb remains superior for the detection of targets with temperatures exceeding about 500° K, but such targets are uncommon and easily shielded.)

The detector controversy was settled by this study since it clarified the regions of superiority (in terms of target temperature and background clutter characteristics) of each detector type. It also provided guidelines for the design of infrared scanners for optimizing the detection of targets both on the basis of their shape and their possession of hot spots.

10. LOGISTICS SYSTEMS LABORATORY

The Logistics Systems Laboratory (LSL) was established at the request of the Air Force in 1956 to study organization, information system policy, and procedure problems related to logistics support of Air Force operations. LSL has developed and uses a technique called game simulation (or man-machine simulation) to study these aspects of systems problems. The game-simulation technique allows the manager to interact with the essential aspects of this system in an environment sufficiently realistic to allow generalization to real-world systems. The experimenter of simulation director has under his control the significant parameters of the environment, allowing him to observe the effect of different system structures on its performance. The goal of game-simulation is to determine the feasibility of new system designs and to evaluate their contributions to the cost and effectiveness of possible future logistics systems configurations.

Over the years, specific design concepts developed in the LSL have been implemented by the Air Force. For example, ARLS (automatic resupply logistics system) for missiles, the MISTR (management of items subject to repair) for depot maintenance, and MMICS (maintenance management information and control system) for base level maintenance management are laboratory developed and assessed concepts. The Air Force is currently building the MMICS for real-world application, and its formulation for this system stems directly from the concepts that emerged from the laboratory project IV (LP-IV), conceived in late 1962. One aspect of this project concerned the use of computers to support the major subfunctions of management, e.g., planning, control, and analysis. This portion of the experiment was convincing in its conclusion that machines could indeed support the manager in performing these functions. The massive redesign of the Air Force maintenance management system, undertaken in 1965, and continuing to this date, has built upon the LSL foundations.

The technique of game simulation is sufficiently refined so that it now appears possible to use the technique for arriving at detailed design decisions—especially in areas such as man-machine interface. The Air Force has recently created a Logistics Simulation Laboratory at AFLC whose purpose is to contribute to the design of the advanced logistics system (ALS) currently under development. LSL has been providing tutorial assistance to the AFLC staff in the use of such a laboratory, and how to use man-machine simulation techniques specifically for the AFLC system development.

11. OVER-THE-HORIZON RADAR

(Clerk's note: Description of this study is classified.)

12. LONG WAVELENGTH INFRARED (LWIR)

Rand's formal involvement in this problem began in 1966. This was followed by participation in the 1966 IDA summer study, at which the possible utility of optical sensors in BMD systems received favorable attention. Rand also participated in a BMD mission analysis conducted by the AFSC West Coast Study Facility.

(Clerk's note: Remainder of description is classified.)

13. ATMOSPHERIC EFFECTS ON OPTICAL AND INFRARED SENSORS

During recent attempts to evaluate the operational capability of several optical and infrared sensors, Rand discovered that the effect of the intervening atmosphere has often been calculated incorrectly. The degradation in performance introduced by the atmosphere takes on different forms depending on the physical nature of the noise. A fundamental paper on this subject has been published, in which the degradation of performance with range is calculated for each sensor type for various target, background, and environmental characteristics. In all but the clearest atmospheres, these effects can have a significant bearing on the relative capabilities of various sensors. With commonly encountered situations, these effects are found to impose a rather low limit on useful operational ranges—with obvious implications for the design of future sensor systems.

14. SPIN PAN SPACE CAMERA

The invention of the spin pan camera emerged from Rand's continuing studies of optics, photography, and cameras which were aimed at maintaining competence in these fields. This camera operates from spin-stabilized spacecraft, with the lens axis mounted normal to the spin axis. Thus, the spacecraft spin performs a panoramic scan for the camera; the lens focuses the image on the film that is moving behind a slit. This slit serves as a shutter as the film moves past it at the proper rate to compensate for the spacecraft spin.

(Clerk's note: Remainder of description is classified.)

15. RADIOACTIVE FALLOUT

This project was started in 1957. Its main purpose has been the investigation of the physics of radioactive fallout, its interactions with climatology, and its propagation. This basic research on radiation and climatology permitted development of analytical techniques that enabled Rand to work on directly applied problems of interest to the Air Force. The following examples are illustrative:

Computer models capable of predicting fallout damage cheaply under a wide variety of assumptions were designed and are in operation;

Special models can be built quickly to satisfy special Air Force needs; e.g., the special model I, developed in support of a study for Secretary Brown in 1968, to analyze the possibilities of using fallout as the kill mechanism for assured destruction under certain conditions;

A methodology for assessing far fallout, as opposed to near, is nearing completion. The need for such assessment arises in looking at controlled nuclear response (what collateral damage to allies or other countries near an enemy; e.g., fallout on Japan or the Soviet Union from attacks on the Chinese Peoples' Republic);

It is now possible to estimate (with a stated level of confidence) the expected number of fallout casualties for an attack on specific targets under actual weather being predicted for the enemy at the time of the attack, rather than for average or historical weather values.

The last two examples have considerable relevance to Air Force nu-opts studies, to studies of controlled strategic war, and to the conduct of base-rights negotiations. The program as a whole has contributed extensively to the national knowledge of this weapon effect, and continues to provide inputs to analyses that consider the employment of nuclear weapons.

16. MILITARY METEOROLOGY AND CLIMATOLOGY

This is a general research program on the atmosphere. Out of this program have come techniques for considering the effect of weather on military operations, knowledge of high-altitude density and winds and their impact on reentry and defense vehicles, the development of more specific programs such as weather modification, etc.

Two recent applications:

"Climatology Atlas of Southeast Asia" (now being used by the Air Force and Navy in Southeast Asia, and already into its second printing).

A study using weather inputs to predict the effectiveness of bombing operations.

17. CLOUD PHYSICS AND WEATHER CONTROL

This project was started about 5 years ago as a basic investigation into the physical characteristics of clouds. It has resulted in the design of one of the most complete numerical models of the growth of clouds and droplets that have been produced to date. This model is enabling investigation of such practical problems as how to dissipate fog at airfields. Currently part of the activity under this project is aiding the Air Weather Service to acquire a similar analytical capability.

18. ATMOSPHERIC RADIATION

This program to examine the effect of atmospheric scattering on the passage of radiation through the atmosphere was started more than 15 years ago. During this time, it has contributed to the general subject of large particle scattering. In addition, however, it has evolved numerical techniques for handling the complex mathematics involved. These techniques and the Rand abilities de-

veloped in this project have provided a continuous source of assistance to specific Air Force problems. Typical of these problems are such things as:

The propagation through the atmosphere of the thermal radiation from nuclear weapons. (This has enabled calculation of nuclear weapon effects on military systems.)

The effect of the atmosphere on the ability to do reconnaissance. (Direct assistance was provided to the Air Force on this point, using analysis of atmospheric particles from volcanic eruptions as an analog of nuclear debris.)

The atmospheric attenuation of laser energy. (This work bears directly on possible weapon effects and use of laser beams for communications and ranging.)

The numerical techniques developed as part of this project are in constant demand by Air Force researchers and by contractors in the defense community.

19. SILENT AIRCRAFT FOR NIGHT SURVEILLANCE

(Clerk's note: Description of this study is classified.)

20. AIRCRAFT VULNERABILITY ANALYSIS

Rand's continuing studies of mathematics, computer simulation, aircraft design, conventional ordnance, and weapon effects made it possible to devise a highly effective means of estimating the vulnerability of aircraft to antiaircraft fire. Rand began in 1964, to develop a series of vulnerability models. These computer models range in complexity from a model which allows vulnerability calculations to be made for a nonmaneuvering aircraft in level flight passing directly over a defense site, to a model which allows the aircraft to maneuver in three dimensions. Most vulnerability analyses to date have been performed using a Rand-developed two-dimensional model (Pen Square). This is an expected-value model for estimating aircraft vulnerability during penetration to and attack of targets defended by antiaircraft guns.

A partial list of Air Force studies which have relied on the Pen Square model for support is given below:

Skoshi Tiger (Evaluation of the F–5 Vietnam, 1965–66).

Improved delivery accuracy of nonnuclear ordnance (an Air Force mission analysis conducted at the West Coast Study Facility under Brig. Gen. W. L. Chairsill, 1967–68).

Light intratheater transport (LIT) study, 1968.

Interdiction of mobile targets (an AFSC mission analysis conducted at the west coast study facility under Brig. Gen. W. E. Williams, 1968).

Comparative evaluation of the F–111, F–4, A–7, A–37 (an Air Force study under Col. H. Fish, 1968).

21. INTERCEPT TRAJECTORY SIMULATION MODEL

In mid-1967 Rand began to develop a computer program for use as a research tool for problems involving intercept trajectories e.g., trajectories of aircraft, missiles and space vehicles. Prior to this time, models designed to investigate the technical feasibility of particular operational concepts or new equipment capabilities were tailored to the particular problem being investigated and had little flexibility or growth potential for use in future applications, even of an analogous nature. Because of increased demand for intercept simulation models for tactical and strategic studies, Rand decided to build a general model capable of solving problems involving interceptor-target trajectories, using a modular building block principle.

The Rand model can simulate the dynamic motion of three vehicles simultaneously in three dimensional space, with open-ended options and choices for guidance, control, maneuvers, etc .This ability to simulate three vehicles in three dimensions is unique among models simulating interceptor-target trajectories and holds great promise as a flexible research tool for studying a wide range of intercept problems.

Some 25 agencies have requested copies of the program. Users include various branches of the USAF, USN, the Japanese Air Self-Defense Force, the Canadian Air Force, and defense contractors. The model is being used for studies of air-to-air combat, FX, AMSA, F–111 follow-on, movable guns, ASM, and SAM applications.

22. HIGH ACCELERATION PROPULSION TECHNOLOGY

Rand has studied the feasibility of applying to surface-to-air missiles (SAMS) the very high thrust-to-weight solid propellant motor technology developed for antiballistic missiles. This work, done in 1967–68, considered missiles designed for both high and low altitude intercepts of tactical aircraft. Results indicate that use of such technology can impose a substantial reduction in the time available to the target aircraft for evasive or defensive action. Further, the high acceleration simplifies the low-altitude SAM guidance, permits intercept of higher velocity targets, and improves the effectiveness of some types of warheads.

The work may significantly influence the choice of future Air Force tactical offensive aircraft and missiles which may have to counter the type of SAM Rand found feasible. Effort is currently underway to assess the utility of high acceleration technology in air-to-air missiles.

23. GASEOUS CORE NUCLEAR REACTOR AND POWER SOURCE

Over the past several years, considerable research by NASA and industry has been directed toward the application of the gas-core nuclear reactor for rocket propulsion. Because of the large potential increase in performance provided by the gas-core-rocket concept, Rand initiated a study to investigate the current status of the gas-core-research program. Because of a lack of basic technical information, the feasibility of the concept could not be established. Also, the only application that had been considered for the gas core was as a rocket device; the application of the concept to power generation appeared to have been completely overlooked.

Studies at Rand were designed to determine if the application of the gas core to power production appeared feasible. These studies have led to several unique concepts involving the gas core, and suggest some very attractive advantages over conventional solid-core reactors for power generation, namely:

(1) Because the fissile material is gaseous, the expense of fabricating fuel elements is avoided;

(2) The heat generation rate of the gas core is not limited as is that of the solid-core reactor by the temperature-strength characteristics of the fuel element structural materials; and

(3) In contrast to the solid-core reactor, which must be periodically shut down to replace fuel elements, the gas core can theoretically operate continuously by providing for continuous replacement of burned-out fissile material and removal of nuclear poisons.

This gas-core power-generation concept was disclosed as required simultaneously to the Air Force and Atomic Energy Commission. The AEC has drafted and filed a patent application of the invention, and Rand has assigned all rights in the invention to the Government.

24. HOT SHOT

Rand's continuing study of sensor technology led to the design of a weapon system to cope with the problem of nighttime infiltration. The system, called Hot Shot, provides a more effective nighttime reconnaissance-strike capability, primarily against fleeting targets. Since the effectiveness of both sensors and guns increases rapidly at close range, the self-contained reconnaissance-strike system uses flexible downward-pointing guns aimed with the aid of forward-looking infrared or low-light-level television sensors. The system operates from a relatively large, slow aircraft.

A test system, incorporating many elements of the proposed system, is being fabricated at Wright Field.

25. MANEUVERABLE SPACECRAFT TECHNOLOGY

The maneuvering capabilities of spacecraft configured for aerodynamic lift after entry into the atmosphere were studied at Rand in the 1965–67 time period. In particular, the maneuver constraints imposed by technology limitations such as maximum lift-drag ratio attainable, temperature limitations of heat shield materials, structural limits, maximum propellant capacity, et cetera, were defined. These capabilities and constraints, in turn, indicated which spacecraft configurations were attractive for particular missions.

These studies, communicated in the form of Rand publications and briefings to cognizant Air Force agencies and industry, influenced the formulation of the multipurpose reusable spacecraft (MRS) studies by industry in 1967. The MRS studies were performed by four major aerospace contractors under the direction of SAMSO/Aerospace, and had the objective of defining the next generation entry spacecraft after Gemini B.

26. MISSILE MONITORING AND SELECTION

The notion of monitoring and selection of ICBM's arose in connection with the review of a BSD study series in 1964, and was suggested by Rand as a useful concept for wing command. This was followed by a statistical analysis which was published initially in 1965.

The acceptance of the ideas of monitoring and selection is indicated by their inclusion in the hard guidance development program for the next several years.

(Clerk's note: Remainder of description is classified.)

27. NETWORK FLOWS

Around 1954, as part of the linear programing research then active at Rand, two mathematicians began a study of abstract mathematical networks. They created new theoretical and computational methods for dealing with flows in such networks. These methods greatly extended the applicability of network models, and they are now being used throughout the world. An application of interest to the Air Force occurred while attempting to study the rail network in Eastern Europe and began, in 1955, looking for help in determining its capacity for moving military cargo and what links and bottlenecks could be most profitably cut in an interdiction attack. Previous work on networks was available and applicable. A more recent example of the utility of the basic theory to Air Force problems is the work currently being done jointly by Rand and Air Force operations analysis in devising an interdiction model for use on sparsely traveled transportation networks—work specifically tailored for application to Vietnam.

Because the theory was developed as pure mathematics and dealt with abstract networks rather than a specific problem, it turned out to have application to a wide variety of subjects of interest to the Air Force, in addition to rail interdiction. Examples are management systems such as PERT and applications of the theory to Air Force personnel training problems.

28. DISTRIBUTED, ADAPTIVE NETWORKS FOR MISSILE COMMUNICATIONS

The advantage of the distributed adaptive network in missile communications is that it provides near-optimum use of the available communication links to move any message from source to destination through the fastest surviving path. It can be used in radio, wire, or combination systems, and offers a good answer to security problems.

The original notions of using such networks for missiles arose in the process of Rand comment on SR 19782, but were based on fundamental research which culminated in a comprehensive series of publications, and a computer simulation of the operation of a distributed, adaptive network.

Recently (1967) SAMSO-sponsored work on the defense system interaction study by Hughes Aircraft indicated use of a high-speed adaptive network for use in a defended missile wing. This study may have some impact on the command-communications structure for a defended Minuteman wing.

A distributed communications network has also been recommended as the appropriate system for transmitting satellite surveillance data in the Air Force study, "Surveillance of Objects in Space in the 1970's" (SOS 1970).

29. WAR GAMING

Early in the fifties, Rand began an effort to adapt classical military (free) gaming to a study of limited or local war based on possible Air Force involvement in the Middle East. The result was the development of a research tool to study limited war problems, and through the use of this tool, the development of valuable insights into the future importance of limited war.

Project Sierra, a series of studies employing gaming techniques, dealt with the role of the military in limited wars. The findings of Sierra cast doubt on the doctrine of massive retaliation, pointing out that a number of situations may exist which call for the exercise of other options.

30. SIMSCRIPT

Rand began development of the Simscript simulation programing language on its own initiative in 1960. Up to that time all computer simulations of industrial, military, and social systems were programed in Fortran or basic machine languages. As a consequence, problem definition times were long and computer programing times even longer. System analyses were hampered by this inefficient methodology.

With the publication of the initial research memorandum in 1962 (later published in book form by Prentice-Hall), and release of the language to the public, a new phase in simulation was begun. Simscript's "world view" assisted in problem definition, its programing language speeded programing, and its specialized features helped both the analyst and the programer.

Starting in 1963 Simscript courses were taught within Rand to Rand personnel, and to the Air Force. Presently, the Air Training Command has taken over the responsibility of Air Force training, offering several Simscript classes a year. Rand supports them as called upon.

Simulation models have been constructed and used for analysis and design purposes in many branches of the DOD. Some Simscript users are: Headquarters USAF, Data Services Center; National Military Command System Support Center; U.S. Army Strategy and Tactics Analysis Group, USMC Air Station, USN Naval Construction Battalion, Air Force Logistics Command and Air Defense Command. Many contractors have used their own and Rand-developed Simscript models in support of their Air Force contracts; most notable are McDonnell-Douglas, Mitre, Lockheed, Boeing and SDC.

In 1964, it became evident that despite its great and growing success, Simscript had some deficiencies. A project to develop an improved language, Simscript II, was started. Today, Rand is completing the implementation of this language on Rand's IBM 360/65 computer. It represents the latest state-of-the-art in programing languages and simulation technique, and can be expected to contribute greatly to expanding and improving the use of simulation. Being a general-purpose programming language, as well as a simulation language, Simscript II should find even wider application than Simscript.

31. DISCRIPT

Rand developed this research tool to provide an information retrieval procedure that can work with file structures used in real-time scheduling and display systems.

Discript is a computer software package used to store and retrieve data from a direct access device (disc). It has several unique characteristics:

Data is accessible both from an on-line console, or from a computer program, as in the Simscript simulation language.

The data structure may be quite complex and hence suitable to a wide class of applications.

The data structure definition is contained in the data base itself, and thus can be accessed in the same way data is accessed. This allows the user to define his data base structure or allows him to query the system regarding the structure of the data base, and even allows him to modify the structure as his requirements demand.

The ability to access data both from a program and from a remote console, and the ability to easily change the data base structure offer advantages in the area of experimental on-line management control systems. Discript was originally designed to be used in the Rand Logistics Laboratory to study man-machine systems such as Camcos (computer assisted control system). It will allow designers to experiment with file structure without paying penalties of reprograming when changes are required. The Discript file structure will allow designers to evolve data base structures rather than requiring complete knowledge before the system is used.

It now appears that Discript will fit very well into the range of maintenance scheduling problems that the Air Force faces at base and depot level, and it can also serve as a useful tool for further man-machine research. Interest in Discript has been expressed by the Human Resources Research Laboratory of the Air Force.

32. COST ESTIMATING METHODS AND FACTORS

This project incorporates most of Rand's background research in developing and improving cost analysis techniques and cost models for Air Force weapon and support systems, organization and force structures. This is basic research in the sense that it involves a continual process of inovation and creation, but its results are continually provided to, and applied by, the Air Force.

This work was initiated unilaterally by Rand in 1950 and has resulted in new and improved cost analysis techniques which have been adopted throughout the Air Force and in other parts of the Military Establishment, as well as by aerospace contractors.

For example, in 1952 the Air Force was interested in expanding to a total force of about 110 wings. Rand estimated the cost of these wings in terms of total weapons system cost methods. These costs were much higher than those being projected by the Air Force. Upon presentation of results to the Air Staff, initial reaction was not favorable. However, some encouragement was received from General Putt, then DCS/Development, who suggested that although the immediate application of the results was in doubt, Rand should continue efforts to develop the methodology. Three years later, in 1955, the Air Force requested that Rand do a total force structure cost analysis—exactly the sort of exercise presented earlier. The result was the development of the Prom model, a technique for considering at one time the major Air Force missions, the weapon systems used on these missions, and the resources involved; this model was the forerunner of the Sable cost model now in use by the Air Force.

During 1954, as the result of considerable thinking about improving budgetary and accounting procedures, Rand published a report making explicit their ideas on improving the efficiency of government operations. This was the forerunner of work on planning, programing and budgeting which has received wide acceptance within the Air Force, the Bureau of the Budget, and other Federal, State and municipal government agencies.

In addition, the committee was furnished AR-430-PR, project Rand semiannual report: July 1-December 31, 1968, which contains detailed information on each individual study project, including description, activity, future work, level of effort, costs, publications and briefings. This format was adopted in January 1968; thus AR-430-PR is the second and latest such semiannual report. This document is classified.

RAND STUDY ON "CHINESE MILITARY AND FOREIGN POLICY"

Mr. LIPSCOMB. What is the nature of the Rand study of "Chinese Military and Foreign Policy" which is listed as a fiscal 1969 program?

Mr. HANSEN. Do you know anything about this one, Dr. Lehmann?

Dr. LEHMANN. No, sir, other than it is a continuing analysis of the background and fundamental characteristics of Chinese foreign policy.

Rand has some China watchers watching what China is doing. That is all I know, sir.

Mr. LIPSCOMB. Is this strictly an Air Force arrangement with Rand for this study on Chinese military and foreign policy?

Dr. LEHMANN. Sir, I am not that specifically familiar with it. I will have to provide that for the record.

General MCNICKLE. It will be on our list.

Mr. HANSEN. We do not know.

Mr. LIPSCOMB. Don't we have other agencies of Government, such as Department of State, Intelligence Research, CIA, that make studies such as this and they are available to the Air Force?

Mr. HANSEN. The study that you picked we do not even know for

sure it is for the Air Force. It may be one that was requested by D.D.R. & E.

We will have to look into it.

General McNickle. We budget for the total Air Force Project Rand work which constitutes their major effort.

General Pitts. The military implication of a study like that would be how should we posture ourselves strategically against China. That may be a byproduct the military would get out of it.

Mr. Minshall. Weren't these studies available through other agencies of the Government, the Defense Intelligence Agency, CIA, and the State Department. Why are you getting into the act?

Maybe you do not have any more faith in the Defense Intelligence Agency than this committee has.

(The information follows:)

CHINESE MILITARY AND FOREIGN POLICY

Description.—This is a continuing analysis of the background and fundamental characteristics of Chinese foreign and military policies to elucidate their implications for U.S. policy. Research provides background for consultations with Air Staff officials and for inputs to interdepartmental studies, such as work on strategic posture toward China.

Activity.—The first in a series of memorandums on aspects of the cultural revolution was published. Analytical work continued on the role of the military in the cultural revolution, including a study dealing with differences on the strategy of national defense that developed within the Chinese military in 1965, which bears upon U.S. strategies and choices of weapon systems. Work is also proceeding on a book-length political biography of Lin Piao.

Future work.—A paper on Chou En-lai's role in the cultural revolution should be completed, together with one or two chapters of the Lin Piao manuscript and publication of a paper on Sino-Soviet relations during the cultural revolution. Plans are to complete the draft on differences in Chinese views of military strategy as a step in developing the more comprehensive study of the role of the Chinese military in the cultural revolution.

LEVEL OF EFFORT

	2d half 1968	1st half 1969
Professional staff	2.1	2.5
Consultants	.4	.4
Costs (in thousands)	$38.9	$49.9

Publications: RM-5781-PR, *Power, Policy, and Ideology in the Making of China's "Cultural Revolution,"* W. F. Dorrill, September 1968 (unclassified).

Briefings: Japanese attitudes toward security issues—Fuchu Air Base; Taiwan Defense Command; Headquarters PACAF.

The Chinese military and foreign policy study is supported exclusively by U.S. Air Force Project Rand. This is a continuing analysis of the political background and fundamental characteristics of Chinese military policies for the purpose of developing present and future developments that might affect U.S. military requirements. It seeks understanding of: the purposes of China's leaders in order to comprehend their actions and to estimate the consequences of alternative courses of U.S. military policy; the consequences of the present border contention between China and the Soviet Union; the military-political posture that a new regime would be impelled to take in dealing with the United States; and the consequences that are likely to arise from domestic political struggles.

The research provides background for the Rand dialog with Air Force officials concerned with concepts, doctrine, plans, and intelligence information and for inputs to interdisciplinary studies conducted by Rand for the Air Force. For example, the Air Force is concerned with strategic posture toward China and with U.S. military reactions to contingencies in the Sino-Soviet conflict—

both subjects of interdisciplinary studies conducted by Rand for the Air Force. Specifically, the research has served as background for formulation of the Air Force input to the joint strategic objectives plan, to the joint long-range strategic study, and to the U.S. Air Force planning concepts.

The study has assumed increased importance to the Air Force in recent months. As a continuing effort to increase the relevance and utility of the Rand product, the Air Force provided Rand in July 1969 with a listing of the most important issues and problems faced by the Air Force. The list is to serve as a guide for structuring the research program and individual study projects. One of these priority items was the issue of "USAF Security Interests in Asia and Africa," which was defined as follows: ———.

Also in July, the Assistant Chief of Staff, Intelligence, assumed responsibility for the Chinese military and foreign policy study as office of primary interest (OPI). In addition, the directorates of plans and of doctrine, concepts, and objectives are closely monitoring and using the results of this research.

The following guidance for Rand has been issued:

Focus of Project Rand research under RPN 1104 on the implications which various contemporary Chinese developments have for future military policy appears consistent with Air Force needs. ———. Consideration is given to the likelihood of an armed conflict between Communist China and the Soviet Union pointing up the significance of continuing research on Chinese military and foreign policy. The topic assumes increased importance in the light of recent Soviet buildups along the Chinese border and the probability of major U.S. military withdrawals from Southeast Asia in the years ahead.

Numerous scholars, both in and outside of government, are researching, writing and speaking on Communist China, its problems, and the impact on Asian affairs which they may generate. Some of this work, though not all, is pertinent to Air Force interests. In the future, (we)' will look at Project Rand, through RPN 1104, to maintain cognizance of what is being written and said about Communist China, and to relate in terms meaningful to the Air Staff those portions which are pertinent. Research conducted under Project Rand should not duplicate what is being or has already been done, but rather should concentrate on gap-filling where additional research is essential to relate or further extend work already accomplished.

In light of the guidance provided, and in view of the intimate understanding of Air Force problems possessed by Rand, we believe that the information to be provided by Rand in this study will not duplicate the work of other Government or contractor agencies.

The Air Force feels this study is necessary for its purposes and cannot rely solely on other agencies.

(Clerks note: Subsequent to the foregoing testimony, the committee was advised by the Air Force that the continuing Rand study on Chinese military and foreign policy has been funded since 1956. The study effort cost an average of about $80,000 per year from 1956 through 1961, and an average of about $100,000 per year from 1962 through 1969, for a total cost through 1969 of approximately $1.3 million.)

METHOD OF EVALUATING WORTH OF RAND STUDY EFFORT

Mr. LIPSCOMB. How does the Air Force measure the Rand output for the $15 million per year which has been spent with Rand?

General MCNICKLE. Sir, this has been a long-term contract of $15 million, and it has been a level of effort as far as the $15 million is concerned. Since 1967, the effort has gone down from 275 professional man-years to 246 in 1970.

Mr. HANSEN. I would like to add in terms of measuring their output we make sure we get the number of man-years we are supposed to, and then we measure things like how many presentations they give and how many reports they write. We attempt to make a qualitative evaluation of the value of the reports which they submit.

REDUCTION IN RAND PROFESSIONAL MAN-YEARS

Mr. LIPSCOMB. Did I understand you to say, General, that the specific number of technical man-years has gone down?

General MCNICKLE. Yes, sir.

Mr. LIPSCOMB. From what to what?

General MCNICKLE. It was 275 in 1967, 264 in 1968, 255 in 1969, and estimated to be 246 in 1970.

COST-OF-LIVING INCREASE OF 4 PERCENT

Mr. HANSEN. This reflects a cost-of-living effect on a constant dollar level.

Mr. LIPSCOMB. Then how do you arrive at this cost-of-living increase for fiscal year 1970 of $600,000. You said it was 4 percent. Why wasn't it included in 1969 and prior years? What brought about a change now in contractual procedures to include a cost-of-living item?

General PITTS. You are bringing up the point that 1968 and 1969 were a level of effort at $15 million and we put the cost of living at 4 percent for 1970.

Mr. LIPSCOMB. I might add your man-years of effort is going down also. So how do you work in a 4-percent cost-of-living increase for fiscal year 1970?

Mr. HANSEN. I think you have to do both to maintain a constant financial level.

What we are saying is that we do not want to cut the manpower as much as the cost of living plus the expense of materials and so on would require. So we want to be able to raise the amount so that we do not have to take each year's change in the cost of doing business out of the number of people that we have.

Mr. LIPSCOMB. What brought about this change of concept for fiscal year 1970 to add the cost of living. We have been living with this cost-of-living problem now for several years.

Is there a new contract or new arrangement?

Mr. HANSEN. We have also been living with a decreasing number of people working each year.

Mr. LIPSCOMB. That is true all through Government. Living with a decreasing amount of people was the intent of our Revenue and Expenditure Control Act last year.

General MCNICKLE. I believe the reason it was not done last year and the year before was because of the ceiling on the FCRC.

Mr. LIPSCOMB. Would Rand fold up if we did not allow this cost-of-living increase and we kept it at $15 millon?

Mr. HANSEN. No, I am sure they would not fold up.

RAND NOW CONDUCTING NON-DOD RESEARCH WORK

Mr. LIPSCOMB. To what extent is the Rand Corp. now performing work for other Government agencies and for organizations outside of Government?

General MCNICKLE. Between 20 and 25 percent of their effort is other than DOD. They have recently entered into one contract, non-Government, for the analysis of the paperwork on the New York and American Stock Exchange.

Mr. SIKES. Is this recent?

General MCNICKLE. Yes, sir.

Mr. SIKES. Prior to that time were they doing a greater proportion of their work for the Government?

General MCNICKLE. Primarily Federal Government, yes.

Mr. SIKES. Were they doing all of their work for the Government prior to that time?

General MCNICKLE. Prior to that time. This is the first non-Government contract. They have a study for New York City, a local government. However, this is the first commercial contract although it is viewed as being in the public interest.

PERCENTAGE OF RAND EFFORT DEVOTED TO AIR FORCE WORK

Mr. LIPSCOMB. What part of the total Rand effort is devoted to Air Force work?

General MCNICKLE. About 60 percent.

When I say Air Force, I do not separate the levies we get from OSD to do studies for them or to help other agencies within DOD. Dr. Foster did put out guidance suggesting that approximately 20 percent of the FCRC effort could be non-DOD.

NUMBER OF RETIRED MILITARY PERSONNEL WORKING FOR RAND

Mr. SIKES. Do you know how many former DOD personnel, and I include all of the services, now work for Rand.

General MCNICKLE. No, sir, I do not have that here.

Mr. SIKES. Give us any information you are able to provide on that.

(The information follows:)

FORMER DOD PERSONNEL WORKING FOR RAND

Rand employs 22 retired military personnel as regular members of the technical and administrative staffs. Two employees were DOD civilians immediately prior to their employment by Rand.

BACKGROUND OF RAND CORPORATION

Mr. DAVIS. What is the background of the Rand Corp.?

Mr. HANSEN. What is the background of the Rand Corp.?

Mr. DAVIS. Yes.

Mr. HANSEN. It is about 25 years old. It was originally formed by people who came primarily from Douglas Aircraft in Santa Monica. It was formed in response to a request from the Air Force to have a select group of people who could do studies for the Air Force. The Douglas Aircraft Co. in some way fathered the birth of Rand just after World War II, and supplied the people. It was then cut free with its own board of trustees and became a separate nonprofit corporate entity. It has continued that way to date doing at first exclusively Air Force work, then branching out and doing work for other DOD and more recently for other Government agencies. They are now getting into commercial work. It has its principal location at Santa Monica, Calif. They have a branch operation here in Washington.

It is mainly thinkers, although they do have some limited laboratory type work involving computer application.

BACKGROUND OF TOP RAND PERSONNEL

Mr. DAVIS. Could you provide us for the record—I assume this is available to you—a listing of what would be considered the top 10 people in the organization and what their immediate previous business background was?

General MCNICKLE. Yes, sir, I have it and I will put it in the record.

(The information follows:)

BACKGROUND OF TOP RAND PERSONNEL

The top Rand personnel, according to salary level, are:

Mr. H. S. Rowen, president, returned to Rand from the Bureau of the Budget in January 1967, with 10 years previous Rand experience.

Mr. J. R. Goldstein, senior vice president, joined Rand from Douglas Aircraft in November 1948.

Mr. L. J. Henderson, vice president, Washington, joined Rand from Douglas Aircraft in November 1948.

Mr. B. W. Augenstein, vice president, research, returned to Rand from IDA, with 9 years prior Rand experience, in June 1967.

Mr. G. H. Shubert, vice president, development, joined Rand in March 1959 from Hycon Eastern, Inc.

Mr. L. B. Rumph, chairman, research council, joined Rand from Curtiss-Wright Corp. in October 1949.

Dr. R. Latter, member, research council, joined Rand in July 1949 from student status at CIT.

Dr. A. Latter, head, physics department, joined Rand in September 1951 from student status at UCLA.

Mr. W. B. Graham, head, engineering sciences department, joined Rand from Sperry Gyroscope Co. in July 1950.

Dr. F. C. Ikle, head, social sciences department, returned to Rand from MIT in July 1967, with 8½ years prior Rand experience.

ANALYTIC SERVICES, INC. (ANSER)

Mr. LIPSCOMB. You are requesting a small increase for Anser, Analytic Services, Inc. for fiscal year 1970. The request is $1.6 million as compared with $1,572,000 last year. What is the basis for the increase of $28,000?

General MCNICKLE. This is to maintain the present 48 professionals.

Mr. LIPSCOMB. That is the cost of living?

General MCNICKLE. Yes, sir.

ROLE OF ANSER IN PREPARING AIR FORCE BRIEFINGS

Mr. LIPSCOMB. In the backup justification, it is indicated that a function of Anser is to prepare briefings. In general, for whom does Anser prepare briefings?

Mr. HANSEN. Briefings to the Air Force or for use within the Air Force.

Mr. LIPSCOMB. Does Anser prepare briefings for Air Force personnel to present to the DOD and to Congress?

Mr. HANSEN. Not to my knowledge, but they assist us in the preparation of briefings within the Air Force.

Mr. LIPSCOMB. Does Anser prepare briefings for one office in the Air Force to present to another?

Mr. HANSEN. Yes, sir.

General MCNICKLE. Actually Anser helps us respond to questions from DOD, from Systems Analysis and so on. I think you are very

familiar with the fact that we live in a world of paperwork, and it does help us respond.

Mr. LIPSCOMB. Does Anser brief Air Force officials on certain programs upon request?

General MCNICKLE. Yes, sir; they brief us on results of their analyses.

Mr. LIPSCOMB. In addition to the approximately $1.5 million the Air Force has been spending with Anser, do you spend additional sums for the use of Anser personnel on a consultant basis?

General MCNICKLE. No, sir. That is the total effort.

FISCAL YEAR 1970 PROGRAM FOR ANSER

Mr. LIPSCOMB. What can you tell the committee about your proposed fiscal year 1970 program for Anser?

What efforts do you now propose to have Anser undertake?

General MCNICKLE. I can give you a few examples right now and submit some more for the record, if you like. We have been scheduled to work on the studies on tactical aircraft self-defense, tactical aircraft vulnerable area analysis, tactical night and all-weather capabilities, follow-on study for the light intratheater aircraft, command control and survivability and vulnerability.

SIZE OF ANSER STAFF

Mr. LIPSCOMB. What gives them their expertise? How big an organization is this?

General MCNICKLE. They have 48 professionals. They have a staff of engineers which work particularly with our requirements.

NEED FOR ANSER

Mr. MINSHALL. What can they do, General, that you cannot do in-house?

General MCNICKLE. We have some people like this, but we augment our in-house capability to get new analytical perspectives.

Mr. MINSHALL. I am saying in-house. You have people on board that have a lot of expertise in these things.

General MCNICKLE. Yes, sir; and they do some of the same kind of work.

Mr. MINSHALL. What do you need this added organization for?

General MCNICKLE. We just need added effort to cope with the many defense problems that we face.

Mr. MINSHALL. That sort of reflects unfavorably on the personnel of the Air Force; does it not?

Mr. HANSEN. No, sir. I have talked about this particular point and I would like to explain it this way: As the in-house study goes along, a particular area will be identified that needs to be explored in considerable depth. That takes more people than the in-house capability will provide, and they put that out as a task to Anser in the form of specific questions or studies which they want to get the data back from to put into their own studies. I look at this as a sort of peak in the workload-type of thing, in which they use this outside capability to augment the in-house capability that runs along at a steady level.

KEY ANSER PERSONNEL

Mr. MINSHALL. Along with previous questions we have asked here, will you also supply for the record who are some of the key people in this Analytic Services, Inc.

Mr. HANSEN. Yes, sir; we have that data readily available.

(The information follows:)

KEY PERSONNEL IN ANALYTIC SERVICES

President—Stanley J. Lawwill.
Vice president—Thomas W. Chappelle.
Secretary—James S. Troutman.
Treasurer—Walter R. Longanecker, Jr.
Chief, strategic branch—John A. Englund.
Chief, tactical branch—Harry E. Emlet, Jr.
Chief, defense branch—Raymond S. Timm.
Chief, research and technology branch—Bernard S. Gershan.

KEY ANSER PERSONNEL WITH PREVIOUS DOD AFFILIATION

Mr. MINSHALL. How many of these people are former DOD personnel, if any?

General MCNICKLE. Yes, sir.

(The information follows:)

Of the eight key personnel at ANSER, five have held civil service positions. In addition seven of the eight have had tours of duty in the military.

Mr. DAVIS. Is the Air Force ANSER's only customer?

General MCNICKLE. Yes, sir.

BACKGROUND OF ANSER ORGANIZATION

Mr. MINSHALL. When were they organized?

Dr. LEHMANN. They were organized out of MELPAR. I think in about 1958. Rand helped to establish ANSER.

Mr. MINSHALL. I cannot hear you very well, Doctor.

Dr. LEHMANN. I am sorry. They were organized about 1958. Their predecessor had been a part of the MELPAR Corp., a profit company. They found they had troubles with the willingness of industry to come in and lay their plans before a potential competitor. Therefore, it was decided to go not-for-profit. The Rand Corp. on the west coast played a role in the establishment of ANSER here. There was a consideration of whether Rand would establish a Washington office. The decision was no. Rand helped get ANSER started. ANSER has a separate board of trustees. The chairman is Dr. Joseph Platt.

ANSER REPORTS USUALLY CLASSIFIED

Mr. LIPSCOMB. What would be the arrangement with an organization such as ANSER when they prepare a briefing or a formal report or informal report for the Air Force? Is this then a classified document for the Air Force only, or can it be purchased and used by outside interests?

General MCNICKLE. No, sir; the reports are usually classified and for the use of the Air Force only.

Mr. LIPSCOMB. They have no publication rights to release on their own?

General MCNICKLE. No, sir, not in a practical sense. Even if one of their people wants to publish his work, we have review authority.

Mr. LIPSCOMB. A trade publication cannot go to ANSER and say we want some work done?

General MCNICKLE. No, sir; it is strictly for our information.

Mr. LIPSCOMB. It is a good name—ANSER.

Mr. DAVIS. It is misspelled.

(Discussion off the record.)

ANSER BEING ENCOURAGED TO TAKE OUTSIDE WORK

Mr. HANSEN. I think, for the record, in connection with ANSER we should say that the current DOD policy is to encourage ANSER to devote some additional effort to doing work for Government agencies other than the Air Force up to a limit of 20 percent of their total.

To my knowledge that has not been implemented yet at their place. As a policy matter we would encourage them to do that.

Mr. LIPSCOMB. Mr. Secretary, one of the things that raises a question on some of these organizations is that they seem to take on every job that comes along, and I do not see where they get the time or the personnel or the ability to put out the necessary reports in the depth and quality that are needed.

Mr. HANSEN. Clearly it is a function of their management to not commit themselves to more effort than they can do a quality job on.

Mr. LIPSCOMB. They do not have anything to say about it. It is the requirement laid on, evidently in this case by the Air Force. If they never say no, they become overloaded.

Mr. HANSEN. My understanding is that it does not work that way. The Air Force indicates things they want them to do which the Air Forces believes are within their capability and capacity. We hold the administration of that organization responsible to reclama if it is being asked to do more than its capability and capacity for doing a good job.

Mr. LIPSCOMB. You just suggested that ANSER take on perhaps 20 percent more outside work from other Government agencies.

Mr. HANSEN. They would have to increase their capability in order to be able to do that.

Mr. LIPSCOMB. What responsibility is it of the Air Force to have ANSER take on outside work? Why not leave them the way they are if they are doing a good job?

Mr. HANSEN. We have been directed by OSD to encourage these companies to get into things like transportation, pollution, urban problems, and similar problems that are of a system nature that require the same general sort of expertise that they have. They need to add to the staff to take on those additional types of tasks to benefit the country. In the case of ANSER, to my knowledge, no steps in that direction have been taken.

In the case of Rand rather significant steps have been taken in that direction and we are already over this 20-percent limit. This is a matter of discussion between us and the OSD right now?

Mr. LIPSCOMB. Would you suggest that we could reduce the Air Force's contribution to ANSER by 20 percent and let some other agency pick it up?

Mr. HANSEN. No.

Mr. LIPSCOMB. Would this be a quick way to accomplish it?

Mr. HANSEN. That could be a quick way to accomplish it but that would only give the Air Force 80 percent of the support that we think we need.

Mr. LIPSCOMB. It would give you more in-house capability.

Mr. HANSEN. How does it give us more in-house capability? I don't understand.

Mr. LIPSCOMB. You could ask for a couple of more employees.

Mr. HANSEN. There is a thought. I think from an administrative point of view if we could hire the number of people in-house that are in an organization such as ANSER or Rand and get the same quality of people, administratively it would be a lot simpler operation.

AVERAGE COST OF ANSER PROFESSIONAL MAN-YEAR

Mr. LIPSCOMB. We figured up here while we were talking that the average professional in ANSER, if you divide it out, is around $33,000 per professional.

General MCNICKLE. That is one of our lower cost FCRC's. I think across the board, DOD or OSD uses a $50,000 figure, including support and so on. A professional man-year usually runs about $50,000.

Mr. LIPSCOMB. These would probably average out higher for the professional level because this $1.6 million includes secretarial and other expenses.

General MCNICKLE. I mean when you figure a man-year it is $50,000 and that includes the support, overhead, and everything else. ANSER is one of our lower cost organizations. The $33,000 is not average salary, but average total cost per professional. The average salary would be much less.

CONCEPT FORMULATION PACKAGE FOR LIGHT INTRATHEATER TRANSPORT

Mr. MINSHALL. General, what is the concept formulation package for the light intratheater transport?

General MCNICKLE. The concept formulation package contains the rationale of why we need and how we would use this airplane as well as the technical approach to be followed in developing it.

Mr. MINSHALL. You say ANSER has been working on this for 2 years. What have they come up with?

General MCNICKLE. We have an almost finished package to submit to OSD. I believe it will be finished in July.

Mr. MINSHALL. This is a completely new aircraft proposal?

General MCNICKLE. Yes, sir. It is expected to be a tilt wing, V/STOL airplane.

Mr. MINSHALL. This is on paper?

General MCNICKLE. Yes, sir, paper only.

Mr. MINSHALL. In other words, this is just the camel's nose under the tent.

General McNICKLE. Not even that.

Mr. HANSEN. A whisker?

General McNICKLE. This is the initial paper effort to seek approval to come up with an airplane in a few years.

LIGHT INTRATHEATER TRANSPORT (LIT)

Mr. MINSHALL. Give us some feel for this aircraft. What are you looking for?

General McNICKLE. An airplane that will be V/STOL, a transport, somewhere in the neighborhood between the C–130 and C–123. It will carry the standard Air Force communications van or 96 percent of the equipment in an Army infantry battalion.

Mr. MINSHALL. How big a plane are we talking about? What is the passenger or cargo capacity? What have they been working on for 2 years?

General McNICKLE. It will have a 5-ton cargo capacity using its vertical takeoff mode or, if 1,000 feet of runway is available, it can take up to 17 tons.

Mr. MINSHALL. How many passengers?

General McNICKLE. It is not primarily a passenger airplane, but will be able to carry about 70 to 80 troops.

General PITTS. I think the General said, Mr. Minshall, between the size of a C–130 and C–123, in that ball park.

Mr. MINSHALL. You have not even developed a smaller V/STOL aircraft in this country that will fly, much less a great big one like that.

XC–142 V/STOL AIRCRAFT

General McNICKLE. We had the XC–142, which was almost the size of the C–123.

Mr. MINSHALL. Who made that?

General McNICKLE. Ling-Temco.

Mr. MINSHALL. It never worked, it crashed.

General McNICKLE. It was never intended to be an operational aircraft and although we did have some accidents, we got over 400 flying hours and learned a great deal.

Mr. MINSHALL. Why didn't you carry on with that program?

General McNICKLE. We still have one of the original prototypes. We are working with NASA with that one to learn more about V/STOL. We now feel confident that we can build an operational V/STOL aircraft with a meaningful military capability.

Mr. MINSHALL. The British have developed a V/STOL.

General McNICKLE. Yes, sir; a V/STOL fighter. And we lost a pilot the other day in one of them.

Mr. MINSHALL. The Harrier.

General PITTS. Fighter aircraft, sir.

Mr. MINSHALL. I know, but the principle is there and they claim they can go ahead and make this thing bigger to carry a bigger package.

General MCNICKLE. There is considerable difference in the mission requirements between fighters and transports. The fighter only lands at its base or pad which can be prepared to varying degrees. The transport may operate from a base but must land wherever its load is needed in the forward area. We think a transport is more of a requirement than a fighter at the present time as far as our needs are concerned.

Mr. MINSHALL. In this package that you are hoping to come up with for a light intratheater transport, in previous years with the XC-142, the engines were not anywhere near powerful enough to do the job. What are you doing with the XC-142 you have out at Ling-Temco-Vought now? Is it in a museum?

General MCNICKLE. The aircraft is at the Langley AFB, NASA facility. NASA is putting up all the money flight testing the airplane in order to advance our knowledge of V/STOL technology.

Mr. MINSHALL. Do you think this is a better route to go than what the British have done? Why can't we adopt some of their technology and know-how and put it in an aircraft in this country. Just because you did not think of it, I do not think it is such a bad idea.

General MCNICKLE. We are interested in a transport and we think this tilt wing is much easier, simpler, and definitely more adaptable to the transport mission I described earlier than all the fans on the Harrier. We have four of the Harrier predecessors—they are not Harriers, they are P-1127's—still flying for NASA and ourselves.

(Discussion off the record.)

AIRCRAFT AND RELATED EQUIPMENT

Mr. SIKES. The program for "Aircraft and related equipment," in R.D.T. & E., Air Force, which was presented to the Congress last year included $572.1 million. The fiscal year 1969 program now calls for $472.7 million. What major items were affected by this decrease?

General MCNICKLE. This decrease of $99.4 million was brought about by reprograming, congressional action, and comparability shifts. The F-106 squadron was decreased $28 million; "Aircraft propulsion subsystems integration," by a million dollars.

Mr. SIKES. You can provide a list for the record.

(The information follows:)

MAJOR ITEMS AFFECTED BY DECREASE IN AIRCRAFT AND RELATED EQUIPMENT

A variety of changes—both increases and decreases—account for the total change of —99 million in "Aircraft and related equipment." These changes are shown below in a tabulation of the fiscal year 1969 and fiscal year 1970 programs:

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MAJOR ITEMS AFFECTED BY DECREASE IN AIRCRAFT AND RELATED EQUIPMENT

[In millions of dollars]

	1969 project listing	1970 project listing	Change
B-52	11.7	0	[1] −11.7
FB-111	49.0	39.0	−10.0
SR-71	0	3.0	+3.0
F-106	28.0	0	[2] −28.0
A-7	7.4	7.4	.....
F-111	117.3	97.3	−20.0
RF-111	11.5	12.0	+.5
Aerial targets	2.0	2.0	.....
C-141	1.9	1.9	.....
C-5	128.0	128.0	.....
Aerospace flight dynamics	22.9	24.3	+1.4
Aircraft prop subsystems	5.0	4.0	−1.0
Advanced aircraft navigation	3.0	3.0	.....
LIT	15.0	5.0	−10.0
Flight vehicles	10.0	7.5	−2.5
FC/Msl Tech	5.0	1.5	−3.5
Recon Tgt Acq	4.5	4.8	+.3
Aerosp Str Mtl	9.4	9.0	−.4
Hypersonic vehicles	2.0	0	−2.0
VTOL engines	15.0	14.0	−1.0
Advanced avionics	4.6	8.9	+4.3
ATEGG	7.0	4.0	−3.0
AMSA	30.0	25.0	−5.0
SCAD	0	4.0	+4.0
ARS	3.0	.3	−2.7
F-4 avionics	5.0	0	−5.0
VTOL (US/FRG)	2.0	2.0	.....
F-15	30.0	45.5	+15.5
AWADS	3.0	37.7	+.8
AX	2.5	0	−2.5
Aircraft equipment development	8.5	15.5	+7.0
SEG	27.9	0	[1] −27.9
Total	572.1	472.7	−99.4

[1] Transferred to another budget activity.
[2] Specific congressional action.

F-106X AIRCRAFT

Mr. SIKES. What degree of adversity would you say was inflicted by the decrease? Were you hurt by it or just inconvenienced?

General MCNICKLE. We lost the F-106X. I think you remember DOD wanted us to have the F-106. We wanted a mix of F-106's and a small number of F-12's. Congress opposed the F-106 and we ended up with nothing. We are still on dead center. I think that one program was hurt very much by this cut.

Mr. SIKES. Is that the principal adverse effect?

General MCNICKLE. Yes, sir; that was the principal one.

FB-111 AIRCRAFT

Mr. SIKES. On the FB-111, you are requesting $84.9 million for the current fiscal year. A total of $39 million was programmed for the aircraft in fiscal 1969, and $46.8 million in fiscal 1968. How much more money do you now estimate will be required to complete the development of the aircraft?

General MCNICKLE. We estimate that $16.3 million will be required in 1971 to complete the development of that aircraft.

BREAKDOWN OF FB-111 COMPONENTS IN FISCAL YEAR 1970 BUDGET

Mr. SIKES. I would like for the record a breakdown of the various components of the FB-111 which are included in the current request.

(The information follows:)

FB-111 COMPONENTS INCLUDED IN FISCAL YEAR 1970 BUDGET

The total fiscal year 1970 R. & D. request is $84.9 million. Included in the $84.9 is $39.5 million for the P-100 engine. The breakout of other task components is as follows:

Air Vehicle $4.9 million at GD/FW

Development and specialized testing of FB-111 peculiar equipment such at attack radar, astro compass, Doppler radar, and visual attack set.

Aerospace Ground Equipment (AGE) $6.7 million

Incremental funding of work authorized in prior years for development of AGE for FB-111 peculiar items.

Development $23.3 million

Fatigue testing, Cat I and Cat II flight testing, spares for support of flight testing, and data development costs.

Engines $5.4 million

Engine spare parts and overhaul in support of test program.

Miscellaneous $3.6 million

Wind tunnel and Edwards AFB test support.

Data $1.5 million

MARK IIB AVIONICS SYSTEM

Mr. SIKES. How much is in the requested sum for the MK-II avionics program?

Mr. HANSEN. There is no MK-II money in the FB-111.

Mr. SIKES. I believe the committee has been told that some of the components of the MK-II will be included in the avionics package.

General MCNICKLE. Yes, sir; the Mark IIB avionics.

Mr. SIKES. Provide the answer for the record.

(The information follows:)

MK II AVIONICS COMPONENTS IN FB-111

Components of the Mark II avionics system which are common to the Mark IIB-FB-111 system are essentially the inertial navigation set, the converter, the digital computers and a portion of the programing for the computers. However, all FB-111 aircraft equipment has been procured with fiscal year 1969 and prior year money. In fiscal year 1970, the only MK II associated money is $6.7 million for remaining aerospace ground equipment (AGE) development.

ESTIMATED TOTAL COST OF FB-111 DEVELOPMENT

Mr. SIKES. For the record, how much is the presently estimated total cost of the FB-111 compared with the original estimates of the development costs of this aircraft?

(The information follows:)

FB-111 ESTIMATED COST VERSUS ORIGINAL ESTIMATED COST

The original FB-111 development cost estimate in January 1966 was $85.1 million. The estimated increase to $234 million involved the addition of full SRAM integration at approximately $34 million; P-100 engine development costs at $28 million; increased requirements for aerospace ground equipment associated with MK II at $24 million; expanded flight testing at $15 million; and miscellaneous changes to include Triple Plow II inlet investigations, weapons separation tasks plus price increases due to escalation for a combined estimate of $48 million; a total increase of $149 million.

During the fiscal year 1970 period action will be taken to update FB-111 financial data by reallocating TF-30-P-100 expenditures heretofore charged to the FB-111 program. This is considered appropriate because the P-100 will not now be available for a FB-111 production effectivity. Also, an extensive effort is underway to reduce the estimated $149 million increase. It is currently estimated that the total cost of the FB-111 R.D.T. & E. program will be $218.6 million.

CERTAIN MAJOR MILESTONES HAVE NOT BEEN MET

Mr. SIKES. What milestones in the FB-111 program have been met in fiscal 1969 and what milestones which were planned for fiscal 1969 have not been met?

General MCNICKLE. A number of major milestones in the F-111 program have been effected to some extent because of the carry-through box problem we are having now. However, we are flying the FB-111 at Eglin and the tests of the bombing system have been very satisfactory.

Mr. SIKES. What major milestones have not been met?

General MCNICKLE. I will provide that for the record, if you desire.

Mr. SIKES. For the record then, tell us what principal milestones were met, and what major milestones have not been met.

(The information follows:)

The wing box problem, the decision to incorporate the Triple Plow II inlet modification, and production schedule and quantity changes have impacted to a degree on the accomplishment of some milestones. Production deliveries were delayed somewhat due to the schedule revision. Major milestones which have been met are accomplishments in the areas of:

1. Ground structural testing of various peculiar elements of the FB-111A program.
2. Flight flutter testing of the FB-111 with various stores.
3. Category I weapons delivery and navigation testing with excellent results
4. P-7 and P-12 engine flight evaluation.
5. Category II system testing in first FB-111 (No. 1) at Edwards AFB.

The milestones that have not been met are:

1. Basic FB-111A aircraft category I testing was scheduled to be completed in the second quarter of fiscal year 1969. Aircraft engine and system testing has also been delayed. These activities will now be completed in fiscal year 1970.
2. SRAM/FB-111 category I testing was scheduled to begin in February 1969 and continue through June 1970. Test initiation was delayed; however, the testing was initiated in May 1969 and results have generally been satisfactory thus far. Tests will extend into the fall of 1970.
3. The production quantity was reduced from 263 to 126 in November 1968 and to 76 in March 1969, with resultant stretchout in the early phase of the delivery schedule. Final delivery will be in December 1970.

MAJOR DEVELOPMENT MILESTONES PLANNED FOR FISCAL YEAR 1970

Mr. SIKES. For the record, tell us what major development milestones are planned for fiscal 1970.

(The information follows:)

MAJOR MILESTONES PLANNED FOR FB-111 IN FISCAL YEAR 1970

The major development milestones planned for fiscal 1970 include:

a. The completion of category I flight testing of avionics, flutter, airloads, stability and control, SRAM and nuclear weapon separation, and P-7 engine propulsion and performance testing. Also the initiation of live firings of the SRAM from the FB-111A.

b. The continuation of category II flight testing of systems, propulsion, performance, stability and control, and weapons separation.

TF30-P-100 (A-32) ENGINE

Mr. LIPSCOMB. Describe the A-32 engine which will be used in the FB-111A, and what is the projected cost of this engine development effort?

Mr. JONES. The A-32 engine was an earlier Pratt & Whitney designation for what we now call the TF30-P-100 engine which was mentioned earlier in the hearing here. It provides about 25-percent increase in thrust over the presently installed TF30 engine. For example, it gives you an increase of about 950 feet a minute rate of climb on a hot day takeoff. This is a very necessary improvement, especially with the high ordnance loads you are able to carry with the basic F-111. Another performance improvement is that it will give us an increase of about 70 knots in cruise speed over the target at a time when we are loaded with external stores, which is a problem we currently have unless afterburning is used.

Mr. LIPSCOMB. You can describe that more fully in the record.

(The information follows:)

F-111 AFTERBURNING PROBLEM (CRUISE SPEED OVER TARGET WITH EXTERNAL STORES)

The problem as stated relates primarily to the performance of the F-111A/E/D. The P-100 (A-32) engine will not be installed in the FB-111.

The operational payload of the F-111 is determined by its low-altitude, terrain-following, high-speed, night operation. In other words, the operational requirement maintain a high speed in a high density threat area with engine thrust at or below military power (nonafterburning) dictates the payload. The aircraft range will be reduced significantly if the load is such that afterburning is required to maintain sufficient maneuvering capability.

The P-100 engine to be used in the F-111D will allow carriage of a larger number of bombs over the target with an improved margin of maneuverability. In military power at sea level, the P-100 engine provides a ——— increase in thrust over the P-3 engine installed in the F-111A/E. With a bomb load of ——— M-117 bombs of an aircraft gross weight of 100,000 pounds, the F-111D with the P-100 engine can achieve a speed at sea level of ——— knots. The F-111A/E, with the P-3 engine, are only capable of ——— knots under these conditions.

Mr. LIPSCOMB. Could you say what the projected cost of the TF-30-P-100 engine development will be?

Mr. JONES. $78.4 million is the development cost.

Mr. LIPSCOMB. How many FB-111 aircraft will be fabricated before completing work proving the A-32 or the P-100 engine?

Mr. JONES. The FB-111 is not going to have the P-100 in it, sir. Originally it was to have been included in some of the airplanes, but with the cutback in the FB-111 program, it is only going to be programed for the F-111D. I can give you the number of F-111D's.

Eighty-nine F-111D's will be delivered with the P-9 engine installed (first delivery in October 1969). The next ——— aircraft delivered will have the P-100 engine installed (first delivery in March 1971).

TF-30-P-100 ENGINE NO LONGER PLANNED FOR FB-111A

Mr. LIPSCOMB. The first question that I gave you was describe the A-32 engine which is being developed for the FB-111A. The answer is it is not being developed for the FB-111A.

Mr. JONES. Not for the FB-111A, sir. I think we did mention a little earlier in the hearings that the funds that were in the program under the FB-111A line for the P-100 engine are actually to be used on the F-111D development of the P-100 engine. There is about $36 million in the 1970 program for the continuation of development.

General MCNICKLE. The February decision to cut back production on the FB-111 changed this engine's application to the FB-111D only.

Mr. LIPSCOMB. You mean you were developing the engine originally for the bomber version?

General MCNICKLE. For both. Now there is no use for it on the FB-111.

General PITTS. If I could clarify, sir, it is under the FB-111 line in the budget. The development was planned for both aircraft. With the cutback of the FB-111 program, it will be reprogramed to the F-111D where it has an application.

DATE TF-30-P-100 ENGINE DEVELOPMENT TO BE COMPLETED

Mr. LIPSCOMB. When will the engine development and testing program be completed?

Mr. JONES. It is under development right now, Mr. Lipscomb, and some green engines are running. I will have to supply for you the exact dates for the flight rating test and the actual operation.

(The information follows:)

DATE OF COMPLETION—P-100 ENGINE DEVELOPMENT AND TESTING

Development engines are being tested now. Flight test engines are being procured. First flight of the P-100 engine in the B-45 flying test bed is to occur in November 1969. Flight testing of the engine in an F-111 is scheduled for May 1970 and is to be completed by November 1970. First delivery of an F-111D equipped with the P-100 engine is scheduled for March 1971.

NOT ALL F-111D'S WILL HAVE TF30-P-100 ENGINE

Mr. LIPSCOMB. Will F-111D's be fabricated before this engine is ready?

General BOYLAN. Yes; 89 of them will. This engine will go into the 90th article.

Mr. JONES. It will actually go in in March 1971.

Mr. LIPSCOMB. Does the F-111D have to be modified in any way to take this engine?

General BOYLAN. It is my understanding that it does not, sir.

Mr. LIPSCOMB. When do you find out whether this engine will work in the F-111D? How do you find that out?

General BOYLAN. As Mr. Jones has indicated, we are running some new engines. The sizing has all been determined. The engineering marriage with the airplane based on the knowledge I have is absolutely no problem at all.

General MCNICKLE. These are internal changes in the engine.

Mr. LIPSCOMB. You do not have to make any external changes?

General MCNICKLE. No, sir.

REASONS FOR FB–111 DEVELOPMENT COST INCREASES

Mr. LIPSCOMB. What have been the principal difficulties in this program which have caused the total estimated cost of development to increase from the $85.1 million estimated in January of 1966 to the $234.4 million presently estimated?

General MCNICKLE. The large cost increases which have developed in the FB–111 program could not really be identified at that time. The original concept was to develop a bomber aircraft with minimum modifications to the F–111. Since then, there have been added requirements. Some major examples of these are SRAM integration, development of the P–7 version of the TF–30 engine, development and testing of the 600-gallon external fuel tanks, to give it more range, weapons bay fuel tanks, and increased requirements in avionics and aerospace ground equipment to make a real bomber version of the airplane. The cost increases were to make a bomber version of the airplane.

REASONS FOR 6-MONTH SLIPPAGE IN FB–111 DEVELOPMENT

Mr. LIPSCOMB. The first combat crew training squadron of 15 FB–111 aircraft is estimated to be fully equipped in the third quarter of fiscal 1970. Last year the committee was given an estimate of July 1969 for this program milestone. Is this indicative of the slippage now in this program? Is it a total of 6 months or more?

General MCNICKLE. We think that the program slippage is 6 months and is due to two reasons. One is the fatigue problem in that carry-through box and the other was the modification of the engine inlet.

Mr. LIPSCOMB. So it is 6 months?

General MCNICKLE. Yes, sir.

Mr. LIPSCOMB. Estimated?

General MCNICKLE. Yes, sir.

Mr. LIPSCOMB. How confident is the Air Force that the difficulties with the FB–111 program can be worked out in a reasonable time and at a reasonable cost?

General MCNICKLE. Considerable testing has been done with the initial articles and we have a relatively high degree of confidence that the program is going well now. I think we will have a good airplane.

Mr. LIPSCOMB. I hope so.

SECURITY CLEARANCE FOR NEW DOD EMPLOYEES

Mr. Chairman, I would like to ask one question that is unrelated. If you were to hire a new person of a professional level in management research in the Air Force right now, how long would it take him to get a security clearance, or could he work without one?

General MCNICKLE. It would depend on his previous affiliations.

If he had not worked with Government before——

Mr. LIPSCOMB. He is on the faculty of a university.

General MCNICKLE. At best it would take approximately 60 to 90 days to get him on the payroll. I say this from my experience in OSD because I am familiar with bringing people in.

Mr. LIPSCOMB. Could he go to work without a security clearance?

General MCNICKLE. If he was working in unclassified areas and the job was nonsensitive. I would think there would be some of that work that would be available. However, we found that processing a high grade civilian through the Civil Service Commission and the time to get a clearance is approximately the same. I assume he would be a PL-313 or GS supergrade.

Mr. LIPSCOMB. He would be analyzing job requirements at all levels of professional positions in the security organization. Do you think this would take a security clearance?

General MCNICKLE. Analyzing the job descriptions?

Mr. LIPSCOMB. Yes.

General MCNICKLE. No, sir, I don't think so.

Mr. LIPSCOMB. In a security organization, though.

General MCNICKLE. Some of those security organizations are very strict and some have rules that no matter who you are, you have to have security clearance.

Mr. HANSEN. I think that might be one reason. Another reason might be that the combination of the job descriptions of all of the people that work in a security area might in itself paint a classified picture of what the effort of that organization was. If the desire is strong enough, there are interim procedures that are available. I could cite my personal example where I had a top secret clearance in industry. When I came to work for the Government I was given an interim clearance on which I worked for the 3 or 4 weeks that it took to get a permanent clearance. But this took the very highest level of push to rush the necessary administrative matters and security checks.

From my friends and relatives I find that they were very thorough in making those security checks. It is just that my file must have been put fairly close to the top of the pile.

Mr. LIPSCOMB. Under usual circumstances a new employee does have some kind of security check.

Mr. HANSEN. Yes, sir.

Mr. LIPSCOMB. It takes about 45 days.

Mr. HANSEN. Yes, sir.

Mr. LIPSCOMB. Not for a thorough one like yours.

General MCNICKLE. For a high grade position where they really want to check the person out, yes, sir; particularly if they give references scattered around the country.

Mr. LIPSCOMB. Thank you very much.

Mr. MAHON. Thank you, gentlemen. We will resume at 2 p.m.

AFTERNOON SESSION

Mr. MAHON. We will resume the hearing.

SR-71 AIRCRAFT

Mr. LIPSCOMB. We will go to the SR-71. What is the purpose of your request for another $8 million for the SR-71 squadrons? This is the same amount as was programed last year for the SR-71. What do you hope to accomplish with this expenditure?

Mr. HANSEN. By coincidence, Mr. Jones and I had a meeting this morning with Kelly Johnson on the SR-71 before we came here and

we were discussing this very subject. I think in general we can say that a sustaining program is required on the SR-71 ———.

This program could primarily be described as a sustaining effort for keeping ——— this airplane ahead of the environment that we are seeing and anticipating.

HOW FISCAL YEAR 1970 FUNDS WILL BE USED

Mr. LIPSCOMB. That is in a broad form of what the program is, but perhaps you could describe how you apply this $3 million. Do you have a contractor? What do you do for the $3 million? How do you handle it?

Mr. HANSEN. I have about three pages here in answer to that. Would you like for me to run through that or submit it for the record?

Mr. LIPSCOMB. What do you mean, three pages, Mr. Secretary?

Mr. HANSEN. I have a description of the SR-71 program activities and the amount of money that goes with each one, and what it is for.

Mr. LIPSCOMB. Why don't you just highlight the use to be made of the estimated $3 million?

Mr. HANSEN. In fiscal year 1969 R.D.T. & E. effort concentrated on increasing the survivability of the SR-71 in a hostile ——— environment ———.

A total of $925,000 was programed for vulnerability studies and flight test support ———. Computer simulations and flight test evaluations are required because of the unique environmental conditions in the SR-71 flight envelope.

A total of $960,000 has been programed for start of development of ———.

$1,115,000 was programed for development of increased photographic sensor capability for the SR-71.

Mr. LIPSCOMB. Mr. Secretary, you may place the remainder of the description in the record.

Mr. HANSEN. Very well.

(The information follows:)

The $1.115 was programed for development of an increased photographic sensor capability for the SR-71. This program will provide a prototype of the ——— installed in a redesigned nose section of the SR-71 ———.

The objective of the fiscal year 1970 R.D.T. & E. program for the SR-71 is a continuation of effort to make the system more capable of providing reconnaissance support ——— as directed by the Joint Chiefs of Staff. ———. The highest priority R.D.T. & E. requirements are a continuation of development efforts to provide ——— survivability ———.

The fiscal year 1970 will continue the development started in fiscal year 1969 ——— to provide survivability against advanced threats. ———; $1 million is proposed for this effort.

Development of the ———; $1.175 million is proposed for this effort.

Survivability and vulnerability support is a continuing program involving computer simulations, flight tests, and analytical studies to determine changing requirements ———. Results of these studies will define areas for improvement of weapons system capabilities and, as a byproduct, define the limitations which will have to be placed on the system in today's configuration in order to perform the ——— mission. ———. For contractor support to threat simulation and flight tests, a total of $385,000 is proposed.

R.D.T. & E. efforts are the minimum required to provide sensor system improvements so that the SR-71 can remain responsive to its mission requirements. Survivability of the SR-71 system must be maintained ———.

MOST FISCAL YEAR 1968 FUNDS FOR SR-71 SQUADRONS REPROGRAMED

Mr. LIPSCOMB. The committee notes that the Air Force fiscal year 1969 reprograming decreased R.D.T. & E. fiscal year 1968 funds for SR-71 squadrons by $1.7 million, leaving only $316,000 for this purpose. It was stated that the decrease represents funds which are in excess of requirements for the fiscal year 1968 SR-71 program.

What are your requirements for fiscal year 1969 and fiscal year 1970 in the SR-71 program? Can they also be decreased?

Mr. JONES. Mr. Lipscomb, we required the entire $3 million in 1969 to cover some of the programs that Secretary Hansen was talking about initiating ———.

In 1970 we project the continuation of some of this effort and also the initiation of some additional threat study simulation work.

There will be $1 million continued on the ——— system. There is $1.175 million on the ———. There is about $400,000 we are going to put into ——— and the remaining $365,000 is for contractor support in the threat analysis, and some test work.

In both years we feel we will require the $3 million.

Mr. LIPSCOMB. What part of the $3 million is paperwork and what part is hardware?

Mr. JONES. The contractor threat simulation work is paperwork. Actually it is computer work as well as analytical work. ———.

So really a small part of the total $3 million is actually paperwork.

A-7 AIRCRAFT

Mr. LIPSCOMB. Is the $3,100,000 you are requesting for the A-7 the last money which you anticipate for the R.D.T. & E. effort on this aircraft?

General MCNICKLE. We expect about $100,000 a year until the A-7 gets out of testing. It is for relatively minor problems that historically appear in a test program.

A-7 AIRCRAFT DEVELOPMENT COST INCREASES

Mr. LIPSCOMB. How does the A-7 program stand with respect to living within the original cost and time estimate?

General MCNICKLE. The original program, $26.3 million, was to develop an afterburner for the TF-30 engine. Instead of that it has been a completely different program in that we have adopted a new engine, the TF-41, which is now in our A-7D airplane and will be in the Navy A-7E airplane. We have put in a nose gun, new wheels, brakes and avionics system.

The budget was approved at $57.1 million, which takes it through 1969. Then the subsequent stretchout now makes a total program of $60.3 million for the R. & D. effort. Really, to compare the original program with the present program——

A-7 AIRCRAFT DEVELOPMENT PROGRAM SLIPPAGE

Mr. LIPSCOMB. What about the time schedule, when do you first plan to finish it?

General MCNICKLE. We were 8 weeks behind with the test run on the engine and consequently each one has been slipped. Most of the milestones have been met and we will be close to the current estimate.

Mr. LIPSCOMB. Does the $60.2 million estimated to the total development cost of the A-7 include the cost of the development of the TF-41 engine?

General MCNICKLE. Yes.

I would like to correct my previous statement, Mr. Chairman. The test program, as we know it now, is doing pretty well. However, because of all the changes, the overall program is about a year and a half behind.

Mr. LIPSCOMB. How successful has the A-7 development program been? Do you believe this aircraft will be a very fine aircraft and will serve the Air Force well, or do you have some doubts about it?

STATUS OF A-7 AIRCRAFT DEVELOPMENT PROGRAM

General MCNICKLE. I think it is going to be a good airplane for its purpose. I think there are people who would rather have F-4's and people who would rather have F-111's, but I think the A-7 will do a creditable job.

Mr. LIPSCOMB. Do you want to fill in more for the record on that?

General PITTS. I think we could take it item by item and say that the engine may be meeting or exceeding expectation. The new gun the general spoke about has been successfully flight tested throughout the operational envelope. The development of the larger wheel and brakes, as well as an antiskid system, has been proven successful in tests recently concluded and the tests to date in the avionics system shows outstanding performance with no major deficiencies.

Perhaps we can amplify this more in the record, sir.

Mr. LIPSCOMB. All right.

(The information follows:)

SUCCESS OF A-7 DEVELOPMENT PROGRAM

The TF-41-A-1 engine in the A-7D has successfully completed the military qualification tests and has demonstrated thrust in excess of the specification (14,250 pounds) value. Performance and handling characteristics are considered to be excellent. A growth version (TF-41-A-2) is now being qualified at 15,000 pounds thrust for use in the Navy A-7E. Further, growth to over 16,000 pounds thrust is now our goal. The TF-41 engine development is considered highly creditable. The M-61 20-millimeter nose gun being use in the A-7D and the A-7E has been qualified through the operational envelope and has demonstrated accuracies within specification values.

The larger wheels and brakes, coupled with the antiskid system have exceeded expectations. Stopping distances have been better than specification values and wet runway operation, aborted takeoffs, and heavyweight stops have been successfully conducted at the Air Force flight test center.

We are in the midst of testing the avionics and the weapon delivery accuracies at Eglin AFB, Fla. Tests to date indicate that performance and accuracies better than specified values can be achieved. Reliability of system components is our current major concern (normal in the development and testing stages) and we are experiencing some expected development problems but foresee no major deficiencies. The contractual guarantees are scheduled to be formally demonstrated during the November 1969–January 1970 time period. We expect to meet or exceed these guarantees.

The A-7D development program has been highly successful to date. It is expected to be a very fine operational aircraft in its assigned role.

Mr. HANSEN. I talked with one of the pilots at Edwards about 2 weeks ago who had been testing the airplane and he was enthusiastic in his feelings about the airplane. He thought it was a good airplane and that it handled well.

General BOYLAN. As you know, Air Force pilots participated with the Navy on the carrier operations of the A–7 series aircraft. All pilots who fly the airplane have nothing but good things to say for its characteristics. It will bring to the close air support role capabilities that we haven't had before.

The avionics package is far superior to the F–4. Like General McNickle said, its critics point to the fact that it is a subsonic aircraft but in the principal mission that the airplane will be committed to, supersonic speed is not necessarily a virtue. Again, as you know, we anticipate a total program of ——— wings in the Air Force inventory.

F–111 AIRCRAFT

Mr. LIPSCOMB. You are requesting $73.7 million for the F–111 aircraft development in fiscal year 1970. How much more money do you estimate will be required to complete the development of this aircraft?

General PITTS. About $6.2 million, I believe, sir.

Mr. JONES. That is——

General PITTS. That is beyond 1970.

Mr. JONES. That is about $6.2 million net.

General PITTS. That is in addition to the $58 million now shown in this budget as required beyond fiscal year 1970 which would bring it up to about $64.2 million.

FUNDS REQUIRED TO COMPLETE F–111 DEVELOPMENT

Mr. LIPSCOMB. You are asking for $73.7 million in the fiscal year 1970 estimate. How much more do you estimate will be required to complete the development?

General PITTS. There is an additional requirement in the out years of $64.2 million. That comes from some plus and minus figures. This morning, for example, we testified that the P–100 engine would be moved from the FB–111 line to the F–111 line. The minuses had to do with deletion of Maverick and some flight testing.

Mr. LIPSCOMB. So really that amount that was in the FB–111 program should be added to the F–111 program?

General PITTS. Yes, sir. It has netted out to $6.2 million additional. There is a plus on the engine and a minus in connection with the deletion of Maverick and some flight tests.

Mr. LIPSCOMB. According to the justification book on page 38, it says "Additional need to completion, $58 million."

General PITTS. Plus the $6.2 million: yes, sir.

Mr. LIPSCOMB. Plus the $6.2 million?

General PITTS. Yes, sir. Since we printed the book, we are asking for another $6.2 million beyond fiscal year 1970 to completion. That was the net effect of moving the P–100 engine over and the deletions which I mentioned, which makes the out year requirements $64.2 million.

Mr. LIPSCOMB. $64.2 million.

General PITTS. Yes, sir; to complete.

Mr. LIPSCOMB. If you will correct the record as we go through this, I think you said additional to completion was $6.2 million.

General PITTS. Yes, sir; and I meant that to be an addition to the amount shown as the cost to complete in the justification book. We will correct the record.

F–111 AIRCRAFT DEVELOPMENT PROGRAM COST INCREASES

Mr. LIPSCOMB. How does the $1,569,037,000 estimated total cost for the development of this aircraft compare with original cost estimates of this development program?

Mr. JONES. Mr. Lipscomb, the original estimates were made in the November 1963 time period. Something in the neighborhood of $868 million or $864 million. That was right after the selection of the prime contractor. You will recognize, of course, there have been additions to the program since that time, including the decisions to add to the original F–111A and F–111B program, the latter being the Navy program, the F–111E's and the F–111D's. So the present $1.5 plus billion relates to the initial program, plus the additions that have been made for the other versions of the Air Force aircraft.

Mr. LIPSCOMB. There must be an answer as to how this compares with the original cost estimates of this development program. What were the original cost estimates——

Mr. JONES. The original estimates, Mr. Lipscomb, that I referred to, in 1963, were based upon the Air Force F–111A, plus the F–111B Navy version right after contractor selection. The R.D.T. & E. at that time was around $860 million. However, since the 1963 period, the F–111D was added with the Mark II system. The RF–111, the P–100 engine, as we have talked about it and so forth.

The total now for the entire program is reflected in the $1.5 billion.

Mr. LIPSCOMB. Over the original cost estimates it is about 100 percent greater, but with a lot of changes made in the specifications.

Mr. JONES. A lot of additional models and changes made, yes, sir.

SLIPPAGE IN IOC FOR SECOND F–111 TACTICAL WING

Mr. LIPSCOMB. How does the initial operational capability (IOC) date for the second fully equipped tactical wing of the F–111 aircraft, which is scheduled for ———, compare with the oiginally estimated schedule?

Mr. JONES. Well, Mr. Lipscomb, here again the 1963 date, at the time the estimates were made for the second wing, IOC referred to the F–111A aircraft version. At that time it was estimated to be February 1969. Since the printing of the justifications that you have, we have had some further slippage in the IOC date of the second wing

due to the modification programs on the wing box carry-through structure and because of certain other schedule adjustments on the production program.

The airplane being delivered now in the second wing is going to be in July of 1970 and this will be what we refer to as the F–111E version. This has some updated equipment, including the continuous-solution computers; it has an improved inlet on it over the A version.

What we now reflect is the schedule of July 1970 as the IOC for the second wing as opposed to an initial estimate of February 1969 which was made back in 1963.

REASON FOR F–111 DEVELOPMENT COST INCREASE IN FISCAL YEAR 1970

Mr. LIPSCOMB. What difficulties caused the increase in the total estimated cost from the $1.473 billion estimated last year to the $1.569 billion estimated cost given this year?

Mr. JONES. This is primarily because of the additional problems we have had in the F–111D program and for additional flight testing that has resulted.

Mr. LIPSCOMB. For the record, you can explain more fully what difficulties have caused the $95 million increase in the estimated total costs in a year's time. We are not strangers to this program but we would like to keep the record current on the causes for increases.

Mr. JONES. I will be glad to give you for the record a detailed summation, Mr. Lipscomb. The Mark II avionics development program accounts for about $76 million and the increased flight test program about $19 million. I will give you a more detailed statement for the record.

Mr. LIPSCOMB. Very good.

(The information follows:)

F–111A/D EXPLANATION OF INCREASED COST

The Mark II avionics development program accounts for $76.8 million of the increase. Items within Mark II associated with this cost growth include the attack radar, integrated displays, and the systems' integration task. For example, the development of the digital doppler processor unit (DDPU) was required in order to meet specification requirements for the attack radar. The remaining $19.0 million is required for the rephased flight test program, partially due to a slippage of planned fiscal year 1969 testing into the fiscal year 1970 time period.

PORTION OF FISCAL YEAR 1970 REQUEST FOR MARK II AVIONICS SYSTEM

Mr. LIPSCOMB. How much of the $73.7 million request in fiscal year 1970 is for development of the Mark II avionics system?

Mr. JONES. About $3.3 million.

Mr. LIPSCOMB. Would you detail for the committee the development difficulties which have been encountered in the development of the Mark II avionics system? To what extent have these difficulties been overcome? You can do that for the record.

(The information follows:)

MARK II AVIONICS SYSTEM—DEVELOPMENT DIFFICULTIES

The principal early difficulties of Mark II were centered in the radar and displays; the two elements of the system which provide the greatest gain in capability. The radar problems were largely connected with the radar's lookdown

mode. The development and flight test of a digital processing unit has completely overcome this problem. The problems with the displays were less significant and consisted of a certain amount of "jitter" of the symbology and pictures, some nonlinearity and an overheating problem in the horizontal situation display. These problems have been largely overcome by evolutionary engineering; a minor part of the problem remains but is being overcome. The displays work acceptably now and will work better in the near future.

DELIVERY SCHEDULE FOR MARK II AVIONICS SYSTEM

Mr. LIPSCOMB. At what date do you believe a completely developed, reliable Mark II system will be available for the F–111 aircraft?

Mr. JONES. F–111D, No. 3, which will be delivered in January 1970. The first production sets of the Mark II system for the F–111D's are going to General Dynamics in September of this year with the first aircraft installation about October of this year. We are presently flying, however, the first integrated test set of the complete radar and navigation system in a total, Mark II avionics package. We just started flying that in the integrated package in a test F–111D in May.

MARK II AVIONICS WORTH THE COST

Mr. LIPSCOMB. If you could go back again in time and again face the decision as to whether or not to include the Mark II avionics system in the F–111 aircraft, would you again make the decision to go ahead, or is this something which has turned out to be more costly than it is worth?

Mr. JONES. That is a multiple-part question, Mr. Lipscomb.

I think certainly hindsight has shown us a lot about how not to go about initiating and developing programs such as this. I think if we had the choice again we would not go about our initiation the same way. That is, we would probably have taken more time in the actual definition stage before we went to contract. We would have gotten a better understanding of the actual operation of the system before we committed it to production. We would hopefully not have been in as tight a production build-up program at the time we tried to introduce development.

However, looking at the overall system as it is being demonstrated now, it appears to be worth the agonizing pains and costs that we are having to go through. Naturally we would hope to keep the costs down. We would like to have it for a lower price than we are able to get it for at this time. The system is doing well in the development program right now and we do think it is going to give TAC a credible capability.

RF–111 AIRCRAFT

Mr. LIPSCOMB. There is a request for $15 million in fiscal year 1970 and it is estimated that the total RF–111 development program will cost $72.4 mililon. Would you detail the funding request for the RF–111 aircraft for the record, please?

The information follows:)

The funding request for fiscal year 1970 for the RF–111 is to accomplish previously deferred tasks such as development of certain aerospace ground equipment, the reconnaissance subsystem control and test set (RSCTS), data display and general engineering effort. It further includes development of an advanced side-looking radar, Elint and cameras.

	In millions
Peculiar RF–111 equipment development	$12.055
Electronics GFAE development and adaptation	.453
Aerospace ground equipment design, development and drawings	1.0
System development testing	.992
Data	.5
Total	15.000

COSTS RELATING TO SENSOR PACKAGES

Mr. LIPSCOMB. Does this include the development cost for the sensors to be used on aircraft, or is the $72.4 million cost involved only with the packaging of the sensors in the aircraft and modifications to the aircraft to accommodate the sensor packages?

Mr. JONES. This is predominantly for the packaging of the sensors and the modification and adaptation of the airframe for those sensors. There are two of them. The advance side-looking radar and some of the Elint work, which are engineering models. We are taking them from engineering models and putting them into production models and packaging them with the rest of the sensors, but we are not undertaking development, per se, of any of the sensors.

Mr. LIPSCOMB. To what extent must the sensor packages for the RF–111 be developed?

Mr. JONES. Essentially as I have said, sir, we are having to develop some of them from engineering models. They are very advanced sensors which will go in the RF–111D version, but we are not developing the sensors, per se, for the airplane. They are primarily packages in development and/or production for installtaion in the RF–111.

CURRENT COST OF RF–111 DEVELOPMENT

Mr. LIPSCOMB. Last year an estimate of $49.6 million was given for the total cost of the development of the RF–111. The estimated total cost is now stated at $72.5 million. What difficulties have been encountered to cause this large percentage increase in cost?

Mr. JONES. The original estimate of $49.6 million was based upon the development of the RF–111A, which has the Mark I avionics. With the decision to delay the introduction of the RF and use the capability out of the F–111D Mark II system, the whole sensor package was improved and we have had to integrate with the broader capability of the F–111D. So the entire program has gone up somewhat in cost, but we are getting a greater capability, we believe.

TOTAL RF–111 AIRCRAFT TO BE PROCURED

Mr. LIPSCOMB. How many RF–111 aircraft do you plan to procure?

Mr. JONES. Sixty.

Mr. LIPSCOMB. What is the estimated unit cost of a complete RF–111 weapon system in the procurement program?

Mr. JONES. We estimate at the moment $11.4 million, based on the production of 60, and coupled with some 650 other F–111 and FB–111 aircraft. You recognize, of course, that the number is a variable depending upon the total number of aircraft produced and these aircraft are

at the end of the line so they will reflect the learning curve of any of the previous aircraft produced.

Mr. LIPSCOMB. What did you estimate the unit cost to be?

Mr. JONES. The gross weapon system unit cost, we estimate right now, will be $11.4 million.

RF–111 AIRCRAFT PROGRAM COST INCREASE

Mr. LIPSCOMB. And what is the estimated total procurement cost of this aircraft?

General PITTS. The current approved program is $822.4 million, Mr. Lipscomb.

Mr. LIPSCOMB. That is for the 60?

General PITTS. Yes, sir.

Mr. LIPSCOMB. Can you compare the original cost and time schedule estimates for the RF–111 with the present total cost and time schedules? You may do that for the record.

General PITTS. I can give some general figures right now.

As I said, the current approved program is $822.4 million. In January 1968 the approved program was based on a total of 60 RF–111D's and a total production of 1,296 F/FB–111's. At that time the R.D.T. & E. flyaway, AGE training data, and initial spares was estimated at $593.5 million. That compares to the $822.4 million we are now estimating and we will amplify that for the record.

(The information follows:)

RF–111 ORIGINAL VERSUS PRESENT COST AND TIME SCHEDULE

The original total program estimate was $593.5 million with deliveries scheduled for the 1971–72 time period. The total F–111 program buy was 1,429 aircraft. Budgetary decision subsequent to January 1968, along with program and schedule changes have reduced the total program buy to 728 aircraft and slipped the RF–111 deliveries to the 1973–74 time period.

The RF–111D is in reality a much more advanced (and different) aircraft. The current total program estimate is $822.4 million. The increase in costs stem from the effects of total F–111 program quantity and schedule changes, increased prices, the decision to incorporate the TF–30–P–100 engine into the RF–111D, and finally to use more sophisticated reconnaissance sensors commensurate with the anticipated threat and operational environment of the future.

AERIAL TARGET PROGRAM

Mr. LIPSCOMB. Can you describe the aerial target program for which you are requesting $2.2 million?

Mr. HANSEN. Yes. The objective of that program is to simulate the size and maneuverability, the infrared signatures and the electromagnetic radiation of various types of aircraft as targets that are used for testing and evaluation of air-to-air missiles. Some of these are towed by aircraft. Some are self-powered, either with turbojets or rocket engines. In this program, maximum use is being made of targets that have already been developed for other services, primarily the Navy. Modifications are made on those where it is necessary to do so to simulate the particular type of targets in which the Air Force is interested.

Mr. LIPSCOMB. What was accomplished with the $2 million provided for this program in the current fiscal year?

BQM–34–F TARGET DRONE

Mr. HANSEN. The Navy has a BQM–34–E drone being modified into an "F" version, supersonic drone. The $2 million was required for that.

Mr. LIPSCOMB. That is the Air Force's share in the Navy program? Is that what you are saying?

Mr. HANSEN. It was the cost of the Air Force changes to the configuration which had been developed for the Navy. This essentially was to make provisions for a midair retrieval system and put in a scoring system and some signature augmentation systems.

This program slipped. We now anticipate its being accomplished a little later than was originally planned. It will be July of 1970 for completion of the engineering program with deliveries starting in February 1971.

I believe I am correct in saying that the Navy program also slipped.

INABILITY TO USE NAVY DRONE

Mr. MINSHALL. Why does your target drone have to be different from that of the Navy?

Mr. HANSEN. One reason is the Navy is picking them up out of the water and we would like to have the capability to snatch them out of the air, ———

Mr. MINSHALL. Wouldn't it be feasible to do your practice over water?

Mr. HANSEN. That isn't where our test ranges are. Our test ranges are over land.

Mr. MINSHALL. Where are your test ranges?

Mr. HANSEN. Holloman and Nellis. We do testing at Eglin, too. Some of it could be over water.

BMQ–34–F PROGRAM SLIPPAGE

Mr. MINSHALL. How much has this program slipped?

Mr. HANSEN. I don't know what the original dates were. I will have to supply that for the record. I don't think the slippage was in this modification program. I think the slippage is in getting the basic BQM–34–F drone from which we start to make the modifications. I would have to verify that.

Mr. MINSHALL. Supply whatever the facts are for the record, would you?

Mr. HANSEN. Yes, sir.

(The information follows:)

We presently have a requirement to use the BQM–34F (Air Force version of the Navy BQM–34–E) at three ranges. These are Holloman Air Force Base, N. Mex.; Eglin Air Force Base, Fla.; and Clark Air Base, Philippines. Of these three, Clark Air Base and Eglin Air Force Base are water ranges. Our main missile development center, however, is at Holloman which is a land range.

The Navy's BQM–34–E development and production programs have slipped approximately 10 months; as a result the delivery of the Air Force's first production of the BQM–34–F has slipped approximately 10 months. We now anticipate receiving our initial BQM–34–F target drones in November 1970 versus the original schedule of February 1970.

FISCAL YEAR 1969 PROGRAM

Mr. LIPSCOMB. Have you used your fiscal year 1969 funds of $2 million?

Mr. HANSEN. Yes, sir.

Mr. LIPSCOMB. How did you use the $2 million for fiscal year 1969?

Mr. HANSEN. Colonel Hoermann, do you have something on the breakdown of what was actually used on the drone?

Colonel HOERMANN. $205,000 was reprogramed. The rest was used on the drone program.

Mr. LIPSCOMB. Some was a reprograming action on the F-15?

Colonel HOERMANN. Yes, sir; $205,000.

Mr. LIPSCOMB. And then you are planning to use $1.8 million in the drone program for fiscal year 1969?

Colonel HOERMANN. Yes, sir.

Mr. LIPSCOMB. If the program slipped, what are you spending it on?

Mr. HANSEN. The slippage has been starting the program. What has been going on is the preliminary contractor in-house engineering design and development of equipment which will go into the modification of this drone. This is being done at Ryan and about 6 or 8 weeks ago I was out talking to them about the program. I saw the hardware. So I know they have been working on it. The understanding that I have is that the testing and delivery dates are being held up because there is a holdup in the basic development of the Navy version of the drone which will then be modified with the engineering and hardware that is being brought along in parallel with the Navy development for application to it to meet these dates of testing and production deliveries.

CONTINUING DEVELOPMENT PROGRAM

Mr. MINSHALL. Excuse me just a minute.

Before we leave aerial targets, I notice that you have under "Additional to completion"; "Continuing and total estimated cost N/A." I guess that "N/A" means "not available."

Haven't you any kind of a ball park guess as to when you are going to complete this program or is it going to go on indefinitely in an R. & D. stage?

General MCNICKLE. N/A means "Not applicable," or "Not available." A particular drone will be completed, but there will be other aerial targets in various stages of development. These are different drones and targets within the aerial targets line.

Mr. HANSEN. The program element covers aerial targets in general whereas what I have just been talking about is this BQM-34, which is a specific one that is under development now.

Mr. LIPSCOMB. Do you have a cost on that one, Mr. Secretary?

Mr. HANSEN. I think the $2.2 million for fiscal year 1970, as far as I know, finishes up that particular drone program and the expectation is that there will be more advance targets in the aerial target line in the future as we learn more about what we have to shoot at in the future.

CAPABILITIES OF TARGET DRONES UNDER DEVELOPMENT

Mr. MINSHALL. What will be the capabilities of these target drones that you are developing now, supersonically? They will be much what?

Mr. HANSEN. We will have to provide that for the record.

Mr. MINSHALL. I presume they will be something within the ball park of the enemy's capabilities?

Mr. HANSEN. Yes, sir; I think it is like ———. We will supply the specifications sheet for the record.

Are there any other characteristics besides speed that you are interested in?

Mr. MINSHALL. You said you are going to improve them constantly. I would like to know what improvements you are cranking into them aside from the maneuverability, the speed, the range, and so forth.

Mr. HANSEN. We will put a description of it in the record.

Mr. MINSHALL. Thank you.

(The information follows:)

TARGET DRONES CAPABILITIES DESCRIPTION

The advanced targets we are developing will eventually achieve the following performance characteristics:

(1) Altitude—must be capable of performing from sea level to ——— with high maneuvering capability.

(2) Maneuver—must be capable of turns at 5 g.'s (7.33 g.'s desired) in the horizontal and vertical plane, at altitudes between sea level and 25,000 feet mean sea level. Maneuver degradation is acceptable at higher altitudes. Must be capable of performing "S" turns and continuous hard turns in either direction as well as in the vertical plane (dive and climb). Drone must be capable of above maneuvers on command.

(3) Speeds—must be capable of supersonic speeds of ——— up to 35,000 feet ——— and ——— and as low as feasible (subsonic) with ground selectable cruise speed within this regime.

(4) Endurance—must have a minimum range time of 10 minutes (15 minutes desired) when supersonic and maneuvering at 20,000 feet and above. Subsonic range time of 30 minutes is required.

(5) Signature—the target must be capable of presenting radar, infrared, and visual/optical signatures compatible with the threat aircraft. Augmentation, when required, must be available throughout the flight, or on demand, but in all cases of sufficient period to complete the intercept of the launch aircraft and weapon. Augmentation, when used, can be in kit form and ground installable.

(6) Radar—must be selectable to represent fighter and bomber class aircraft, and available for 360° aspect (ground selectable aspect presentation is acceptable). Minimum radar cross-section (X-band) shall be:

Nose: ———.
Beam: ———.
Tail: ———.

(7) Infrared—must be representative of a jet engine (selectable for turbojet or fanjet desired) from the tail aspect ———. Minimum infrared intensity (total at sea level) shall be:

Aspect	Jet-tail pipe w ster	Jet-plume w ster
Nose	——	——
Beam	——	——
Tail	——	——

(8) Visual—should have a capability of presenting full fighter size targets usable with possible future ——— seeker equipped air-to-air missiles.
Minimum ——— contrast area shall be:
Nose: ———.
Beam: ———.
Tail: ———.
(9) Scoring—each missile fired at an aerial target must be scored. Vector miss distance from the missile aim point at closest approach and at fuzing from ——— miss is required for some evaluations. Other missile firing objectives can be met by scoring only whether the missile passed within a certain radius of the aim point or not. As vector scoring will probably be expensive, a family of scoring systems should be investigated.
(10) Control and telemetering frequencies must be compatible with the post-1973 period.
These characteristics include all the improvements presently planned over existing targets. The BQM—34F itself will be a mach 1.8 target with a 61,000 foot maximum altitude.

C–5A Aircraft

Mr. Lipscomb. You are requesting $34.2 million for the continuation of the development of the C–5A aircraft. If these funds are appropriated, how much money will be required for the completion of this program?

General McNickle. $9.6 million required in 1971. This should be the end of the R. & D. funds.

C–5A PROGRAM UNDER OSD REVIEW

Mr. Hansen. We have a very intensive review of the C–5A program which is taking place right now at the direction of Secretary Seamans and led by our new Assistant Secretary for Installations and Logistics, Philip Whittaker. We were discussing at lunch today, as a matter of fact, that one of the very important things that is going to come out of this is the confirmation of not just the R. & D. cost but all of the costs. I think one of the biggest questions that remains in the program today is, what is our most realistic estimate of the run-out cost for that program?

We think if we don't run into any further trouble that the remaining R. & D. bill is pretty small.

Mr. Lipscomb. We realize the Department of Defense and the Air Force are working hard on getting this matter straightened out. It is an inherited problem with you.

Mr. Hansen. We have taken it on. The first trip I made out of town was to go with my predecessor, Dr. Flax down to the factory at Lockheed—Georgia—and review the technical program, the test program, the test results to date and the remaining tests planned. Test-wise, this is a very critical year for the C–5A. If it goes according to plan, I assume this is going to be enough money. It sounds like it ought to be. If we run into any more problems, which we don't expect, it is a new ball game.

CURRENT ESTIMATE OF C–5A DEVELOPMENT COSTS

Mr. Lipscomb. What is the currently estimated total development cost of the C–5A, and what was the cost estimate for development at the time the program was first submitted to the Congress?

General PITTS. The current estimate for R. & D. to completion is $1,003.4 million, Mr. Lipscomb.

At the time the contract was awarded in 1965, we estimated the total R. & D. to be about $900 million. There has been about a $100 million increase in R. & D.

C-5A DEVELOPMENT PROGRAM SLIPPAGE

Mr. LIPSCOMB. How much slippage has occurred in the C-5A development program?

General MCNICKLE. The development program proceeded on schedule through rollout of the first aircraft. The flight-test program is experiencing some delays. The production schedule has slipped 6 months for the first operational aircraft delivery.

General BOYLAN. The previous initial operation capability was forecast for late this year. Our first operational unit will be 6 months late. Before the first squadron is operational, of course, we will man the transport training unit with five aircraft in Oklahoma. But the answer to the question is a 6-month slip in production articles.

Mr. LIPSCOMB. That is not too bad for a program of this magnitude.

Mr. HANSEN. Actually, in terms of cost and the schedule, the R. & D. program isn't really the big problem. The big problem is the production costs for the airplane as projected.

BREAKDOWN OF FISCAL YEAR 1970 FUNDS REQUESTED

Mr. LIPSCOMB. Will you break down for the committee the elements of the $34.2 million request, and indicate how much of this amount is for the various components of the aircraft and for the various categories of testing? Do that for the record.

(The information follows:)

	Dollars in millions
Lockheed:	
Airframe components	4.66
Training	.12
Peculiar AGE (test)	.23
Categories I and II, instrumentation, fatigue and static test	5.23
Systems test management	1.41
Data	.75
Total	12.40
General Electric:	
Peculiar AGE (test)	1.63
Engine test	3.43
Test management	.24
Total	5.30
Air Force adds	16.50
Total	34.20

This includes funds for first destination transportation, depot AGE design, test support, Arnold Engineering Development Center (engine test), and ECO.

C–5A FLIGHT PERFORMANCE COMPARED WITH OTHER AIRCRAFT

Mr. LIPSCOMB. How has the flight performance of the C–5 aircraft been to date? How would you characterize the performance of this aircraft in the test program as compared with other transport aircraft, such as the C–141, which have been developed in recent years?

Mr. HANSEN. Since I have been down there looking at that, I will answer it partly and see if Joe Jones can add to it.

I think that this airplane is performing very well. The flight tests so far indicate that it is meeting its requirements very well. I am told by the Lockheed people that as compared with the C–141 at this stage of development, its performance versus the the requirements is better than the C–141 was. They have four airplanes that they have been flying. They have well over 300 hours of flying time. The people who fly the airplane say that it is amazingly easy to fly for such a big airplane. I think technically it is a good airplane.

Mr. JONES. I think what you have just said is very true. At this point in the program you must recognize we are just starting into the flight test program but we have completed certainly the low-speed part of the flight test, the landings, the stalls, the flutter boundaries and so forth. The evaluation of the airplane up to this point is that it is meeting its specifications and in some cases doing better than the specifications that were set for it. We have a long way to go but at the present time and for the state of the development program itself, it is doing better than most airplanes at this point in the program.

Mr. LIPSCOMB. You can expand that further for the record if you like.

(The information follows:)

TEST RECORD OF THE C–5A

The major portion of the stall development program has been completed. The landing, cruise, and power approach configurations at various combinations of weight and center of gravity for both straight and turning flights have been accomplished. The aircraft performs satisfactory—even at high angles of attack—26°–27°. Approaches are generally smooth with little buffet. Strong elevator power remains at high angle of attack with immediate recovery available to the pilot.

Static and dynamic longitudinal and lateral directional stability have been evaluated at mid and aft center of gravity with no apparent problems. From the initial stall and cruise drag data it appears the aircraft will meet or better the performance guarantees of take-off and landing distances and range/payload.

The most significant problems have occurred in the landing gear, slat, and pressurization systems. At the present time production versions of the landing gear are flying on some test aircraft with no significant problems. The slat difficulty has been determined to be in the moveable islands and an engineering-fix version is flying satisfactorily. The pressurization system has been determined to be a seal problem and appropriate attention is being given to insure a proper solution.

Qualitatively, the aircraft handles very well. Pilots who have flown it find it easy to control altitude and airspeed and it is extremely easy to land. The aircraft handes well on the ground and has made 180° turns within the specified 150 feet.

C–5 TEST RECORD THUS FAR PROMISING

General BOYLAN. Mr. Lipscomb, of course, you understand the tests that have been conducted so far are contractor tests. The airplane will enter category 2 testing by the Air Force where we will verify its performance. But the statements that have been made are absolutely correct. The airplane, from all reports, is performing superbly.

Mr. LIPSCOMB. I saw a favorable article in one of the metropolitan papers the other day on the aircraft. I thought it was unusual to see something come out that was favorable.

Mr. HANSEN. Senator Goldwater flew in it and gave glowing accounts of his impressions.

Mr. LIPSCOMB. The costs and the contract have been publicized by various media but I think it is good to stress the fact that this aircraft was developed for a capability needed by the military, and at this point, all indications are that it is going to perform well.

COST OF DEVELOPING C–5A SUPPORT EQUIPMENT

How much money has been spent by the Air Force and how much more is planned to be spent by the Air Force in the development of various kinds of equipment for the support of the C–5 aircraft? In the procurement hearings, we discussed a 55,000 pound loader. Are there other items of special equipment for the C–5 program for which development funds have been or are being spent?

General MCNICKLE. We have modified five of the present inventory items, the 40,000–pound loader to a 50,000-pound configuration for a total of $634,000. The reason we need the bigger loader, the 55,000-pound loader, is that it takes six pallets. To give the airplane a 15-minute turnaround, it will take six pallets off, whereas the 40,000-pound loader will take only five at a time. To my knowledge, this is the only specific item that has been developed, not on the C–5 line, to take care of the unloading problem. There are, however, other items of air cargo handling being sized for the C–5 although they are not peculiar to the C–5.

MOBILE LOADING DOCKS FOR C–5A AIRCRAFT

Mr. MINSHALL. I thought the funds originally programed for the mobile loading docks had been reprogramed for other critical needs. Am I in the wrong church here?

General BOYLAN. If I may correct the record, I am quite certain that within the overall C–5 contract there is a provision for the development of a loading dock, air transportable. Its purpose will be to be positioned in unprepared airfields. It will have the capability of receiving three C–5A loads of 463–L pallets. It is a roller-conveyor device that would be airlifted, positioned, to assist in the off load of C–5's that are transiting that airfield.

Mr. MINSHALL. Let me ask my question again, please, General.

Last year, fiscal 1969, you requested funds in the amount of $1.4 million to procure four mobile loading docks for the C–5 aircraft. What happened to that money?

Colonel HOERMANN. We spent $2.27 million in R. & D. and production money on the first unit. As General Boylan pointed out, we are

procuring four more, a total of five air transportable mobile loading docks.

Mr. LIPSCOMB. That is not the 55,000-pound loader?

Colonel HOERMANN. No, sir.

Mr. LIPSCOMB. This is another piece of equipment?

Colonel HOERMANN. Two separate and distinct things.

General BOYLAN. It is a semipermanent structure that is air transportable, erected so that C–5's can off load at airfields that are not prepared normally for big cargo aircraft.

MOBILE LOADING DOCK

Mr. LIPSCOMB. We have in front of us a picture identified as truck cargo loading-unloading, 40,000 pounds.

General BOYLAN. Yes, sir, we have a number of those in the Air Force inventory.

Mr. LIPSCOMB. This was given to us as an example of the type of thing the 55,000 pound loader would be.

General BOYLAN. Absolutely.

Mr. LIPSCOMB. It is our understanding that you took R. & D. funds and awarded a contract to some company to build you five 55,000 pound units by modifying this 40,000 pound model. That is the way we understood it from the procurement hearings.

General MCNICKLE. Yes, but with production funds—not R. & D. funds.

Mr. LIPSCOMB. You say you spent——

General MCNICKLE. $634,000.

Mr. LIPSCOMB. Out of R.D.T. & E. funds to modify these five 40,000 pound loader-unloaders?

General MCNICKLE. No, Mr. Lipscomb, those were production funds.

Mr. LIPSCOMB. Now on the back of this picture is a little memorandum—this is a picture that was given to us by the procurement people—which says—

Mobile loading dock, four each. $1.4 million. Last year, fiscal 1969, we requested funds in the amount of $1.4 million to procure four mobile loading docks for the C–5 aircraft. Development of a prototype with R. & D. funds has not progressed as planned and procurement data will not be available during fiscal year 1969. We are now considering a new approach to the problem. Both the mobile and the fixed loading dock are under consideration.

Design studies are being contracted with fiscal year 1969 R. & D. funds. Prototype development will be initiated with fiscal 1970 R. & D. funds. We do not expect procurement data to be available for production until fiscal 1971. Funds originally programed for the mobile docks have been reprogramed to procure other critical needs such as crash fire trucks and base maintenance equipment for Southeast Asia.

That memorandum was attached to the back of this picture which was to demonstrate the truck cargo loading and unloading.

So Mr. Minshall and the rest of us are just trying to receive clarification.

General BOYLAN Yes; I must admit that the combination of that memorandum and picture certainly does not clarify.

Mr. MINSHALL. That is why I asked if I was in the right church.

General BOYLAN. They are two separate and distinct pieces of equipment being discussed here. The picture is of the mobile loader and the dock is completely different.

The status of the funding, I am sorry I will have to defer.

Mr. LIPSCOMB. Did you give up on the mobile loading docks for fiscal 1969?

General BOYLAN. We did not procure the mobile loading docks, but the requirement for the air transportable loading dock remains fixed. It is essential to the operation of the C–5 in forward areas.

Mr. LIPSCOMB. When you say the requirement, have we gone ahead with the program and expended any funds and do we have any funds in fiscal 1970?

Colonel HOERMANN. I did not know sir, that we were starting the development of the loading dock. It seems to me that the procurement money was reprogramed because the R. & D. had not been completed. We will have to check that.

Mr. LIPSCOMB. You have two programs going, loading dock and the loader.

General PITTS. The money which was in the other procurement appropriation was reprogramed because the R. & D. on the mobile loading dock had not been finished.

Mr. LIPSCOMB. You indicate you will have one loader that will go on the aircraft and can be transported to unprepared airfields where they do not have loading facilities.

General BOYLAN. There are two loading docks. One is to be air transportable and the other is called mobile but is not air transportable. The 40–K and 55–K loader will be air transportable, though normally we won't fly them around on a routine basis.

Mr. LIPSCOMB. You were buying enough to place around at certain airfields.

General BOYLAN. That is right, to support the airlift aircraft as they normally transit stations.

Mr. LIPSCOMB. Would you for the record be sure that the questions which we have asked are answered in detail? Are there other items besides the loader—other items of equipment—for the C–5 program for which development funds have been or are being spent?

General BOYLAN. Yes, sir.

(The information follows:)

In addition to the peculiar AGE which was developed and produced concurrently with the aircraft (described in last paragraph) and funded in the C–5 line, the following equipments required development funds:

(a) Design study for a C–5 permanent terminal loading system; $250,000 fiscal year 1969 funds provided. Contract is in process of being written.

(b) Design study for a C–5 mobile loading system; $250,000 fiscal year 1969 funds provided. Contract is in process of being written. This study will result in design of equipment that is capable of operating at air terminals where the C–5 will transit, without being permanently fixed to the facility. It is to be air transportable for movement to another location when desired. This item was referred to in the past as a mobile loading dock until the decision to divide the effort into studies of fixed and mobile systems.

The five 55K prototypes were developed from an engineering change to five 40K loaders while still on the contractor's assembly line. Other procurement funds in the amount of $634,000 covered the cost of this change in configuration.

The air transportable loading dock was developed as peculiar AGE in the C–5 contract. It is for use in bare areas and does not serve the same purpose as the permanent terminal and mobile loading systems described above. All of this equipment is complementary but not conflicting in function.

The 40K loader referenced in the transcript is not a new item, has been in world-wide use over five years, and costs approximately $81,000 each. The 55K loader is a growth version of the 40K which we are estimating at $100,000 each but will hopefully be substantially lower in production quantities.

C-5A DEVELOPMENT COST COMPARED WITH BOEING 747

Mr. LIPSCOMB. Do you know how the development cost of the C-5 aircraft compares with the cost of developing the Boeing 747 aircraft?

General MCNICKLE. No, sir. We do not have those costs. However, we have been told that approximately 200 airplanes is Boeing's break-even point.

MOBILE LOADING DOCK

Mr. MINSHALL. May I ask another question about this much belabored truck, cargo, loading/unloading, 40-K? You have on the back of this memorandum that four of these cost $1.4 million. Is that correct?

If this is so, each one of these vehicles costs $350,000. That is all I have to go by. If that is the case—I do not know how many have seen this—somebody is getting robbed.

General BOYLAN. Mr. Minshall, if I may correct the record, I am quite certain that the figure quoted there of $1.4 million relates to the mobile loading dock and not to the 55-K loader.

(The information follows:)

The $1.4 million figure relates to the four mobile loading docks in the fiscal year 1969 "Other procurement Air Force" budget request. Procurement of the mobile docks has been deferred because development of the prototype has not progressed as planned. Procurement data for competitive procurement is not expected before late fiscal year 1970 or early fiscal year 1971.

Mr. LIPSCOMB. The memorandum, then, must be on the wrong picture.

Mr. MINSHALL. On the back of the picture it says mobile, and it appears to be mobile, looking at the picture. So there is nothing here about any permanent loading dock.

General MCNICKLE. I think the description pasted on the back, though, probably goes with another picture.

Mr. MINSHALL. It mentions mobile in this description on the back of the picture.

General PITTS. May I take a guess at that?

Mr. MINSHALL. Let us stop guessing and clarify the record.

General PITTS. I am trying to be helpful in that respect, Mr. Minshall. I would suggest that we talk about a technique used in presentations before congressional committees. We sometimes have a picture and on the opposite page or facing page that goes with that picture we paste a memo with pertinent facts which describe what you are looking at in the picture. I am suggesting that the words on the back of that picture are intended as a facing page for another picture that would follow and would depict the mobile loading dock.

Mr. MINSHALL. I do not know how these got mismated, but one is scotch taped to the other.

General BOYLAN. Mr. Minshall, would you acquaint me with the gentleman who pasted those two things together?

Mr. LIPSCOMB. We don't know.

Mr. MINSHALL. If the unit cost of one of these vehicles is $350,000, I just cannot believe it. An old-fashioned carriagemaker could put one of those together.

General BOYLAN. Based on memory, I think the 40–K loader is valued at something like $80,000. It is a complex hydraulic machine. I will see that you get the correct price for the loader, 40 and 55–K loader and the mobile dock.

NEW TECHNIQUES IN AIR DELIVERY OF CARGO

Mr. LIPSCOMB. I think this is a good place to discuss additional techniques because we are talking about 55,000-pound drops out of the C–5A. ———. Have we done any research in this area at all, or even thought about this, or is it an impractical approach? This would be more for the Army, I suppose.

Mr. HANSEN. You mean with cargo. That is what we are doing on the moon. The surveyor program did that.

Mr. LIPSCOMB. ———.

General MCNICKLE. We have used chutes for a long time and up to the C–5 we have had a chute capability that would slow the load down enough so that we did not have a problem.

Mr. LIPSCOMB. ———.

General MCNICKLE. We have used multiple chutes and, so far, solved the problem that way. It is joint with the Army, as you mentioned.

Mr. LIPSCOMB. ———.

General MCNICKLE. Yes.

General BOYLAN. In our conversations the other day on extraction, the statement was made that we had accomplished 50,000 pounds. The C–141 was qualified with a drop of 35,000. The project is underway for qualification of the C–5 and we expect a 50,000-pound drop in its qualification.

Mr. HANSEN. I think we should take a specific look at what we have done about this because in the country a lot of work has been done. The lunar landing modules in the Surveyor program and others had a lot of work done on braking retrorockets and soft-landing pads and things like that. ———.

We will certainly go back and take a look at that.

Mr. LIPSCOMB. I feel when you are going into a 50,000-pound drop you are going to have to take a look at your chutes as well as many other things.

General BOYLAN. Yes, sir; and the extraction system itself to get it out of the airplane.

(Discussion off the record.)

AEROSPACE FLIGHT DYNAMICS

Mr. LIPSCOMB. You are requesting $30.8 million for fiscal year 1970 for aerospace flight dynamics. This compares with $24.8 million in fiscal 1969, and $22.7 million in fiscal year 1968. What are the reasons for this large increase in this area?

Mr. HANSEN. We are back in the laboratory area again, and this is Dr. Lehmann's area. He has asked me to excuse him this afternoon. He is off checking on behavioral science programs.

Colonel HOBRMANN. Sir, I can answer that question. First of all, AEDC has been put under an industrial funding concept by OSD. This increase in the flight dynamics program is to pay for the work that will be done in AEDC by the Flight Dynamics Lab. In prior

years this work was budgeted for under an AEDC line. In the 1970 budget the AEDC line has been reduced to a very small amount and all the programs will pay for their own test work.

Mr. HANSEN. I might expand on that just a little. I mentioned earlier today that I had just finished reviewing their program and I would like to point out that if you take this $30.817 million and substract the $7.1 million for AEDC, which would have previously been shown on a separate line, the resulting amount is actually a decrease in funding rather than an increase for this lab. They are complaining about that.

Mr. LIPSCOMB. Would you describe the primary purposes of the aerospace flight dynamics program?

Mr. HANSEN. Yes. Their principal areas are structures, flight control, flight mechanics, dynamics and vehicle equipment. I have a short statement I can put in the record.

Mr. LIPSCOMB. You may insert it in the record.

(The information follows:)

The purpose of this program is to develop flight dynamics technology for current and future aerospace vehicles. This program is concerned with structures, flight control, flight mechanics, dynamics, and vehicle equipment. Efforts are directed toward providing structural integrity in flight vehicles by establishing design criteria, advanced analysis techniques, advanced construction concepts, and new structural testing techniques; developing criteria for future ground test facilities; insuring crew escape and suitable crew station design; providing solutions to problems of stability and control; providing new techniques for control-display integration; solving problems in aeroelastic instabilities and acoustic fatigue; and development of new and unique landing systems.

AMOUNT OF PROGRAM CONTRACTED OUT

Mr. RHODES. How much of this effort is contracted to profitmaking companies and how much is done in colleges, universities and nonprofit organizations?

Mr. HANSEN. There is $10.9 million with profitmaking companies and $600,000 with colleges, universities, and nonprofits.

PURPOSE OF THREE NEW PROGRAMS

Mr. RHODES. Describe the purposes of the three new programs—advance structures, aerospace vehicle combat survivability, and filamentary composite structures.

Mr. HANSEN. May I put that in the record?

Mr. RHODES. Yes, sir.

(The information follows:)

CONTRACTS WITH PROFITMAKING ORGANIZATIONS, COLLEGES, UNIVERSITIES AND NONPROFIT ORGANIZATIONS

The purpose of the advanced structures program is to provide the necessary preliminary design capability to effectively integrate advanced structures technology into current and future Air Force aerospace weapon systems. This program will identify specific structural problems in current and future systems, implement necessary action to furnish a solution, provide trade studies for concept selection and weapon system definition, and exploit embryonic ideas into firm structural applications.

The Air Force Flight Dynamics Laboratory has recently been designated the lead laboratory for aircraft nonnuclear survivability. As a result of this role, the new project titled "Aerospace Vehicle Combat Survivability" has been estab-

lished. The purpose of this project is to develop design concepts and techniques for the design of combat aerospace vehicles which provide maximum survivability against nonnuclear enemy weapons. Included are programs to develop survivable fuel tank systems, variable geometry fuel tanks, parasitic and integral armor systems, survivable flight control/repairable aircraft structures. The project directly supports Southeast Asia activities and design of future Air Force aircraft.

Filamentary composite structures have the potential to provide large weight savings in aircraft structures. These large weight savings will permit increases in the effectiveness of air weapon systems and large increases in range and payload. The objective of this project is to provide a basic understanding of the behavior of these type structures, and to develop structural design techniques to the point where these composite structures can be considered for widespread application.

AIR FORCE DYNAMICS LABORATORY

Mr. RHODES. You are requesting an increase of $7.1 million for the Air Force Dynamics Laboratory operation. Why is such a large increase requested?

Mr. HANSEN. Because of a change in the Comptroller's procedures, the Arnold Engineering Development Center is put under industrial funding and the funds that would have normally been on that line are now dispersed to the various laboratories that use their services. This $7.1 increase represents their proportionate share of the cost of operation of the AEDC facility.

ARNOLD ENGINEERING DEVELOPMENT CENTER (AEDC)

Mr. RHODES. Can you tell us how much is in the budget for the Arnold Engineering Development Center for all of the lines that you mentioned?

Mr. HANSEN. A total of $42,127,000.

That includes the AEDC testing technology program of $4.5 million and the distribution of the remaining dollars among the programs that are separately financing their support.

The purpose of that change, as I understand it, was to give a higher degree of responsiveness to the using laboratories and a higher degree of coupling by giving the money to the labs and then having them give the tasks and the money to AEDC together. Previously that money was all budgeted for AEDC and they just took the job somewhat on call and paid for it out of the budget that had already been established, managed by themselves.

AIR FORCE DYNAMICS LABORATORY

Mr. RHODES. Where is the Air Force Dynamics Laboratory located?

Mr. HANSEN. The Air Force Flight Dynamics Laboratory is at Wright-Patterson Air Force Base.

Mr. RHODES. How many military and civilian employees at the Laboratory?

Mr. HANSEN. Ninety-eight military, 610 civilians.

Mr. RHODES. What have some of its recent contributions been?

Mr. HANSEN. I have a list of them here. Do you want me to supply them for the record?

Mr. RHODES. If you will, please.

(The information follows:)

Some recent contributions of this laboratory are as follows:
1. Established standards for fuel tank survivability testing.
2. Revised MIL-A-8860 specification. This specification is used during systems procurement to insure structural integrity.
3. Completed tantalum leading edge design. This design can be utilized for hypersonic aircraft or lifting reentry spacecraft.
4. Developed improved understanding of transonic buffet onset and alleviation. This work directly supports the F-15 system.
5. Established dynamic loads criteria for landing on soft soil.
6. Developed and fabricated a T-39 all electroluminescent instrument panel.
7. Operated liquid metal pump, valve, and control surface actuator at 1,000° F.
8. Completed flight tests of air cushion landing gear on a LA-4 aircraft.

Mr. RHODES. What part of the $19.3 million requested for the Air Force Dynamics Laboratory is for the pay of civilian employees?

Mr. HANSEN. $9.2 million is for civilian employees.

Mr. RHODES. What are the other major areas of cost at this laboratory?

Mr. HANSEN. As we mentioned before, there is the $7.1 million for industrial funding of Arnold Engineering Development Center. Other areas are $1.3 million for maintenance of equipment and operation, $822,000 for supplies and materials, $615,000 for equipment, and $235,000 for travel. The remaining amount covers rent, printing, reproduction, and training.

Mr. RHODES. Are there any questions on Aerospace Flight Dynamics?

Mr. DAVIS. Is this $19.3 million for the laboratory operation included in the $30.8 million under Aerospace Flight Dynamics?

Mr. HANSEN. Yes, that is right.

AIRCRAFT PROPULSION SUBSYSTEM INTEGRATION

Mr. RHODES. Now we go to Aircraft Propulsion Subsystem Integration. You are requesting $9 million for Aircraft Propulsion Subsystem Integration as compared with the $4 million provided last year.

To what extent is this increase due to the change in the method of funding the Arnold Engineering Development Center?

General PITTS. $4 million of that increase is for the testing at AEDC in fiscal 1970, sir.

WORK RELATED TO AMSA AND F-15 DEVELOPMENTS

Mr. RHODES. What work under this heading will be performed in support of the AMSA program? Why are funds for programs such as AMSA and the F-15 funded here rather than under the line item for those aircraft?

General MCNICKLE. Sir, we are doing a quarter scale SST inlet duct test in 1970, applicable to the AMSA. This is funded under APSI because of its general application. There are also engine distortion tests funded under the F-15 program being done at the NASA Lewis Flight Propulsion Laboratory in Cleveland. There is also some work that is done in connection with the F-15 contractor under the F-15 line.

Mr. RHODES. Why are funds for programs such as AMSA and the F-15 funded here rather than under the line item for those aircraft?

General MCNICKLE. Mainly because these are technology programs applicable to any system rather than for a specific application.

The quarter scale duct, even though applicable to AMSA, is a technology program not specifically tailored to that. The work continues here because of its application to other programs as well as to these two programs.

ADVANCED AIRCRAFT NAVIGATION

Mr. RHODES. Are there any questions on "Aircraft Propulsion Subsystem Integration?" If not, we go to "Advanced Aircraft Navigation," which is another program for which you are requesting a substantial increase in fiscal year 1970. The 1970 estimate is $7 million as compared with $3 million for fiscal 1969, and $500,000 for fiscal 1968. What is your justification for an increase of this magnitude?

Mr. HANSEN. This is the area in which we are bringing along advanced navigation equipment for aircraft. There are three principal navigation system development programs that are ready to move in the next year into phases of their development which are more costly than what they were in the previous year.

THREE NEW NAVIGATION SYSTEMS

One is an electrostatic gyro-aircraft navigation system which uses a revolutionary new type of gyro and will produce order of magnitude improvement in navigational accuracy. Another one is called the velocity inertial position program. The third is called the DIL or doppler—inertial—loran program. Those three programs account for the bulk of the money and the increase.

Mr. RHODES. Will you supply for the record an explanation of what you are attempting to do under this heading with these systems and what the primary areas of difference are with these three systems and existing systems?

(The information follows:)

EXPLANATION OF EFFORT UNDER ADVANCED AIRCRAFT NAVIGATION PROGRAM

This program element is the key source of advanced aircraft navigation system technology and is a continuing effort. The broad objectives are to provide the Air Force with self-contained aircraft navigation systems that are fast reacting, extremely accurate, easy to maintain, highly reliable, and with reasonable life cycle costs.

There are three tasks under this program element. The first one is termed DIL for doppler-inertial-loran. The DIL program will optimally combine, by means of a computer program, doppler, inertial and loran information such that the overall navigation accuracy is much better than any of the three inputs. There is some hardware development involved; however, the principle effect is on the computer programing or software package which will have broad application to navigation systems in the future. The DIL program will provide the first full integration of all three navigation sensor inputs, with resultant increases in system accuracy and reliability.

The second task is to develop a gimballed electrostatic gyro aircraft navigation system called GEANS. This is a new concept which greatly reduces the complexity of an inertial navigation system and provides greater accuracy than older, more complex systems. The GEANS system is unique in that the heart of

the system, the electrostatic gyro, has only one moving part, the rotor itself. The rotor is suspended by an electrostatic charge which means that we have an inherently simple device which eliminates bearings entirely. This promises a significant improvement in reliability, of course. The GEANS system also offers an order of magnitude increase in navigation accuracy. The GEANS system will provide extremely accurate velocity vectors for weapon delivery, which in turn will significantly improve weapon CEP's.

The third task, called VIP, for velocity-inertial position is a program which is a logical extension of the work performed under the DIL and GEANS programs leading to the next generation navigation system. We have identified areas which require further technical development before any hardware system design can begin. For example, we need to improve our multiplexing techniques to simplify the interconnections between the components of the navigation system and to greatly reduce the weight and volume of interconnecting cables. Another example would be the development of a laser gyro which would offer a technological breakthrough in meeting our requirements for fast reaction and long-term reliability of intertial navigation systems.

In summary, the ongoing DIL and GEANS efforts are important steps forward in aircraft navigation, but fall short of providing the accurate, fast reaction, highly reliable, cheap, self-contained navigation system that is our ultimate goal. The VIP program will be an evolutionary step forward and will be the next generation, multisensor navigation system.

Light Intratheater Transport (LIT) Aircraft

Mr. Rhodes. Now we turn to "Light Intratheater Transport." Last year you requested $15 million for the development of a new light intratheater transport aircraft, but the supporting data book indicates that only $5 million had been allocated for this program in fiscal 1969. Do you still plan to obligate all the $5 million on the LIT in fiscal year 1969?

General McNickle. Sir, we are only obligating a million dollars. The concept formulation package has not been submitted and consequently it is not yet approved. We have put a million of that $5 million into a program to demonstrate the system for pitch control with the large diameter prop.

Mr. Lipscomb. Has contract definition of this aircraft been initiated?

General McNickle. No, sir.

CONCEPT FORMULATION/TECHNICAL DEVELOPMENT PLAN NOT YET APPROVED

Mr. Lipscomb. The Office of the Secretary of Defense has not approved the concept formulation package/technical development plan for the LIT?

General McNickle. No, sir. As I mentioned this morning we hope to submit it during July.

FISCAL YEAR 1970 PROGRAM FOR LIT AIRCRAFT

Mr. Lipscomb. What is the basis for the request of $1 million in fiscal 1970 and what will be the effort supported by the $1 million?

General McNickle. It will be for advancing the technology. It will be additional support for the large diameter propeller.

REQUIREMENT FOR A LIT AIRCRAFT

General BOYLAN. Mr. Lipscomb, this morning when we were discussing the LIT, one or two points might be added to the record concerning this program. Our experience in Vietnam has pointed out that one of the major deficiencies in our intra-theater airlift capability is ability to provide support to the Army in the many outlying so-called airfields, basically strips of 1,200 feet or less.

In many cases it is only a helicopter area. The Air Force presently has no vertical capability. The Army's capability is basically helicopter and about a 40-mile radius. We do have a C–7 aircraft that serviced many of these airfields. We understand that we are going to have to be operating those C–7s for a number of years until this airplane can be developed. It will fill a complete void in our airlift capability in support of Army field forces.

Mr. LIPSCOMB. I agree with what you say, but we have known this for a long time.

VARIOUS APPROACHES FOR A LIT AIRCRAFT STUDIED

General BOYLAN. The big problem has been which technology approach to pursue. The lift fan, the jet, the tilt wing, and tilt rotor—all of these have been studied exhaustively. Our evidence now shows that the way to go is the tilt wing turbo prop.

Mr. LIPSCOMB. What contractors are participating in the design studies and what design studies do we have underway now?

General MCNICKLE. Design studies have been completed for the concept formulation package. Lockheed-Georgia, Lockheed, Burbank, McDonnell-Douglas, Sikorsky, and Ling-Temco-Vought participated in the design studies. We also have Hamilton Standard working on the technology program for the large diameter propeller and pitch control.

DE HAVILLAND C–8 BUFFALO STOL AIRCRAFT CONSIDERED

Mr. LIPSCOMB. What consideration has been given to utilization of the DeHavilland C–8 Buffalo STOL transport aircraft for the LIT role?

General MCNICKLE. We recognize that we need a vertical takeoff capability. Some of the C–7s are attritting, and some of the C–123s will be transferred to the Vietnamese. We considered the C–7 and C–8 and others as near term replacements but not as a LIT. Earlier requests to procure an interim aircraft have not been approved. We are presently considering this near term problem again.

Approval was given by Mr. Packard to buy 18 C–130s.

Mr. MAHON. What part of the R. & D. cost of the C–8 was borne by the United States?

General MCNICKLE. The Canadian Government paid a third, DeHavilland paid a third and U.S. Army paid a third, $7 million each.

Mr. LIPSCOMB. Have you looked at any other off-the-shelf aircraft for this role?

General MCNICKLE. Yes, sir.

Mr. LIPSCOMB. What was the result?

General McNICKLE. We did an extensive evaluation of all the airplanes that we knew of that could fill the role and provide a substantial tonnage capability. The Buffalo is by far the best STOL airplane available today.

V/STOL VERSUS STOL TO MEET LIT REQUIREMENT

Mr. LIPSCOMB. What do your studies show as to the trade-offs of a tilt-wing aircraft such as you anticipate developing? The tilt-wing aircraft has great capability for short landing and take off distance. But how does it compare in cost, in range and in payload with STOL aircraft of a more conventional nature which might be procured off the shelf for this mission?

General McNICKLE. The one big advantage of V/STOL airplane is that in the STOL mode it can more than triple its capacity in the V/STOL mode. When you buy a V/STOL capability you buy the very best STOL capability but it must be big enough to do the required job. If you buy a candidate which is too small you are limited by cabin size in what you can carry. V/STOL like our proposed LIT gives you a meaningful carrying capability in the vertical mode and also provides a STOL aircraft that is insensitive to available runway lengths. If you buy a STOL airplane designed for say a 1,000 or 1,500 feet, depending on your definition of a STOL airplane, then you just do not operate unless you have that much runway available where each delivery is required.

V/STOL APPROACH MORE EXPENSIVE

Mr. LIPSCOMB. How about the cost considerations?

General McNICKLE. A V/STOL airplane is a lot more expensive than a conventional airplane like the C–7 or C–8, but it can do a job that those aircraft cannot do. What we have done in our studies is compare a V/STOL with the best STOL aircraft that could be available in the same time period. Under these conditions the V/STOL is more expensive but it can operate even when the STOL cannot. We have the results and we can submit a number of those studies, if you would like.

The capability that you really need to work for is to be as insensitive as possible to unexpected changes of runway availability due to enemy action or weather or other mission uncertainties.

Mr. LIPSCOMB. The concept is understood. The fact is that we just cannot seem to make the grade.

General McNICKLE. That is right.

Mr. LIPSCOMB. We need the capability. The mission is laid out for us and we keep going after something that is certainly off into the future.

General McNICKLE. I know you are more aware than I of the number of V/STOL prototypes that have been financed by the United States, and we just do not want to build anymore prototypes unless we have more advanced technology that dictates prototyping. However, we will continue to pursue V/STOL technology for application to the LIT.

ESTIMATED DEVELOPMENT COST OF LIT AIRCRAFT

Mr. LIPSCOMB. What does the Air Force estimate to be the total cost of development of an LIT aircraft if and when you receive a go-ahead on such development?

General MCNICKLE. Approximately $500 million for the development of an LIT of the size and type that we are talking about.

Mr. LIPSCOMB. The supporting data book last year gave an estimate of the total cost of the LIT aircraft at $455 million. This supporting data indicates a total development cost estimated to be $437.1 million. What is the basis for this estimated decrease in development costs?

General MCNICKLE. Both years were based on 1967 dollars and the second one was a refined estimate and better than the first one which was developed very early in our program.

I would say that a better estimate is about $500 million.

V/STOL VERSUS STOL TO MEET LIT REQUIREMENT

Mr. LIPSCOMB. For this amount of money, why wouldn't it be better to go ahead and get the STOL worked into the system and use that kind of aircraft if we need this capability?

General MCNICKLE. To get an interim STOL?

Mr. LIPSCOMB. And forget the V/STOL for this role for the present.

General MCNICKLE. We do not want to forget it because it is very attractive. However, I agree we have some more work to do. I agree with you we do need an interim STOL capability until the V/STOL can be developed.

Mr. LIPSCOMB. Is all the technology we have developed on this V/STOL aircraft, both in this country and in foreign countries, down the drain? Can't we use some of it?

General MCNICKLE. Yes, sir. We do not want a small V/STOL transport such as the XC-142, although we learned a lot from that program. We could use that technology, and a little more, for a V/STOL LIT. We could build a small fighter without range and payload but the V/STOL fighter technology just won't support a big airplane.

General BOYLAN. Mr. Lipscomb, on this point of STOL-V/TOL, the airplane we are talking about in the STOL mode has a ground run of something over 400 feet in the STOL configuration with an 8½-ton load. It can take off in about 1,000 feet with a 17-ton payload. You cannot buy an airplane off the shelf today that will perform like that, with that weight and that runway length. The problem we are facing is that runway characteristic of something like 1,200 feet downward. For example, the C-7 at its gross weight uses a runway of something like 1,600 feet with only 3 tons of payload. To really make high utility of this airplane where we have the gap, we need STOL or VTOL performance at very short runway lengths. That is not available off the shelf.

ENGINE DEVELOPMENT INCLUDED IN LIT DEVELOPMENT COSTS

Mr. LIPSCOMB. Is the engine development figured in this development cost? One of the critical factors in the V/STOL programs has been the engine.

General McNICKLE. Yes, sir.

Mr. LIPSCOMB. This is included in your LIT development cost?

General McNICKLE. Yes, sir.

Mr. JONES. This is really just uprating turboprop engines. It is not a completely new development by itself.

General BOYLAN. The propeller may be one of the most critical items of this proposal.

ADVANCED FIRE CONTROL MISSILE TECHNOLOGY

Mr. LIPSCOMB. You are asking for a 100-percent increase for the advanced fire control missile technology program under advanced development. You received $1.5 million in each of the last 2 fiscal years and are requesting $3 million in fiscal 1970. Why is such a large percentage increase requested?

Mr. HANSEN. This interrelates with the lookdown fire control and missile capability that had been planned for the F-106X. The program was planned in the expectation that it would be picked up by the F-106X. Since that has not been implemented, we are requesting that the things that are being done for the fire control system be continued as an advanced development.

OBJECTIVES OF FISCAL YEAR 1970 PROGRAM

Mr. LIPSCOMB. What are the objectives for the program for fiscal year 1970?

Mr. HANSEN. The general objective of that area is advanced technology for fire control and missile systems for future interceptors.

The specific things that we want to do work on are some digitizing and miniaturization, the test evaluation of some alternative missile guidance techniques, some work on the radar transmitter for the lookdown capability and some antenna and ECM counter-countermeasures technique work.

ALL WORK DONE UNDER CONTRACT

Mr. LIPSCOMB. To what extent is this work done in Air Force installations and to what extent under contract?

Mr. HANSEN. All of it is contracted.

Mr. LIPSCOMB. Who are the contractors?

Mr. HANSEN. I do not have that list. I think it is Hughes and Westinghouse. Hughes is the major contractor.

FISCAL YEAR 1969 PROGRAM ACCOMPLISHMENTS

Mr. LIPSCOMB. Can you list for the committee some of the accomplishments under this program for the past year?

Mr. HANSEN. Yes; a model of a new transmitter tube for the fire control system has been developed and tested, and this tube was actually used by the contractors bidding on the fire control system for the F-15. Some solid state, state of the art was applied to the radar receivers and data processing. These were developed in the laboratory. In the missile area they developed a folding fin design which will be fabricated and tested as part of the fiscal 1970 program. In the missile electronic area

they developed an improved guidance head and a digital signal processor for the data from that. One of the most expensive developments they have had is the new missile high-temperature radome.

PROGRAM DIRECTED TOWARD NEW INTERCEPTOR TECHNOLOGY

Mr. LIPSCOMB. What is this program for? Did you say the F-106X?

Mr. HANSEN. It is really aimed at a new interceptor, whatever it might turn out to be. The reason I brought the F-106X into it is that in planning the program, the plans were that some of the advanced development work would be picked up and continued in the F-106X program which did not materialize. So we want to continue some of this work further in advanced development.

Mr. LIPSCOMB. This kind of a technology will fit on any interceptor that you may come to in the future?

Mr. HANSEN. Yes, sir. It is specifically fire control and missile technology which is aimed at the lookdown, shoot-down capability for an improved interceptor program, whatever that interceptor turns out to be.

Mr. LIPSCOMB. Could this be considered a little Phoenix program?

Mr. HANSEN. I do not know whether you could really call it that. It is more in the technology area than specifically applied to a particular system. I do not think I really know enough about the Phoenix to answer that question.

Mr. JONES. This is primarily some component improvement advances in the state of the art for a new systems evolution. It could build on a lot of the techniques of the Phoenix and the fire control system in the F-12.

Mr. LIPSCOMB. How deep do you think we will get into this program? You are requesting $3 million for fiscal 1970. How far do you think we will really go?

General MCNICKLE. We are running an exercise now on looking at other possibilities for interceptors. Whenever we come up with one, whether it be the F-15, F-14, F-106X, F-12, whatever it might be, this program would be applicable and would fold right into it.

Mr. LIPSCOMB. This would be applicable to the F-15 program?

General MCNICKLE. In an air defense role, yes, sir. We have studied and are studying all those possibilities for air defense.

WORK BEING DONE FOR PROGRAM NOT IN BEING

Mr. LIPSCOMB. We cannot even fully fund the F-111 program right now and here you are requesting money for a system that we do not even have an aircraft for it to fit on. I realize you are looking to the future.

Mr. HANSEN. This is identified, however, as one of the critical areas and one of the long leadtime things that needs to be done. I think if we waited until we had the airplane, then we might very well find that the airplane had to stand around and wait for this development. The

most critical thing is the lookdown, shoot-down capability of a combination of the radar and the missile to fly into the ground clutter.

Mr. LIPSCOMB. You are developing the advanced fire control/missile technology and we are not even talking about a specific aircraft program right now, are we? So you are developing a system for something we do not even have in our program at the present time.

General PITTS. When this development started, Mr. Lipscomb, we had the F–106X and the F–12. You gave us $55 million that has been locked up on the F–12. We went the F–106X route and right now we are without a candidate because there is a kind of lock between those two systems.

Mr. LIPSCOMB. Until we get that unlocked we would be pouring money into this program and we do not even know what the role is going to be.

Mr. RHODES. If the gentleman would yield at that point? Are you procuring hardware under this program?

General MCNICKLE. No, sir.

Mr. HANSEN. We are developing technology and components.

Mr. LIPSCOMB. If you develop components, then you start developing some hardware.

Mr. HANSEN. It is breadboards and techniques. This would have to be picked up by an advanved interceptor program and redesigned or designed for production and packaged for production. This is just technical feasibility hardware.

General BOYLAN. Mr. Lipscomb, I think you have noted it has been our experience that the thing that gives us the most trouble in these aircraft system is the avonics packages. If the Air Force can continue this development perhaps some of the mistakes of the past can be avoided.

Mr. LIPSCOMB. Maybe you have decided which to develop first; the airframe, and then the avionics, or do you develop the airframe later to fit the avionics? Which comes first when we speak of a complete weapons system?

General BOYLAN. Quite a bit of the technology of candidate airframes has already been proven. For example, the F–12.

General MCNICKLE. Our latest direction from D.D.R.&E. was to continue to work on the F–106X but take another look at the B–58.

Mr. LIPSCOMB. The B–58?

General MCNICKLE. Yes, sir.

General BOYLAN. You are registering surprise, sir, and we did, too.

AEROSPACE STRUCTURAL MATERIALS PROGRAM

Mr. LIPSCOMB. With reference to the aeorspace structural materials, here again we find another materials research and development effort. Will you list at this point in the record all of the materials research and development projects in the Air Force R.D.T. & E. budget and the estimated funding requirement for each for fiscal 1970.

General MCNICKLE. Yes, sir.

(The information follows:)

MATERIALS R. & D. PROJECTS IN AIR FORCE R.D.T. '& E. BUDGET AND ESTIMATED FUNDING REQUIREMENT FOR EACH

[In millions of dollars]

Project	Title	Fiscal year 1970
	Program element 61102F (research):	
7021	Structures and properties of solids	1.067
7342	Research on macromolecular materials	.657
7353	Solid phase behavior	.499
7367	Character of materials	.344
	Total	2.567
	Program element 62102F (exploratory):	
7312	Protection of metals	.800
7320	Fibrous materials	1.450
7340	Nonmetallic materials	4.900
7343	Aerospace lubricants	.800
7350	Ceramics and graphite	1.275
7351	Metallic materials	4.250
7360	Chemical, thermal, and dynamic properties of materials	1.400
7371	Electronic and magnetic materials	1.300
7381	Materials application	2.325
060S	AFML support operations	7.287
	Total	25.787
	Program element 63211F (advanced) aerospace structural materials	9.500
	Program element 63425F (advanced) graphitic reentry materials	2.000
	Overall total	39.854

DIFFERENCE BETWEEN VARIOUS MATERIALS RESEARCH PROGRAMS

Mr. LIPSCOMB. How does this advanced development program relate with the other materials research and development efforts which we have discussed thus far?

Mr. HANSEN. We talked before about the aluminum oxide filaments and the basic material itself. In the advanced development program, what we do is develop techniques of fabricating these materials into specific useful components. For example, we take composites of boron filament plastic, carbon filament plastic, boron filament metal and so on, and actually work with the fabrication of these into useful structural parts.

Mr. LIPSCOMB. What is the overall difference between these programs?

Mr. JONES. The programs we talked about earlier, as Secretary Hansen mentioned, were in the technology development area; that is, we were developing specific materials; in this case the boron filaments themselves. Now in this program we are applying them to complex structures. We actually are trying to build a wing box structure, a fuselage component, a boron tail, and put them under the dynamic loading conditions that they will be subjected to in an aircraft structure, before we take them to the next step which would be to combine them in a new airplane. This program is the steppingstone between the technology development of the material and the application of the advanced material to the structural concepts.

REASON FOR PROGRAM INCREASES

Mr. LIPSCOMB. What is your justification for an increase in this program? You are requesting $9.5 million for fiscal year 1970. For fiscal 1969 it was $9 million and $6 million was provided in fiscal year 1968. To what extent is this effort done in-house and to what extent under contract?

Mr. HANSEN. All of the work is done under contract with industry. I think in the boron plastics composites we are at the stage of development in that program where the complex structural forms that are being made and tested are more elaborate and more costly than they have been. This total composite material in its application to structures is a development program that has the characteristic shape that any of them do. It builds up to a level and then gets finished and tapers off, or gets put someplace else for a more forward production application of it.

This development has progressed to the stage where more hardware has to be designed and fabricated and tested to bring the program along.

F-111 AIRCRAFT HORIZONTAL STABILIZER TESTING

Mr. LIPSCOMB. Your justification sheets for fiscal year 1970 say, flight test of the F-111 horizontal stabilizer will be completed? Is that in this program?

Mr. JONES. Yes, sir.

Mr. LIPSCOMB. The fuselage structure and graphite composite aircraft structure developments will be continued. Is that all on the F-111 program?

Mr. HANSEN. These are developments which would apply to aircraft in general. The applications to the F-111 are used as a specific example of material usage and techniques which would be applicable to other aircraft structures as well.

Mr. LIPSCOMB. What became of the F-111 horizontal stabilizer?

General PITTS. The stabilizer is made of this boron composite. They are making a horizontal stabilizer and testing it in the F-111 aircraft for an application. In addition, on the C-5 program there is a wing slat that is made of a boron composite. It is being tested on that aircraft.

OTHER MATERIALS RESEARCH APPLICATIONS

Mr. JONES. That is correct. The wing structure and the fuselage structure that is being talked about here is a structure that is being built up which will be static tested on the ground. The C-5 wing slat is a wing slat that is being used, and in fact I believe they are being replaced on 10 aircraft, which will be service tested to get the effect of rain, erosion, and so forth, on the material itself. We are starting some work on turbine engine compressor blade applications of these boron fiber materials. This is a basic material that has some tremendous promise for future weight saving and strength improvements in airplane and engine structures.

On the order of 30 to 50 percent weight savings, for example. So the program we have is a broad gaged program to build up experience in application to structural designs ranging from elements on flying airplanes such as the F–111 and C–5 application to complex fuselage and wing structures in static tests and some engine components that we will start next year.

REASON FOR F–111 HORIZONTAL STABILIZER TESTS

Mr. LIPSCOMB. According to your justification sheet it looks like the major part of your program is with the flight test of the F–111 horizontal stabilizer and the C–5A wing slat which will be structurally tested. When you test the new horizontal stabilizer on the F–111, what does this do to your regular F–111 program which is in a state of incompletion?

Mr. JONES. This would be taking just one airplane and substituting either one side or both sides of the stabilizer with this new material and a modest flight test program. These are piggy-back tests more than anything else.

Mr. LIPSCOMB. We will never know if this F–111 works if we keep testing new items on it all the time.

Mr. JONES. This is just a test for the material primarily and not a part of the F–111 per se.

Mr. LIPSCOMB. We are still testing the F–111 with the material that was originally planned for it. Why do we keep adding and testing different materials on it?

Mr. HANSEN. We are not testing in these areas and these tests are constrained to be noninterference tests. They do not wait for them.

General PITTS. This is a test for this material, sir.

Mr. LIPSCOMB. We better get some of these things completed and some aircraft flying some day soon.

General PITTS. The promise of these new materials is tremendous in weight savings, as has been testified, and in future reduction in cost if we can prove what we think we can prove with these new materials. That is the reason for these new tests.

Mr. LIPSCOMB. How will you know if the F–111 will ever qualify if you keep putting new materials on it? Why don't we get a plane completed and operational?

General BOYLAN. Mr. Lipscomb, you appreciate——

Mr. LIPSCOMB. We have them coming off the production line and they are sitting out there waiting for a new wing carry-through box. We cannot even test those production models yet.

General BOYLAN. Yes, sir. Those aircraft were procured and scheduled to operate in units. In the total F–111 procurement there are a number of test aircraft that will stay in a test status for the purpose of continuing tests on the F–111 system. I am sure this boron composite structure is going to be on one of those aircraft.

Mr. RHODES. If the gentleman will yield; one of the problems you had with the F–111 was the difficulty of shaping the metal, wasn't it? Didn't you have problems with actually fabricating the metal you used in the F–111 or am I thinking of another aircraft?

Mr. JONES. I am not aware of a metal shaping problem that we have had. We had our share of problems but I am not aware of that particular problem.

Mr. RHODES. I am happy to hear that I hit on a problem you did not possess.

BORON COMPOSITE MATERIALS

Mr. HANSEN. I think this boron composite material program is one that we could stand to emphasize a little more. We ought to take a lot of pride in it. It has been a very successful program. We have come up with new materials with 30 to 50 percent weight saving and high strength. It is working out very well. I think we ought to shout about it.

Mr. LIPSCOMB. How long has this boron composite material been around?

Mr. HANSEN. As a structural material you mean?

Mr. LIPSCOMB. Yes.

Mr. HANSEN. Three to four years.

Mr. LIPSCOMB. Don't I remember some people wanting to do some work on it years ago? Wasn't it shoved off to one side? Do you remember anything like this? This was probably 7 or 8 years ago.

General PITTS. I think you are talking about Project Forecast. We are getting the go ahead to do some of the things we looked at at that time. One of the things that Mr. Rhodes spoke about involves the difficulty of shaping metal into a difficult form. Under this program you build the boron composites to the shape; and this is one of the benefits of a program like this.

Mr. LIPSCOMB. I was thinking of the problem we may be having with the new Navy F–14 which might cause it to be a very expensive aircraft.

General PITTS. With titanium, yes, sir.

Mr. MAHON. Mr. Lipscomb, may I interrupt? It seems I remember that when we were working toward the ill-fated B–70, we talked at one time about a bomber using a boron fuel.

General PITTS. Yes, sir; boron fuel for that bomber.

Mr. MAHON. I realize we have not been discussing fuel, but structural material; I am just searching for the boron relationship.

Mr. HANSEN. There is 20-Mule Team Borax which is basically the boron material. What we are talking about here is the making of a composite material with a boron content that has these interesting structural properties.

General PITTS. There is another one, graphite composites.

Mr. JONES. We have built up the structures very similar to the way you build up fiber glass structure. You get the strength out of the core material, in this case the glass material, that you string in conformance with where you want the strength to go, and then you put this into a resin or plastic of some form and mold it. There you have a very light weight structural material that has a lot of strength. In this case we use the boron fiber instead of the glass fiber and we come out with a very good composite material for aircraft usage. We are trying it in these various programs to get experience so we understand its usage before we put it into a full airplane development program.

TOTAL COST OF RESEARCH IN BORON FUEL

Mr. LIPSCOMB. Do you remember how much we spent in researching the boron fuel for the B–70 before we closed out the program? Was it about $140 million?

Mr. JONES. In that order of magnitude, sir. I am not sure of the exact number. I would have to provide it to you for the record. This was a program started originally by the Navy, and the Air Force came into it primarily for the B–70 program that was later scrapped. I just do not remember the exact amount.

Mr. MAHON. Give us the total research on that and place it in the record.

(The information follows:)

The total Air Force cost of boron fuel, and related programs to apply it to the B–70 aircraft, was $120.2 million.

Mr. MAHON. Thank you very much, gentlemen.

We will resume tomorrow at 10 a.m.

THURSDAY, JUNE 12, 1969.

HYPERSONIC VEHICLE TECHNOLOGY

Mr. SIKES. We will now discuss hypersonic vehicle technology. You are requesting for this program $2 million. Would you describe the program?

Mr. HANSEN. Mr. Chairman, the program plan for fiscal year 1970 investigates reusable and refurbishable thermal protection systems, integral structures, and low-cost reusable launch vehicle configurations. This is a technology based to prepare us for flight in the Mach 5 regime.

Mr. SIKES. Is this a new program?

Mr. HANSEN. No, sir, this is the continuing program which we have had in the past.

PROGRAM FORMERLY FUNDED UNDER "ADVANCED STRUCTURES"

Mr. SIKES. How was it listed in the past? I do not find any funds for that previously under this name.

Colonel HOERMANN. It might have had a different title, sir, but back in 1967 it was funded with contract money. In 1968 and 1969 we were doing in-house work and cleaning up the program.

Mr. SIKES. Nothing shows for 1968 and 1969. How much was funded in 1967?

Colonel HOERMANN. I will have to furnish that for the record.

(The information follows:)

In fiscal year 1967, this program was funded at $1.9 million. At the beginning of fiscal year 1967, the program was titled "Advanced Structures," and was identified as program element No. 6.34.06.54.4. During the fourth quarter of fiscal year 1967, the scope of the program was increased to include efforts in the flight mechanics area. The title was then changed to "Hypersonic Vehicle Technology" to reflect this increase in program scope.

Mr. SIKES. What is the status of the program?

Mr. JONES. This is proposed as a new start with outside contracting to take advantage of some of the accumulation of in-house work that

we have done for the past 2 years, projected at doing some new design work on hypersonic reentry type of vehicle.

Mr. SIKES. Does this program envision the construction of a new hypersonic test facility at Tullahoma?

Mr. JONES. No, I don't believe so. I am not sure which facility you are referring to. I believe you may be referring to the low altitude hypersonic facility, which really is not oriented toward this task.

LIST OF TASKS FOR HYPERSONIC VEHICLE TECHNOLOGY

Mr. SIKES. Can you provide the committee with a list of the tasks for which you are requesting the $2 million?

Mr. JONES. Yes, we can.

(The information follows:)

The program planned for fiscal year 1970 will investigate the following:

(1) Reusable/refurbishable thermal protection systems;
(2) Low cost hypersonic structures;
(3) Reusability criteria;
(4) Integral structures for hypersonic application;
(5) Configuration development for reusable launch vehicles and advanced high speed interceptors.

PROPOSED USE OF X-15 FOR HYPERSONIC EXPERIMENTS

Mr. SIKES. Proposals have been made to reform hypersonic aircraft experiments with a modified version of the X–15. Has the Air Force considered this proposal, and, if so, what do you think of it?

Mr. HANSON. This proposal has been considered. In April a year ago the Air Force requested the Air Force Scientific Advisory Board to review this program. NASA has also been asked to get into this and has. In summary, the feeling is that the modification of the X–15 to take these higher flight velocities for a sufficient length of time to yield the data that is desired would be very difficult and costly, and that would not be the best approach.

Mr. SIKES. Is the hypersonic vehicle technology program for which you are requesting the $2 million a continuing program, or do you have certain experiments to be performed over a finite time period and concluded at a certain point in time?

Mr. HANSEN. I think at this stage of the program it is visualized as a continuing program to bring this technology along to the point where the application of it is more clearly visible. There are several possible applications that we have in mind. One is related to simply higher-speed flight in the atmosphere. Another very important one is related to the anticipated results of the studies now underway in response to the President's questions about future space programs. This technology is very important to reentry vehicles.

VTOL ENGINE DEVELOPMENT PROGRAM

Mr. LIPSCOMB. It has been generally understood that the limiting factor in successful development of VTOL aircraft has been the area of propulsion. Have you completed development of any promising new engines in the VTOL engine-development program for which $12 million is requested in fiscal year 1970?

Mr. HANSEN. Mr. Jones will answer these questions on the VTOL.

Mr. JONES. Yes, we have, Mr. Chairman. As you may recall, there were two basic programs in this VTOL engine program. One was the lift-cruise engine which provided lift during vertical takeoff as well as thrust during cruise flight, and the second was the lift engine which only provided auxiliary thrust during takeoff. The first use for both engines was to have been the proposed US/FRG V/STOL fighter which was discontinued. The direct lift engine was to have been used only during takeoff, landing, and hover. The lift cruise engine was to have augmented the lift engine operation and provide thrust for all other aircraft maneuvering. The lift-cruise demonstration program we completed in 1968 and that has performed the baseline work for the advanced engine development for our F–15 fighter and jointly by the Navy in their use of the same engine core in the F–14B.

The lift engine program was a joint program between the United States and the United Kingdom. That program is continuing. We have run the engine. We started running it last August.

We have some new milestones that we set for the program. We are discussing with the British, right now, what would be the best point to arrive at the termination of demonstration of the technology we have developed in this program, since we do not have a direct application to which we can put the engine.

APPLICATION TO LIGHT INTRATHEATER TRANSPORT (LIT) PROGRAM

Mr. LIPSCOMB. Earlier, we discussed the light intratheater transport (LIT) program. What about this engine for the LIT?

Mr. JONES. The type of propulsion system we are thinking of at the moment for the LIT is a turboprop engine with a large monocyclic propeller. So it is not directly applicable to that concept. The basic technology, of course, does have application for gas generators for future engines and is a high-performance gas-generator engine.

It would be useful in concepts for fighter aircraft in the future, or possibly for other types of V/STOL other than the tilt wing.

Mr. LIPSCOMB. I did not quite get the connection when you mentioned the F–14B, and the use of this engine in that demonstration.

RELATIONSHIP TO ADVANCED TECHNOLOGY ENGINE PROGRAM

Mr. JONES. We have, jointly with the Navy, what we call an initial development program on an advanced engine which the Air Force will first use in the F–15 fighter, and a version of the same engine is being developed through proof testing which could be used by the Navy for updating their F–14 aircraft with an improved engine sometime in the future. This is a common gas-generator development in which they would use a slightly larger fan and it would have different controls and other minor changes in the engine. But the baseline engine would be applicable to both programs. It came basically—the technology and the basic components—from the lift cruise engine which I mentioned earlier.

Mr. LIPSCOMB. Is this a third engine for the F–14 program?

Mr. JONES. As I understand their program, they are presently using the TF-30-P12 engine, which was formerly the engine used in the F-111B. They have plans for updating their aircraft at some point in the future with an advanced engine which would be a derivative engine from this program.

TWO SEPARATE ENGINE DEVELOPMENT PROGRAMS

Mr. SIKES. Let us get down to cases. If this is not a VTOL engine, why do you call it a VTOL engine development? Presumably you are not seriously undertaking the development of a VTOL engine. You have been working on this for years. It has not been productive. The Navy is proposing to buy Harrier V/STOL aircraft from Great Britain for the Marines. If we are in the VTOL engine field, why are we in it? If we are not in it, why do you call this a VTOL development?

Mr. JONES. Mr. Sikes, as I mentioned, this particular program was originated at the time we were looking at a joint United States and German V/STOL fighter program, and there were two baseline engine programs. One was the cruise engine which also provided some lift during takeoff and the other the pure lift engine. These are the derivative engines that have come out of that program.

As you know, the U.S.-FRG V/STOL fighter program did not survive, and has not gone forward as a full-scale development. But the basic technology that came out of this program has now been applied to the advanced engines which will be used in the next generation fighter.

Mr. SIKES. These are not VTOL engines, as such?

Mr. JONES. The new developments are not, but the new developments are not funded in this particular line. This is a continuation——

Mr. SIKES. Do you have another program which also contributes to the development of the new engines?

Mr. JONES. Yes, sir.

Mr. SIKES. You mean you have two developmental programs on the new engine?

Mr. JONES. Yes, sir.

Mr. SIKES. Now I am really confused. Why do you have two?

Mr. JONES. The engine that is associated with the F-15 program is carried and funded under that line. The development of the lift engine is carried and funded under the VTOL engine-development line.

Mr. SIKES. What use will you make of the engine being developed under the VTOL engine development program?

Mr. JONES. This is a completion of the technology that came out of the lift-engine program—the United States-United Kingdom lift-engine program—and is winding up the demonstration of that basic engine.

At the moment we do not have an aircraft program——

Mr. SIKES. Is a similar development taking place in Great Britain for the Harrier aircraft engine?

Mr. JONES. Not in connection with this particular engine approach, Mr. Sikes.

ENGINE DEVELOPMENT FOR NONEXISTENT AIRCRAFT PROGRAM

Mr. SIKES. What are you going to do with this engine when you get through developing it? What are you going to use it in?

Mr. JONES. Basically this engine will demonstrate the technology of an advanced lift engine which is more advanced than any other lift engine we know of right now.

Mr. SIKES. Do you foresee you are going to use this in tomorrow's Harrier-type aircraft?

Mr. JONES. Tomorrow's Harrier might be a proper definition.

Certainly the concept that was employed in the U.S.-FRG V/STOL fighter was far advanced over the Harrier as a fighter aircraft.

Mr. SIKES. Are you sure this is not something that you just got stuck with and you have been working with for a long time and you don't know how to get rid of?

Mr. JONES. As I mentioned, Mr. Sikes, we are working with the United Kingdom right now in defining a demonstration point where we would bring this particular engine to a conclusion during the coming year. But the technology that is demonstrated here is useful work that will be applied to advanced engines.

Mr. SIKES. What is it demonstrating that is particularly useful?

Mr. JONES. The thrust-to-weight ratio in this engine is about 20 to 1, which is about 60 percent better than any other lift engine.

Mr. SIKES. Better than the Harrier engine?

Mr. JONES. Yes, sir.

Mr. SIKES. Why is not this one in the Harrier?

Mr. JONES. It is a different concept. The Harrier engine is the kind of engine which provides both the lift and the cruise power, that is, the sustaining power in flight after direct lift-off. This particular engine is a lift-augmentation engine.

Mr. SIKES. I have the feeling that when you have completed this development you are going to put the engine on the shelf and, hopefully, something will come along to use it. Am I wrong?

Mr. JONES. I think this is correct as far as this particular engine is concerned.

Mr. SIKES. Can we afford to develop engines and put them on the shelf?

Mr. JONES. This engine was started at the time the United States-Federal Republic of Germany V/STOL fighter program was going and had a direct application. We are now trying to get all of the technology we can out of the basic hardware that we bought for the earlier program.

COST OF LIFT AND LIFT CRUISE ENGINE DEVELOPMENT

Mr. SIKES. What does this engine cost in its entirety?

You have $13.8 million for 1968, $14 million for 1969, and $12 million for 1970. That is around $40 million in those 3 years.

What is the cost altogether?

Mr. JONES. That covers both of these programs. I would have to submit the detailed breakout to you for the record between the lift cruise

engine for which there were three contractors, and the lift engine program.

MAJOR PROGRAM ACCOMPLISHMENTS

Mr. SIKES. Do that, and tell us what major accomplishments you can point to at this stage as a result of the VTOL engine development program.

Mr. JONES. I will be glad to do that.

(The information follows:)

In the United States-United Kingdom lift engine program, we and the United Kingdom agreed to continue the demonstrator phase as a technology program when the United States-Federal Republic of Germany aircraft effort was terminated in early 1968. The design of the XJ-99 advanced engine has been completed; hardware fabrication is proceeding; and testing of the demonstrator engine at Rolls-Royce and Allison has begun. We have experience what can be called normal development problems, but considering the advanced design concepts in this engine, this is not unexpected. To date we have on contract a total United States funding of $22.9 million which includes $1.6 million in fiscal year 1966, $5.9 million in fiscal year 1967, $8.8 million in fiscal year 1968 and $6.6 million in fiscal year 1969.

Since we do not have a firm application for a lift engine, we plan to continue the program to a logical termination point which is presently being negotiated with our United Kingdom friends.

MAJOR ACCOMPLISHMENTS AND TOTAL COST OF DEVELOPING VTOL LIFT ENGINE

The VTOL engine development program was initiated in 1965 with the objective of developing a lift cruise engine and direct life engine for the United States-Federal Republic of Germany V/STOL tactical fighter program. With regard to the lift cruise engine, we had three contractors (Curtiss-Wright, General Electric, and Pratt and Whitney) in a competitive engine demonstrator phase which ran from early 1966 to early 1968. The total funds expended on the demonstrators and the engine Contract Definition Phase for the system was $51.1 million which included $28.8 million fiscal year 1966, $17.3 million in fiscal year 1967 and $5 million in fiscal year 1968. Even though the lift cruise engine was not carried on into development, the lift cruise demonstrators have provided a sound base of high thrust to weight engine technology upon which our current F-15A/F-14B Initial Engine Development (IED) program is proceeding. During the current year we have used $7 million of our fiscal year 1969 fund on this program for the Initial Engine Development program. Based on our success with the lift cruise demonstrators and these funds, the F-15A/F-14B engine program is proceeding satisfactorily. The designs have been completed, the component tests are well underway and the engine hardware fabrication has been initiated.

ADVANCED TURBINE ENGINE GAS GENERATOR

Mr. SIKES. On Advanced Turbine Engine Gas Generator, you are requesting $5 million for fiscal 1970. It has been going up about a million dollars a year. What are you doing and why is the cost increasing?

Mr. JONES. This program is one of the key programs in our total engine development effort.

This is the program in which we take the advanced technology and components that have come out of the exploratory development work and put it into running hardware for the first time as the basic gas generator which is the core or the heart of the jet propulsion engine. From this program then the advanced engines for the transports, such as the C-5, and the fighters, such as the F-15, really derive.

In the C–5 engine, for example, the gas generator came from this type of program before it was coupled with the big fan to go into the C–5A.

Mr. SIKES. Is this a relatively low priority item?

Mr. JONES. It is not a low priority item, Mr. Sikes.

Mr. SIKES. Last year you asked for $7 million, but only $4 million was applied.

Mr. JONES. That is correct. This is a program in which, since its origination in 1965, we have planned more funds than we have been able to afford to put into it. What this means is we have had to bootstrap ourselves off of the hardware of other development programs, that is, some of the hardware from the lift-cruise engine program, as an example.

This coming year we are hopeful of buying some new hardware from completely advanced technology that will allow us to get along with demonstrating new gas generators for the next generation of turbojet engines.

OBJECTIVES OF THE PROGRAM

Mr. SIKES. In the supporting data—the discussion which describes the purpose of this program—it is stated that a secondary program objective is to assure an adequate advanced engine industrial base from which the Government can solicit some tentative proposals. How is this accomplished?

Mr. JONES. We have basically four engine contractors participating in what we call the Advanced Turbine Engine Gas Generator program. These are the Allison Division of GM, Continental, General Electric, and Pratt and Whitney.

We fund them essentially on an equal basis although the proportions may vary from year to year depending on how much of the advanced component work that is coming out of their exploratory program is going into new engine running during the course of a year. Their work is planned, it is directed and it is closely monitored by the engineers of the Air Force Aeropropulsion Lab at Wright-Patterson AFB. The basic key is to try to look forward into the future and try to provide the core development work in some rotating machinery, sized to about the size of future engines, with the primary objective of reducing the risk in our future engine development programs, and secondly, providing us with multiple sources for competitive developments in the future.

The C–5, as I mentioned, started with a basic program such as this, from which Pratt & Whitney and General Electric both derived their basic gas generators. General Electric ultimately developed the TF–39 engine for the C–5, and Pratt & Whitney later went on with a commercial development for the Boeing 747.

Mr. SIKES. For the record, tell us how much of the money programed for the advanced turbine engine gas generator program has been and will be used in the secondary program objective?

(The information follows:)

ADVANCED TURBINE ENGINE GAS GENERATOR

The two objectives of the advanced turbine engine gas generator program are the adequate demonstration of advanced engine-design concepts and the maintenance of a broad competitive industrial base. The accomplishment of the first

objective at our four engine contractors will insure achievement of the second objective. Therefore, we are emphasizing the first objective and allocating our resources accordingly, and not specifically funding the program to achieve the second objective. Thus, we have not specifically directed expenditure of funds solely to provide a broad industrial base, but undertaking those advanced concepts at each company will insure well-balanced technology programs responsive to potential future engine requirements as well as provide growth for existing engines.

NEED FOR GOVERNMENT SUPPORT OF NEW ENGINE TECHNOLOGY

Mr. SIKES. With the number of aircraft programs which are being carried out in this country today, should we not have a sufficiently healthy jet-engine industry that support from the Government is not really required?

Mr. JONES. No, Mr. Sikes, not in my judgment, if we are still looking for the high-performance type of engines that we in the military need for our weapons system.

We have, of course, a broadened engine base today over what we had 5 years ago. Certainly there has been a great expansion in the commercial market. However, the military engine requirements are always demanding greater and greater technical performance from these engines.

While the commercial base has provided us with probably some lowering of production costs, the commercial development programs do not really meet the stringent requirements for the military engines. So, I think if we want to continue to get superior engines for our weapons systems of the future, we are going to have to fund programs of this kind to demonstrate that technology.

Mr. SIKES. What is industry doing in this area? Are they not plowing some of their profits back into the same type of research?

Mr. JONES. They do component research, Mr. Sikes, by plowing some of their profits back into advanced technology. But I do not know of any program, such as this advanced turbine gas generator, program, which really is a program that combines advanced technologies in compressors, combusters, and turbines, and runs them as a core demonstration of advanced cycle conditions of the future before then adapting it to a specific application.

ADVANCED MANNED STRATEGIC AIRCRAFT (AMSA)/B–1 AIRCRAFT

Mr. SIKES. Let us turn to advanced manned strategic aircraft (AMSA). In fiscal year 1968, and in prior years, a total of $118.8 million has been provided for AMSA. You received $25 million in fiscal 1969, and you are requesting over $100 million in fiscal 1970. After all these expenditures, the descriptive summaries document indicates that the total estimated cost in the development of AMSA is "undetermined." Why can't you provide an estimate of the cost of the development program?

ESTIMATED AMSA DEVELOPMENT COST

Mr. HANSEN. Mr. Chairman, we now estimate the development cost for the AMSA at about $1.8 billion. That excludes prior-year study efforts.

Mr. SIKES. How realistic is this? We have been hearing a great deal in recent weeks about cost overruns. There has been much criticism of cost overruns. How valid would you say this estimate is?

What do you base it on?

Do you think it includes everything?

Mr. HANSEN. We think it is a good number. It is the best we can estimate short of actually getting contractor cost proposals. The next step, as far as we are concerned, is to get requests for proposals out to the contractors and let them give us firm proposals. We think the evaluation of those cost proposals against our in-house-generated estimates are the next pieces of data from which we can sharpen up our view of what this costs.

Mr. SIKES. When do you propose to do this?

Mr. HANSEN. We would hope to be able to get our proposal requests out next month.

BASES FOR AMSA/B–1 DEVELOPMENT COST ESTIMATE

Mr. SIKES. I would like you to provide for the record some of the bases on which this cost estimate was made.

(The information follows:)

B–1 COST METHODOLOGY

B–1 DEVELOPMENT COSTS

Introduction

The methodology used for synthesizing the cost of the B–1 system is based on the use of historical data from past and current programs used in conjunction with costing formulas. These formulas are empirically corrected whenever additional cost comparison information becomes available.

Assumptions

Development program.—The development program includes all research and development required to design and fabricate test aircraft and to perform initial flight test. Specifically, this requires five flight-test vehicles plus one static-test article and one fatigue-test article. Three equivalent sets of avionics are included in the development program.

Production program.—It is assumed for planning purposes that ——— production aircraft will be procured. This is the number required to supply ——— wings of operational B–1 systems together with replacement and support aircraft. It is assumed that the first eight production aircraft will be utilized for test and at the conclusion of the test program these eight aircraft will be refurbished to become part of the operational inventory.

Other.—All costs are 1968 dollars. Weapon costs are excluded since these will be developed and procured as separate programs; however, aircraft/weapon integration and compatibility costs are included.

Terminology

Some of the terms used in this cost methodology report are not well known and are defined for clarity:

(*a*) *Nonrecurring costs.*—This is the money that must be spent on a one-time basis. Design and development costs are nonrecurring costs.

(*b*) *Recurring costs.*—Recurring costs are those associated with the buying of quantities of similar equipment. The buying of several B–1 systems and support equipment would be identified as recurring, or repetitive, costs.

(*c*) *Flyaway costs.*—This is a term used to identify the cost of an airplane complete with all of its installed equipment but not including the costs of ground support equipment, training equipment, or any other equipment or capabilities not associated directly with the flying machine. If the question is asked "What is the cost of a B–1", the answer would probably

be given in terms of the flyaway cost based on the advantage of a large production buy.

(*d*) *AMPR or DCPR weight.*—This is a technical term associated with the actual structural weight of an aircraft. It includes all of the structure and crew provisioning, but not fixed equipment such as engines, avionics equipment, fuel, payload, and so forth. In a large bomber such as the B–1, the AMPR or DCPR weight will usually be about 30 percent of the gross takeoff weight.

(*e*) *Learning curve.*—Whenever a large number of identical items are produced (whether aircraft, automobiles, refrigerators, etc.), experience shows that the cost of each succeeding production item is slightly less than that of the preceding item. The learning curve is simply an easy way of placing a numerical relationship on this fact. A learning curve with a 90-percent slope means that the cost of an item decreases by 10 percent as the specified baseline quantity doubles.

Methodology

The basic methodolgy used to estimate the cost of an airframe is based on multiplying the weight of an aircraft structure or equipment by dollars-per-pound figure which has been determined from historical data. In the case of the engine, the cost is usually computed by multiplying the pounds of thrust by a dollar-per-pound figure. Supporting costs are calculated as percentages of the above basic costs.

Airframe.—Airframe nonrecurring development costs are based on a formula which multiplies the cost per pound by the AMPR weight, the product of which is then multiplied by another figure which is associated with the type of aircraft (fighter, cargo, bomber, etc.) and its operating capabilities (speed, altitude, etc.). All of these factors have been empirically derived from historical data. The B–1 airframe recurring costs are based on the latest available F–111 airframe cost data. The F–111 cost of $203 per pound at unit ——— was multiplied by the AMPR weight of the B–1. This figure was then reduced by a percentage factor to allow for a historically identified lower cost based on the larger airframe size—that is, large airframes are somewhat cheaper on a cost per pound basis than smaller aircraft where all other factors, such as manufacturing techniques, are identical. This results in a cost per AMPR pound of $169 for the B–1 at ——— units. The B–1 cost at any unit of production can then be derived from the learning curve which in this case has been established at 75 percent for the first 74 units and 80 percent for subsequent production. This split learning curve is based on F–111 and other aircraft data. The use of the F–111 airframe cost base is conservative since it is the highest cost base available from historical data and the figure is considerably higher than the average cost data base from other recent aircraft programs.

Engine.—Nonrecurring engine development costs are based on recent data submitted by General Electric and Pratt & Whitney. Both companies have built a B–1 demonstrator engine in the correct size class and with similar—in some cases, identical—cycle characteristics. In addition, both companies have recent experience in developing cost estimates for the F–15 engine, the US/FRG fighter engine, and of course, the TF–39 (C–5A) and JT–9D (Boeing 747). Data submitted by the two contractors for study purposes have been modified by inhouse estimates to take advantage of the development work already accomplished in the B–1 program. Recurring engine costs were derived from essentially the same data source as in the nonrecurring case. From new estimates and historical data, an equation was developed and unit costs were then derived using a 93 percent learning curve. It should be noted that for a buy of ——— aircraft, ——— engines would be required, not including spares.

Avionics.—Nonrecurring avionics development costs are based on a cost-per pound methodology which has been derived from historical data and detailed studies by avionics contractors. The B–1 estimate results from a figure of ——— per pound for the development of complex avionics equipment. An additional ——— million was added to the development program to provide for avionics design efforts that will be accomplished to permit realistic space, weight, power, cooling, and structural provisions to be made in the airframe for growth avionics capabilities, if and when a requirement is validated. Recurring avionics costs are also based on a cost-per-pound methodology. Using data from the F–111/MK–II avionic subsystem, and using detailed cost estimates from study con-

tractors, a figure of ——— per pound at unit ——— has been derived. This cost per pound, which does not include spares and other supporting costs but does include the costs for the airframe/avionics integration and nuclear hardening, is then multiplied by the estimated weight of the avionics subsystem to derive the average flyaway costs. A learning curve slope of 92 percent is projected for the avionics subsystem.

Other.—In addition to costs for the airframe, engine, and avionics, a very large cost element must be taken into account. This element breaks out into a number of items which are listed below together with the cost factor used with each item:

(*a*). *Spares.*—Airframe spares are determined by applying a factor of ——— to recurring airframe costs. Engine spares are calculated at ——— for the development program and ——— for production spares. Avionics spares costs have been determined by applying a factor of ——— to the number of installed avionics subsystems during the development and ——— to the number of avionics installations during production.

(*b*). *Training equipment.*—Nonrecurring training equipment developed costs are derived by applying a factor of ——— to the nonrecurring airframe cost. Recurring training equipment costs in their respective areas are derived by applying a factor of ——— to the recurring development airframe, propulsion, and avionics costs and ——— to the production cost of the same three items. Training equipment spares are derived by applying a factor of ——— to the recurring developmental training equipment and ——— to the production training equipment.

(*c*). *Aerospace ground equipment* (AGE).—This item covers all nonflying test, checkout, and support equipment such as ground power units, maintenance equipment, electronic checkout units, etc. Nonrecurring AGE development costs are ——— of nonrecurring airframe, propulsion, and avionics costs. Recurring AGE costs are ——— of the recurring development costs and ——— of production costs of these same items. AGE spares are ——— of AGE costs.

(*d*). *Test program.*—This includes the cost of mockups, wind tunnel tests, static tests, fatigue tests, all of the sophisticated structural and simulation tests and, of course, all flight tests. Each type of test is costed either as a percentage of an associated equipment development cost or by using historical data on the hourly cost of tests—particularly in case of flight tests and wind tunnel tests. Flight test costs are estimated at ——— per hour in category I and ——— an hour in category II. Wind tunnel tests are estimated to cost ——— per hour of tunnel occupancy.

(*e*) *Engineering changes.*— ——— of recurring development airframe costs. ——— of the production airframe cost.

(*f*) *First destination transportation.*— ——— of total recurring costs for propulsion and avionics.

(*g*) *Systems management.*— ——— of total recurring costs for airframe and avionics.

(*h*) *Technical data.*— ——— of total recurring development hardware costs, ——— of the production hardware costs.

(*i*) *Tooling.*—Under this item are the costs of basic tooling which is necessary to construct and assemble the first and all succeeding aircraft; the rate tooling, including replacement tooling, is required to achieve higher monthly rates of production. Basic tooling costs are based on a dollar-per-hour figure for labor and material times the AMPR weight of the aircraft. Rate tooling is ——— of basic tooling.

(*j*) *Production engineering.*—Production engineering costs are ——— of nonrecurring airframe development costs.

(*k*) *Production improvement.*— ——— of production propulsion costs. ——— of production avionics costs.

(*l*) *Stock and supporting equipment.*—This item covers POL, trucks, jeeps, construction equipment, nonaircraft supplies (office supplies, medical supplies, paint, heating oil, etc.), and miscellaneous stock supplies (nuts, bolts, tools, etc.). The costs associated with this item are based on the total number of support personnel and by application of a historical data factor based on the number of personnel and basing concept.

(*m*) *Shipping costs.*— ——— of AGE, training equipment, spares, data, stocks, and support equipment.

PRIORITY OF AMSA/B-1 DEVELOPMENT

Mr. SIKES. Do you consider there is a possibility that the AMSA will fall by the wayside as the search continues for areas in which to make reductions in the Department of Defense?

Mr. HANSEN. I think we have to consider that there is a possibility of that.

I think there is a possibility on most of the other programs that are under consideration similarly.

Mr. SIKES. How vigorously will the Air Force defend this program? Would you give it higher priority than the MOL program?

Mr. HANSEN. Yes, sir.

Mr. SIKES. Where in your priority listing would you consider this if the question were raised about its continuation at the OSD level? How high in your priority list do you consider AMSA?

Mr. HANSEN. The present bomber, the B-52, is pretty old, and I believe it is the conviction of the responsible people in the Air Force that it is necessary to modernize our Nation's bomber capability.

I think if we were asked to choose between the F-15 and the AMSA, we would choose the F-15. We think we should have them both. We think the AMSA is very high priority.

General MCNICKLE. We studied AMSA for 5 years, and when the new administration came in and reviewed the program they actually put more money on it and said we ought to go ahead and develop this aircraft rather than just keep studying the problem.

Mr. SIKES. I think this committee has shown that attitude also in support of the AMSA program.

NORTH AMERICAN-ROCKWELL REDUCES SCOPE OF INTEREST IN AMSA

I note that one of the principal prospective contractors has withdrawn from the field of competition.

What is the significance of this?

Mr. HANSEN. I have talked with John Moore of North American about that. I read the article in the newspaper and was quite disturbed about the thing as presented by the writer.

North American issued a statement on the 2d of June as follows:

> North American Rockwell Corporation announced today that although it has reduced the scope of its activity on the Air Force Manned Strategic Aircraft it is continuing to maintain a significant team effort in connection with the program. Further, officials point out, the company is not reducing its effort on the avionics for AMSA. The reduction followed a careful evaluation of North American Rockwell corporate resources and was made to enable North American Rockwell to apply its maximum attention and capabilities to the F-15 fighter weapon system competition.

Mr. SIKES. What interest is being shown by other competent companies in the AMSA program?

Mr. HANSEN. Very high interest is being shown in the AMSA by Boeing, General Dynamics, Lockheed, as well as North American. North American is the only competitor in the F-15, which is also trying for the AMSA. They had a level of effort around the first of the year on the AMSA which they stepped way up in anticipation that the RFP was going to come out on the 1st of May.

When it did not and was delayed and they had reached the last stages of the F–15 competition, they decided that they had better put more effort into the F–15 and cut back on the AMSA. However, their remaining level on the ASMA is about twice, and is planned to continue about twice, what it was in February. So they are definitely very interested in the program.

PLANNED AMSA/B–1 FORCE

Mr. SIKES. What is the planned Air Force program for AMSA? In other words, how many production aircraft do you plan to procure and over what period of time?

Mr. HANSEN. The plan as presently being proposed is to proceed with the development and not commit the Government to production at this time. So officially the force structure has not been determined. However, our thinking is based on a production of over 200 airplanes which would support a UE of about ——— airplanes. So we would plan to proceed by getting out the request for proposals as quickly as we can and try to get those back in and evaluated by about the end of the year and proceed with the development program. Achievement milestones would be included in the development program for which reviews would be made to determine whether or not we should proceed. At an appropriate time we would come forward with proposals to proceed with production.

Our present thinking is that we would ask in the proposals for production options with a "not to exceed" ceiling. And, those options in our present thinking would be on a baseline production quantity and a total buy of over 200 aircraft, and would be based on an IOC schedule of about 1976. However, that schedule would be the earliest possible schedule based on moving through from one step to another and proceeding all the way without running into any serious difficulties.

Without the commitment to production there is no commitment to an IOC date. However, an IOC date would be used for the purpose of structuring a production option to give us a better idea what the program is going to cost.

FISCAL YEAR 1970 REQUEST—OPTIMUM AMOUNT OF FUNDS REQUIRED

Mr. SIKES. Is this the optimum amount of money, the $100 million plus, for the earliest availability of the AMSA? Could you produce it more quickly if you had more money?

Mr. HANSEN. No, sir, I don't think so.

Mr. SIKES. Do you consider this the optimum amount?

Mr. HANSEN. I do not think we could intelligently spend any more money than that on the AMSA in fiscal 1970.

NO KNOWLEDGE SOVIETS ARE DEVELOPING AN AMSA

Mr. SIKES. Is there a comparable Russian bomber in process of development insofar as you know?

Mr. HANSEN. Not as far as I know.

General McNickle, would you answer that?

General MCNICKLE. We are not aware of one at this time.

Mr. HANSEN. We feel the Russians have the capability to produce a comparable bomber based on the things we have seen, including their transport work.

Mr. SIKES. You stated that the total development cost is now estimated at $1.8 billion.

Mr. HANSEN. Yes, sir.

Mr. SIKES. Did you take into consideration the cost history of the C–5A, where the cost has been very considerably in excess of the estimate, and all other factors, in arriving at the AMSA estimate?

Mr. HANSEN. Yes, sir, we have been very conscious of the lessons of the C–5A and other programs.

ECONOMIC INFLATION NOT INCLUDED IN AMSA DEVELOPMENT COST ESTIMATE

Mr. SIKES. What economic inflation has been cranked into this?

Colonel BLOCK. These are based on 1968 dollars. Inflation has not been included in the cost.

Mr. SIKES. Then the $1.8 billion is not a realistic estimate.

General PITTS. You made reference to the C–5.

Our estimates for the C–5 development cost, back at contract time in October 1965, were around $900 million, and estimates to completion for that plane right now, as we testified the other day, are $1,003,-200,000 for R. & D. These are fairly close.

Mr. HANSEN. I think it is a good point to bear in mind that the development cost on the C–5A including inflation and everything only exceeded the original estimate by 10 percent.

INFLATION SHOULD BE ADDED TO AMSA DEVELOPMENT COST

Mr. SIKES. You are running 6 to 10 percent a year in inflation in this area. Should that be added to the $1.8 billion?

Mr. HANSEN. Sir, I think it should.

Mr. SIKES. Over a period of how many years?

Mr. HANSEN. We are not permitted to budget on the presumption that the inflationary trends will continue.

Mr. SIKES. This is only an estimate. We are not appropriating $1.8 billion.

Mr. HANSEN. Yes. I think this is one of the areas where it helps to get cost proposals from the contractors. They have to try to anticipate what is going to happen to their labor rates based on their labor contracts, how long they run, when they expect to have to renew their contracts and what kind of bargain they expect to be able to make. With the probable impact of inflation, probably $2 billion is a better number.

Mr. SIKES. The development will extend over how many years at this point?

Mr. HANSEN. More than 4 years.

Mr. SIKES. You think $2 billion would be a closer approximation of what could be anticipated?

Mr. HANSEN. I feel a whole lot more comfortable about being able to keep the cost within that kind of a number in consideration of the continuance of the past inflationary trend.

ESTIMATED AMSA/B–1 PROCUREMENT COST

Mr. SIKES. What is the estimated aircraft procurement cost?

General MCNICKLE. Based on the number we have been talking about, we estimate it would be between $25 and $30 million each. This includes R.D.T. & E., investment, aerospace ground equipment, and 10 years of operating costs.

ESTIMATED COST OF AMSA/B–1 INITIAL SPARES

Mr. SIKES. And the estimated cost of initial spares.

General MCNICKLE. I do not have an estimated cost of initial spares. We could arrive at one by applying a percentage, but I do not at this time have any estimate on initial spares.

Mr. SIKES. In trying to arrive at a total cost of AMSA, wouldn't you for the committee, based on your experience, give a percentage figure?

General MCNICKLE. We can and will be happy to submit it.

(The information follows:)

Our experience has shown that initial spares are about 21 percent of the total flyaway costs.

ESTIMATED COST OF GROUND SUPPORT EQUIPMENT

Mr. SIKES. For the record, tell us what specialized ground support equipment will be associated with the program and give the cost of development and procurement of this equipment.

General MCNICKLE. There again I do not have that although we can work that on a percentage too.

However, I would like to point out that one of the concepts in AMSA is to build in a self-testing capability, so that there will be a smaller amount of test equipment required.

Mr. SIKES. Give us the best estimate you can.

We do not want to go into this blind.

(The information follows:)

The AMSA would not require any significant amount of special or unique type of ground support equipment other than that normally associated with other aircraft systems. In fact, certain ground support equipment related to the testing of the avionics subsystem would not be required for AMSA because this test capability is planned for integration into the aircraft as part of the avionics package. We call this the Central Integrated Test System (CITS).

Aerospace Ground Equipment (AGE) includes all nonflying test, checkout, and support equipment such as ground power units, maintenance equipment, electronic checkout units, etc. Nonrecurring AGE development costs are estimated to be ——— of nonrecurring airframe, propulsion and avionics costs. Recurring AGE costs are estimated to be ——— of the recurring development costs and ——— of production costs of these same items.

PLANNED AVIONICS SUBSYSTEMS FOR AMSA/B–1

Mr. SIKES. What special avionics will be required for AMSA?

Mr. HANSEN. In a general way our plan on AMSA avionics is to have a basic avionics subsystem which includes the equipments you need no matter how you use the airplane, like the navigation system and so on, and then provide a kit concept. This airplane is anticipated to have a service life out to maybe 1995. We know that the threats are going to change and the utilization of the airplane is going to change. If you

take the highest estimate of the threat and the capability of all of our potential enemies and try to build avionics into the airplane to counter all that, we think it would be prohibitively high priced. If we take only the current approved national intelligence estimate for the threat we think there can be a sort of basic package which can be handled within the unit airplane cost that General McNickle mentioned. The approach that we have is to build this basic package and then kits that can be added that contain the specialized electronic countermeasures, armament subsystems, or whatever is necessary, to counter a particular threat. The whole philosophy of this airplane is to be that it is a military bombardment aircraft bus with a very large amount of flexibility. It has to be capable of accomplishing the SAC mission, but we want to maximize its flexibility to do missions like the B-52 is now doing in Vietnam, or be adaptable to whatever might come up in the very long life time that is planned for this airplane.

PROPOSED AMSA/B-1 CHARACTERISTICS

Mr. SIKES. I think at this point it would be appropriate to have more information on the characteristics which are sought for the AMSA. Will you provide that information for the record?

Mr. HANSEN. Yes, sir.

(The information follows:)

Our studies have identified an aircraft which would have a total refueled design range of ——— (of which ——— NM is low altitude penetration) with a payload of ———. The need for both very low altitude, high subsonic ——— and supersonic ——— and high altitude supersonic ——— penetration capability has also been identified. In addition, enduring survivability is required and will be satisfied by either airborne alert or by the capability for quick dispersal to austere alternate bases. Operation from these austere bases will require a capability to take off and land on relatively short runways ——— over a 50-foot obstacle, sea level standard day. An aircraft designed to meet these requirements is estimated to have a takeoff gross weight of approximately ———. It will have four advanced turbo fan engines of approximately ——— thrust each and a crew of four (2 pilots and 2 navigator/system officers). The internal weapons bay will have capacity for carriage of ——— SRAMS or approximately ——— of nonnuclear munitions. The aircraft will probably have variable geometry wings in order to provide optimum flight characteristics for both low altitude and high altitude flight and for operation from short fields. Construction will be primarily of aluminum but titanium, steel, and other materials will be used to achieve an efficient structure.

ESTIMATED COST OF DEVELOPING AMSA/B-1 AVIONICS

Mr. SIKES. What is the cost of development of the avionics equipment we were talking about?

Can you give an estimate?

General MCNICKLE. Between $250 and $300 million.

Mr. SIKES. Mr. Secretary, I want to commend you on your ability to grasp the questions on these diverse and complex matters. I know, of course, of your very extensive background in this field, but I have been impressed with the way in which within a very short period of time you have exhibited such a fine grasp of Pentagonese. Usually that takes longer.

Mr. HANSEN. Thank you very much, Mr. SIKES. It is very kind of you.

ESTIMATED COST OF AMSA/B–1 ENGINES

Mr. SIKES. What engine development costs are associated with AMSA? For the record, what is the estimated cost of development of the engines, and what is the estimated procurement unit cost of the engines?

(The information follows:)

B–1 ENGINE DEVELOPMENT

Engine development costs are estimated to be about $320 million. The estimated procurement cost of the engines is $650,000 to $750,000 per engine based on a buy of about 1,000 engines.

ESTIMATED COST OF AMSA/B–1 AIRFRAMES

Mr. HANSEN. Mr. Chairman, when we provide you the buildup on how we came to the $1.8 billion, that will give you the answer.

Mr. SIKES. For the record, what is the estimated cost of the development of the AMSA airframe, and the estimated unit cost of the AMSA airframe?

(The information follows:)

B–1 AIRFRAME AND ESTIMATED UNIT COST

Airframe development costs are estimated to be about $680 million. The procurement unit cost of the airframe is estimated to be $13 to $15 million based on a buy of more than 200 airplanes.

AMSA/B–1 FLYAWAY AND TOTAL PROGRAM COST ESTIMATE

Mr. SIKES. Can you tell us your best estimate of the unit flyaway weapons system cost of AMSA?

General MCNICKLE. We will put that in the record, to the extent that we can estimate it at this time.

Mr. SIKES. And the full estimated cost of the AMSA program including all spares and 5 years of operation.

(The information follows:)

B–1 FLYAWAY COST AND PROGRAM COST ESTIMATE

Preliminary estimates of flyaway costs are $22 to $25 million per aircraft based on a buy of over 200 aircraft. The total cost of the AMSA program, including R.D.T. & E., investment (based on a buy of over 200 aircraft), and 5 years of operations is estimated to be about $11 billion. The flyaway cost does not include cost of aerospace ground equipment.

BREAKDOWN OF FISCAL YEAR 1970 REQUEST FOR AMSA/B–1

Mr. SIKES. I would like to have for the record a detailed breakdown of the $100.1 million request for AMSA development in fiscal 1970.

(The information follows:)

BREAKOUT OF FISCAL YEAR 1970 B–1 REQUEST

We have requested $100.2 million for fiscal year 1970. Our estimates include ——— million for propulsion, ——— million for airframe, and the remainder for avionics. These requested fiscal year 1970 funds will be applied against the first several months of a full-scale engineering development program. During this early phase of development, the majority of the effort will be directed toward detailed engineering design and associated effort such as engine/airframe and avionics/airframe interface. The degree of design and interface accomplished early in a development program varies from contractor to contractor and the

estimates shown above may change significantly when firm contractor cost quotes are obtained later this year.

BREAKDOWN OF AMSA/B–1 FUNDS PROGRAMED TO DATE

Mr. SIKES. Using the same breakdown elements, tell the committee how much has been programed to date on each of these major components of the AMSA program.

(The information follows:)

B–1 FUNDS PROGRAMED TO DATE

The tabular breakout shown below itemizes the funds appropriated, versus the funds approved by OSD by fiscal year. These funds have been used to conduct a variety of weapon-system studies and propulsion and avionics advanced development efforts. The majority of the funds (about $72 million) was applied against a propulsion advanced development program which resulted in the design, development, and testing of demonstration engines which are very close to the size and cycle required for the envisioned AMSA missions. Avionics studies and avionics advanced development resulted in flight-hardware test programs to prove the technical feasibility of specific avionics subsystems designed for use in the AMSA. Some $41 million has been applied against these tasks. The remainder of the funds have been utilized to conduct weapon-system studies and for test program support associated with the advanced development efforts.

[Dollars in millions]

	Fiscal year 1965	Fiscal year 1966	Fiscal year 1967	Fiscal year 1968	Fiscal year 1969	Total
Appropriated	52	22	22.8	47	[1] 5	148.8
Approved	28	46	18.8	26	25	143.8

[1] Planned for carryover to fiscal year 1970.

PROPOSED NEW MILLITARY CONSTRUCTION ASSOCIATED WITH AMSA/B–1

Mr. SIKES. You mentioned a dispersal program for AMSA. What new military construction including the modification of existing air base facilities would probably be required for AMSA?

General MCNICKLE. We would hope there will be none. The B–1 will operate with less runway, since it is smaller than our present bombers. Also, one of the features is that being small and operating on smaller runways it will be easier to disperse and the avionics self-test features tie into this concept.

Mr. SIKES. No newer and larger shops and hangars will be involved.

General MCNICKLE. No, sir.

Mr. SIKES. Since you do not anticipate new and additional facilities, do you envision some possible modernization of existing facilities?

General MCNICKLE. Yes, there might be a requirement to update some.

AMSA/B–1 COST COMPARED WITH MINUTEMAN III COST TO DESTROY SAME TARGETS

Mr. SIKES. How does the total cost of the development, procurement, and 5 years operation of AMSA compare with the cost of enough Minuteman III missiles, including production, installation, and operation for 5 years, sufficient to destroy the same number of targets that your anticipated AMSA force could destroy?

(The information follows:)

B-1 MINUTEMAN TRADE-OFF

First it is important to understand that we do not consider bombers to be competitive with our missile forces. Rather, we consider them to complement each other in providing the United States with both an effective deterrent force and a war fighting capability across a broad range of possible conflict situations. Our strategic deterrent force, consisting of bombers, land-based missiles, and sea-based missiles form a triad in which each provides a hedge against an unexpected failure or a Soviet technological breakthrough affecting the other. Each triad element provides strengths which compensate for the weaknesses of the other elements. Bombers and land-based missiles provide assurance against a Soviet breakthrough in ASW. Sea-based missiles and land-based missiles provide assurance against a Soviet breakthrough in negating our warning systems. Bombers and sea-based missiles provide assurance against a Soviet breakthrough in yield/accuracy. Further, we would not completely trade off bombers for missiles because bombers have utility in lesser conflicts such as nonnuclear war where a variety of constraints may prevent the use of missiles.

Secondly, it is impossible to provide a simple and direct answer to this question because comparisons of the type you suggest are extremely sensitive to the assumed scenario. There are, of course, a large number of possible war scenarios and a wide range of assumptions associated with each. For example, the number of Minuteman III missiles required to equal the effectiveness of a given U.E. bomber force is significantly influenced by the degree of strategic warning assumed and the generation rate of the bomber force during this warning period. For example, assuming no Minuteman III's destroyed before launch, the ratio of Minuteman III 5-year costs to B-1 5-year costs to deliver the same number of weapons to target would be about .58 for a bomber generation rate of 40 percent. For a fully generated bomber force (90 percent) the ratio would be about 1.34. Similarly, the number of missiles assumed to be destroyed before launch is also a driving factor and this is dependent on a host of assumptions regarding attack timing, warning time, launch doctrine, attacking missile accuracy, etc. For example, the above ratios would change to .73 and 1.67 if 20 percent of the missiles are assumed to be destroyed before launch. The described comparisons are relevant to soft targets where delivery accuracy is not a significant factor. If hard targets are considered, the better delivery accuracy of the B-1 would alter the ratios in favor of the B-1.

In general, our past studies have shown that the relative cost effectiveness of pure missile and pure bomber forces varies as the scenarios and assumptions are changed. These studies have also shown that a mixed force of missiles and bombers can, against an uncertain threat, provide a more cost effective deterrent than a pure force of either system.

JUSTIFICATION FOR AMSA/B-1 BOMBER FLEET

Mr. SIKES. In this instance, I think you would want also to include a re-analysis or a new listing of the reasons why you want to continue to have a bomber fleet. It is not just a matter of equal destruction, but it is alternative attack.

General MCNICKLE. That is right. We do not think the missile is a complete substitute for aircraft. The missiles do not have some of the flexibility of the aircraft.

Mr. SIKES. That is something you want to bring out in detail.

General BOYLAN. May I comment on that for a moment?

Mr. SIKES. I wish you would.

General BOYLAN. This particular question in a very real sense relates to a question asked earlier as to priority of systems. In an absolute sense—and this is not a contradiction of the answer, you were provided earlier—the deterrent posture of the United States under every condition has to come first. The subquestion that works is when should a particular system occupy a position of priority over another system in the same fiscal year for resource support? So the timing really is the key to that question. But back to the deterrent posture,

I know this committee has heard countless words on the subject, but I would submit that our deterrence has to have three basic characteristics.

Certainly it must be adequate. There is an awful lot of debate on this question of adequacy, but it is certainly a combination of the target system that threatens the United States.

It certainly derives from the offensive posture of those who possess the target system as a threat to the United States. It certainly derives from the policy of the United States which guides the application of that deterrence. Specifically, I mean our attack policy. The Nation has accepted a policy which says that the United States will retaliate. I think the second principal characteristic is reliability. By that I mean that our deterrent has to in every way protect us against surprise. Surprise from the standpoint of the potential enemy capabilities, and surprise that may result from technical failure of any part of our deterrence—certainly reliability. I think the third and last characteristic that I would submit to you is flexibility. The deterrent cannot be fixed in the sense of one enemy or one characteristic. It has to be fully responsive to the decisionmakers. We must be certain that it can be applied in a variety of ways against a variety of unknowns.

Currently, after continued study, the United States posture is based on three elements of deterrence—three forces which contribute to deterrence: Land-based missiles, sea-based missiles, and the bomber force. You can find those who will disagree with this statement, but the majority of knowledgeable, responsible students of the problem agree the bomber will remain a part of our deterrent posture for the foreseeable future. I would describe that foreseeable future as long as man utilizes the sensible atmosphere for application of weapons as one in which a bomber will be involved in that application. I think one of the reasons that a bomber will be involved is, by its very nature, it can be applied to a wide range of situations. The world in front of us may not be just a nuclear threat world. If it is, it does not necessarily follow that it is absolutely massive. It can be a selective nuclear type environment, but certainly the bomber must have a conventional capability.

Again, we can't predict the circumstances which will require U.S. military forces to be deployed somewhere. It might be Russia; it might be China, but it could be some unnamed country in a very remote area of the world. I cannot describe the circumstances that would bring this about but those circumstances certainly are in our future.

I would think that certainly another reason there should be a bomber is that this system, more than any other, can reflect the temperature of our national concern. People do know when a bomber force is placed on high alert and people certainly know when a bomber force is placed on airborne alert.

I think the next reason for the bomber would be that the system complicates the defense of any potential enemy by a major factor. I would say by an order of magnitude. This is extremely important. The demands are made of him that his resources, his technology be spread over a wide area and not be focused on, let me say, a single characteristic of missiles.

This next reason doesn't receive very much attention. The bomber is reusable. It can be launched as a gesture. It can be launched to exe-

cute a strike, but in either of those cases some fraction of the force will certainly return for further missions in the national interest. I think those are the four principal points.

AMSA/B-1 TO HAVE LOW-LEVEL ATTACK CAPABILITY

Mr. SIKES. That is very interesting. I presume the effectiveness of any bomber attack of the future may well depend on its low-level attack capability, is that right?

General BOYLAN. It might very well, Mr. Sikes, but it might not.

Mr. SIKES. In that case, do you anticipate that this capability will be successfully built into the AMSA?

General BOYLAN. It most absolutely will.

VULNERABILITY OF A BOMBER FORCE

Mr. SIKES. Let me go one step further. To what extent will the effectiveness of bomber attack and the value of bomber availability be negated by its vulnerability, either before or after take-off?

General BOYLAN. I think the vulnerability of any of our systems will depend upon two principal factors. The technology which is applied against them and our intelligence. I think it is certainly within feasibility, under periods of increased tension, to place the great majority of our bomber force in a posture that will permit its launch in a matter of a very few minutes; not 15, but something far less than that, especially with the airplane being designed in the B-1 program.

With systems such as "Over-the-horizon" radars, the ——— satellite system and others, I think our forces will have the necessary tactical intelligence so that a major fraction of the manned system can be airborne and largely escape the effect of the enemy's weapons.

This is one hard part of the problem upon which the Air Force continues to work.

Mr. SIKES. I understand it will not be necessary to have an airborne alert.

General BOYLAN. I would think, Mr. Sikes, that would depend upon the peculiar circumstances at the time. That, of course, is more expensive. It tends to downgrade the effectiveness of the force over a period of time because of the human factors, but it is certainly an option that is available and tends to increase your survivability under periods of acute strategic distress.

COST OF AMSA FORCE COMPARED WITH COST OF INCREASED FBM SUBMARINE FORCE

Mr. SIKES. How would the cost of an increased force of FBM POSEIDON submarines, which will be under the seas and therefore relatively invulnerable to attack, compare to the AMSA force you are proposing? Provide this for the record.

(The information follows:)

B-1—POSEIDON SUB COMPARISON

The answer to this question is generally the same as that provided on page 540. Bombers are not competitive with Poseidon but rather we consider them to complement each other in providing the United States with both an effective deterrent force and a war fighting capability across a broad range of possible con-

flict situations. They are part of the "triad" previously discussed. The relative cost effectiveness of pure forces of either varies significantly as the scenarios and assumptions are changed. As previously mentioned, a mixed force of missiles and bombers provides the most cost effective deterrent against an uncertain threat.

PROPOSED AMSA/B-1 PERFORMANCE CHARACTERISTICS

Mr. SIKES. I have asked this question before, but I will repeat it. Describe the AMSA aircraft as you now see it; what performance characteristics you are looking for: including weight, range, speed, payload, et cetera?

(The information follows:)

B-1 CRITERIA

The following is a summary of the B-1 characteristics as we now see it:
360,000 lb. class takeoff gross weight;
Four man crew;
Four advanced turbofan engines;
Takeoff and landing distance over 50 ft. obstacle of ——— ft. maximum;
Payload capacity for ——— SRAM or ——— lbs. of nonnuclear bombs;
Maximum speed capability of Mach ——— at high altitude and Mach ——— at low altitude;
Maximum refueled range using a KC-135 is ——— nautical miles of which ——— nautical miles would be at low altitude delivering a ——— pound payload.

PRESENT TANKER FLEET SUFFICIENT FOR AMSA/B-1

Mr. SIKES. As you can see the AMSA now, will the range be intercontinental or will it have to be refueled?

General MCNICKLE. Normally it will have to be refueled.

Mr. SIKES. Will the present tanker aircraft be able to accommodate it?

General MCNICKLE. The B-1 is sized for the KC-135.

PROPOSED AMSA/B-1 CONTACT

Mr. SIKES. At what point in time do you anticipate selecting an AMSA contractor, if funds are available?

Mr. HANSEN. Very early next year.

Mr. SIKES. What kind of a contract do you anticipate letting for the development of AMSA?

Mr. HANSEN. The Air Force would prefer an incentive, cost-reimbursable type contract for development. However, the subject of the type of contract is under very intensive discussion in the Pentagon these days. We definitely would not want to use a total package plan.

As I mentioned, we wouldn't propose to ask for a commitment by the Government to production at this time but merely an option which will help us to refine our ideas of total systems cost.

ARGUMENTS FOR AND AGAINST FIXED-PRICE CONTRACT

Mr. SIKES. Will it be possible to obtain a fixed price contract for AMSA development?

Mr. HANSEN. I think it would be possible, but I think it would be highly undesirable.

General McNICKLE. We obtained a fixed-price contract for the F–111 development, but we don't think that is the way to do the R. & D. We have a lot of arguments though.

Mr. SIKES. Do you want to provide for the record some arguments pro and con on this?

General McNICKLE. Yes, sir.

(The information follows:)

B–1 CONTRACT CONSIDERATION

Cost plus incentive fee (CPIF) contract for development arguments for—

By properly structuring incentives contractor can be motivated to emphasize the best technical solution considering producibility rather than attempting to stay within the fixed cost for development.

Encourages close government control during the critical development phase.

Permits greater freedom to include future technology improvements and a wide range of trade off studies before selecting a specific design approach.

Arguments against—

Entire cost risk is assumed by the Government.

Requires larger number of Government personnel than under a fixed-price contract to insure proper control.

Fixed-price incentive (FPI) contract for development arguments for—

Greater contractor participation in cost risk.

Provides better cost control and engineering change discipline by the contractor and the Government.

Arguments against—

Inhibits technical innovations even when these may result in future cost savings.

Discourages hardware changes in response to changes in threat and national policy/strategy.

Less Government control and visibility concerning actual costs, hence contractor is in better position to negotiate production contract.

PROVISIONS FOR CONTRACT TERMINATION

Mr. SIKES. What will be the provisions of the AMSA contract insofar as termination costs are concerned if Congress or the DOD decides, at some point in time, not to continue the program?

Mr. HANSEN. As I mentioned earlier, we wouldn't be starting production at this time. The development contract would have the normal contract clauses relative to termination at the convenience of the Government. Clearly, if the funds were not available to continue, we would terminate for the convenience of the Government; at that point we would have the normal termination costs——

Mr. SIKES. Let me see if I understand you. Are you planning to include options in the contract to be exercised at a certain point in time?

Mr. HANSEN. Yes, but prior to the exercise of those options, there would be no obligation incurred.

General McNICKLE. The emphasis, however, Mr. Chairman, is on the performance of specific actions rather than on the calendar.

CONTRACT AUDIT AND SURVEILLANCE PROCEDURES

Mr. SIKES. Has the Air Force been able to use your experiences—some of them unhappy—with the C–5 program to develop contract audit and surveillance procedures which will give instantaneous notice of cost difficulties in the program?

Mr. HANSEN. I don't know about instantaneous, but we have certainly been intensively studying the experience of the previous problem areas. There is a very strong resolve in the current administration to apply better techniques of management information and management control to try to do a much better job in the future than has been done in the past.

I might mention, incidentally, that the particular job I am in is normally filled with what you might call a scientific type—which I am not, really. I believe I was selected for this job because of my experience in program management.

NOTIFICATION TO CONGRESS OF DIFFICULTIES ENCOUNTERED

Mr. SIKES. What assurance can Congress have that if funds are granted for AMSA and the program proceeds but then runs into difficulty, Congress will be informed in a timely way so that reasonable decisions can be made as to whether or not to continue the program.

Mr. HANSEN. One of the other congressional committees has asked for periodic reporting on the progress and status and projections for certain major programs.

Mr. SIKES. Will that be sufficiently meaningful that it will alert us to danger signals?

Mr. HANSEN. Yes, sir. It certainly is the intention of the request that it be, and it would be our intention to furnish information that would meet that criterion.

Mr. SIKES. At this point I would like to make the request that such reports also be sent to this committee.

Mr. HANSEN. Yes, sir.

General PITTS. I might amplify just briefly for the committee, Mr. Chairman, at this point, that there is a system in effect now within the Department of Defense, and the Air Force has its program which is "Selected Acquisition Information Management System." The responsibility for this is vested under the Directorate of Production and Programing which comes under General McNickle. Basically, and generally, this comprises two systems, a cost information reporting system which derives from the contractor; historically reporting costs incurred and estimating costs to completion and a system for the systems program office, our program directors, who have plant representatives down at the plant to collect costs and report up through Air Force channels into this office so that we can collate these and get real good visibility on costs being incurred, and any abnormal escalations or overruns.

AMSA/B–1 VERSUS SPACE-BASED OFFENSIVE SYSTEMS

Mr. SIKES. What would be the answer from the standpoint of this committee if criticisms were advanced that the Air Force is looking backward rather than forward in its decision to develop the new advanced manned strategic bomber, instead of developing a fractional orbit bombardment system, such as the Russians appear to have, or an advanced ICBM, or other space-based offensive systems? I would like you to discuss that in some detail for the record.

(The information follows:)

B–1 Versus Spaced-Based Weapons

Any criticism that the Air Force, in seeking to modernize its bomber force, is looking backwards could only stem from a lack of appreciation of the roles and characteristics of bombers vis-a-vis the other systems mentioned. The manned aircraft still remains the most versatile system yet devised for delivering munitions of almost every type. The fact that the aircraft is designed to carry large payloads over long distances in a hostile environment and hence, is called a "bomber" only serves to enhance its versatility. The B–29 was used for delivering high explosive bombs, fire bombs, nuclear weapons, and psychological warfare pamphlets. They mined the waters of Japan and performed long-range weather and ground reconnaissance. They bombed industry, airfields, bridges, and deployed troops. They were displayed openly and worldwide as visible evidence of U.S. strength and technical expertise. There is reason to believe that these kinds of tasks may be required in the future and that in most circumstances a high performance bomber, if available, would be the preferred system. Missiles and space systems are obviously restricted to accomplishing only part of the list.

In the most important function of nuclear deterrence the characteristics of the manned bomber complements rather than competes with missile and space systems. This can be clearly seen in the offensive and defensive problems that the TRIAD of bombers, land-based missiles and sea-based missiles pose to the enemy.

Offensively, for example, a coordinated ICBM/SLBM attack on our ICBM's would free the alert bombers from the SLBM threat while an SLBM attack on the bomber bases would allow us more decision time for ICBM launches prior to arrival of Soviet ICBM's. Bombers are most vulnerable to short-warning SLBM attacks, least vulnerable to improved Soviet accuracy or ASW. Sea-based missiles have the least vulnerability to enemy attack but they are potentially vulnerable to Soviet ASW improvements. Land-based ICBM's are most vulnerable to improved Soviet accuracy, least vulnerable to SLBM's and not affected by ASW. Therefore, each TRIAD element provides strengths which compensate for the weaknesses of the other elements. Bombers and land-based missiles provide assurance against a Soviet breakthrough in ASW. Sea-based missiles and land-based missiles provide assurance against a Soviet breakthrough in negating our warning systems. Bombers and sea-based missiles provide assurance against a Soviet breakthrough in yield/accuracy.

Just as a mix of bombers and land and sea based missiles compounds the enemy's attempt to negate our deterrent through offensive action, so does this mix compel the enemy to maintain separate and expensive defenses against both our aerodynamic and ballistic delivery systems. Without this combination of offensive weapons the enemy could concentrate his efforts in one of several specific areas to counter our deterrent. Not only would our costs be much higher to insure a retaliatory capability but our confidence would be seriously reduced by the knowledge that a single technological breakthrough or tactic might negate our deterrent.

A decision to modernize the bomber force in no way reflects a curtailment of effort to maintain an effective land based missile capability. On the contrary, as the threat to the missile component of the mixed force increases the Air Force is continually studying and testing concepts to counter the threat. Such programs as Hard Rock Silo, ABRES, and Advanced ICBM Technology are examples. While concepts such as FOBS and space based weapons may appear attractive in certain respects, in-depth analysis tells us that in addition to the political aspects of weapons in space, there are other concepts that warrant more serious attention. MIRV is certainly one of these as are new basing concepts and some advanced reentry systems capable of flying shaped trajectories which would result in essentially the same effectiveness as FOBS.

In summary, the allegation that long range, large payload attack aircraft are made obsolete by missiles could only be based on the one thing that these systems have in common; that is, the ability to deliver nuclear weapons. Such an allegation not only ignores the fact that the method of delivery is importantly different but also that the systems are totally dissimilar in every other capability. It is because of these important differences that we say that missiles and aircraft complement each other.

AMSA/B–1 BOMBER VERSUS MISSILE-SPACE AGE CONCEPTS

Mr. SIKES. The Air Force as an organization is built around the flying of aircraft. The rated pilot is the nucleus of the Air Force. It would be normally natural for an organization with this orientation to try to continue manned aircraft in all phases of operation. To what extent has the advanced manned strategic bomber, as a concept, become generally obsolete in this missile and space age?

You can develop that for the record.

(The information follows:)

B–1 MANNED BOMBER VERSUS MISSILE-SPACE AGE CONCEPTS

The information has been provided on pages 540 and 546.

AMSA/B–1 VERSUS B–52 MODERNIZATIONS

Mr. SIKES. If Congress or the Department of Defense were to deny funds to the Air Force for the development of AMSA, what is your next priority as a replacement strategic-weapons system to cover the target system in current operational plans?

Mr. HANSEN. I think the answer to that is that we would have to continue the B–52 force and continue to make modifications to it to insure that it has the structural integrity to continue.

Mr. SIKES. Is that possible?

Mr. HANSEN. Yes, sir.

Mr. SIKES. You have been adding to, improving, modernizing and refurbishing the B–52 for years and it still is an effective aircraft, but time is passing. You can't continue to crank new significant improvements in it, can you?

Mr. HANSEN. I think you can. Our analysis——

Mr. SIKES. Really, in keeping with the times?

Mr. HANSEN. Our analysis says it would not be cost effective to do that. In order to do what you would have to do and hang onto the ever-aging framework, we are at the point where it would be more costly actually to proceed on that basis than it would be to go ahead with the development of AMSA.

Mr. SIKES. Aside from cost, would you have sufficient modernization to make it worthwhile?

Mr. HANSEN. Well, you could. You could jack up the hub caps and put a new airframe in. Some of the modifications at this time in my view are not really too far from that.

I went out and inspected the line out at the Oklahoma City Air Materiel Base where they are bringing the B–52's in, stripping them down, making the necessary structural modifications and reskinning them. That operation looks to me like it is practically a complete rebuild of the airplane. In fact, when I saw it, I said it looked to me like we should have these fellows on the bidders' list for AMSA.

Mr. SIKES. Should we be undertaking this approach, the modernization and future modernization of the B–52 rather than to go to the

risk of developing a new aircraft with problems of cost overruns and uncertainty of product?

Mr. HANSEN. No, sir. I think that would be very wrong. Something on the order of $144 million has already been spent studying AMSA and for advanced technology, so we are certainly not that unknowledgeable about what is involved in the job and what we ought to do. I think that the cost and the knowledge of what would be involved in modernizing those old airplanes show us an assured cost and an assured risk that, in my opinion, is higher than it would be for a new one.

You get to the point in fixing up something that is old when you just know from very obvious things that it is better to bulldoze it down and start over; I think we have that kind of a case here.

Mr. SIKES. You may want to add to your answer.

(The information follows:)

B-1 VERSUS B-52 MODERNIZATION

There are two specific points which elaborate on the foregoing. First, the latest model B-52, the "H" model, represents about the maximum growth attainable within the constraints of the basic B-52 design. While we might be able to use new weapons or penetration aids on the aircraft, we are approaching some very restrictive limits. For example, the costs and downtime required to provide antennas for active bomber defense, or to improve the aircraft's self-sufficiency for wide dispersal are exorbitant.

The second point concerns structural life. The engineering science relating to aircraft structures is still inexact. Even if we could predict with accuracy exactly how the aircraft will be used in the future, i.e., number of landings, air refuelings, hours at low level, etc., we still cannot predict, as well as we would like, how the structure will respond to this usage. The problem here is that by the time we detect structural fatigue it may be too late to acquire a replacement aircraft on a timely basis. Therefore, to avoid catastrophic failure we replace or beef up the affected structure. The problem is compounded by the fact that the uncertainties in forecasting the type and extent of wear out are accompanied by large uncertainties in the magnitude of the costs that may be required to keep old systems viable. We do know, however, that as age increases so does the risk of incurring large modification costs.

ALTERNATIVES TO AN AMSA/B-1 FORCE

Mr. SIKES. It has been stated that the underlying basis for the strategic nuclear capability of the United States is the ability to absorb the first strike by any enemy nation and then retaliate with sufficient force to cause an extent of damage which would clearly be unacceptable to that nation. Could we continue to maintain this objective through other means if no new manned strategic bomber is developed and placed in inventory?

Will you prepare an answer to that for the record, and list alternatives?

(The information follows:)

STRATEGIC NUCLEAR CAPABILITY

It is conceivable that this could be accomplished by other means: however, the reliance on a single type of system is certainly a high-risk approach to strategic deterrence. Further, the flexibility of the force to respond to other types of conflict situations would be greatly reduced and the overall cost of our strategic forces would be increased.

[Additional classified information was provided to the committee.]

ESTIMATED TOTAL COST OF AMSA/B–1 PROGRAM

Mr. SIKES. Estimates have been made publicly that considering the weight and complexity of the proposed AMSA, that the aircraft will probably cost in the area of $50 million each. I would assume this would include spares and ground support equipment and whatever it takes to make the system operational. Is this probably a fairly reasonable estimate?

Mr. HANSEN. If you think of taking the total cost of the program, the development costs, the spares and the whole business, and then spread that over something like 200 or more aircraft, then I think that is a fairly reasonable number. It is my personal view that perhaps it is a little on the high side, but the difference between that number and my own number that I would estimate is within the estimating accuracy at this point.

COST OF MODERNIZING B–52 FORCE

Mr. SIKES. What would it cost to update a B–52 by comparison?

Mr. HANSEN. It would cost more to keep it in service for a life comparable to a new bomber.

General BOYLAN. As a measure of this type of cost, we have already invested $2.5 billion in updates on the B–52 through fiscal year 1969.

Mr. HANSEN. I believe that costs computed on the same basis I just described for the B–52 would amount to more, and the studies that have been made in DOD say that same thing.

WILL AMSA/B–1 BECOME OBSOLETE BEFORE IT IS DEPLOYED?

Mr. SIKES. After about 10 years and $1.5 billion were spent on the B–70 strategic manned bomber aircraft, the program was canceled. Even the uniformed Air Force witnesses agreed at the time of the cancellation that the aircraft, which was designed to fly high and fast, would have been vulnerable to air defense systems which had been developed and would probably not have been a very useful weapons system. What chance do we take of facing the same kind of a dilemma after spending several billion dollars on the development of AMSA?

Mr. HANSEN. I think a minimal chance because this bomber is being deliberately designed to have the maximum flexibility that we know how to build into it.

Mr. SIKES. You don't anticipate that any of the mistakes that have been made in previous programs are going to be repeated here, is that what you are saying?

Mr. HANSEN. We are not planning to repeat any previous mistakes; no, sir.

Mr. SIKES. The B–70 wasn't considered a mistake. We supported the B–70. It was the best thing that was offered at that time. Hindsight shows that it wasn't a good investment. That is the context of my question.

Mr. HANSEN. The B–70 was overtaken by events. It was designed as a very high, very fast bomber and as you stated, the development

in the antiaircraft capability made the B–70 appear to be too vulnerable.

Now, this AMSA airplane is being designed to fly high and low, to have the necessary penetration aids, to have the necessary armament, to have the necessary flexibility so that it will operate in any conceivable environment that we know of, and some compromises are being made. It will not be as good a high altitude, fast airplane as it would be if it were designed just for that. It won't be as good a low altitude airplane as it would be if it were designed just for that. It is a multipurpose bombardment aircraft which will do the best job we know how to do of providing something that can have a very long life and can be used with whatever tactics and in whatever environment that it needs to be used.

ACCOMPLISHMENTS OF THE XB–70 PROGRAM

Mr. LIPSCOMB. Mr. Chairman, at this point in the record, inasmuch as we have mentioned the B–70, I believe it would be of value to have a list of the things that we learned from the B–70 program and the accomplishments that came from that flight test program and the R. & D. effort?

Mr. HANSEN. Yes. I think that would be a significant list. Could we provide that for the record?

Mr. LIPSCOMB. Yes, please. From the standpoint of both military and civilian areas.

(The information follows:)

XB–70 ACCOMPLISHMENTS

The purpose of the joint USAF/NASA XB–70 flight research program was to meet the future needs of both military and civilian aviation. The XB–70 flight research program yielded vital information required in the design and in evaluating the operational aspects of large supersonic-cruise aircraft, such as the SST and B–IA, and also provided information relating to the design and operational characteristic of systems, structures, and equipment which will be used in such future high-performance aircraft. The major objectives of the flight research program were to gain new knowledge in the areas of flight dynamics, stability and control, handling qualities, effects of gusts and dynamic loads, performance of engine and inlet combination, sonic boom investigation, and the collection of supersonic performance data in the Mach 2.0 to 3.0 region. Even though the aircraft has stopped flying, analysis of the recorded flight test data will continue, and the real benefits from the program will continue for many years in the future. Through the joint DOD/FAA supersonic information exchange program, the Department of Defense has provided, on a continuing basis, supersonic technological data to the Department of Transportation, Boeing Aircraft Company and to their subcontractors for their use in the development of the SST. This is knowledge we acquired primarily from the XB–70 flight test program but also includes the accumulation of Air Force experience in supersonic aircraft, such as the B–58 and SR–71. Over 1,400 USAF technical documents have been disseminated to DOT and industry through this program.

Following are a few specific examples of some of the major technological contributions the XB–70 flight research program has made in increasing our knowledge of the supersonic flight environment:

1. Flight dynamics and stability and control:
   (*a*) Validation of aerodynamic prediction techniques which account for the effects of aeroelasticity.
   (*b*) Compilation of control usage and airplane response parameter data.
   (*c*) Correlation of ground based simulator data with airborne data.
   (*d*) Validation of predicted aircraft performance techniques.

(e) Development of instrumentation calibration methods.

2. Handling qualities:

(a) Validation of proposed handling qualities criteria for large transport aircraft.

(b) Identification of specific piloting problems associated with high-speed flight (i.e., altitude control, lateral-directional control) and terminal area operations (i.e., optimum glide slope, flare height).

3. Engine inlet compatibility:

(a) Investigation of internal high-speed shock wave systems and associated variable geometry and controls.

(b) Turbulent inlet flow measurements.

(c) Spillage drag tests.

4. Validation of aerodynamic load prediction techniques.

5. High speed friction measurements and pressure distribution data.

6. Noise pollution measurements to support the national sonic boom program.

7. Dynamic response:

(a) Vehicle response measurements relative to high altitude turbulence, landing loads, and normal operation.

(b) Evaluation of structural-mode suppression subsystem.

I think it should also be pointed out that the contributions to technology from the flight test program reflect only a small portion of the total technology that emanated from the XB–70 program. Literally hundreds of new developments were made during the design and manufacturing phases of the XB–70 aircraft. These concerned the development of new materials and new manufacturing methods. Problems in forming titanium required the development of totally new metallurgical concepts. A family of ultra light weight titanium I beams were developed for the XB–70's inner structure. New stainless steel alloys were also developed to meet critical strength and temperature requirements. New techniques for heat treating, machine welding, processing, and forming stainless steels were developed. Steel honeycomb panels were developed to meet the basic structural requirements of the XB–70. Special high temperature materials and air-cooled turbine blades were developed which made much higher engine turbine temperatures possible.

These are but a few of the many examples of XB–70 technology which has contributed not only to the advancement of the aviation industry, as reflected in our current civil and military aircraft (i.e., C–141, DC–8, C–5A, 727, F–111, Apollo, and SST), but also to expanding our overall industrial capability.

PROPOSED FISCAL YEAR 1970 AMSA/B–1 PROGRAM

Mr. SIKES. The January budget showed $77.1 million estimate for the AMSA. The April revision shows $100.1 million. For the record show what you will buy with the additional $23 million and why that is an additional amount which is necessary.

(The information follows:)

NIXON BUDGET B–1 INCREASE

The additional $23 million will allow us to take a more positive and accelerated approach to the AMSA program. We plan to initiate full scale engineering development in fiscal year 1970 in lieu of a competitive design program. This revised approach would place us in a position to make an earlier procurement decision and would permit advancing the IOC by about 1 year. In addition, the rather extended period of competition previously envisioned for the first 2 years of development will be eliminated and this would result in a total R.D.T. & E. cost reduction of at least $300 million.

BOMBER ROLE IN PERMISSIVE AIR ENVIRONMENT

Mr. SIKES. The use to which the B–52 heavy bomber force has been placed in recent years is the bombing of undefended targets in a permissive air environment. It is unlikely that this role will continue in future wars, but if this role were to continue, how difficult would it be

and what would be the difference in cost to build an aircraft to fulfill this role only, and leave the strategic attack of defended targets to missiles? Do that for the record. Show what the shortcomings would be with what the advantages and costs would be.

Mr. HANSEN. I think the answer to that is very simple. If you had undefended targets, we wouldn't need to develop any new airplane. We could do it with C-141's or we could take the C-5A and put a 50,000-pound bomb in it and push it out the back end.

Mr. SIKES. Expand on that for the record.

(The information follows:)

BOMBER ROLE IN PERMISSIVE AIR ENVIRONMENT

There are two basic design considerations for a manned bomber: penetration capability and accurate weapon delivery. The penetration capability must be able to defeat the defensive environment. It must consider the quantity and quality of enemy detection systems, their command and control capabilities, and the nature of their defensive weapons—be they interceptors, antiaircraft artillery, surface-to-air missiles, or some combination of them. The costs of countering these various elements of the defensive threat environment can be substantial. In terms of penetration aids, we have found that considerable effort in electronic warfare, decoys, and defense suppression weapons is not only warranted, but essential. Further, we have found that we must design a wide range of performance flexibility into a bomber that is to survive in a sophisticated defensive environment and place its bombs "on target." It must be able to cruise economically, but it must also be able to perform effectively once it is in defended areas—there, it may have to fly high and fast or low and fast.

Designing all of these capabilities into a strategic bomber adds expense. First, the airframe must be stressed for the rigors of flight at a variety of altitudes and airspeeds—particularly low altitude and high speed. Second, the engines must be designed to perform efficiently at many different combinations of airspeed and altitude. Third, the different penetration aids—the electronic countermeasures, the decoys, and the suppression weapons—must be developed and integrated into the bomber design.

In terms of getting bombs on target, we are concerned with the accurate delivery of a variety of weapons independent of night or weather conditions. While there are some interactions between enemy defensive capabilities and our all-weather bombing-navigation systems, our requirements on these systems are largely without regard to the defenses. We do, of course, want to be able to use short bomb runs, to change altitude and attitude in the process of bombing, and not attract attention to our bombers, but the demands for accuracy and reliable all-weather performance are overriding.

Now, if we were to design a bomber strictly for attacking undefended targets in a permissive air environment, we would not have the expense of designing, developing, and then procuring those features associated with penetrating defended environments. We would, however, still be concerned with accurate, all-weather weapon delivery systems. Under such less demanding conditions, the Air Force would probably not develop a new bomber—rather, we would adapt those that we have to the postulated permissive environment. We would probably improve the weapon delivery accuracy and remove all penetration aids. We would also worry a lot less about the structural life of our aircraft since they could always be flown at medium altitudes.

The disadvantage of such an approach is the limited utility of a large and still expensive bomber—albeit not as expensive as a penetrating bomber. A force of "permissive bombers" would have to be manned and maintained in readiness for use in a permissive environment. In this posture they would contribute nothing to nuclear deterrence nor could they be readily configured to any other mission. Further, to the extent that a permissive environment existed for their use, their utility would be wholly contingent on the continuation of that permissiveness—a single SAM, or the appearance of a single Mig, would change the environment from permissive to defended. With the tenuous nature of permissiveness, having a force dedicated to that singular application would seem to be both unwise and uneconomical.

DELAY IN ISSUING REQUEST FOR PROPOSALS FOR AMSA/B–1

Mr. SIKES. Has the request for proposals on AMSA been sent to industry as indicated in the statement before us?

Mr. HANSEN. Not yet.

Mr. SIKES. When will this be done?

Mr. HANSEN. We hope to be able to do that next month.

Mr. SIKES. I believe you indicated in your statement it would be done in May. You now think it will be done in July.

Mr. HANSEN. I said that in the original plan upon which North American and others made their build-up, it was planned to have the Request for Proposal out in May. We didn't make it. The principal reason has to do with how we contract and this is backlogged behind the question of how we do it on the F–15.

Mr. SIKES. When do you expect the request for proposals to go out?

Mr. HANSEN. We hope to get that cleared up in the very near future and get our proposals out next month.

Mr. SIKES. That would be July.

Mr. HANSEN. That would be July.

COST OF CONTRACT DEFINITION ONLY

Mr. SIKES. If the Congress decided to fund your AMSA programs for fiscal 1970 only through contract definition, and with the objective of reviewing the cost and performance criteria of the aircraft before actually funding initiation of the development contract, how much money would be required in fiscal 1970 at this time?

General MCNICKLE. I estimate it would be approximately $40 million. As you know, we have been studying this for years and years and I think this would be just more paper we would be buying.

Mr. SIKES. What would it do in the way of delaying the program?

Mr. HANSEN. About six months.

EFFECT OF CONGRESSIONAL REVIEW PRIOR TO CONTRACT AWARD

Mr. SIKES. In funding the initiation of the F–14 fighter aircraft for the Navy last year, the Congress provided in the conference report on the appropriation bill that a report be made to Congress prior to the signing of the contract so that Congress might be better informed as to the cost of the program and the performance criteria of the new aircraft before permitting full-scale development to go ahead. Would you object to such an arrangement with respect to AMSA?

Mr. HANSEN. An arrangement like that would be agreeable to us, but I would like to suggest a better way.

Mr. SIKES. All right.

Mr. HANSEN. Wherever there is a problem there is always a tendency to try to pull the review level up. I personally believe that it is a very sound principle of management that we need to work hard to push the decision criteria that we want used down. Rather than to say, "Bring it in to us and we will decide if it is too much money," we would rather that you would generate guidance that says, "If it turns

out to be more than this amount of money, either don't do it, or then come and see us."

I very much believe that a conscious effort needs to be made to push good decision criteria down rather than to keep saying, "Bring problems higher for decision." I think it makes for better management.

WEAPON SYSTEMS FOR AMSA/B–1

Mr. SIKES. We haven't discussed the weapons system of AMSA. Is the weapons system included in the cost figures you have given us?

Mr. HANSEN. Do you mean, does it include the avionics and the missile capability and the whole business? Yes, sir.

Mr. SIKES. I would like a detailed discussion for the record at this point, for continuity, of the weapon systems which would be utilized, and their capabilities.

(The information follows:)

TOTAL B–1 SYSTEM PACKAGE

The B–1 will be capable of carrying existing inventory gravity laydown nuclear weapons and it is programed to carry advanced weapons such as the SRAM and SCAD. These systems, SRAM and SCAD, will be the primary armament used by the B–1 against the post 1975 threat. ———.

The SCAD is an airlaunched subsonic cruise armed decoy ———.

Mr. SIKES. Are there questions on the AMSA?

General PITTS. Mr. Chairman, a point might be made here. A lot of estimates have been made here this morning in response to questions from the Chair. The Secretary and General McNickle rightly pointed out they are estimates because requests for proposals are not even out. In the light of present-day publicity on cost of defense systems, it might be well to point out that it would be a proper procedure if we were allowed to put out requests for proposals and then select a contractor. At that time, which would be after the first of next year some time, we should be allowed to come back and revise these estimates to the Congress if the information from contractors so indicated.

Mr. SIKES. At that time we will have an opportunity, of course, to examine the whole field.

General PITTS. Yes, sir.

Mr. SIKES. Are there questions on AMSA?

Mr. HANSEN. Mr. Sikes, I need to correct the record on something that I just said that isn't right. Joe Jones points out to me that the cost estimates that we have made include avionics and provisions for the weapons like SRAM and SCAD, but the development costs of the weapons themselves have not been included.

SUBSONIC CRUISE ARMED DECOY (SCAD)

Mr. ADDABBO. To what extent is the subsonic cruise armed decoy (SCAD), for which you are requesting $17 million, designed only for AMSA? Is it also being designed for utilization with the FB–111 or B–52 aircraft?

Mr. HANSEN. Yes, sir; it is. It is being designed to be carried by the B–52 and AMSA; however, it can also act as a decoy for the FB–111 when they are penetrating along with the B–52's.

DIFFERENCE BETWEEN SCAD AND HOUND DOG

Mr. ADDABBO. Compare the subsonic cruise armed decoy with the Hound Dog missile which is a subsonic cruise missile presently carried on our heavy bombers.

Mr. HANSEN. These are aimed for quite different missions. The SCAD has a much greater range than the Hound Dog and acts as a decoy to complicate the Soviet defensive problem as well as to attack designated targets. The Hound Dog is a system already operational which carries a much larger warhead than planned for SCAD and is used primarily as a standoff attack or rollback weapon.

I have a side-by-side tabulation of the characteristics. Perhaps I should supply that for the record. I think it is useful data.

(The information provided the committee is classified.)

DIFFERENCE BETWEEN SCAD AND SRAM

Mr. ADDABBO. Why do you need both this new missile, which is referred to as SCAD, as well as the SRAM, which is still not perfected?

Mr. HANSEN. To expand on what I just mentioned a little bit, they serve a different purpose. The SCAD decoys the bomber and has some of them armed so that it becomes necessary for the enemy to use his defensive capability against the decoys, giving the bomber a better chance to get through. The other weapons are to kill targets at the terminal point.

Mr. ADDABBO. In the justifications it says SCAD can be used both as decoy and arms. It will be used in both cases?

Mr. HANSEN. That is right. The reason for that is that if you just had a decoy, we don't think it is possible to make a decoy that cannot be discriminated at some point from the bomber itself. So they would discriminate and ignore the decoys and go after the bomber, but if some of the decoys are armed, then in order to protect themselves, they have to assume that they are all armed and they have to go after them all. So you can saturate their defenses with a large number of objects and significantly improve the probability that the bomber itself will get through.

NEED FOR NEW DECOY WEAPON

Mr. ADDABBO. You could make a Hound Dog decoy or a SRAM decoy also, couldn't you? Why do you have to develop a new piece of equipment to accomplish this purpose when you have a cruise missile in the inventory and a new short-range attack missile under development? And you also have a Quail missile, which is a decoy, in the inventory.

General BOYLAN. May I comment, sir? To begin with, as pointed out earlier, the Hound Dog is a long-range attack weapon. It is used principally to fight the bomber through. It is relatively inaccurate. ———. Its warhead is probably unnecessarily large but it is the warhead that was available at the time of development; the SCAD—may I add one other comment on Hound Dog? Hound Dog, standing alone, does not have the characteristics to properly decoy for the bomber force. It is an object, but it does not represent a decoy.

Quail has been designed as a decoy. It lacks all of the characteristics that we foresee as a requirement for proper decoy techniques in the immediate future. ———. Its design, however, as compared to Hound Dog is more properly a reflection of the characteristics of the attacking force.

The SCAD's armament, in the armed version, assists the bomber in its penetration of peripheral defenses. It is to be used against SAM sites, principal radar installations and other similar targets.

SRAM is entirely different from SCAD and is not properly applicable as a decoy. It is a terminal defense weapon and will be used by the bomber to destroy the terminal defenses that protect the target from the bomber gravity weapon, or lay-down weapon.

Quail does not meet the technology requirement of the threat SCAD will. Hound Dog, relatively, versus SRAM, is ineffective for terminal defense.

Mr. ADDABBO. Is this initial backup for SRAM? Will you have such difficulty with SRAM it will not be developed, and is this why you want to initiate a new missile program?

Mr. HANSEN. The answer to all those questions is no.

TOTAL SCAD MISSILE PROGRAM

Mr. ADDABBO. What is the proposed program for the SCAD missile? How many missiles do you expect to procure and when?

Mr. HANSEN. The next major step in the program for SCAD is completion of concept formulation and the technical development plan next month.

The initial development program would then lead to flight demonstrations in the 1970 to 1972 period; a production source selection in 1972; and production to start in ——— giving us a fiscal ——— I.O.C.

ESTIMATED TOTAL COST OF SCAD PROGRAM

Mr. ADDABBO. What is your best estimate of the cost of the development program of this missile and the cost of procurement of the missile and its initial spares and necessary ground-support equipment?

General PITTS. Initial development is estimated at $103 million; engineering development, $88 million. Production based on about ——— missiles—did you ask for the estimated development and procurement, sir?

Mr. ADDABBO. Yes.

General PITTS. Production then for about ——— missiles, $283 million. Cost for initial spares is estimated at $44 million and ground support equipment to include training and technical data at about $36 million. That totals around $554 million. We are revising our production cost figure and this may increase the figures in a small way.

STATUS OF SCAD DEVELOPMENT PROGRAM

Mr. ADDABBO. What is the status of the development program?

Mr. HANSEN. There are just studies and preliminary designs at the present time.

Mr. ADDABBO. When do you expect to select a contractor?

Mr. HANSEN. About March next year, 1970.

FISCAL YEAR 1969 SCAD PROGRAM

Mr. ADDABBO. With what contractors are you expending the $4 million programed for this effort in the current fiscal year?

Mr. HANSEN. Part of that $4 million has been reprogramed. About half of it is earmarked for some engine work for the SCAD engine. The contractor has not yet been selected. One of the leading candidates is the Williams Research, Inc., which has a research engine which looks suitable for this. It was developed by ARPA for a jet belt manlift device. The Air Research Division of Garrett Corp. has also indicated they think they have an engine which could be adapted. I think there are other people who would be interested in competing.

PROPOSED CONTRACTORS FOR SCAD DEVELOPMENT

Mr. ADDABBO. Will you place a list of proposed contractors in the record?

Mr. HANSEN. Yes, sir.

(The information follows:)

LIST OF CONTRACTORS FOR SCAD

The following contractors are currently engaged in fiscal year 1969 funded SCAD efforts:

Cornell Aeronautical Laboratory, Buffalo, N.Y.: Decoy electronic package studies.

Air Research Division of the Garrett Corp., Phoenix, Ariz.: High density fuel studies for the SCAD propulsion system.

The following contractors may be funded this fiscal year for SCAD related programs:

The William Research Inc., Walled Lake, Mich.: Engine component development tasks.

Source selection is in progress to choose a contractor for SCAD air vehicle sizing studies. The companies competing for selection are—

The Boeing Aircraft Co., Seattle, Wash.
Lockheed Missile and Space Co., Sunnyvale, Calif.
The Beech Aircraft Corp., Wichita, Kans.

SCAD PROGRAM INITIATED WITH REPROGRAMING ACTION

Mr. ADDABBO. The SCAD program was not included in the fiscal year 1969 budget. Would you review for the committee the reprograming under which this effort was initiated?

Colonel HOERMANN. That came out during the apportionment exercise when we were balancing the President's budget for 1969. The Secretary of Defense set up the program and allocated $4 million.

General PITTS. The reprograming was for $2 million and it was within the flexibility of the Air Force to reprogram.

Mr. LIPSCOMB. General Pitts, would you say that again? I didn't quite hear.

Mr. FINE. If I understand the question correctly, sir, it was relating to the establishment of the initial $4 million in the program and not the disposition of the $2 million which has been reprogramed since.

In the initial apportionment program established for fiscal year

1969, the Office of the Secretary of Defense, did approve $4 million to be added to the program and this was done through a formal reprograming action.

The OSD number was fiscal year 1969–70. This was the initiation of the program and was under the ground rules which govern reprograming actions as they are followed by the Air Force. This particular action did not require the prior approval of the committee.

Mr. LIPSCOMB. Are you saying that you reprogramed $4 million for fiscal year 1969 with no prior justification before the Congress and now, as just reported here, we are getting into a program of over a half billion dollars.

Mr. FINE. No, sir; the reprograming action itself was submitted to the committee within the 2 to 4 weeks that is normally prescribed as a notification, so the committee was aware within a month after approval of the reprograming action was granted by the Secretary of Defense—in effect, it was a notification. If you are raising the question of the technicality as to whether or not this was to be a prior approval, the committee does have an opportunity when the notification has been received to review these actions.

Regarding the question of whether it is a prior approval in a very specific sense, it was not considered to be, as I recall, a major undertaking in the sense that it would have been committing the Air Force to a program of such magnitude that prior approval would have been required.

It was merely initiation of a program at a fairly low level of cost with certain milestones——

Mr. LIPSCOMB. From the testimony we have heard here this morning on the SCAD and the future plans for it, how do you view it now? It is a major decision?

Mr. FINE. It will be a major decision when we reach the point where we have gone through concept formulation and we have progressed to where a major commitment of funds would be involved. At this stage of the game, it is rather preliminary and it has involved only costs related to the study of the program. I think I have stated the case correctly, unless anybody else would care to add to anything I have said.

EXTENT OF AIR FORCE COMMITMENT TO SCAD PROGRAM

Mr. LIPSCOMB. How deeply, Mr. Secretary, are we committed to the SCAD program now?

Mr. HANSEN. To my knowledge we have no commitment on SCAD at all. We are convinced from an analysis of the tactics of the bomber penetration that SCAD would pay for itself many times over in the number of bombers that it could commit to do their job and be reusable. This is still in a stage of preliminary design and study and no significant commitment has been made to the program financially. I think the concept of AMSA makes it very highly desirable that as a part of the overall system we have a low altitude decoy capability to help saturate the defensive environment into which the bomber

airplane will fly. This can't be done by the Quail as we said earlier, because it won't match the penetration flight patterns of an advance bomber.

General PITTS. That reprograming, sir, was for concept and design studies and as the Secretary just testified, we hope to get concept formulation and the technical development plan approved in July of this year.

We haven't reached that point yet. Following that, we will go into initial development and that is the point in time when substantial funds will be put in.

Mr. SIKES. What if you had continued the development of Skybolt, would it have been obsolete or obsolescent, or would it have filled an important need today?

Mr. HANSEN. Skybolt was an entirely different kind of weapon. It was an air-launched ballistic missile which was intended to get around the vulnerability of the fixed-point launch site. I worked on the Skybolt program at Douglas Aircraft. Here the concept is to carry a missile into the range from which it can be launched, then launch it on a ballistic trajectory. It is a completely different concept. I don't think there is any way that you can really compare that capability with the SCAD, whose purpose it is to help the bomber to penetrate defensive environment and maximize its chances of survival in making its mission.

Mr. SIKES. Further questions on SCAD?

NATIONAL CLEAR AIR TURBULENCE PROGRAM

You are requesting $1.6 million for the initiation of a new program, the national clear air turbulence program. What are the principal objectives of this program?

(The information follows:)

PRINCIPAL OBJECTIVES OF NATIONAL CLEAR AIR TURBULENCE PROGRAM

The objective of the national clear air turbulence program, which includes actions by DOD, NASA, ESSA, and FAA is to find a way to reduce the effect of CAT on aircraft flight. The DOD portion of this program, assigned to Air Force, is to provide a national focal point for collecting, storing and retrieving data for the solution of CAT detection and forecasting problems.

The program is intended to provide a complete understanding of the basic meterological processes involved in the development, maintenance, and dissipation of clear air turbulence (CAT) in order to insure a reasonable probability of safe flight through or around CAT areas. Information gained will be used for—

(*a*) Development of airborne equipment to detect CAT ahead of an aircraft in flight.

(*b*) The solution of CAT detection and forecasting problems.

(*c*) The establishment of valid turbulence design criteria for advanced structures, flight control systems, and human factors investigations.

(*d*) The direct use of pilots and operators.

(*e*) The preparation of upper air climatology of CAT.

(*f*) The improvement of CAT reporting and alerting systems.

(*g*) The preparation of flight manuals and/or publication on seasonal and geographic occurrences of CAT.

Mr. SIKES. Is there any funding of this program by other Federal Government agencies?

Mr. HANSEN. Yes.

Mr. SIKES. Set that out for the record.

(The information follows:)

FUNDING OF NATIONAL CLEAR AIR TURBULENCE BY OTHER FEDERAL GOVERNMENT AGENCIES

The total estimated cost of the program is $32,515,000. Individual agency cost estimates are:

NASA	$21,380,000	FAA	$670,000
DOD	8,000,000		
ESSA	2,465,000	Total	32,515,000

Mr. SIKES. What is the total estimated cost of the program?

Mr. HANSEN. The total national program will cost approximately $32.5 million including other Government agency contributions.

Mr. SIKES. What is the purpose of the program?

Mr. HANSEN. The program is to try to figure out what causes clear air turbulence, how we can detect it and what we can do about it to make flights more safe.

Mr. SIKES. Is there anything that can be done about a natural phenomena of this type?

Mr. HANSEN. If we knew how to detect it, we could at least go around it like we do with the present weather-detection radar.

HOW PROGRAM IS COORDINATED

Mr. SIKES. Are you coordinating your efforts with the other Government agencies?

Mr. HANSEN. Yes; as a matter of fact, this is a national effort coordinated by the Federal Coordinator for Meteorology under Department of Commerce, and the Air Force is assigned as the agent for one portion. Various Government agencies support the Air Force portion and are putting their efforts into this common program.

PROGRAM RESULTS

Mr. SIKES. Provide for the record some information on what you have learned to date.

(The information follows:)

CLEAR AIR TURBULENCE PROGRAM—INFORMATION LEARNED TO DATE

The program begins in fiscal year 1970. It is the result of a review by a National Committee on Clear Air Turbulence with representation from DOC, DOD, NASA, FAA, ESSA, State, Agriculture, and NSF. This Committee reported that the problems of flight in clear air turbulence (CAT) could not be alleviated until there was more knowledge on the characteristics of CAT. The Air Force, however, for the last 3 years has been actively collecting and reducing clear air turbulence

data for the primary purpose of establishing valid aircraft structural turbulence design criteria. This program is called ALLCAT and is one of the ongoing programs funded under the flight vehicle subsystems program element (P.E. 63205F).

The objective of the ALLCAT program is to establish valid turbulence design criteria for advanced vehicle structures and flight control systems in order to insure a reasonable probability of safe flight through or around areas of atmospheric turbulence. The turbulence criteria established by this program will be used in the design of all advanced flight vehicles and in evaluating structural modifications, life determinations, and special problems of existing flight vehicles. Because of the random nature of this turbulence, a vast amount of data is required to establish an adequate description of the turbulence environment for all altitudes up to 200,000 feet. The output of the ALLCAT program provides for the periodic revisions of MIL-A-8861 (Aircraft Strength and Rigidity Flight Loads) plus the dissemination of interim changes. These specifications revisions will appear as complete rewrites scheduled for publication in 1969, 1974, and 1979.

Over 950 hours of useful clear air turbulence data has been collected within various altitude regimes from 250 feet to 70,000 feet since the inception of the ALLCAT program. The ALLCAT program is our insurance program, so to speak, that the new aircraft, both military and civilian that are on the drawing boards today, will be designed to safely fly through the varying levels of clear air turbulence which are likely to be encountered.

Canceled DOD Projects and Weapons Systems

Mr. Mahon. I would like for Mr. Sinclair, from the Office of the Secretary of Defense, if he is here today, and the committee staff, to make sure that we have in our hearings a list of the projects and weapons systems that have been started by the Defense Department and later canceled as well as the funds involved. I think perhaps we would want to break that down as between weapons systems that have gone to full development and those canceled out before being completed, such as the Skybolt. We have talked about these things quite a bit during the hearings. Maybe we already have this kind of information, but we need it at our fingertips because this kind of thing comes up often.

General McNickle. We have a pretty complete list and we will be happy to put it in the record.

Mr. Mahon. As I understand, the Democratic Caucus of the Democratic members of the House may give consideration to the military budget. We are moving toward a meeting. This question will undoubtedly arise and I want us to make sure that this kind of information is fully available.

Mr. Sikes, do you recall whether this information is already in the record?

Mr. Sikes. It has been in the record in previous years but it would be useful to have an updated list here.

Mr. Mahon. We want this not only for the Air Force, but for the whole Department of Defense, broken down by service, but in a single package.

As I understand it, in the last 15 years the Department of Defense has canceled, if you include MOL, about $9.5 billion in projects and weapon systems.

Another figure that is tossed around for a certain period is $23 billion. I think we need, every member of this subcommittee and the Congress needs, this kind of information and, in addition to that, we need a statement as to why such cancellations were made. It doesn't have to be in great length. The cancellation of the B–70; we have gone into that in detail many times and this committee is conversant with it, but when you hit the people who haven't worked directly in this field cold with these kinds of things, they are stunned and dismayed, and they tend to completely lose any faith or confidence whatever in the management of the Defense Department.

This thing must be put in proper focus. One way we could do it is to place it in the record when the Secretary is before us, Secretary Laird, or Dr. Foster, because we want to put it where people can find it; however, we need to have it available to the members of this committee now. We would like to have several copies prepared for the committee so we can have it before us. It is increasingly going to be an item of considerable interest, I think we all agree.

General PITTS. Colonel St. John has been taking notes and he will get this request to Mr. Sinclair for you.

Mr. MAHON. First, we want the basic, cold facts and then the reasons for it.

For example, MOL. I don't know whether or not you can go into that in great detail, but there are reasons why that was canceled. There as a change in the situation with the B–70, and so forth.

In addition to other factors, Mr. Lipscomb points out, we need to have the spin-off, or the fallout, or the benefit we derived from these programs which is authentic and which will demonstrate that while the losses have been great, there have been some benefits received. We don't want to exaggerate those benefits.

I think we could go back 10 years or 15 years, or do what you best can to answer this request.

Mr. HANSEN. Mr. Chairman, we need clarification on one thing you asked. You said something about programs which are canceled after they became fully developed. You mentioned two numbers which were significantly different. Would you, for instance, want to include a program like the Atlas which was deployed? It was never used in anger, and that is good; it served its purpose, but it was discontinued.

I wouldn't think something like that should be included.

Mr. MAHON. I wouldn't think it ought to be included unless it was very carefully explained because the Atlas served its purpose. Just like the horse and buggy preceded the automobile. I think we will have to be careful about that.

(The information follows:)

MAJOR PROJECTS TERMINATED DURING THE PAST 16 YEARS

Project	Year started	Year canceled	Funds invested (millions)
AIRCRAFT			
Army: XV-3 convertiplane	1952	1960	$10.1
Subtotal			10.1
Navy:			
Seamaster	1951	1959	330.4
F-8U-3	1956	1958	100.0
HSL-1	1950	1955	94.0
F-5D-1	1954	1957	49.0
A-2D-1	1950	1954	47.0
T-40	1954	1958	33.0
A-2J-1	1948	1963	20.0
J-40 engine	1944	1953	18.0
F-10F-1	1950	1953	15.0
F-2Y-1	1949	1955	15.0
F-111B	1961	1968	[1] 418.0
Subtotal			1,139.4
Air Force:			
ANP	1951	1961	[2] 511.6
F-108	1958	1959	141.9
XF-103	1950	1957	104.0
F-107	1954	1957	100.0
J-83 engines	1956	1959	55.0
C-132	1952	1957	54.0
T-61 engine	1957	1959	37.4
YH-16	1951	1954	23.4
X-21	1960	1966	36.0
X-19	1962	1966	16.0
XB-70	1958	1967	1,468.1
X-15	1959	1968	210.5
F-12 (as distinguished from YF-12)	1966	1969	41.0
Subtotal			2,798.9
MISSILES			
Army:			
Hermes	1944	1954	96.4
Dart	1952	1958	44.0
Loki	1948	1956	21.9
Terrier (land based)	1951	1956	18.6
Plato	1951	1958	18.5
Mauler	1960	1965	200.0
Subtotal			399.4
Navy:			
Sparrow I	1945	1958	195.6
Regulus II	1955	1958	144.4
Petrel	1945	1957	87.2
Corvus	1954	1960	80.0
Eagle	1959	1961	53.0
Meteor	1945	1954	52.6
Sparrow II	1945	1957	52.0
Rigel	1943	1953	38.0
Dove	1949	1955	33.7
Triton	1948	1957	19.4
Oriole	1947	1953	12.5
Typhon	1958	1964	225.0
Subtotal			993.4
Air Force:			
Navaho	1954	1957	679.8
Snark	1947	1962	677.4
GAM-63 Rascal	1946	1958	448.0
GAM-87 Skybolt	1960	1963	440.0
Talos (land based)	1954	1957	118.1
Mobile minuteman	1959	1962	108.4
Q-4 Drone	1954	1959	84.4
SM-72 Goose	1955	1958	78.5
GAM-67 Crossbow	1957	1958	74.6
MMRBM	1962	1964	65.4
Agena D	1956	1968	7.2
Subtotal			2,781.8

See footnotes at end of table, p. 564.

MAJOR PROJECTS TERMINATED DURING THE PAST 16 YEARS—Continued

Project	Year started	Year canceled	Funds invested (millions)
SHIPS			
Navy:			
Type II towed Torpedo countermeasures	1945	1955	$13.0
Subtotal			13.0
ORDNANCE, COMBAT VEHICLES, AND RELATED EQUIPMENT			
Army:			
Vigilante	1952	1961	26.6
Tank, medium and heavy, T-95	1955	1960	18.0
Truck, cargo, 2½-ton	1946	1965	5.9
Truck, cargo, 16-ton	1959	1965	[3] 4.8
Truck, tank, 5,000-gallon	1959	1966	(1)
Truck, wrecker, 20-ton	1959	1966	(1)
Area scanning alarm (E-49)	1957	1966	3.9
Infantry mortar, 107 mm, XM-95	1960	1967	10.7
Howitzer 155-mm. self-propelled XM-138	1964	1968	5.3
Subtotal			75.2
OTHER			
Army:			
AN/USD 5 drone	1957	1962	103.3
AN/USD 4 drone	1957	1960	40.0
Aerial tramway	1947	1957	13.5
Auto integrated switch	1958	1965	39.9
Subtotal			196.7
Navy:			
NRRS, Sugar Grove	1957	1962	70.0
High energy boron (ZIP)	1952	1959	123.0
Subtotal			193.0
Air Force:			
AN/ALQ-27	1957	1959	142.0
High energy boron (ZIP)	1956	1959	[4] 135.8
Dyna-Soar	1960	1963	405.0
MOL	1963	1969	[5] 1,494.9
Subtotal			2,177.7
Total			10,778.6

[1] Estimated R.D.T. & E. plus PAMN, funds. Exact investment will not be available until termination negotiations with the contractor are completed.
[2] AF costs only.
[3] The 3 trucks listed comprise the 16-ton series of the GOER program which was terminated in June 1965. Work was officially terminated on the tanker and wrecker in February 1966. The cost of the program was $4,800,000.
[4] AF costs only.
[5] Includes an allowance for estimated termination costs. Exact investment will not be available until termination negotiations with the contractor are completed.

ARMY

System:

(*a*) Title: XV-3 convertiplane.

(*b*) Mission (desired capability): The XV-3 was designed to determine the feasibility and performance characteristics of the tilt/propeller/rotor concept.

Date:

(*a*) Year initiated: 1952.

(*b*) Year terminated: 1960.

Funds expended: $10.1 million R.D.T. & E.

Reasons for termination: The program was concluded successfully in 1959. Concept was proven technically feasible; and program goals were met.

Technical fallout: Resultant information and design data are available for use by the aircraft industry in the tilt/rotor/prop field. Transmission of power problems were identified and alternate approaches to improve the design of future similar vehicles were defined. Dynamic stability problem areas were explored and solutions were outlined where possible.

System:

(*a*) Title: Hermes.

(*b*) Mission (desired capability): To explore and extend missile technology starting from the V-2 base, and to develop the Army's first surface-to-surface missiles.

Date:
(a) Year initiated: 1944.
(b) Year terminated: 1954.
Funds expended: $96.4 million R.D.T. & E.
Reasons for termination: The accelerated development of Corporal and Redstone had overtaken the range and payload requirements to be fulfilled by the Hermes.
Technical fallout:
(a) Boron chemistry for propellant additives.
(b) Control systems for aerodynamically unstable missiles.
(c) Reentry heating phenomena.
(d) Technological base for development of Sergeant and Pershing systems.

System:
(a) Title: Dart.
(b) Mission (desired capability): To provide an antitank missile capable of being guided into a target.
Date:
(a) Year initiated: 1952.
(b) Year terminated: 1958.
Funds expended: $44 million R.D.T. & E.
Reasons for termination: A technical evaluation of the Dart program in 1958 indicated that serious deficiencies in reliability, trajectory deviations, acquisition difficulties and human engineering aspects would require a major redesign of the system and attendant additional time and cost to complete development. At the same time, evaluation of the French SS–10, SS–11 and Entac antitank missile program revealed major improvements and progress, consequently, the French missile was purchased and placed in service.
Technical Fallout: The Dart program produced significant technical data and experience which have subsequently been utilized in small missile developments. The design requirements for successfully paying out dynamic wire used in wire guided missiles was determined. The overall feasibility of flying a missile into a target with the only requirement placed on the gunner of keeping the optical system cross hairs on the target was established. The technology on solid propellants for small rockets was developed. The design of shaped charge warheads was advanced for optimum penetration. Production facilities experience for small missiles was gained and provided a technique base for subsequent similar systems.

System:
(a) Title: Loki.
(b) Mission (desired capability): To defeat high-performance aircraft by firing large numbers of unguided rocket darts simultaneously from box launchers.
Date:
(a) Year initiated: 1948.
(b) Year terminated: 1956.
Funds expended: $21.9 million R.D.T. & E.
Reasons for termination: The development schedule was not considered sufficiently ahead of other weapons systems which were believed to be more promising, and due to budget restrictions, termination of Loki was authorized.
Technical fallout:
(a) Increased hypervelocity propulsion technology which was used in development of antitank weapons. Also used in the development of the Safeguard system.
(b) Flash deflectors developed in the program later applied to other missile systems.
(c) Obtained significant data on the aerodynamic behavior of missiles under hypervelocity conditions.
(d) Developed new materials for rocket nozzles.

System:
(a) Title: Terrier, land based.
(b) Mission (desired capability): Medium-altitude air defense of United States.
Date:
(a) Year initiated: 1951.
(b) Year terminated: 1956.
Funds expended: $18.6 million R.D.T. & E.

Reasons for termination: System development was terminated after evaluation revealed marginal effectiveness against low-altitude targets and significant requirement for launcher modification to sustain a high rate of fire. Concurrently the Nike-Ajax was achieving excellent results in firing tests, and the decision was made to proceed with that system.

Technical fallout: None directly. The Terrier has continued as a Navy system.

System:

(*a*) Title: Plato.

(*b*) Mission (desired capability): Use the Zeus antiballistic missile system in a mobile deployment for either United States or overseas deployment.

Date:

(*a*) Year initiated: 1951.

(*b*) Year terminated: 1958.

Funds expended: $18.5 million R.D.T. & E.

Reasons for termination:

(*a*) It became apparent with the continuing development of the Zeus system that the radars could not be effectively and cheaply made in a mobile configuration.

(*b*) The responsibility for the concept of a mobile ABM was transferred by OSD from the Army to the Advanced Research Projects Agency, and no further funding was received.

Technical fallout:

(*a*) Analytical techniques and computer programing techniques were developed. Much of this technology was directly applicable to the BMEWS program.

(*b*) Technology developed assisted in the development of linear/phased array radar concepts.

(*c*) The Field Army Ballistic Missile Defense System (FABMDS) concept was developed. Although Plato could not be considered a pure precursor of FABMDS, technology and techniques developed in the Plato program did asssist.

System:

(*a*) Title: Mauler.

(*b*) Mission (desired capability): To defeat law altitude high performance aircraft over the forward battle area in any weather conditions.

Date:

(*a*) Year initiated: 1960.

(*b*) Year terminated: 1965.

Funds expended: $200 million R.D.T. & E.

Reasons for termination: The system, consciously conceived as making full use of advanced technology, encountered extensive development problems, and the resulting design changes caused what would have been high production costs. After further studies indicated hostile aircraft would not be capable of all-weather low level attack for several years it was decided to terminate the system in favor of Redeye and Chaparral.

Technical fallout:

(*a*) Developed the propulsion technology now being further exploited in AFAADS development for rapid response air defense systems.

(*b*) Developed ground support equipment technology essential for any rapidly responding missile system.

(*c*) Developed the basic guidance and control techniques essential for any future all-weather missile system.

System:

(*a*) Title: Vigilante.

(*b*) Mission (desired capability): To provide low altitude air defense for the forward battle area.

Date:

(*a*) Year Initiated: 1952.

(*b*) Year terminated: 1961.

Funds expended: $26.6 million R.D.T. & E.

Reasons for termination: After considering results of limited service testing on developmental models, additional R.D.T. & E. funds and lead time required to develop and produce the system as an interim forward area weapon pending availability of Redeye and Mauler, further development was considered unjustified.

Technical fallout:

(*a*) Rapid loading feed system for present and future gun systems.

(*b*) Complete integration of fire control equipment with gun systems.

(*c*) Provided the technological base and then later the test bed for Vulcan and development of the AFAADS gun systems.

System:

(*a*) Title: Tank, medium and heavy T–95.

(*b*) Mission (desired capability): To provide a new medium tank (main battle tank).

Date:

(*a*) Year initiated: 1955.

(*b*) Year terminated: 1960.

Funds expended: $18 million R.D.T. & E.

Reasons for termination: As initiated this program included the T–96 heavy tank; however, that vehicle never progressed beyond a wooden mockup. The T–95 medium tank development was pursued through the construction and initial testing of 13 prototypes, and was terminated during service test. Termination resulted from a combination of factors: An urgent need for a new medium tank made it necessary to formulate a concept composed primarily of proven components, if the desired production date was to be met; problems with the smooth bore gun and ammunition for the T–95 indicated a need for further development so that time requirements could not be met with that development. The M60-series tanks, therefore, superseded the T–95 development, with type classification in April 1959.

Technical fallout: The T–95 program produced unusually valuable fallout in the following areas: optical ranging techniques (not fully useful until laser became available); relationships between gun accuracy and tube wear; obturation of high-pressure gun breeches; high-velocity projectile design; quick-change gun tubes; factors influencing gun-tube wear; empirical data on hull and turret ballistic protection; XPG-type transmission and flat-track system later used on M107, M108, M109, and M110 self-propelled guns; infrared shielding of exhaust gases by introduction of coolant air; and main-gun stabilization techniques now being applied to M60-series tanks.

System:

(*a*) Title: AN/USD 5 surveillance and target acquisition drone.

(*b*) Mission: General surveillance within its range capability (500 miles) and target acquisition. Targets located by the SD–5 were to be engaged by the Jupiter surface-to-surface missile. The SD–5 target location accuracy was to be consistent with the CEP of the Jupiter missile. The SD–5 also possessed a high altitude mapping capability employing a special mapping camera.

Date:

(*a*) Year initiated: 1957.

(*b*) Year terminated: 1962.

Funds expended: $103.3 million R.D.T. & E.

Reasons for termination: Termination of the SD–5 surveillance drone system resulted from an evaluation of the program which concluded that the SD–5, while technically feasible, would be too expensive for procurement in quantities adequate to provide the Army with an effective capability.

Technical fallout:

(*a*) The techniques employed in the Terrain Avoidance Radar (TAR) for the SD–5 were used in numerous TARs now in production. Some of these are AN/APQ–99, AN/APQ–101, AN/APQ–115.

(*b*) The inertial navigation system employed conventional techniques. Some of the components of the inertial navigator from the SD–5 were used on the Centaur missile.

(*c*) The techniques employed in the Side Looking Airborne Radar (SLAR) were used in SD–2 drone program. Also, some of the SD–5 SLAR components are presently being used by the Department of the Interior in their earth resources program.

(*d*) The Infrared Detecting Set, AN/AAS–16, developed for the SD–5, was the forerunner of current production equipments. Some of these are the AN/AAS–21, AN/AAS–22 and AN/AAS–24.

(*e*) The trialateration and guidance system pushed the state-of-the-art using psuedo-random noise-cross correlation techniques. This technique has

since been used in the long range survey system and the visual airborne target location system.

(*f*) The wide band data link pushed the state-of-the-art. The experience gained in this program was used in formulating the specifications for the joint in flight data transmission system (JIFDATS).

(*g*) The KS–57 aerial camera represented a significant advance in the state-of-the-art and introduced in-flight photographic processing. This experience was used in formulating the specifications of the joint in flight data transmission system (JIFDATS).

System:

(*a*) Title: Truck Cargo 2½ Ton XM410E1.

(*b*) Mission (Desired Capability) High mobility 2½-ton cargo capacity. Significant improvement in mobility. Improved reliability, and maintainability.

Date:

(*a*) Year initiated: 1946.

(*b*) Year terminated: 1965.

Funds expended: $5.9 million R.D.T. & E.

Reasons for termination: Service testing and confirmatory testing indicated that after extensive development time and effort, serious unacceptable mechanical deficiencies remained uncorrected. Further, to correct the unsatisfactory reliability, the Army would be required to invest a large amount of R.D.T. & E. funds for a major corrective effort without great confidence of technical success.

Technical fallout: The Army gained extensive technical insight into vehicular power requirements, and the relationship between engine power and engine durability. The Army also gained extensive knowledge of the weight requirements for high mobility trucks and the effect of weight on the durability of suspension components. Lessons have been applied to improve the durability of new vehicles in R.D.T. & E. During the R.D.T. & E. period the requirement for a high mobility 2½-ton truck was validated as cost effective The new development effort being planned will be shortened considerably with accrued savings in both time and money as a result of the XM410E1 effort. Prototype systems are currently being used to generate mobility data and function as test beds for power and suspension component qualification.

System:

(*a*) Title: Truck, cargo, 16-ton and associated model adaptations, 5,000-gallon tanker and 20-tone wrecker.

(*b*) Mission (desired capability): High-mobility, large-cargo-capacity truck with extensive reliability and durability.

Date:

(*a*) Year initiated: 1959.

(*b*) Year terminated: 1966.

Funds expended: $4.8 million R.D.T. & E.

Reasons for termination: Program was terminated on the basis of the USAREUR troop test which indicated that the truck was unreliable and could not be maintained in a satisfactory manner. Basic problems occurred in the adaptation of electrical systems used for power transmission and steering.

Technical fallout: The mobility required was achieved. Many lessons were learned on the use of large tires and articulation for high-mobility large-size truck systems. Extensive experience was gained in electric drive systems. This information is being applied to combat vehicle systems currently in R.D.T. & E. Electric drive systems are expected to be more and more important to reduce articulated vehicle investment and operation costs.

System:

(*a*) Title: Area scanning alarm E–49.

(*b*) Mission (desired capability): Provide area chemical detection capability for field use utilizing an active infrared detector.

Date:

(*a*) Year initiated: 1957.

(*b*) Year terminated: 1966.

Funds expended: $3.9 million R.D.T. & E.

Reasons for termination: Absorbtion of infrared occurred in the spectrum of analytical wavelengths of interest to chemical agent detection. (Water droplets and high concentrations of certain dusts absorbed the IR.) Created high false alarm rate.

Technical fallout: Analysis and subsequent research on shortcomings of the E–49 revealed that the interference created by moisture and dust can be selec-

tively screened by use of appropriate filter technology. This information has been applied to development of a passive long path infrared system which utilizes the ambient infrared energy emitted by terrain background.

System:
(a) Title: Infantry mortar, 107-millimeter XM95.
(b) Mission (desired capability): to provide a lightweight system weapon superior in range, accuracy, stability, rate of fire, and lethality to replace the current standard mortar.
Date:
(a) Year initiated: 1960.
(b) Year terminated: 1967.
Funds expended: $10.7 million R.D.T. & E.
Reasons for termination: The XM95 failed to meet essential military characteristics during engineer and service tests because of a lack of stability during firing which required frequent relaying of the mortar. Since no better approach was apparent within the foreseeable state-of-the-art the program was terminated in April 1967 and mortar effort reoriented to the status of exploratory development.
Technical fallout: The XM95 program produced significant technical data and progress on rocket assisted projectiles which subsequently have been utilized in development of artillery projectiles of this type. Design requirements for mortar recoil cylinders were determined and experience was gained in packaging different warhead materials in a single projectile body design. Technical data and techniques were acquired on the use of light materials in mortar design. Technology gaps were identified in the basic parameters for baseplate design and provided a clear basis for follow-on exploratory development in this area.

System:
(a) Title: Howitzer, 155 millimeter self-propelled.
(b) Mission (desired capability): Close artillery support for the infantry division.
Date:
(a) Year initiated: 1964.
(b) Year terminated: 1968.
Funds expended: $5.3 million R.D.T. & E.
Reasons for termination: During concept formulation, it was determined that while the XM138 would represent a significant increase in range and ground mobility when compared to the current 155 millimeter howitzer, it could not be lifted by helicopter and could not fully support the infantry division when engaged in airmobile operations. The Army requires a towed howitzer with comparable firepower which can be helicopter transported.
Technical fallout: The cannon and ammunition systems developed for the XM138 will be applied to the XM179 armored self-propelled 155 millimeter howitzer and to the new towed weapon.

System:
(a) Title: AN/USD 4, surveillance and target acquisition drone system.
(b) Mission: Conduct general surveillance missions within its range capability (200 miles). Locate targets for engagement by the Sargeant surface-to-surface missile. The target location accuracy was to be consistent with the CEP of the Sargeant missile.
Date:
(a) Year initiated: 1957.
(b) Year terminated: 1960.
Funds expended: $40.0 million R.D.T. & E.
Reasons for termination: The principal reasons for terminating the SD-4 development were large cost increases, significant technical difficulties in sensor subsystems resulting in major program slippages, and the SD-5 could perform the SD-4 mission.
Technical fallout:
(a) The techniques employed in the terrain avoidance radar (TAR) for the SD-4 were used in numerous TAR's now in production. Some of these are AN/APQ-99, AN/APQ-101, AN/APQ-115.
(b) The inertial navigation system employed conventional techniques. Some of the components of the inertial navigator from the SD-4 were used on the Centaur missile.
(c) The techniques employed in the side looking airborne radar (SLAR) were used in SD-2 drone program. Also, some of the SD-4 SLAR com

ponents are presently being used by the Department of the Interior in their earth resources program.

(*d*) The infrared detecting set, AN/AAS–16, developed for the SD–4, was the forerunner of current production equipments. Some of these are the AN/AAS–21, AN/AAS–22, and AN/AAS–24.

(*e*) The trilateration and guidance system pushed the state-of-the-art using psuedo-random noise-cross correlation techniques. This technique has since been used in the long range survey system and the visual airborne target location system.

(*f*) The wide band data link pushed the state-of-the-heart. The experience gained in this program was used in formulating the specifications for the joint in-flight data transmission system (JIFDATS).

System:

(*a*) Title: Aerial tramway.

(*b*) Mission: To develop an aerial tramway system suitable for handling general cargo in resupply operations particularly in areas of adverse terrain or in areas where conventional ports are denied or untenable.

Date:

(*a*) Year initiated, 1947.

(*b*) Year terminated, 1957.

Funds expended, $13.5 million R.D.T. & E.

Reasons for termination: The concept was tested resulting in the following disadvantages:

(*a*) Erection and placement problems of great magnitude.

(*b*) Disassembly and deployment to another location extremely difficult.

(*c*) Posed a large engineering problem.

(*d*) Maintenance was a problem.

(*e*) Limited capability for transfer of cargo (volume and type).

(*f*) Concept of transfer of cargo from ship-to-shore by use of amphibians was determined to be most suitable. This concept has since proved to be correct and has led to the LARC family of amphibians.

Technical fallout: This development did produce desirable technical advantages subsequently exploited in the form of the DeLong pier (barge type, self-elevating, non-propelled, steel) which was type classified as standard A and is in the inventory.

NAVY

System: SEAMASTER.

Cost: Research and development, $330,400,000.

Discussion

Canceled due to budgetary pressures in the wake of increasing cost and the loss of two aircraft by structural failure. With cancellation of this high-speed, sea-based offensive weapon it became necessary to perform the military mission with either carrier-based or land-based aircraft.

Benefits from the project

Major technical advances achieved in a low drag hull, retaining good hydrodynamic characteristics, in automatic mine laying control systems, and in accomplishing a sealable large rotary bomb bay. Structural loads and technology in high-speed, low-altitude regime, milling of large skin sheets.

System: F8U–3

Cost: Research and development, $100,000,000.

Discussion

Highly successful technical development. Cancelled, after flight tests, due to Congressional insistence on elimination of duplication in carrier-based fighter weapons field.

Benefits from the project

Provided strong competitive environment for the F–4 program and thereby contributed to its success. Engine development (J75) continued and used in F–105 and F–108, with later version used in SR–71. Control system experience gained used in A–7. The two-engine, two crew factors which contributed to selection of F–4 over the F8U–3 formed the base for all subsequent naval fighter development.

System: HSL–1.

Cost: Research and development, $94,000,000.

Discussion

Technical deficiencies, weight growth, mechanical vibration problems. Limited operational use. Succeeded by HSS-1.

Benefits from the project

Tandem helicopter technology, characteristics of two blade tandem rotor systems. Minesweeper towing experience.

System: F5D-1.
Cost: Research and development, $40,000,000.

Discussion

No operational requirement. F8U-3 and F4H-1 alternatives available.

Benefits from the project

Supersonic delta wing technology.

System: A2D-1.
Cost: Research and development, $47,000,000.

Discussion

Original performance objectives could not be met. Unsuccessful development due to gearbox problems associated with counterrotating propellers of turboprop engine.

Benefits from the project

Engine development contribution to the T56, presently used in the C-130, P-3A, P-3B, P-3C, E-2A, C-2A and a variation used in several commercial aircraft.

System: T-40 (engine).
Cost: Research and development, $33,000,000.

Discussion

Turboprop engine with counterrotating propellers. Installed in R-5Y seaplanes. Canceled because of technical difficulties with the combining gearbox, propellers and control system, performance, and high fuel consumption at altitude.

Benefits from the project

The T56 engines, used in C-130, P-3, C-2 and E-2 aircraft, are benefits derived from the T-40.

System: A-2J-1.
Cost: Research and development, $20,000,000.

Discussion

Turboprop version of the AJ. Canceled in favor of the A-3D.

Benefits from project

Engine development contribution to the T-56 presently used in the C-130, P-3A, P-3B, P-3C, E-2A, C-2A and a variation used in several commercial aircraft.

System: J-40 (engine).
Cost: Research and development, $18 million.

Discussion

Technical difficulties with the compressor and the electronic control system delayed progress. Alternate engines were available.

Benefits from the project

Provided technology and experience in the development and testing of electronic engine control systems.

System: F10F-1.
Cost: Research and development, $15 million.

Discussion

Variable swept wings. Canceled because F4D-1 alternative available and more cost effective.

Benefits from the project

Subsonic variable sweep wing feasibility and technology.
System: F2Y-1.
Cost: Research and development, $15 million.

Discussion

Convair sea dart. Some technical problems, engine development behind schedule, requirement for seaplane fighter canceled in favor of carrier based models.

Benefits from the project

High speed hydrodynamic technology, single and dual skis.
System: F-111B.

Cost:

Research and devolopment	$182,900,000
PAMN	148,000,000
Total	330,900,000

Discussion

Technical problems incapable of solution in dual service roles. VFX alternative adopted.

Benefits from the project

Supersonic variable sweep wing technology. Engine and AMCS experience used in F-14A.

System: Sparrow I (AAM).
Cost: (dollars in millions)

Research and development	$53.7
Production	112.0
Operations	29.0
Total	195.6

Discussion

The Sparrow program was started at the end of World War II, in 1945, to provide the Navy with an all-weather air-to-air missile system. Three parallel guidance methods were explored simultaneously: Sparrow I, a beam rider; Sparrow II, an active homing missile, and Sparrow III, a semi-active homing missile. The Sparrow I system became operational in 1955 and the F3D night fighter naval aircraft. With the success of the more versatile Sparrow III, there was no further production of Sparrow I, and it was phased out of inventory in 1958, being replaced by Sparrow III.

Benefits from project

Provided air-to-air guided weapon for the F3H-2M. Provided the basic airframe for Sparrow II and III.

System: Regulus II.
Cost: Research and development, $144,400,000.

Discussion

Regulus II commenced development in 1955 and was intended as a longer-range supersonic follow-on to the sub-sonic Regulus I. It was intended to carry nuclear warheads and to be fired from surface submarines to ranges in excess of a thousand miles.

Plans for Polaris, with its submerged launch capability commenced in 1956. Progress was so good that the decision was made in 1958 to terminate the Regulus II program as a weapons system. The Regulus II missiles were, however, used as high performance drones (the KD2B target) and served in that role until phased out, due to "old age," in November 1965.

Benefits from project

As best determined from resources available, follow-on utilization of Regulus II components, subsystems, or systems, other than for limited drone target purposes on a one way basis, was not effected subsequent to program termination at the initiation of Polaris development in 1957.

System: Petrel.
Cost: Research and development, $87,200,000.

Discussion

Development of Petrel was the end result of the "Kingfisher" program commenced by the Bureau of Standards at the end of World War II, in 1945, and later transferred to the Navy. The objective was to provide wings, a control system and an engine to be attached to Naval torpedoes, and which would permit

them to be command controlled for long distance before entering the water. Thereafter they would perform as normal torpedoes.

Petrel completed development and was planned for use by both ships and aircraft. It was given extensive operational testing as an antisubmarine weapon to be carried by Naval petrol aircraft. However, the system encountered severe reliability problems during these tests and was not approved for service use. The development of the Mk 44 torpedo, with its use in the ASROC system for ship launch, and its ability to be dropped from aircraft, led to the decision that further developmental effort of Petrel was not warranted. The program was canceled in 1957.

Benefits from project

Active radar seeker techniques explored and successfully demonstrated.

System: Corvus.
Cost: Research and development, $80 million.

Discussion

The Corvus developmental program commenced in 1954 as an effort to put into service a system to provide a weapon that would home on an enemy's radar and destroy it (an Arm, or antiradiation missile).

The state-of-the-art was such that Corvus, during developmental testing, was unable to select and home on a single target when several radars were operated simultaneously. The Corvus program was therefore canceled in 1960. Research was continued and resulted later in the Arm missiles, Shrike and Standard Arm, which have seen extensive service in Vietnam.

Benefits from project

Basic antiradiation missile techniques explored and demonstrated.

System: Eagle.
Cost: Research and development, $53 million.

Discussion

Eagle was designed as a fleet defense weapon against aircraft. It was to be a long-range (50-mile) weapon with terminal active homing. Six of these were to be carried in a subsonic "Misileer" fighter aircraft, which was to be equipped with elaborate radars.

The Eagle/Misileer system approached the limits of the state-of-the-art and developmental costs were high. The projected production costs for a Misileer aircraft with six Eagle missiles reached $15 million and the program was canceled in 1961 in favor of further modifications and improvements to the F–4 supersonic fighter with its Sparrow III missiles. The Phoenix missile system is being developed now to fill the role originally planned for Eagle.

Benefits from project

Use of high-strength steel in motor cases demonstrated and later used in Phoenix motor. Provided background information for Phoenix project.

System: Meteor.
Cost: Research and development, $52,600,000.

Discussion

The Meteor program was started at the end of World War II as a contract with M.I.T. to design and develop an antiaircraft missile system. It was originally conceived as a surface-to-air missile, but after extensive study M.I.T. decided that such a system would be prohibitively expensive. They asked that they be permitted to develop an air-to-air system which would be more cost effective.

Their studies indicated that a two-stage missile of considerable range, using interferometer homing guidance, and carried in numbers aboard relatively slow aircraft, would be most effective (the Eagle and Phoenix systems also used this concept). Unfortunately, M.I.T. was unable to develop a radar of sufficient capability to support the missile. The program was canceled in 1954 in favor of the competing Sparrow development.

Benefits from project

Interferometric homing techniques explored and established and subsequently drawn upon for Talos terminal seeker.

System: Sparrow II.
Cost: Research and development, $52 million.

Discussion

Sparrow II was the active homing member of the Sparrow air-to-air development program which was started in 1945. It competed during development with the Oriole air-to-air active homing missile program. Technical difficulties in the packaging of power requirements of an active seeker led to the selection of the semiactive Sparrow III instead of Sparrow II. The Sparrow II program was canceled in 1957.

Benefits from project

Active seeker used as a measurement tool in current KU band seeker program. Basis for Eagle seeker design.

System: Rigel.
Cost: Research and development, $38,100,000.

Discussion

Rigel design was started at the end of World War II. It was a ramjet powered pilotless aircraft for use by surface submarines in launching nuclear weapons. The system was conservatively designed. With successful flight tests of the more capable Regulus I in 1951, it was apparent that this turbojet propelled system was preferable in Rigel. Development of Rigel was therefore discontinued in 1952.

Benefits from project

Present information available indicates that the primary "Spinoff" gain from the Rigel program is an improved understanding of aerodynamics and technology associated with Mach 2 capable airfoils. Also, best information available indicates that actual later uses of components or subsystems from this program is nonexistent.

System: Dove.
Cost: Research and development, $33,700,000.

Discussion

Dove commenced development in 1949 as an unpowered, essentially free fall, bomb but with infrared terminal homing seeker designed to correct aiming errors against such targets as ships.

In performance tests of the system, severe problems were encountered under many tactical conditions, in discriminating targets from background noise. Reliability problems were also encountered. The serious technical difficulties of the seeker system were the primary reason that the Dove program was canceled in 1955.

Benefits from project

Initiated early infrared component developments.

System: Triton.
Cost: Research and development, $19,400,000.

Discussion

Triton was a concept begun in 1948, with the successful tests of ramjets by the Navy, for the use of a ramjet powered cruise missile, launched from surface ships against long-range surface targets, and using a nuclear warhead. It was essentially a study program, and system development never commenced.

The program concepts were reviewed in October of 1956 by the Scientific Advisory Committee to the Secretary of Defense. As a result of this review, Polaris development was accelerated, and the Triton concept was discontinued.

Benefits from project

Triton provided significant early engineering experience in radar map-matching and inertial guidance techniques, which have been carried forward in many other programs.

System: Oriole (AAM).
Cost: Research and development, $12,500,000.

Discussion

Oriole commenced development in 1947 as an active homing air-to-air system, in competition with Meteor and Sparrow, to provide an all-weather interceptor capability. Like Meteor, Oriole was canceled in favor of the Sparrow program. Formal cancelation of the program occurred in 1953.

Benefits from project

Simultaneous lobbing technique. Some portions used by Martin in Bullpup development. NADC used seeker in their development programs.

System: Typhon (SAM).
Cost: Research and development, $224 million.

Discussion

Typhon was designed to be a surface-to-air missile system as the major armament of cruisers, commencing with CG–13. It was planned to make full use of the most advanced technology. It made use of fixed phased array radars, track-via-missile guidance, and elaborate computer programing.

When the decision was made to cancel CG–13, and with no further plans for building cruisers, attention was transferred to restructure Typhon for frigates of much smaller size. The resulting system was put on *U.S.S. Norton Sound* for testing. As the result of these at-sea tests, the program was terminated in fiscal year 1964, and studies were begun to develop a system as a successor to Terrier, Tartar and Talos. These studies have led to the advanced surface missile system, which is now being developed. At-sea tests of the ASMS system are scheduled for 1972.

Benefits from project

The Typhon project generated the initial effort in the following improved missile components now being incorporated in the standard missile.

(*a*) The medium range (MR) dual thrust rocket motor.
(*b*) The fore and aft fuze.
(*c*) The medium range (MR) standard missile fin control system.

In addition basic concepts for the computer control of radar developed in Typhon are being carried forward into the MFAR radar to be used with advanced surface missile systems.

System: Type II towed torpedo countermeasure.
Cost: Research and development, $13 million.

Discussion

The type II towed torpedo countermeasure was a merchant ship protection system conceived as an answer to the submarine launched straight-running torpedo threat which took such a heavy toll in World War II. Essentially the system towed explosive charges behind paravanes which were streamed from the ship's bow. The explosive charges were detonated by proximity fuses upon approach of a torpedo, rendering the torpedo ineffective against the ship. After technical feasibility had been demonstrated at sea, the project was abandoned when determined to be not cost effective.

This program, started in 1945, was canceled in 1955.

Benefits from project

The only "spin-off" was some advance in the state of the art of underwater proximity fuses and explosive resistant cables.

System: NRRS, Sugar Grove.
Costs:

Research and development	$1,000,000
Military construction, Navy	70,000,000
Total	71,000,000

Discussion

The major "spin off" from this project is the advanced digital computer techniques enabling the solution of linear equations involving very large matrices (999×999). These techniques have been used by NASA in the design of the Lunar landing vehicle, in the ensuring of the structural integrity of the Saturn vertical assembly building, and the design of the 210-foot parabolic antennas for the Apollo program.

Other spin offs include—

(*a*) Technology for design of Teflon fabric bearings carrying extreme loadings.
(*b*) Design parameters for very large servomechanisms.
(*c*) Structural design concepts employing intersecting conic sections enabling substantial weight reductions for given deformation limits.

(*d*) Fine-grain analysis of wind effects on large movable structures.
(*e*) Design criteria for heavy loaded, slow-speed gears.

System: High energy boron—ZIP.
Cost: $123 million.

Discussion

Expected high production costs did not encourage fleet introduction and the full potential energy increase was not realized at the early production period. The cancellation of such programs as the B–70, as well as, the changes in economic and political areas contributed to the cancellation of the high energy fuel program.

Program started in 1952 and was canceled in 1959. It was also supported by the Air Force.

Benefits of project

The high energy fuels (ZIP, slurries, borons, etc.) were developed to the stage where feasibility was proven. Problems such as deposits on turbine blades, smoke, toxicity, handling, etc., were solved.

AIR FORCE

AIRCRAFT AND ENGINES

Item	Year started	Termination	Cost (in millions)
ANP	1951	1961	$511.6
XF-103	1950	1957	104.0
F-107	1954	1957	85.0
F-108	1958	1959	34.3
F-12	1966	1968	41.0
XB-70[1]	1958	1967	1,468.1
XC-132	1952	1957	54.0
X-15	1956	1968	191.4
X-19	1962	1966	16.0
X-21	1960	1966	36.0
YH-16	1951	1954	5.3
J83	1956	1959	55.0
T61	1957	1959	37.4
MISSILES			
SM-64 Navaho	1954	1957	$679.8
SM-62 Snark	1947	1962	677.4
GAM-63 Rascal	1946	1958	417.3
GAM 67 Crossbow	1957	1958	72.5
GAM-87 Skybolt	1960	1963	414.7
SM-70 (land-based Talos)	1954	1957	118.1
SM-73 Goose	1955	1958	50.4
Mobile Minuteman	1959	1962	108.4
MMRBM	1962	1964	64.7
Q-4 Drone	1954	1959	84.4
OTHER			
AN/ALQ-27	1957	1959	$60.0
High-energy fuels	1956	1959	91.0
MOL	1963	1969	1,494.9
Agena D	1956	1968	7.2
X-20 Dyna-Soar	1960	1963	405.0

[1] Redirected 1959—experimental only; carried through flight test.

ANP (Aircraft Nuclear Propulsion)

Fifteen-year program (feasibility study through actual hardware and testing):
Resolved many theoretical questions in ANP technology.
Advanced the state of the art in ANP technology.
Specifics:
Reactors reduced tremendously in size. Increased tremendously in power output.

In actual flights of a modified aircraft carrying a reactor, defined many of the shielding requirements of an airborne reactor.

Identified and defined many hard data on ANP technology.

Confirmed that using nuclear power to propel a supersonic aircraft was still years away, especially in terms of performance, efficiency, and relative cost.

ANP:

Started: 1951.
Terminated: 1961.
Cost: $511,600,000.

Reason for termination: Technical problems associated with small high temperature reactors suitable gas turbine engines and the great shielding weights required to protect crew and equipment from the high levels of radiation proved greater than anticipated. Aircraft performance, based upon the then current ANP technology, would have been very marginal and such an aircraft would not have been useful. Meanwhile, chemically fueled propulsion systems, plus in-flight refueling, had advanced to the point where aircraft could be built with good speed and altitude performance as well as with sufficient range—the major factor hoped for in the ANP program.

XF–103

Provided technological advances in several specific areas of new concepts * * * also identified numerous obstacles to immediatae use of some of these concepts.

Use of titanium as a primary material for airframe construction.
Design experience in the Mach–3 flight regime.
Hardware definition work and performance problems in perfecting the dual cycle (turbojet/ramjet) propulsion systems.
Work on variable area ram air intake.
Early work on pilot capsule for high speed escape.

Never flown; production/inventory decision not made; competition loser (to F–100).

XF–103:

Started: 1950.
Terminated: 1957.
Cost: $104 million.

Reason for termination: This was an advanced fighter concept for a titanium mach 3.0 fighter, powered by a dual cycle (turbo/ramjet) propulsion system. It was canceled primarily as a result of technical problems (e.g. poor visibility, J–67 engine problems) rising costs, and greater promise of the F–100 program (e.g. long range).

F–107

"Developmental" fighter aircraft. Competition loser (to F–105). Not produced, but prototypes were flight tested and later used extensively for high-speed testing by NASA.

Provided significant test data on such innovative features as relocated air intake. Also furnished test data on early model of J–75 turbojet engine, since used in F–105, F–106, and other high-performance aircraft.

F–107:

Started: 1954.
Terminated: 1957.
Cost: $100 million.

Reason for termination: This was a fighter-bomber development program in competition with the F–105. It was canceled in favor of the latter, which proved to be a superior weapon system.

F–108

One step in a steady progression (over 15 years and longer) toward development of a high-performance interceptor aircraft.

Several major components and subsystems were continued in development, to provide the most advanced technology available for the YF–12A or any other future aircraft which could use the:

Propulsion system,
Advanced air-to-air missile, and the
Fire control system.

Advanced the continuing Air Force investigation of stainless steel for airframe construction.

No F–108 prototype was built or flown.

F–108:

Started: 1958.
Terminated: 1959.
Cost: $141,900,000.

Reason for termination: The F–108 program was stopped on September 23, 1959, for several major reasons: (1) The costs of the program were exceeding previous estimates and did not indicate they were leveling off. Original estimates of around $1 billion for 250 aircraft were then considered to be half of the final cost. Subsequent estimates were nearer to $2.5 billion. (2) The number then of current interceptor aircraft and surface-to-air missiles was believed adequate to cope with the most probable threat. (3) The advanced propulsion, fire control systems, aircraft and aircraft development technology programs, which might be employed, were being evaluated, or considered for inclusion, in programs such as the XB–70, ASG–18, GAR–9 and Nike improvements. (4) The use of the B–58 or the B–70 as a missile carrier, and possible replacement for the interceptor, was being considered by the Air Force.

X–21 LFC (laminar flow control)

An experimental hardware effort, culminating more than 15 years of study and laboratory work in the related areas of boundary layer control and lamina flow control. The X–21 program was an actual investigation of the theoretical advantages of laminar flow control—an aerodynamic means for reducing friction drag on aircraft surfaces by as much as 80 percent. Resultant performance benefits could be a 50-percent increase in range or 50 percent greater endurance—without refueling, new engines, or other propulsion improvements.

The X–21 program was terminated on completion of the flight test and feasibility demonstration.

The aerodynamics benefits of drag reduction and increased performance are available for future aircraft—especially where range extension or long endurance flights may be a major requirement, as in airborne early warning aircraft.

X–21:

Started: 1960.
Terminated: 1966.
Cost: $36 million.

Reason for termination: Terminated at conclusion of test program.

F–12

An experimental prototype aircraft, carrying forward the F–108 long-range-interceptor technology, in an aircraft capable of sustained high speed and long-range missions.

Announced by President Johnson in February 1964: "Far exceeds in performance any other aircraft in the world today;" a development made possible by major advancements in aircraft technology.

The YF–12A in May 1965 claimed nine world speed and altitude records from just 1 day of flight testing.

The F–12 experiment incorporates the most advanced knowledge of titanium metallurgy and fabrication. It has also moved far along the development path the experimental fire control and air-to-air-missile systems from the F–108 program.

A significant portion of the technical advances are also incorporated, as a result of F–12 testing, in operational strategic aircraft.

Testing continues.

F–12:

Started: 1966.
Terminated: 1968.
Cost: $41 million.

Reason for termination: Terminated by OSD in favor of the proposed F–106X program.

XB–70

As an experimental vehicle, explored in actual flight testing a whole new area of aircraft performance, including:

Demonstration of sustained flight at mach 3 for as long as 32 minutes.
Demonstrated the largest gross takeoff weight until the C–5A.

Provided hard test data pertinent to design and operation of large, flexible, supersonic-cruise aircraft directly applicable to the SST, the B-1A.

Also furnished data on subsystems, structures, and equipment.

Specifically, provided a tremendous advance in knowledge of and experience with fabricating large-scale stainless steel vehicle structures—knowledge pertinent to any large, supersonic aircraft.

Also confirmed or corrected wind tunnel and theoretical data.

Specific benefit areas:

Flight dynamics:

Stability, response, and control (at supersonic and landing speeds).

Aeroelasticity.

Handling qualities (including ground handling, altitude control, and oscillations at supersonic speeds).

Baseline data for simulators.

Air induction system (applicable to SST, B-1A, F-14, F-15): Match engine airflow requirements to inlet size and compression characteristics.

Ground effects measures: Valuable for both V/STOL and conventional aircraft.

Aerodynamic loads measured: For advanced design criteria.

Noise research: Effect on population, on crew and passengers, and on structural loads on the aircraft itself.

Measured effects of: High-altitude and clear-air turbulance; landing loads; supersonic cruise on crew, passengers.

Defined: Takeoff/landing visibility problems, climb/descent procedures.

Inspired major materials advances, especially for high-temperature applications, in such areas as: hydraulics; fuels and lubricants; wiring; heat exchangers.

XB-70:

Started: 1958.

Terminated: 1967.

Cost: $1,468,100,000.

Reason for termination: Terminated at completion of the R. & D. test program's major objectives.

XC-132:

Provided early design progress in the direction of a transport to carry a payload over 100,000 pounds.

In the mid-1950's, this concept was far ahead of any verifiable, immediate need; thus, the XC-132 lost in competition to the C-133 and was never flown.

The giant transport work laid a technical and design criteria base within the Air Force for such later aircraft as the C-141 and the C-5A.

C-132:

Started: 1952.

Terminated: 1957.

Cost: $34 million.

Reason for Termination: This was a turboprop heavy long-range transport designed to carry 100,000 pound payload. It was canceled because of potential high cost and because the C-133, although not capable of as high a payload, appeared sufficiently versatile to most Air Force needs.

X-15:

This 15-year experimental program included almost 10 years of flight testing. It developed the world's first manned probe into the lower edges of space.

In an orderly research progression, following the X-1 and X-2, the X-15 was uniquely successful as a test bed and as a platform for carrying out new studies in aerodynamics and space.

As an additional consequence of this exploration of a whole new corner of the areospace realm, the X-15 pilots achieved maximum speeds over Mach 5 and maximum altitude flights of almost 60 miles.

Among the many specific technological benefits—of use to the U.S. space program and to pilots of new aircraft as they move to the X-15 area of performance:

Propulsion:

Development of a man-rated rocket motor (LR99) to push the X-15 into flight regimes never before penetrated by manned aircraft.

Special thrust units, for control in the thin air of the upper atmosphere.

Human factors:

Preliminary design research—perhaps the most extensive in bioastronautics history—covering flight simulation, a special pressure suit, cockpit arrangements, instruments, the pilot's seat, and pressurization/cooling.
Physiological measurements of pilot reactions during actual flight tests.
Guidance and control:
Reinforced primary flight controls.
A special hydraulic system to power the control surfaces.
Auxiliary power units.
Materials:
A whole range of structural materials improvements to meet the extra stresses of hypersonic flight, including a special nickel alloy for airframe components, as well as special metals and materials for extra loads on almost every element in the aircraft.
Special-strength wiring, lubricants, gears, paint, and bearings, as well.
Verification of laboratory technology in such areas as:
Aerodynamic heating.
Pilot reaction—to acceleration/deceleration and weightlessness.
Control problems.
Hypersonic aerodynamics.
Atmospheric exit and reentry.
Performance of many special scientific measurements, including:
A star-tracker, used at peak altitudes, above most atmospheric clutter.
An ionization gage for measuring atmospheric density.
A special micrometeorite measurement pod.
Infrared and ultraviolet data measurements.
X-15:
Started: 1956.
Terminated: 1968.
Cost: $191,400,000.
Reason for termination: Terminated upon completion of the joint AF/NASA test program.

X-19

One of several experimental approaches to the VTOL (vertical takeoff and landing) capacity desired for DOD and for commercial applications.
The triservice X-19 test bed investigated (in limited flight testing) the concept of rotating or tilting four propellers—for lift/descent or horizontal flight.
The 4-year X-19 program contributed valuable test data on this aspect of VTOL techniques. It also provided additional test experience on turbine engines.
Specifically, the X-19 program identified technical problems requiring solution before this tilt-propeller approach to VTOL could be adopted as an efficient, operational configuration.
X-19:
Started: 1962.
Terminated: 1966.
Cost: $16 million.
Reason for termination: Developmental aircraft program terminated when the aircraft was destroyed during flight. Test program identified technical problems which must be solved before the tilt-propeller approach to VTOL could be adopted as an operational aircraft.

YH-16

An experimental effort to create, in the mid-1950's, a large helicopter capable of carrying a 5-ton load (an ambitious target for that time). The YH-16 was not produced, but two different prototypes were flight tested.
From the YH-16 program came basic technological data for large helicopters, providing a technical foundation for today's "Jolly Green Giant" and other large vehicles of this type. (The YH-16 had a cabin about the size of a DC-4 or C-54 fuselage.)
The second YH-16 model, for example, as early as 1955 demonstrated that turbine engines, in place of piston engines, would lighten the vehicle, provide additional power, and increase load-carrying efficiency. This YH-16 was the first large U.S. helicopter to serve as a test bed for turboprop engines. Its testing identified both the benefits and problems associated with the use of turbine engines.
YH-16:
Started: 1951.
Terminated: 1954.
Cost: $23,400,000.

Reason for termination: This was an extremely large fuselage, twin-motor, high capacity helicopter. Hampered by technical problems, delays and cost overrun, it was cancelled as a result of reappraisal following the crash of an experimental model.

J38 (Turbojet)

The J83 was the loser in a two-way competition started in the mid-1950's. The objective was a compact, lightweight, afterburning, high-thrust turbojet for use in manned aircraft. The J83 was tested, but the Air Force came to feel the competing J85 engine had greater growth potential.

Test results from the J83 effort aided J85 engine program, including some innovations in compressor development.

Reflecting the soundness of the Air Force conclusion (and the value of dual developments were possible), the J85 has gone on to become one of the most widely used turbojets, as power plant for the F–5 and T–38 aircraft, the SM–73 and GAM–72 missiles, as well as several modern utility aircraft.

J–83 (engine):

Started: 1956.
Terminated: 1960.
Cost: $55 million.

Reason for termination: This was a small lightweight turbojet engine in the 2,000 lb. thrust range, for possible missile or aircraft application. It was cancelled in favor of the competitively superior J–85 engine (General Electric).

T–61 Turboprop

An experimental development program to produce an advanced-design turboprop engine, for possible application to large transport aircraft or long endurance missions.

The T–61 never emerged from the "experimental, development" stage, largely because it never acquired designation as the power plant for a specific aircraft.

Principal tchnological benefit from the T–61 program was the effort to reduce the engine's fuel consumption—knowledge used in developing later turbine engines.

T–61 (engine):

Started: 1957.
Terminated: 1959.
Cost: $37,400,000.

Reason for termination: This was an internal combustion turboprop engine of advanced design. Cancellation was a combination of program austerity with the fact that the engine had not been designated for application to any specific future weapon system.

SM–64 (Navaho)

In terms of technical benefits, probably one of the most widely influential programs of the last 15 years.

Advanced technology in several broad areas:

Flight testing of airframes and components in the Mach–3 flight regime.
Ramjet development, including actual flight testing.
Developed a whole family of large, liquid-propellant rocket boosters.
Guidance by the late 1950's, the SM–64 autonavigator was the best system of its time and the basis for future improvement.
Advanced the use of titanium and other materials.

Specific benefits:

Booster rockets:

Early version (LR43) was produced and used by the Army for the Redstone;
Later version (LR79) powered the Thor, first operational US IRBM;
Another version adapted for the Jupiter missile;
Still later SM–64 boosters were the direct ancestors of the Atlas first stage boosters.

Guidance:

Defined and proved out several key concepts in inertial guidance.
Advanced inertial guidance in several directions and laid technical base for Hound Dog missile guidance.
Navy used an actual SM–64 guidance system, secured directly from the SM–64 program, to guide the first polar voyage of the submarine *Nautilus*.

Drones:

SM–64 program's X–10 drone missile added benefits of expedited flight testing.

X–10's were also used in such other programs as Nike, Falcon, and Bomarc.

Navaho:

Started: 1954.
Terminated: 1957.
Cost: $679,800,000.

Reason for termination: Canceled due to the decision to develop a ballistic missile approach to intercontinental system. State-of-the-art advancements and pursuing rocket rather than air breathing propulsion of techniques contributed to decision to cancel. Experience gained by Navaho system applied to subsequent systems, e.g., large liquid booster, inertial guidance and Mach 3 flight regime data.

SM–62 (Snark)

Perhaps the most significant benefit of the SM–62 program was its direct contribution to the U.S. strategic deterrent posture in the 1958–61 period. This atmospheric missile was developed, deployed in limited numbers, and put into the active inventory.

For a year or more, the SM–62 provided the United States with an intercontinental-range strategic missile and a deterrent capacity, until the completion and deployment of the Atlas ICBM.

Among technological advances was the self-contained, nonjammable, stellar-monitored guidance equipment developed for the SM–62. It marked an early advance in long-range navigation techniques.

Snark:

Started: 1947.
Terminated: 1962.
Cost: $677,400,000.

Reason for termination: This was a subsonic surface-to-surface intercontinental strategic missile. Although completely developed and placed in the active inventory, it was rendered quickly obsolete by the accelerated ICBM program.

GAM–63 (Rascal)

Starting at an early point (1946) in modern technology, this 12-year investigative program sought to create a sophisticated air-to-ground missile. Proceeding from studies through development (including flight test), the GAM–63 program's slow progress defined most critical problem areas for this type missile, including: propulsion, guidance, target-acquisition, reliability, accuracy.

The lessons learned from the GAM–63 program were directly instrumental in the later success of the Hound Dog missile. They have also been applied more recently in the creation of a new generation of air-to-ground missiles with great accuracy and striking power.

The guidance system developed for the GAM–63 is in use today, for data stabilization in high-performance, high-resolution radar programs.

GAM–63 Rascal:

Started: 1946.
Terminated: 1958.
Cost: $448 million.

Reason for termination: This was an air-launched air-to-surface missile for use by strategic forces (B–47). The program was canceled in favor of the inherently superior B–52/Hound Dog combination.

GAM–67 (Crossbow)

Another pioneer-type vehicle, the original antiradiation missile . . . the basic investigation of technology leading to such missiles as today's Shrike.

The GAM–67 program established basic guidance criteria applicable to all antiradiation systems, to this day and for the future as well.

GAM–67 Crossbow:

Started: 1957.
Terminated: 1958.
Cost: $74,600,000.

Reason for termination: This program was the original air-to-surface antiradiation missile (ARM). The modern version is the Shrike. It was canceled because other systems were considered more favorable and because of uncertainties in the guidance system.

GAM–87 (Skybolt)

This program, carried through early flight testing, actually demonstrated the feasibility of an air-launched ballistic missile as one means of extending the striking power of manned bombers. Strategic and budgetary considerations (the relatively lower cost of other methods for strengthening the U.S. deterrent posture) ultimately led to termination of this program.

The stellar-inertial guidance system developed for the GAM–87 led directly to successful adaptation for use in advanced operational strategic aircraft and in the C–5A transport.

GAM–87 Skybolt:

Started: 1960.
Terminated: 1963.
Cost: $440 million.

Reason for termination: The major factors that led to the decision to cancel Skybolt (GAM–87) were: (1) The technical problems arising out of the complexity of the system itself, and their consequences in determining when the system could be expected to work and how well. (2) Progress in developing alternative ballistic-missile systems, which have advanced much more rapidly than had been anticipated. (3) An air-launched ballistic missile did not present a different threat than some of the missiles already under development and scheduled for early deployment. (4) The GAM–87 could not compete on a cost-effective basis with other equally effective systems.

SM–70 (land-based Talos)

The Air Force part of this program sought to adapt the Navy's Talos missile to a land-based, air-defense configuration. The program was transferred to the Army when the latter acquired sole responsibility for short-range, surface-to-air, point-defense weapons.

Among the areas of SM–70 development providing technological benefits were:

Further development testing of ramjets for propulsion of high-performance vehicles.

Guidance, command, and control simultaneously of multiple high-defense missiles against several individual, maneuvering targets.

Talos (land based):

Started: 1954.
Terminated: 1957.
Cost: $118,100,000.

Reason for termination: This was a land-based surface-to-air missile for the air defense mission. It was canceled when short-range surface-to-air missiles were assigned as an Army sole responsibility.

SM–73 (Goose)

One of the early efforts to provide penetration aids for operation in hostile environments. The SM–73 program sought to provide a surface-to-surface, long-range decoy missile.

SM–73 work on plastic airframes and corner reflectors provided some of the earliest measurements and hard data on means for reducing radar reflectivity and for simulating bomber aircraft to confuse enemy radar.

The SM–73 program was largely responsible for development of the widely used J85 engine, a most successful turbojet in the F–5, T–38, and other current aircraft.

SM–73 Goose:

Started: 1955.
Terminated: 1958.
Cost: $78,500,000.

Reason for termination: This was a supersonic long-range decoy missile for strategic application, to be air launched as an electronic countermeasure device. The program was overtaken by other developments (e.g., GAM–72 Quail) and by changes in concept of operation.

Mobile Minuteman

This feasibility demonstration identified and defined many of the operational benefits and problems associated with the concept of a rail-mobile ICBM system.

With the demonstration completed, the concept was shelved (rather than terminated), to be held against any possible future U.S. need for a rail-mobile deterrent force.

Mobile Minuteman:
Started: 1959.
Terminated: 1962.
Cost: $108,400,000.
Reason for termination:
Cancelled due to higher cost effectiveness of hardened and dispersed version of system. Mobile version would have called for additional development for guidance, command and control, and operational maintenance ground equipment.

MMRBM (mobile mid-range ballistic missile)

This program provided, like such earlier mobility investigations as the Mobile Minuteman, basic data on problems of logistics command and control, guidance, and targeting. The MMRBM program carried one step farther the definition of operational problems associated with a mobile strategic system. Against the day when mobility might be the key U.S. requirement, such programs as MMRBM provided the Nation with a technological base from which a future program might advance.
MMRBM:
Started: 1962.
Terminated: 1964.
Cost: $65,400,000.
Reason for termination:
Congressional restraints on this program caused it to be funded at such a low level that systems development could not be pursued.

Q–4 Drone

Originally conceived as the most sophisticated of a "family" of target drones, the Q–4 program sought to provide a supersonic target vehicle.
Even though the Q–4 failed its flight test—not being able to provide the desired performance in the desired time period—the program provided considerable experience in developing and controlling high-performance drones. In addition, fabrication of the test models provided early experience in the use of plastics for airframe components.
Q–4 Drone:
Started: 1954.
Terminated: 1959.
Cost: $84,400,000.
Reason for termination:
This was a small turbojet drone to be used by Air Defense Command for training. It was canceled because of a lack of funds and a change in requirements.

AN/ALQ–27

This was an ambitious (for the time) attempt to provide a completely integrated ECM subsystem for the B–52. The integration effort was a technical advance in ECM technology.
During development, the postulated threat changed, altering the ECM requirements.
For this and other reasons, the program was redirected as an advanced development project—
To take advantage of new component technology.
To work toward desired reductions in:
Weight.
Size.
Complexity.
Cost.

AN/ALQ–27:
Started: 1957.
Terminated: 1959.
Cost: $142 million.
Reason for termination:
This program was a complete integrated electronic countermeasures system for the B–52. It was canceled because of the extreme cost.

High-energy fuels

This program provided a considerable technical advance in knowledge of high-energy fuels, a demonstration of their power output, confirmation of theo-

retical data—as well as identification of problem areas in the use of "exotic" boron fuels.

The knowledge acquired is available against any future need for such special fuels to power advanced aerospace vehicles.

High-energy boron (ZIP):

Started: 1956.
Terminated: 1959.
Cost: $135,800,000.

Reason for termination:

The program was for the development of fuel to power a chemically powered bomber. It was canceled because it was overtaken by other developments, because of technical problems encountered, and because the requirement was canceled for the specific aircraft to which it had known application.

Agena D

Under development as early as 1956, the Agena has become the most versatile and widely used of all satellite vehicles in the U.S. space program.

From its first orbital mission in early 1959, the Agena has compiled a 95-percent reliability record. It is a completely stabilized, controllable, and maneuverable spacecraft, adaptable to a variety of missions and payloads, and capable of restarts in orbit.

The Agena has served as a long-life spacecraft, as a target vehicle for space missions, and as an in-orbit booster for lunar, Mars, and Venus missions. It has also carried into space—and released into their own orbits—auxiliary or piggyback satellites.

In recording more than a score of world space firsts, the Agena has carried more diversified experiments and has been an upper stage on more different boosters than any other satellite.

Among the specific "firsts" for the Agena are:

First spacecraft to achieve circular orbit.
First to achieve a polar orbit.
First to be stabilized in all three axes in orbit.
First to return a manmade object from space.
First to propel itself from one orbit to another.
First rendezvous and docking of two spacecraft.
First space vehicle to provide propulsion power for another.

Agena D:

Started: 1956.
Terminated: 1968.
Cost: $7,237,000.

Reason for termination:

Agena D. The improved version of Agena was canceled when it was determined that most requirements could be satisfied with present vehicles and that the cost of the improved version could not be justified.

X-20 (Dyna-Soar)

Long in the study phase, the X-20 program afforded a beneficial investigation of maneuvering reentry, which later led into the Asset, Start, and lifting body programs.

The X-20 program also provided a beginning to study of the mach 6 to 25 flight regime.

As a further indication of benefits from the X-20 program, at least 27 projects within the program were continued after termination. They included:

Pilot control of boost trajectories.
X-20 heat protection system.
Full pressure suit.
High temperature elevon bearings.
Nose cap.
VHF search and rescue receiver and transmitter.
Test instrumentation subsystem ground station.
Simulator crew station.
Sensor and transducer equipment for telemetry.

In addition, the contractor identified over 40 specific items in the X-20 effort as technology breakthroughs. Among these were:

Eight items in materials development, including:
High-temperature bearing materials.
High-temperature wire (1800°).

High-temperature refractory materials (to 3000°).
Eighteen items in hardware development, including: X–20 reaction control system.
Seven items in technical data, including: 4 aerothermodynamic studies.
Two items in engineering management.
Nine items in quality control development, including: Fusion and resistance welding processes.

Many of these and other X–20 elements had a direct application to the MOL program.

Dyna-Soar:
Started: 1960.
Terminated: 1963.
Cost $405 million.

Reason for termination:

Dyna-Soar (X–20) had two principal objectives: (1) To provide man controlled maneuverability during reentry from orbit and determine its practical value; (2) to investigate the hypersonic flight regime between that of the X–15 (Mach 5) to orbital reentry velocities (Mach 25). It became apparent that the Dyna-Soar design was marginal and expensive. Since the spacecraft was very small, it had too limited an endurance and the capacity to carry useful payload was extremely small. It became obvious for the above reasons that the capability of the vehicle to explore man's military usefulness in space was exceptionally poor. Because of this DOD embarked on the manned orbiting laboratory program.

MOL (Manned Orbiting Laboratory)

This program was announced in 1963, approved for development in 1965, progressed to the contract-award stage in 1967, and was terminated in 1969.

The stated aim was to learn more about what man can do in space, by developing and experimenting with the necessary technology and equipment for such an inquiry.

To these ends, the program contemplated a two-man spacecraft, in orbit for 30 days or longer. Within the laboratory portion of this space vehicle, each crewman would have 400 cubic feet of unencumbered space in a shirt-sleeve environment.

The man-centered MOL program was to concentrate on the human-factor aspects of long-term missions, including:
The ability to do efficient work.
Use, construction, and repair of equipment.
Observation of natural and technical phenomena.
Performance of both military and nonmilitary experiments.

The MOL program carried forward all useful elements of the X–20 (Dyna-Soar) program.

MOL:
Started: 1963.
Terminated: 1969.
Cost: $1,494,900,000.

Reason for termination:

MOL—Terminated in view of budget limitations and effectiveness of unmanned satellites.

Mr. SIKES. Very well, gentlemen. Thank you.

The committee will resume its hearings at 2 o'clock.

AFTERNOON SESSION

CONUS AIR DEFENSE INTERCEPTOR

Mr. MAHON. We will now take up the CONUS Air Defense Interceptor.

You are requesting $18.5 million in fiscal year 1970 to initiate the development of a new air defense interceptor aircraft. Why do this if you already have developed the F–12 and, in addition, the F–106 aircraft has been considered to fill this role?

Mr. HANSEN. The $18.5 million on the defense interceptor is proposed to be used: $9 million for development of the fire control system, $5.5 million for the missile, $2.5 million for studies on the basic interceptor airframe itself, $1 million for flight test support, and $500,000 for advanced radar studies.

NECESSITY FOR NEW INTERCEPTOR PROGRAM

Mr. MAHAN. In view of the F-12 and the F-106, is this program necessary?

Mr. HANSEN. We think so, yes.

Actually, only $2.5 million is aimed at selecting the interceptor. The candidates include the F-106X, the F-12, the F-14, or some possible new interceptor.

The rest of the money is all being spent on things which we are confident will be common requirements, whatever the interceptor turns out to be.

The main requirements in this interceptor will be its fire control system, the radar and missile, and those are the things that most of the money is being spent on. Those will be applicable to whatever airframe we select.

As you know very well, Mr. Chairman, we have wanted to go to the F-106X in the past.

Some people want the F-12 believing the F-106X to be too old an airplane. The F-12 is believed by others to be too expensive an airplane. So we are trying to see if we cannot find a solution that will do that job and satisfy enough of the requirements to let us get on with it. We do need a modern air defense interceptor, in my opinion, but we have to make sure we are getting the right one.

Mr. MAHON. What will the total cost of the study be and how long will it last?

Mr. HANSEN. The interceptor study itself?

Mr. MAHON. Yes.

Mr. HANSEN. That is the $2.5 million and that would be completed by the end of fiscal 1970.

OBJECTIVES OF FISCAL YEAR 1970 PROGRAM

Mr. MAHON. What is the major purpose of the $18.5 for fiscal 1970 other than what you have already told us?

Mr. HANSEN. I would say that the purpose of that is to put us into a posture where we could recommend a suitable solution to the problem of modernizing our air defense interceptor force. That has two principal parts. The first is bringing along sufficient effort on the principal technical challenges so we can be convinced that we know how to solve those problems. These are the radar and the fire control system and the missile. The second part is to pursue the matter of which is the best airplane to do this job—whether it is a modification of an existing airplane or whether that is not feasible.

Mr. MAHON. What contractors will you work with?

General PITTS. I do not believe the contractors have been selected yet, sir.

THREAT TO BE MET BY A NEW INTERCEPTOR AIRCRAFT

Mr. MAHON. Against what threat is this interceptor study oriented?

Mr. HANSEN. ———. This is that the heavy bombers and medium bombers would be expected to be able, without an interceptor system, to penetrate at low altitude.

General MCNICKLE. ———. As you know, there has been some disagreement as to whether or not the Soviets would use their medium bombers on a one-way mission, or refuelable, but this is just the threat against the long-range bomber.

Mr. HANSEN. The emphasis is on the low-altitude penetration. That is why it is so important to get the radar and fire control and missile to have the look-down, shoot-down capability.

Mr. MAHON. Is there any evidence that the Soviet Union either is developing a new bomber with low-altitude penetration capabilities or have modified their existing bombers in order to provide low-altitude penetration capabilities?

General MCNICKLE. ———.

There has been a real step up in the number of penetrations between the United Kingdom and Iceland, and up around Alaska there has been an increase in the number of penetrations that the Soviet heavy bombers have made in the past 2 or 3 months.

USE OF NAVY F–14 AIRCRAFT TO BE STUDIED

Mr. MAHON. Would the Navy-developed F–14 aircraft, utilizing the Phoenix missile and fire control system, be a good interceptor for the purpose we have been discussing here?

Mr. HANSEN. That is certainly one of the candidates that would be studied under the interceptor portion of the overall program.

NEW PROGRAM A SUBSTITUTE FOR F–106X APPROACH

Mr. MAHON. To what extent is this program a substitute for the F–106X program which was denied by Congress last year?

Mr. HANSEN. I would say that is what it is.

This program is to develop a suitable alternative approach to the problem which could have been solved by the F–106X.

DECISION ON AIRCRAFT TO BE MADE DURING FISCAL YEAR 1970

Mr. MAHON. Do you plan to select the new continental air defense interceptor during fiscal 1970?

Mr. HANSEN. Yes.

Our plan would be to come out of these studies with a hard defensible recommendation and plan as to what the airplane should be.

Mr. MAHON. Is there money in the $18.5 million to initiate a contract definition on a specific new aircraft?

Mr. HANSEN. No, sir.

CLOSE AIR SUPPORT WEAPONS

Mr. MAHON. You have a new program entitled "Close Air Support Weapons." You are requesting $5 million for the initiation of this new program in fiscal year 1970. What are the objectives?

Mr. JONES. I will respond to that, Mr. Chairman.

The objectives of this program, which is a new program really established by the OSD with us, is to take some of the technologies that we have developed and some of the experience we have developed in Southeast Asia and try to put it into a new close air support weapon that all of the services can use.

The idea is really to have a modular design that can use varying types of acquisition and guidance techniques, various classes of warheads, and to be able to stand off away from the enemy ground fire and be able to go in with good guidance accuracy against close support type targets.

Mr. MAHON. Are the other services contributing or scheduled to contribute funds for this program, or is it an all-Air Force study?

Mr. JONES. The study itself—the initial study—was done by the Institute of Defense Analyses to arrive at some of the concepts. At the moment the funding is all Air Force, but we are working with the other services and would expect that over the long term the system, if we develop it, would be applicable to all three of the services.

Mr. MAHON. Since no contractors have been selected and since there is not much guidance indicated as to what you want in this program, are you a bit premature in requesting the $5 million? How sure are you that this sum can be utilized prudently in fiscal 1970?

Mr. JONES. We are pretty sure, Mr. Chairman, that we can prudently use these funds. We have identified now some acquisition techniques. ———.

Mr. MAHON. During fiscal 1970?

Mr. JONES. Yes, sir.

BASIS FOR TOTAL COST OF THE PROGRAM

Mr. MAHON. What is the basis for your estimated total cost of this program of $21 million? This seems rather low as compared with other tactical missile development efforts in recent years. Is this another one of those overly optimistic estimates?

Mr. JONES. The $21 million number came out of the IDA original estimate when they were looking at this concept.

At the moment it is simply that, an estimate, because the details have not been pinned down to the point where I can describe to you precisely all of the elements of the program that will be carried out and make it into the close air support weapon.

That is the best estimate we have at the moment for exploring some of the techniques that would be applied.

PROPOSED NEW WEAPON COMPARED WITH MAVERICK

Mr. MAHON. Will this new close air support weapon differ materially from current weapons, such as the Maverick?

Mr. JONES. It will differ mainly from the Maverick in that the Maverick is designed as a hard target killer, and this particular weapon would be used in the close support area where we are using it more in terms of soft targets. We would hope to be able to use varying classes of warheads with it. So it does have a different role and function from the Maverick, and is against different classes of target.

PRIORITY BASED ON SOUTHEAST ASIA TYPE OF WAR

Mr. MAHON. Would you say this project is of medium priority, or high or low priority?

Mr. JONES. I think, Mr. Chairman, we would certainly put a high priority on this 1970 effort.

If we can identify the techniques that will give us this kind of capability to support the ground troops, I think we would put a high priority behind the further development.

Mr. HANSEN. This is aimed at the Southeast Asia type of war. To some extent the priority has to be judged against what we believe the situation will be. It is an outgrowth of the ——— technique and would be applicable in that kind of a war. If we could assume that we would not be doing that sort of thing, we could take our time.

I think we have to take the conservative approach in bringing along a technology to do something that we think we know how to do.

STATUS OF INSTITUTE FOR DEFENSE ANALYSES STUDY

Mr. MAHON. Have you received the study referred to which is being conducted in this area by the Institute of Defense Analyses—IDA?

Mr. JONES. We have only the draft or preliminary study up to this point. We understand that the final report will be published by IDA in the near future.

Mr. MAHON. Did IDA make some basic recommendations?

Mr. JONES. Yes, it has made some basic recommendations. ———.

It has recommended some of the other techniques that we should explore in the type of ordnance, and so forth. But we do not have the final report nor have we finalized all of the elements that we would be undertaking in the program.

TO DEFEND AGAINST REDEYE TYPE WEAPONS

Mr. LIPSCOMB. On page No. 79 of the justification book, it says: "This close air support weapon will possess a standoff capability out of the range of hostile Redeye type weapons."

What does that mean?

Mr. JONES. Redeye type of a weapon, sir, refers to shoulder fired missiles launched from the ground at aircraft.

Mr. LIPSCOMB. Do you know of any Redeye type weapons held by other nations at the present time?

Mr. JONES. I cannot answer whether there are any held by other nations. We have not seen any appear in Southeast Asia to my knowledge, but I would like to have General McNickle or General Boylan speak to that.

General BOYLAN. ———. Certainly the air-to-air missile available to the Mig is a heat seeker.

Mr. LIPSCOMB. It is justified as a close air support weapon that is being developed with capability out of range of hostile Redeye type weapons. I am just wondering what evidence we have that we need this type of capability.

Mr. HANSEN. I would like to point out that the Soviets have had infrared homing air-to-air missiles operational since 1964.

REDEYE MISSILE DEPLOYMENT

Mr. LIPSCOMB. Where has this been in the field, Mr. Secretary—the Redeye?

Mr. HANSEN. This is an Army weapon that is produced by General Dynamics at their Pomona plant. They have made thousands of them. ———.

This is a very short-range weapon. Are you familiar with the Redeye?

Mr. LIPSCOMB. Yes, Mr. Secretary, I was here when it was under development.

General PITTS. I would like to add something for the record.

That descriptive summary says out of the range of 57mm. antiaircraft guns, so it has a multiplicity of things it would evade; not only Redeye, but antiaircraft guns.

Mr. LIPSCOMB. I was concentrating on the Redeye. Do you know every place that the Redeye is in the field?

General PITTS. You mean in active combat?

Mr. LIPSCOMB. So that the enemy could have obtained a copy of it to duplicate it.

General PITTS. No, sir; I do not.

General BOYLAN. I do not, Mr. Lipscomb.

Mr. HANSEN. The Redeye has been deployed by the Army. While missiles are in these areas, they have not been issued to individual soldiers. They are secured in tactical storage areas under armed guard.

General PITTS. I would like to back up the Secretary. If we have a weapon system like this, I think the point Secretary Hansen was making is that it is entirely within the realm of possibility ———.

Mr. LIPSCOMB. Have you looked into the deployment or the testing of the Redeye over in ———, for instance?

General MCNICKLE. We have tested the Redeye as an airborne missile.

Mr. LIPSCOMB. If the Soviets have this capability now and if you know about it, I would like to have it on the record.

Mr. HANSEN. ———. Everything I have said was a presumption based on the relationship I have had with it, my knowledge of the development and test programs, and the numbers that have been produced.

Mr. LIPSCOMB. I am a little surprised that the Air Force here apparently is discounting the technique of the seeker in the Redeye missile.

I did not know other countries had the capability to copy it so easily.

General MCNICKLE. We are certainly not discounting the Redeye seeker technique, but others could copy it.

General PITTS. I am remembering your remark about ———.

Mr. LIPSCOMB. I do not think we ought to get into that here.

General PITTS. Yes, sir.

Mr. HANSEN. We were cautioned yesterday about not assuming that the other people are not as smart as we are. Really if I can push into it just a little bit, this is a very small weapon, as you know, but some-

thing that would do the same kind of job could be built that was maybe three times the size, if necessary, because of the lack of miniaturization techniques. It would still be a formidable threat against which we would have to stay at a stand-off distance to avoid to be able to successfully do soft target close air support work.

Mr. LIPSCOMB. There is no doubt in my mind that the technique of the Redeye-type missile will be obtained by others eventually if they have not already gotten it.

My point originally in opening this up was to ask if you have any evidence that Redeye-type missiles are being used by other countries at this time.

Mr. HANSEN. I know of no evidence that they are being used by the Soviets or other Communist countries. ———.

Mr. LIPSCOMB. I would assume you will check the record about the deployment of Redeye in Southeast Asia.

Mr. HANSEN. Yes, sir.

(The information follows:)

EVIDENCE OF REDEYE BEING USED BY OTHER COUNTRIES

The Army has advised that no Redeye missiles have been deployed to Southeast Asia.

STATUS OF INSTITUTE FOR DEFENSE ANALYSIS STUDY

Mr. LIPSCOMB. On this study by the Institute of Defense Analyses, was this a requirement laid onto IDA by the Air Force, or was this originated by IDA? How did this study originate?

Mr. JONES. By Defense Research and Engineering.

Mr. LIPSCOMB. How did D.D.R. & E. lay on this study requirement with IDA?

Mr. JONES. D.D.R. & E. actually tasks IDA for the work that they do. They establish a task and the IDA group will then assemble a study group and perform the necessary analyses and report back to D.D.R. & E.

Mr. LIPSCOMB. Could you say when this study requirement was laid on for this close-air-support weapon by D.D.R. & E.?

Mr. JONES. I would have to provide the date for the record.

(The information follows:)

THE DATE OF CLOSE AIR SUPPORT STUDY BY IDA

The requirement was laid on for this close air support weapon study by D.D.R. & E. on November 21, 1968.

IDENTITY AND BACKGROUND OF IDA STUDY TEAM

Mr. LIPSCOMB. Do you happen to have the names and the backgrounds of the team that performed the study for IDA on the close air support weapon?

Mr. JONES. I do not have it with me. I can furnish it to you.

Mr. LIPSCOMB. Do you have any idea of who was in charge of the study at IDA?

Mr. JONES. No, sir, I am afraid I do not.

(The information follows:)

CLOSE AIR SUPPORT STUDY NAMES AND BACKGROUND OF TEAM THAT PERFORMED STUDY FOR IDA AND WHO WAS IN CHARGE

The IDA team performing the study consisted of: Mr. L. M. Biberman, Dr. J. A. Navarro, Mr. R. E. Schwartz, and Miss Jean G. Taylor.

Their backgrounds include technological disciplines in weapon systems analysis and evaluation, mathematics, and laser technology.

Dr. J. A. Navarro was in charge of the study at IDA.

SOVIETS PROBABLY HAVE REDEYE TYPE OF MISSILE

General BOYLAN. Mr. Lipscomb, may I comment on your previous question?

Our intelligence information concerning Soviet capability in surface-to-surface missile systems points to what has been designated as the SA–6. It was seen in November 1967, in Moscow. Three missiles on a track mobile transporter launcher and associated electronics not identified. ———. The initial operational capability was projected for ———. Other Soviet options include an improved Hawk type or IR homing technique such as Redeye or Chaparral. ———.

Mr. LIPSCOMB. From newspaper reports on the use of weapons it appears that they could have that type of weapon in Southeast Asia but it has never been found there.

General BOYLAN. There is no evidence.

Mr. LIPSCOMB. From some of the newspaper reports of the firing on helicopters and other things it appeared to be that type of weapon.

General MCNICKEL. If they had it, I think we would know a lot more about it.

Mr. LIPSCOMB. If they do have it, I hope it is not a duplicate of ours.

General BOYLAN. I do, too.

ADVANCED RESCUE SYSTEMS

Mr. MAHON. With respect to advanced rescue systems, you are requesting $3 million for an item entitled "Advanced Rescue System." Three hundred thousand dollars was programed for this effort in fiscal 1969 and nothing in fiscal year 1968. Do you propose to develop a new helicopter under this program?

What do you have in mind?

FISCAL YEAR 1970 PROGRAM FOR TECHNOLOGY DEVELOPMENT

General MCNICKLE. Mr. Chairman, a little over a year ago there was a great effort put on greater rescue capability, and at that time we considered whether or not we ought to have a new rescue vehicle. After going through all the problems we determined that a completely new rescue vehicle with significantly improved capability was not achieved at that time. What was really required and possible was better radio, better methods of finding the downed person and better means of helping him after you found him. We are presently improving our helicopters along those lines and will soon have a good night visual capability followed very shortly by a full adverse weather capability. The effort you referred to envisions advanced development studies and model testing of new lift and propulsion concepts.

However, we are not planning to initiate development of a complete system at this time. But we do need to study ways to increase our knowledge of new technological possibilities for providing a truly advanced rescue system.

Mr. MAHON. Just what do you mean by a stowed rotor?

General MCNICKLE. One that stops and can be folded away either into the top of the fuselage or into the pads at the wingtip.

General BOYLAN. May I amplify General's McNickle's comments on the system? As he said, a little over a year ago the Air Force evaluated available vehicles and an attempt to improve our combat air crew recovery rate. The base line against which other available vehicles were measured was the HH–53 helicopter which is currently being procured. The results of that evaluation showed that the improved operational effectiveness of other available systems was not sufficient with respect to the costs that would be involved.

Indeed, the Air Force has been working since that evaluation on other associated techniques such as radios, hoist equipment and so forth.

The fact remains the HH–53 is, with the HH–3, our only air crew recovery vehicles. Downstream the requirement is there to maintain this capability.

CURRENT OVERALL DEFICIENCY IS LACK OF SPEED

This technology or this investigation is aimed in that direction. If I may, one or two points about what this vehicle has got to do. The current deficiency, if there is one overall deficiency of the current rescue vehicle, is lack of speed in response. When a man goes down it is critical to be over him in a matter of minutes and not hours, especially in enemy-occupied territory. Part of the basic concept is that the new vehicle would have a high speed so that it could accompany or be shortly behind the strike forces.

Mr. ANDREWS. What is the speed of the chopper you are using now for rescue?

General BOYLAN. The HH–53 is something on the order of 170 knots. Its dash speed is probably around 195 knots. This vehicle based on an evaluation so far should be on the range of 400-plus knots.

Mr. ANDREWS. Could you get that in a chopper?

General BOYLAN. You cannot get that to my knowledge under current helicopter configurations. You have to go to a vehicle that uses lift fan or blades to get the vertical and then other propulsion to achieve the high speeds.

Mr. ANDREWS. Doesn't the Army have a chopper that goes 250?

General BOYLAN. That was the Cheyenne.

Mr. ANDREWS. What is the fastest chopper in the service today?

General MCNICKLE. The Cobra.

Mr. ANDREWS. Your rescue helicopter is as good as you can get at this time.

General BOYLAN. Yes.

Mr. ANDREWS. To what extent does this new program depend on the availability of better propulsion systems?

General MCNICKLE. This program won't necessarily depend on a new engine but rather on a new lift system like the stowed rotor.

If we can solve the technology problems associated with stopping and stowing the rotor, we can probably use an engine that will be more or less off the shelf.

Mr. MAHON. If you are going to develop a better VTOL aircraft do you need a new propulsion system?

General MCNICKLE. Yes, to the extent that the stowed rotor will allow the excellent hover flight which is very necessary and also the high forward speed in the same aircraft from auxiliary cruise engines or perhaps adaptation of the compound engine for both purposes.

Mr. MAHON. What experience has the Air Force or the other military services had with the folded and stowed rotor aircraft?

General MCNICKLE. No one has ever folded and stowed a rotor in flight. We had the XV-3 that successfully demonstrated the tilting wing tip rotor but that did not fold or stow.

Mr. MAHON. Do you plan to do anything more than perform studies and analyses with the $3 million requested?

General MCNICKLE. Tre Air Force XV-3 program demonstrated the feasibility of tilting a rotor system to transition from hover to forward flight. However, no program has demonstrated that once in forward flight the rotor system could be stopped, folded, and stowed. This is exactly what the proposed demonstrator aircraft program is designed to do.

If the $3 million were to be utilized, $500,000 would serve to expand studies currently underway. The remaining $2.5 million would be used for wind tunnel model design, fabrication, test, and analysis.

Mr. MAHON. How do the performance characteristics of the advanced rescue system you seek compare with the capabilities of the HH-53B helicopter?

Three million dollars was programed for this effort in fiscal 1969 and only $300,000 was used. Is this a relatively low-priority project from which you reprogramed funds to other higher priority projects? Was this an item which was reduced as a part of the general reduction mandated last year? You may answer those questions for the record.

(The information follows:)

ADVANCED RESCUE SYSTEM

A comparison of the main characteristics of the two aircraft are listed below:

	HH-53	ARS
Number of engines	2	2.
Speed (Kts)	175	400.
Radius (NM)	330	500.
Max. hover	5,700'/95° F	6,000'/95° F.
Crew size	5-6	3-4.
Armament	3 Flex miniguns	Fire control system.

An Air Force evaluation of different aircraft designs indicated that significant near-term improvements over our current rescue aircraft could not be achieved without initiating a high-cost, high-risk development program. The $3 million would have been adequate to initiate such an effort but the urgency of the requirement was not commensurate with the overall technical risks and the total program costs. NASA currently has a broad-range technology program studying the preferred design identified in the Air Force evaluation. The $300,000

was the level of funds needed for NASA to contract for specific areas of work that were of special interest to the Air Force.

VTOL Aircraft Development Program

Mr. Mahon. You are requesting a million dollars for the VTOL aircraft development program with Germany in fiscal 1970. Will this amount complete this program?

Mr. Jones. Yes, sir. Under this program element we would expect this $1 million to complete this program. This program is a continuation of the old United States-Federal Republic of Germany V/STOL program and this is therefore in the engineering development area. We would probably have an advanced development program that may carry on some of this work in the future. This will complete the recent arrangements that we have with the Federal Republic of Germany.

Mr. Andrews. I thought you had just about written that plane off.

Mr. Jones. Yes, sir.

Mr. Andrews. Given up hopes on it. Didn't you tell us that the other day, General?

General McNickle. Yes, sir.

Mr. Andrews. And the only thing available today is that British plane that was out at Andrews several weeks ago.

Mr. Hansen. The Harrier?

Mr. Andrews. The Harrier, that is right, Mr. Secretary. Why spend another million if you have given up on it?

Mr. Jones. This million dollars is in relation to some continuation of work we are doing in this country and the Germans are doing some work in their country. We have provided for an informational exchange on these programs.

This particular work does fund some work looking at the Harrier with the United Kingdom which is not a part of the exchange agreement with the Germans. We are continuing some work with Fairchild-Hiller on concepts that came out of their work with the German Republic.

TOTAL PROGRAM COSTS

Mr. Andrews. What is the total amount we have spent on that V/STOL program with the Federal Republic of Germany? You can supply it for the record.

(The information follows:)

A total of $8 million of U.S. funds was spent on the joint United States/Federal Republic of Germany V/STOL aircraft program; $5 million in fiscal year 1966 and $3 million in fiscal year 1967.

TECHNOLOGY EVOLVED FROM PROGRAM IN FISCAL YEAR 1969

Mr. Mahon. What useful areas of technology are being studied under this program since the development of the prototype aircraft was canceled in January of last year?

(The information follows:)

Technology Involved Since Cancellation of Program

In fiscal year 1969, the U.S. effort was divided approximately equally between two studies and V/STOL technology projects. One study is concerned with vectored thrust aircraft wherein the cost, performance, and utility of a spectrum of STOL and V/STOL aircraft are compared. A second study is being done jointly

with the United Kingdom to compare the effectiveness of V/STOL and conventional aircraft in a European "scenario." It is not planned to exchange the results of either of these studies with Germany. The U.S. technology effort has placed emphasis on propeller investigations to include new materials for propeller and work on large-diameter propellers. In addition, significant work has been done on aerodynamics prediction techniques for high-disk-loaded aircraft, V/STOL structural criteria, jet engines interference, engine inlet studies, and V/STOL landing criteria determinations.

The German program has concentrated on aerodynamic investigations with V/STOL models, criteria for structural stress of V/STOL aircraft, integration of electronic equipments with V/STOL weapon systems, flight testing of the VJ-101 and noise levels and effects on aircraft structures.

F-15 Aircraft

Mr. Mahon. You are requesting $175 million for the fiscal year 1970 increment of the development program for your proposed new fighter aircraft designated F-15. The justifications indicate that $45.4 million was programed for this project during the current fiscal year and $2 million obligated in fiscal year 1968 and prior years.

The program presented to Congress last year was for $30 million for this effort. There were indications in the status of program reports of December 31, 1968, that $55 million would be required for this program in fiscal year 1969. You now show $45.4 million. Will you explain to the committee just what has occurred to cause these fluctuations in the funding of the program in the current fiscal year?

General McNickle. The initial Air Force request to OSD for fiscal year 1969 was $54 million. We received $30 million which was intended to cover the Air Force share on the jointly funded Air Force/Navy advanced technology engine, the radar and avionics development, and the contract definition phase for the F-15. During apportionment, the $30 million was increased to $45.45 million to provide funds for accelerating the program. When the bids for the initial development of the avionics and engine came in, the contractor estimated spending rates were higher and additional funding was requested; $13.5 million was added to take care of this.

Three of the proposals that were submitted were interesting in that each one presented a different approach. We received OSD approval to keep three contractors in competition rather than two. To pay for these increased options we added, $9.6 million. These two additions amount to $23.1 million for a total of $68.5 million now in the fiscal year 1969 budget.

Comparison of F-15 with the Navy F-14 Aircraft

Mr. Andrews. General, this is more or less the Air Force version of the Navy F-14, is it not?

General McNickle. No, sir, Mr. Andrews, they are two completely different purposes.

Mr. Andrews. Aren't you using some of the same components?

General McNickle. The basic core of the engine for the F-14B is the same, yes; however, there are some differences in the engine such as different bypass ratios and air flow with resultant differences in weight. The engine is basically the same. The F-14A is a two-place variable geometry airplane, carrying the Phoenix missile for fleet air defense. It can fire multiple missiles at one time. It is actually an

antibomber airplane. The F–15 is lighter, uses two engines, carries a gun, has a short-range missile and a long-range missile, and has a fixed wing for maneuverability. It has low wing loading, weighs approximately 40,000 pounds, and has a thrust to weight ratio on the order of one to one. It is an anti-MIG airplane, a fighter-fighter, with one pilot.

Mr. ANDREWS. I thought both planes were designed to be superiority fighters.

General MCNICKLE. No, sir not in the same sense. The Navy plane is a big missile carrier and has a variable geometry wing. It will be a multi-mission airplane while the F–15 will be primarily an air superiority fighter.

Mr. ANDREWS. You assigned this one of your highest priorities?

General MCNICKLE. Yes, sir.

Mr. ANDREWS. The Navy assigned the F–14 one of their highest priorities.

General MCNICKLE. Yes, they need it for fleet defense and we need the F–15 for the anti-MIG role. I might point out that the Navy is using the Phoenix system and the TF–30 engine from the F–111B.

Mr. ANDREWS. I did not want you . . get into another TFX situation. I wanted to find out how much commonality there was between the F–15 and F–14. At what point in time do you anticipate completion of contract definition evaluation of the F–15?

General MCNICKLE. Before the end of the year.

Mr. ANDREWS. The Navy has already reached that point.

General MCNICKLE. Yes, they have already awarded the contract to Grumman.

Mr. ANDREWS. At what point in time do you anticipate selecting the F–15 contractor and awarding the contract?

General MCNICKLE. By the end of the year.

Mr. ANDREWS. Is there any possibility that both you and the Navy will get the same contractor?

General MCNICKLE. No, sir; Grumman dropped out of the F–15 competition after working in the design studies.

Mr. ANDREWS. Would it be advantageous to either to select the same contractor? That almost certainly would cause slippage in one program.

General NICKLE. Yes, sir. I do not think any one contractor could handle both.

Mr. HANSEN. I think both jobs would overload the same contractor.

TYPE OF CONTRACT TO BE AWARDED FOR F–15 AIRCRAFT

Mr. ANDREWS. What kind of contract do you plan to let for the F–15, and would you detail the contract procedure to be followed for the committee at this point?

(The information follows:)

TYPE OF CONTRACT FOR F–15—DETAILS OF PROCEDURE

The Air Force plans to use a controlled development procurement approach for the R.D.T. & E., test aircraft, and first wing of production. Not-to-exceed ceiling price option will be obtained for the second and third wing of production aircraft. We will use a combination cost and fixed price contract to accomplish this objective. The R.D.T. & E. will be on the cost portion and the test aircraft and first wing will be on the fixed price segment of the contract.

Mr. ANDREWS. Tell us briefly about the contract and then extend your remarks in the record.

Mr. HANSEN. The Air Force desire is to develop this airplane on a cost-incentive type contract, and to do the production phase on a fixed price incentive contract.

The matter of the type of contract is a very lively subject with OSD where the preference there is for a different type of contract.

As of this moment, the matter of what type of contract we will use for the F–15 is unresolved.

INCREASED PROGRAM MANAGEMENT TO AVOID COST OVERRUNS

Mr. ANDREWS. The word "overrun" has been in the paper all too frequently recently. Are you going to bend over backwards to try to keep an overrun from occurring in this program?

Mr. HANSEN. Yes, sir; we certainly are.

Mr. ANDREWS. What are you going to do, for instance, to keep such from happening?

Mr. HANSEN. It is my personal conviction that the key to the control of costs on a program is not the type of contract; it is the matter of how well the program is planned, how visible that plan is, how good the status information is against the plan. By good, I mean accurate and timely. It then requires an analysis of any deviation from the plan and corrective management action either by the contractor or the Government to bring the program back onto course.

There is a very firm resolution by the present administration to improve our program management. Secretary Laird has stated in some recent publicized testimony that he is appointing a blue ribbon outside committee to assist the DOD. In addition to that, he is structuring his organization inside to bring more attention to the problem of managing programs so as to avoid the kind of cost problems we have had in the past.

NUMBER OF AIRCRAFT FOR THE TEST PROGRAM

Mr. ANDREWS. Do you plan to buy so many for test before going into full procurement?

Mr. HANSEN. Yes, sir.

The plan would call for having some test airplanes.

Mr. ANDREWS. How many? Has that been worked out yet in the contract?

Mr. HANSEN. I think that subject is still under some discussion. It is part of the discussion taking place between the Air Force and OSD people on exactly what kind of contracts we should use, and whether the test airplane should be in the production portion of the contract or in the development part of the contract. I can check that and supply it for the record. It is my impression that it is 20, but I would want to verify that for the record. That would be just the test airplanes.

(The information follows:)

F–15 AIRCRAFT—PLANNED BUY FOR TEST

The Air Force originally planned to acquire 12 aircraft, consisting of 10 single place and 2 dual place, with R. D. T. & E. (3,600) funds. In addition 6 single place aircraft would have been procured with production (3,010) funds for a total of 18 aircraft to be used during category I and category II testing.

The 12 aircraft purchased with R. D. T. & E. funding would be heavily instrumented. It was anticipated that these 12 aircraft would be used to complete all category I tests and the category II performance, stability and control test for both the fighter and trainer configurations. The remaining six aircraft would be procured with production funding and used to evaluate the aircraft subsystems plus complete the all-weather environmental tests. These six aircraft will probably be returned to tactical units on completion of the tests. After submittal of the phase IA proposals, an evaluation of the three proposals indicated that an additional two single seat aircraft would be required to meet the expected category I flight test hours. Therefore, the test force is 20 aircraft.

It must be recognized that these numbers are planning figures and the final test inventory will be firmly established after receipt of the phase IB contractor proposals during source selection.

OVERLAP BETWEEN DEVELOPMENT AND PRODUCTON TO BE REDUCED

Mr. ANDREWS. I do not know anything about avionics hardware and military planes. I am just speaking as a layman. I think it is most essential for you to be sure that the plane will work, it is what you want, and the bugs are out of it before you go into production. I have been here for 25 years and have seen the taxpayers pay through the nose because of the failure of the military services to do just what we are talking about.

Mr. HANSEN. Our plan for the F–15 has been recently revised to reduce the amount of overlap between engineering and production. It is our belief that the program as previously planned had too much concurrency. This enables us to have test milestone points at which a program review can be held and a determination made, based on the test results at that point in time, on whether or not we would proceed with the program as planned, or whether that plan would be adjusted because of problems.

Mr. ANDREWS. There is an old saying, "Fly before you buy." This is mighty good advice. Fifteen years ago the Navy bought a lot of planes and they could not get them off the ground.

TOTAL COST OF F–15 R.D.T. & E. PROGRAM

In the descriptive summary material in support of your fiscal year 1969 request, it was stated that the total estimated cost of the F–15 program was $84 million for R.D.T. & E. that $50 million would be required after fiscal year 1969, and as previously mentioned, $30 million would be required in fiscal 1969. This year we find that $45.4 million was used in fiscal 1969, $175.1 million is requested for fiscal year 1970, and no estimate is given as to the total estimated cost in this development program.

Explain the figures given to the committee last year. Tell us why they did not turn out to be very accurate figures.

General MCNICKLE. Sir, I would like to refer back to my previous comment, in that we did add a third contractor. That added some additional cost—$9.6 million.

The increased spending rate for the joint engine program and also for the radar program was higher. That in conjunction with accelerating the program accounts for the additional increase in last year's cost.

Mr. ANDREWS. The material this year does not indicate the total estimated cost of development of the F–15. Why is that?

General McNICKLE. The total cost at the present time is estimated to be about $1.1 billion.

Mr. ANDREWS. Why is that not included in the descriptive summary material?

General McNICKLE. At that time they were made up—6 months ago—we did not have a good estimate. That was in December 1968.

Mr. HANSEN. What we have now is an in-house estimate which we will be able to test in the fairly near future against our contractor cost proposals which are due in the end of August.

Mr. ANDREWS. The committee fully understands that cost estimates are refined continuously, and the cost estimates given in the early stages of a program are not expected to be very accurate figures. Nevertheless, there was an estimate made last year and submitted to the committee. But in the material submitted this year no estimate was included at all. This is somewhat difficult to understand. One year later, we would expect to have a better figure, not no estimate at all.

Mr. HANSEN. Yes, sir; I agree. We should have had our best estimate figure in the submittal.

Mr. ANDREWS. Let me ask you this question, General, and Mr. Secretary. What do you estimate the total cost for your R.D.T. & E. program to be with reference to the F–15.

Mr. HANSEN. $1.1 billion.

Mr. ANDREWS. $1.1 billion?

Mr. HANSEN. Yes, sir.

Mr. ANDREWS. Does that include the 20 planes that you mentioned?

General McNICKLE. It includes 12 airplanes for R.D.T. & E. The reason the 20 figure came up is that some of the test airplanes would be included in the production account.

Mr. HANSEN. We should correct the record where I said 20. That should be made to say 12.

Mr. ANDREWS. You are talking about 12 in R.D.T. & E.

General McNICKLE. Twelve in the $1.1 billion.

ADDITIONAL INFLATION WILL INCREASE ESTIMATE

Mr. ANDREWS. How firm do you consider that price estimate to be and over what period of time will that money be expended and what consideration have you cranked in for escalation during the period of time?

General McNICKLE. It is as firm as we can make it at this time. We should have a better estimate by the time we evaluate the contractors' submissions which we will get in August. In the fall, we should have a better estimate.

Mr. ANDREWS. Do you expect it to be up or down?

General McNICKLE. We hope it will be close.

Mr. ANDREWS. I do, too.

Did you crank anything in that estimate for inflation?

General McNICKLE. These are 1969 dollars. We have not cranked in additional amounts for inflation.

Mr. ANDREWS. Over what period of time are we talking about now?

General McNICKLE. Through fiscal year 1974.

Mr. ANDREWS. Of course, you could have more inflation, a leveling off, or deflation.

General MCNICKLE. Yes, sir.

Mr. ANDREWS. None of us has a crystal ball. Your guess about it is possibly better than mine. This $1.1 billion does include 12 fly-away planes for testing.

General MCNICKLE. Yes, out of development funds.

PLANS FOR PRODUCTION AIRCRAFT

Mr. ANDREWS. Are you planning to buy any additional planes at this time under the contract you will execute which will be paid for out of procurement funds?

General MCNICKLE. As the contract is envisioned now, no.

Mr. ANDREWS. You do plan to stick by that sound advice of flying before buying?

General MCNICKLE. Yes, sir, insofar as we can.

Mr. ANDREWS. You will not purchase any production aircraft until you have thoroughly tested the 12 R.D.T. & E. planes and gotten the bugs out of them?

Mr. Secretary, you are shaking your head. You do not agree?

Mr. HANSEN. That is not quite right.

Mr. ANDREWS. Explain what you are planning to do.

Mr. HANSEN. The plans are to determine what are the critical concerns about the ability of the airplane to fly properly and do its job. We will devise testing milestones to determine that those things are reasonably in hand and demonstrated by test before we proceed with that portion of the production.

The thing that is wrong with the complete fly before you buy is that you build up to make the test airplanes, then you shut down your production while you test and you have to build it up again for production, which is not economical at all.

Mr. ANDREWS. I can understand that.

Mr. HANSEN. We want to try to pull testing and production enough together to minimize the cost of what would be a gap in production but still not get so much concurrency that we are heavily committed to production before we have enough test demonstration.

Mr. ANDREWS. How will those 12 be run off the line—one a month? Does anybody know?

General MCNICKLE. No, sir. We do not have a production delivery schedule at this time. It will depend on the submittal of the contractor and his plan.

Mr. ANDREWS. Don't you think you could test those 12 aircraft and determine whether or not they meet specifications before you make a contract to procure?

Hr. HANSEN. Yes, sir. Those aircraft will be tested before there is any significant production.

For instance, certain long lead production items would be released for production only after satisfactory completion of specified tests on those items, such as perhaps a vibration and fatigue life test or something of that nature.

What we are trying to avoid is ever having to relearn the lesson of the F–111 wing box.

Mr. ANDREWS. That is what we are trying to help you learn. We are poor teachers but we are trying to give you the benefit of what we have seen happen over a long period of time.

General MCNICKLE. That fatigue problem was not found by flying. The test jig is the only place where we have any failures on that wing box.

Mr. LIPSCOMB. I think the best lesson can be learned from the F-111B program. That was a good example of trying to go into production too early. We began getting pretty heavily committed to production too early in the F-111B program, and we do not want to see that happen again.

Mr. HANSEN. Yes, sir.

Mr. LIPSCOMB. The Navy had too much "concurrence." I think that was the word that you used.

Mr. HANSEN. I agree. The RFP which the contractors were working on had also, in our judgment, too much concurrence. We provided them, just in the last few days, a revised schedule plan and a request that they propose to use testing milestones and decision points for production releases. These would be included in their recommendation as to how we could best get on with the job and at the same time protect ourselves against releasing for production any parts that have not been adequately proven by test that they have a very high probability of doing their job properly.

NAVY CONTRACT FOR THE F-14 AIRCRAFT

Mr. LIPSCOMB. I hope the Air Force is very careful how they work out this contract.

With the F-14, it looks on paper as though the Navy has us committed to six production aircraft in their contract now although we haven't even appropriated the funds. The committee has been told if the Navy doesn't go ahead with the six production aircraft, or at least three of them, the Navy will have to negotiate a new contract. That is a pretty rough way to handle it and it could prove dangerous. The Navy could have a problem.

Mr. Secretary, under the F-14 contract, they have six R.D.T. & E. aircraft and they have six more financed with procurement funds. Now if the Congress doesn't finance those production aircraft, they have a problem in their development and test program.

General MCNICKLE. I think if we can't come over and convince you that we are ready for production then maybe we shouldn't go to production.

Mr. LIPSCOMB. The Navy contract is already signed.

Thank you, Mr. Chairman.

PROPOSED AIR FORCE F-15 PROCUREMENT PROGRAM

Mr. ANDREWS. What is the planned Air Force program for the F-15?

General BOYLAN. Mr. Chairman, we are planning a force of ———. This would be on the order of ——— odd aircraft in units. The total production to support this force structure would be on the order of ——— F-15 aircraft.

Mr. ANDREWS. What do you estimate the cost of the procurement program to be?

General BOYLAN. The total cost that I have identified, separate from investment costs——

Mr. ANDREWS. What do you mean, "separate"?

General BOYLAN. Separate from research and development costs. I am sorry. That is approximately $5.9 billion.

Mr. ANDREWS. What is the anticipated flyaway weapons system cost of the F–15 aircraft?

General BOYLAN. That cost is based on all of the estimates we have been discussing here. It is now ——— million average flyaway for each aircraft.

Mr. ANDREWS. In other words, an F–15 would cost ——— million?

General BOYLAN. That is based on current estimates, Mr. Chairman.

Mr. ANDREWS. That is fully equipped with all the electronic gear and so forth?

General BOYLAN. Yes, sir.

Mr. ANDREWS. You would have to add nothing to it to have it ready for service?

General BOYLAN. It doesn't include missiles to be fired and ammunition.

Mr. ANDREWS. That is something that is attached after you get it on the runway?

ESTIMATED COST OF SPARES AND GROUND SUPPORT EQUIPMENT

General BOYLAN. It is an aircraft that can fly.

Mr. ANDREWS. What is your estimate as to the cost of spares and special ground support equipment and other special support for the F–15?

General BOYLAN. If I may correct the record, the estimates that have currently been identified for other support, spares included, is approximately $1.6 billion.

PROPOSED CASELESS AMMUNITION GUN FOR F–15 AIRCRAFT

Mr. ANDREWS. What will be the cost for the development of the gun which you propose to develop for the F–15?

General MCNICKLE. Approximately $30 million.

Mr. ANDREWS. With respect to the development of the new gun, you state that this gun will use caseless cartridges. As you are undoubtedly aware, the Army has had considerable difficulty with the use of caseless cartridges in the Sheridan weapon system program. Why would you choose this type cartridge in view of the considerable difficulty the Army has experienced?

General MCNICKLE. Sir, there are many advantages to having a caseless round in an airplane.

Mr. ANDREWS. That isn't the question. If it works. The point is, the Army has had trouble perfecting caseless ammunition.

General MCNICKLE. We are aware of the Army's problems, but we think this will work in an aircraft gun system.

Mr. ANDREWS. What are you going to do that the Army has not been able to do?

General McNICKLE. We are working with them. Our contractor has a different binder for the propellant and we are using a different approach. We have a backup, however. We will go to a cased round in case we have troubles.

Mr. ANDREWS. How much are you spending for R.D.T. & E. for this caseless cartridge?

General McNICKLE. I haven't the breakout for the caseless cartridge. Development cost of the caseless round and feed system combination gun will be approximately $30 million.

Mr. ANDREWS. The caseless cartridges go along with the gun?

General McNICKLE. Yes, sir.

Mr. ANDREWS. In case you can't get this caseless ammunition to work, that means the gun you have in mind will not be——

General McNICKLE. We will use a case cartridge gun system.

Mr. ANDREWS. The gun can use either?

General McNICKLE. The basic mechanism will have to be redesigned to accommodate the cased round, but the projectile will be the same. If we still have problems, we can fall clear back to our 20-millimeter gun that we have at the present time.

Mr. ANDREWS. Do you have any gun now comparable to the gun that you are developing to use caseless cartridges?

General McNICKLE. Not at present, no, sir. We have a 20 millimeter Gatling gun in our present fighters, but this will be a ——— caseless if all works out.

NAVY AND AIR FORCE DEVELOPMENT OF 30-MILLIMETER GUN

Mr. ANDREWS. The Navy has under development a 30-millimeter gun. Would that be anything like the one you are planning?

General McNICKLE. We are developing a 30-millimeter gun for the A–X, which is for ground targets and is not optimized for air-to-air. It will have a lower rate of fire and will fire a large round.

NEED FOR A NEW GUN FOR THE F–15 AIRCRAFT

Mr. ANDREWS. You haven't any problem about the gun for the F–15?

General McNICKLE. We have an insured program.

Mr. ANDREWS. The airplane will be configured so it can use caseless or case cartridges?

General McNICKLE. Yes, sir.

Mr. ANDREWS. If the F–15 aircraft performs as well as you say it will and if you have a new Dogfight missile on it, why is it absolutely essential to have a new gun also? Some of the current guns in our inventory are quite impressive in their capabilities.

General McNICKLE. Sir, we found out that even though we thought our missiles were very reliable, in close they had problems. We went to an internally mounted gun on the F–4E for a sure kill and we feel that is an essential back-up. For the 70's and 80's we want an improved gun based on the latest technology.

Mr. ANDREWS. You will recall that a Navy aircraft was shot down recently by a Mig off North Korea.

General McNICKLE. The C–121?

Mr. ANDREWS. Yes.

General McNICKLE. Yes, sir.

Mr. ANDREWS. From what I read and heard about that tragic incident, the North Koreans fired only one rocket.

General McNICKLE. The fighter was probably at point-blank range—flying right up his exhaust pipe.

General PITTS. A very large target flying on a straight line, no maneuvering.

General BOYLAN. Not only that, Mr. Andrews, but at point-blank range.

Mr. LIPSCOMB. When the chairman asked that question I don't think he was questioning the need for a gun on the aircraft. The question was, Why is it necessary to have a new gun when we have guns in our inventory which are quite impressive? Why can't we try to use something we already have?

General McNICKLE. The characteristics of the new gun give a large increase in target kill effectiveness and a much better chance of hitting a maneuvering target. We are concerned though that the aircraft we may face will be a Foxbat or one of those other new Soviet fighters and we will need increased projectile velocity.

Mr. LIPSCOMB. You know those will be the aircraft you will be faced with.

General McNICKLE. We need the best gun we can possibly develop for close-in air-to-air combat. We need the caseless round so we won't have a brass disposal problem and also so we can carry more ammunition, or less weight of ammunition.

Mr. ANDREWS. But you are not certain at this time that the caseless cartridges will work. You may have the same problems that the Army had in the Sheridan program. Why spend any money on a new gun when, as Mr. Lipscomb says, you have plenty of them that are designed primarily for the use of conventional case cartridges? That is his point and that was my point.

Mr. HANSEN. A fall-back capability to a gun mechanism that uses the conventional case cartridges is planned if the caseless round system fails. This will still be a better gun because it will have a more effective round.

ADVANTAGES OF NEW GUN BEING DEVELOPED

Mr. ANDREWS. Well now, percentagewise, how much better capability would you have with this new gun that you are trying to develop with case ammunition, than you would have with any gun that you have in your inventory today that uses case ammunition?

General McNICKLE. I can't express that in a percentage, but I would like for the record to detail the advantages of the new gun over the old one.

Mr. ANDREWS. All right.

(The information follows:)

ADVANTAGES OF NEW GUN BEING DEVELOPED

Several identifiable factors lead to increased effectiveness of an aircraft gun system in an aerial duel against a tough, highly maneuverable target: short time of flight to target by the gun projectile, energy of the projectile on striking the target, higher impact velocity of the projectile on the target, projectile design optimized to destroy the target, high rate of fire and ability of the gun to reach the desired maximum rate of fire with the least possible delay. In the case of the F-15 gun, the time of flight ——— that of the current 20 millimeter at a range of

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6,000 feet, thus enhancing the probability of hit against a highly maneuverable target. The gravity drop is reduced by a factor of ——— thus simplifying the fire control problem. The projectile weight ——— that of the current 20 millimeter projectile and, therefore, correspondingly greater amounts of high explosive incendiary mix and metal can be put on target for greater effectiveness by each hit. The kinetic energy of the projectile on a target at 6,000 feet is ——— as great, and its striking velocity ——— is ——— as great as that of the current 20 millimeter projectile, giving an armor-piercing incendiary shell a correspondingly greater capability against engines and the tough elements of the aircraft structure. The new gun comes up to speed in less time than the current M-61, thus insuring that a greater number of rounds are fired in the short time the pilot usually has the target in his sights. It will have ——— as the current M-61 gun, but will have a selectable, variable rate of fire at the option of pilot.

STATUS OF ADVANCED TECHNOLOGY ENGINE DEVELOPMENT

Mr. ANDREWS. What is the development status of the advanced technology engine which is to be used in the Air Force's F–15 fighter and the Navy's F–14B and C?

General MCNICKLE. The design is completed; the testing is well along. The release of the hardware for the demonstrator engines has been effected and the F–15 size engine should be on test before October of this year.

Mr. ANDREWS. Is the program on schedule?

General MCNICKLE. Yes, sir, ahead of schedule.

Mr. ANDREWS. What difficulties have been encountered in the engine program?

General MCNICKLE. It is ahead of schedule right now.

Mr. ANDREWS. Is the same company doing the work for both Navy and Air Force engine?

General MCNICKLE. Yes, Mr. Andrews, we have two companies, both General Electric and Pratt & Whitney and later we will select one.

Mr. ANDREWS. The same company will eventually produce both?

General MCNICKLE. The Navy and the Air Force are bound to select the same contractor.

ADVANCED TURBINE ENGINE GAS GENERATOR PROGRAM

Mr. LIPSCOMB. General, just to clarify something that I didn't quite understand this morning, is this "advanced turbine engine gas generator," a development for both the F–15 and the F–14? Are we talking about the same thing now?

General MCNICKLE. The component technology for the F–15/F–14B engines came from the advanced turbine engine gas generators and the lift cruise demonstrations. The F–15/F–14B engine, however, is being developed and funded under the F–15 program. It is not under the ATEGG item.

Mr. LIPSCOMB. The technique and the components came from this advanced turbine gas generator program, and now we find the funds to continue this over in the F–15 program?

General MCNICKLE. Yes, sir, this is an application of that engine technology.

Mr. LIPSCOMB. If we are so far along then on this advanced technology engine, what is the necessity of continuing with $5 million worth of funds in this other program?

Mr. JONES. As I mentioned this morning, Mr. Lipscomb, the funds for that line are to take the component work that has come out of the laboratory in the last couple of years and put together new hardware for future generations of turbojet engines. That line that you are referring to, the ATEGG line, is a technology line built upon the concept for future hardware programs like the F-15 engine. The final evolution of the components and new techniques that will come out of this line will find themselves in the aircraft engines of the future. We try to plan some 4 to 5 years ahead of time in testing various components in the class of turbine temperatures we will be seeing in the future.

For example, we will take some of the hardware that will be made out of the new composite materials technology that we spoke about earlier and put that in some of the ATEGG testing. Yet it will probably be several years down the road before we have an airplane flying with compressors made of composite materials.

Mr. LIPSCOMB. When is this advance technology engine scheduled to go into the F-14B and C? In 1975?

Mr. JONES. The advance technology engine we are developing today?

Mr. LIPSCOMB. The one we are testing.

Mr. JONES. Yes, sir. This will in about ———. We will start flying in the F-15 and F-14B.

Mr. LIPSCOMB. Then what you are saying is that you are planning a second or third generation of the advance technology engine some time in the late 1970's?

Mr. JONES. This is another generation of engines, yes, sir. That is in the gas generator technology program. That will be the components that are tested there. The engine cycle concepts that are tested there will evolve into future engines 4 or 5 years down the road.

General MCNICKLE. But there is only one engine for the F-15. There is not another engine coming out of ATEGG, not another evolution for the F-15. It has already been spawned out of ATEGG into the F-15 program.

Mr. JONES. One of the earlier core gas generators came out of the ATEGG line, went into an advance engine development line for the C-5 and finally wound up as the developed engine now called the TF-39 which is flying in the C-5 aircraft. This is an evolutionary process of how we take components developed in the laboratories such as a high temperature turbine; we size that component, put it together with a combuster and compressor which forms the gas generator, and test the concept there. Later we will add a fan to it. If it is going to be a transport engine, it will be a large bypass fan; if it is going to be a fighter, it will be a much smaller low bypass fan; and then we add the afterburners and the control systems to make it into a modern engine for the future.

Mr. LIPSCOMB. Does it cause you any concern when a new engine is developed to place it into an airframe that was designed to carry a different engine originally such as in the case of the F-14? There the Navy is intending to use one engine for a while and then come along with this engine in 1973 or 1974 and put it in the same airframe.

Mr. JONES. I am just glad that we are developing one core engine that can serve these dual applications, such as the F-14 and the F-15, rather than having to develop individual engines for both programs.

I think this is one of the advantages of the engine development concept that I have been trying to describe, of carrying through our component developments in a gas generator development line and then being able to adapt the engine components such as fans, the afterburners and so forth, that each of the services would use.

COMPARISON OF PROPOSED F-15 AIRCRAFT WITH F-4E AIRCRAFT

Mr. ANDREWS. What plane do you have now in operation that is nearest to the F-15?

General MCNICKLE. The F-4E is the best all-around fighter we have at the present time.

Mr. ANDREWS. How much comparison is there between it and your expected F-15—have you discussed this?

General MCNICKLE. Yes, sir; it would be a significant improvement.

Mr. ANDREWS. How much more capability will you have in the F-15?

General MCNICKLE. Considerable, Mr. Andrews, but I don't have the details right here.

Mr. ANDREWS. Put something in the record about it.

(The information follows:)

F-15 COMPARED WITH F-4E

In the initial design studies the Air Force looked at ways to modify and improve the F-4. However, the modifications and redesign required to provide the performance capabilities needed were so extensive that this approach was discarded. It was simply design limited. In comparison to the F-4E the F-15, with its high thrust to weight (approximately 40 percent greater than the F-4E) and low wing loading, approximately 65 versus 84 pounds per square foot, will give us a fighter that will provide a large margin of performance improvement over the F-4E and current Soviet fighters. In addition this performance margin in the "dogfight" or visual air-to-air combat role should also prove a match for any fighter the Soviets design and produce in the next generation of aircraft. The F-15 is a balanced fighter and includes the proper blend of speed, maneuverability (or turn and acceleration), range—to carry the fight to the enemy over his territory—and weapons—to defeat him either in close-in combat or from standoff ranges.

ADVANCED TECHNOLOGY UPON WHCH F-15 DESIGN IS BASED

Mr. ANDREWS. Do you believe you will be able to maintain the thrust-to-weight ratio planned?

General MCNICKLE. Yes.

Mr. ANDREWS. List for the record the capabilities of the advanced technology upon which you are basing your F-15 aircraft.

(The information follows:)

F-15 ADVANCED TECHNOLOGY

The technological base for the F-15 program comes from a broad spectrum of experience with engine, airframe, and avionics equipments, some of which resulted from earlier programs and some from advanced development programs designed specifically to provide this needed information. Some examples of this experience follow:

The engine to be developed for the F-15 is based on advanced technology which has been substantiated by many hours of demonstration engine testing under such programs as ATEGG, VTOL engine development, and AMSA engine development. As an example, the lift cruise demonstrators under VTOL engine development demonstrated the high thrust to weight technology capability required for an air

superiority fighter. The AMSA demonstrator engine program has provided sufficient confidence that cycles and metal temperatures required are obtainable.

With this sound technological base, the Air Force and the Navy have jointly underway and F-15/F-14B initial engine development program, which will provide for an actual evaluation of F-15 engine prototypes at both General Electric and Pratt & Whitney. This program will result in both sea level and altitude tests of the engines and will provide a sound technical basis for source selection and greatly reduce the development risk.

Airframe—Actual experience gained in the manufacturing process and use of titanium in the SR-71 and current high-performance fighters will be of great value, since the F-15 will probably require a relatively high percentage of titanium. Extensive wind tunnel testing is underway well ahead of actual manufacture which provides confidence in the design of this aircraft.

The F-15 radar development program will culminate in a fly-off between Hughes and Westinghouse of engineering model radars installed in bailed B-66's. Each contractor has previously demonstrated a high PRF pulse doppler radar production capability (Hughes with the ASG-18/YF-12A and the AWG-9/F-111B/F-14A and Westinghouse with the AWG-10/F-4J). Both contractors are using the Hughes high-power gridded traveling wave tube that was developed under the ASG-18 program and has been successfully demonstrated in the past. Each contractor is using his own design slotted array antenna that has been developed and already flown on other aircraft. The state of the art is well in hand for all portions of the radars. Each contractor is building two models of his respective radar; one for flight test and one for environmental test. Each is concerting considerable effort to keep his engineering model radar beneath a stringent weight and volume ceiling. The F-15 radar will be placed on contract during the fall of 1970, after having successfully passed one of the most rigid and demanding development and actual flight demonstration programs in the history of radar.

WHY DEVELOP BOTH THE F-14 AND F-15 FIGHTER AIRCRAFT?

Mr. ANDREWS. The Navy started the development of the F-14 aircraft in January of this year. The Air Force plans to go forward with the F-15 in January of next year. Both aircraft are designed to be air superiority fighters as their primary role. Why couldn't you use the Navy's F-14 aircraft so that the development cost of an F-15 would not be necessary?

General MCNICKLE. Our airplane is an air-to-air fighter. The Navy F-14 is a fleet air defense airplane.

Mr. ANDREWS. In presentations before the committee, the Navy has emphasized the F-14 air superiority fighter; they go into great detail showing examples of performance and how the F-14 should be able to outmaneuver MIG aircraft in dogfights, and has given at least some indication of fighter superiority as opposed to defense of the fleet.

In the Navy's view, what you say doesn't seem to carry quite as much weight. I think primarily their emphasis has been on the air superiority role of the aircraft, and they have included the fleet air defense almost in a secondary role.

F-15 WILL BE SUPERIOR TO F-14 IN DOGFIGHT ROLE

Mr. HANSEN. Let me state what I think General McNickle was getting at in a little bit different way. I have been in some discussions on this subject.

The F-15 is designed and optimized to be an air superiority fighter, period. The Navy plane has an air superiority capability compromised to the ability to also do other things with the airplane, such as fleet air defense. Therefore, for the air superiority role the F-15 is a better fighter. The F-15 would outfight an F-14 in a dogfight affair.

Now, our objective is to build an airplane which we believe is the very best that we know how to do in building an airplane which is optimized for the air suepriority role. I, for one, am finding already that people are coming in and saying, "Well, if you just compromise a little bit here, you could make an interceptor out of it," or "If you would just compromise a little bit there, you could make a strike airplane out of it."

I think that that is a pitfall that we shouldn't get into. If we want an airplane that is an air superiority fighter that is going to fly against airplanes that are designed for that mission and no other, it has to be the very best that we know how to make it for the air superiority role, and not compromised to give it any secondary capabilities. After it is once designed to do that, then if we want to hang something on it and accept the degradation to a different job, that is something else and that might be feasible.

Mr. ANDREWS. This is a good statement, Mr. Secretary.

The committee is well aware of the difficulties involved in trying to have the same aircraft perform several different missions, but the F–14 and the F–15 seem to be a different case, a case of two aircraft with the same mission. To what extent would the future capabilities of the Air Force be downgraded if you had to use the F–14? I speak of the F–14B and C because we fully realize that the F–14A is not fully a satisfactory aircraft because it will not have the new engine.

You have partially covered that. Do you want to add anything to what you have said?

F–14 MORE EXPENSIVE THAN F–15 AIRCRAFT

General MCNICKLE. The F–14A will be quite more expensive than the F–15 because it is bigger and has two pilots.

Mr. ANDREWS. In other words, you think you can do a better job then with the F–15 than you could with the F–14B and C?

General MCNICKLE. Unquestionably.

Mr. ANDREWS. And as the Secretary said, you have only one mission in mind for the F–15. The Navy has one or more missions in mind for their F–14.

General MCNICKLE. That is why we are able to optimize the F–15 for air superiority and use a fixed wing tailored to this mission.

Mr. ANDREWS. Would the F–14 be inferior to projected Soviet aircraft and therefore place our tactical force in danger, in your opinion?

General MCNICKLE. We have not run out that many characteristics on the F–14B. In fact, the only briefing we had on the F–14 was on the F–14A.

CANNOT DUPLICATE SUCCESS WITH F–4 AIRCRAFT

Mr. ANDREWS. The Air Force has had great success with the F–4, which is a Navy-developed aircraft. Could we possibly duplicate this success with the F–14?

General MCNICKLE. No. The F–4 started out as a Navy-air defense interceptor. It later had all these modifications. It was an outstanding airplane, and it is today, because it has plenty of power. It is not as good in a dogfight as we would like it to be. It was made shorter than

what might have been optimum to fit a spot on a deck. It is not as good a fighter as we need and does not stand up against some of the Mig capabilities.

COST TRADE-OFF IF AIR FORCE USED NAVY F–14 AIRCRAFT

Mr. ANDREWS. In testifying before the committee, the Navy represented their F–14 proposed aircraft as being capable of defeating all Soviet aircraft, which are known or known to be under development, and it will be superior to these aircraft throughout the time period for which they are projecting the F–14. If it has this capability, it could perform the Air Force mission, couldn't it? If it has that capability?

General MCNICKLE. If it has that capability, it could do the job. However, I would like to point out that it would cost considerably more for the number we think we need. It would be a large increase in dollars required.

Mr. ANDREWS. Would that increased cost offset your $1.1 billion development cost of the F–15?

General BOYLAN. Could you restate that question, sir?

Mr. ANDREWS. The unit cost of the F–14 is greater than that of the proposed F–15, and buying the F–15 would be a saving of dollars to the Air Force in this regard, but these savings are offset by the requirement for $1.1 billion to develop the F–15, which offsets this advantage. Does it totally offset it, more than offset it, or is there a plus factor based on your requirements for numbers of F–15 aircraft?

General BOYLAN. When you look at the problem in the broadest sense, the Air Force has a task that we think can be performed by ——— wings of an uncompromised, relatively simple, one-man aircraft. The 10-year system operating cost works on the point that you are raising with respect to development cost as well.

It is my judgment that in the quantities of aircraft that we require for the air superiority mission, that the 10-year operating cost of F–15, including development, compared to the F–14, would show a distinct advantage to the F–15.

General MCNICKLE. A quick calculation indicates an F–15 would be $1 to $2 million cheaper including the F–15 development costs, but not the F–14 development costs.

Mr. ANDREWS. Including 10-year operational cost?

General PITTS. On an average flyaway cost, a $2.2 million differential for a ——— buy; that is about a billion and a half dollars.

When you go into operating costs, you have the Phoenix missile system with very complex avionics and operating costs that would figure in here, so I don't know. We would have to do some studies on this.

Mr. ANDREWS. It would seem that such studies would have been made when two such aircraft are being proposed in almost the same period of time.

General BOYLAN. The aircraft are being proposed for different missions. That becomes obscured at times.

You know, all this boils down to something that is pretty basic. There are two principal ways to kill opposing aricraft. One is on the ground and one is in the air. The F–15 is being designed against the best that the Soviets will either operate against us or provide to its friends to operate against us. Our mission includes destroying enemy

fighter air as well as enemy bombers. The F–15 will do that job and will do it superior to the F–14 in that particular mission.

The F–14 in the principal role of fleet defense is to prevent standoff missiles being launched against capital ships, carriers, et cetera. It is being designed to perform that job.

To kill the enemy fighter in the air is going to be the classical dogfight situation.

Mr. ANDREWS. Now, let me ask you this question: Could you come out cheaper if you took the Navy F–14 B and C and configured it to meet your special needs, and buy the F–14 instead of the F–15?

General MCNICKLE. I don't think you can reconfigure that airplane.

General BOYLAN. You would have another development program, Mr. Andrews.

General MCNICKLE. You would have an F–111 A and B type of program.

Mr. ANDREWS. Let me see if I understand the situation. The Air Force has a unique need for its proposed F–15. It meets your needs better than any version of the Navy F–14, and including the development cost for the F–15, your unit price will be cheaper for your F–15 than it would be for the F–14. Is that it in a nutshell?

Mr. HANSEN. That is a very good statement, and let me say why that is. Because it is a single-purpose airplane. The Navy says the F–14 will outfight any Mig, but I don't believe the Navy will say that the F–14 will outfight an F–15.

Mr. ANDREWS. This committee is concerned with two things, Mr. Secretary. Trying to fulfill your needs for the security of this country, and also trying to save dollars for the taxpayers.

Now, you have stated a definite need for the F–15, a need which can be met better by the F–15 than any of the versions of the F–14 that the Navy is planning.

Mr. HANSEN. Right.

Mr. ANDREWS. Now, second, with all the cost of R.D.T. & E. added in, you still will be able to get the F–15 at a cheaper flyaway cost than you could any version of the Navy's F–14.

F–15 WILL NOT BE PRODUCED IF COSTS EXCEED ESTIMATE SUBSTANTIALLY

Mr. HANSEN. Yes, sir; and the reason I say that so emphatically is that if it should turn out that the F–15 can't be produced for the kind of cost that we estimate, I don't think we are going to be able to produce it.

Mr. ANDREWS. We certainly hope you won't go into production until you have all the bugs out of it and you know it is a good aircraft. The committee is trying to urge you to be cautious, and has done so repeatedly.

Mr. LIPSCOMB. If you can't produce this at the cost which you are now estimating, you won't go ahead with it? Is that what I am to understand?

Mr. HANSEN. What I have said is that we have been told by D.D.R. & E. that if we don't come up with the design of an airplane that does what we say that it will do and can be produced for a production unit flyway cost that is in the general vicinity of ——— million, they don't intend to support our going ahead with production of it.

Mr. LIPSCOMB. Do you mean there have been guidelines laid down as to the flyway cost for the aircraft and that you are building the program to meet these guidelines?

Mr. HANSEN. I don't know exactly what you mean by guidelines.

Mr. LIPSCOMB. It sounds to me that you have been told by D.D.R. & E. that if you design a plane which can be produced for around ——— million per copy, flyway cost, you can go ahead with the program. But if you come up with a design that is going to cost more per unit than that estimate, then there will be no program.

Mr. HANSEN. Significantly more.

Mr. LIPSCOMB. To me that is not sound reasoning and it could prove dangerous. I mean the reason we are getting an F-15 is because the U.S. Air Force has a requirement to meet a specific threat. It is not only a future threat but one that is with us today, apparently. If it is going to take a certain price to meet that threat, we have to face up to it and pay the price.

If we are laying down a guideline of ——— million per copy and building a plane to that or else don't build, then I think this is not the way to develop the program.

I have listened to the testimony this afternoon and when you came up with an answer to a question that it is going to be a flyway over-the-fence cost of something like ——— million per copy, I couldn't help but feel that was a very optimistic price, after living with some of these programs. I felt in my mind that perhaps some day the Air Force would be living with an albatross. If this is the way the program is being developed, I think it is very dangerous.

Mr. HANSEN. I share your view, Mr. Lipscomb, but I am telling you of the pressure that is being put on us by D.D.R. & E. Now, what is behind that pressure, I couldn't say. I would think that this question would have to be addressed to Dr. Foster. Perhaps this is just leverage to make sure that the Air Force doesn't put any goodies in the airplane that aren't absolutely necessary, but we have been told that very great emphasis should be put on designing the airplane so that it can be produced at a unit cost of less than ——— million and that if the airplane is designed to have any unit production cost of significantly more than that, it will seriously jeopardize the prospect of being able to go ahead with the production of the airplane.

Mr. MAHON. How much would you have spent probably by that time.

Mr. HANSEN. We expect to be able to get a good fix on the production cost of the airplane as we get the cost proposals from our contractors which will commit to a "not to exceed" production price and that is due to us at the end of August. If that "not to exceed" production cost comes out more than our view of what the ariplane ought to cost, then we will be going into some very intensive exercises to try to determine what the elements of that number are, and what has to be given up in order to be able to get the cost down.

Mr. ANDREWS. And it could mean under those guidelines and that formula that has been laid down, that you would lose all you had spent in R. & D. up to that point?

General MCNICKLE. Yes, but we wouldn't have spent very much.

Mr. ANDREWS. I don't care how much you would have spent, you would have lost it.

General McNICKLE. You may be forced to take a more expensive airplane.

Mr. LIPSCOMB. I am not carrying a torch for the F-15 yet, but what we want is the best, the most capable plane that we can get at the best cost possible. We purchase these weapons systems for the purpose of being clearly capable of defeating a threat as we see that threat now and visualize it in the future. I don't see how you can put a firm price tag on the required aircraft before you even develop it.

Mr. HANSEN. I agree with you completely and I appreciate your guidance on it because my view is if we are designing an air superiority fighter, it ought not to be aimed at outflying the best MIG we visualize. It ought to be the best air superiority fighter that we know how to build with the state of the art that we have.

I think the reason that the Navy cannot have that objective in their program is that they have decided that they will accept the compromise that is necessary to have a single airplane be able to serve a multimission role. I agree with what you say, that if the kind of an airplane which is the best one that we know how to build with the state of the art turns out to be more costly, then we should re-examine the cost and the capability and decide, when we have that knowledge, whether or not we, as a country, still can afford it.

I am reporting to you accurately that there is very great pressure on cost consideration, even to the point that we have had an argument about whether or not we should tell the contractors in advance of their cost proposals how much cost we will accept. I have been very strong against that because of my feeling that this would tend to have them come in and tell us what we want to hear. I want them to come in and tell us what they think the cost is. If it is more than we expect, then we can re-evaluate the proposition in the light of that information.

STATUS OF CONTRACT DEFINITION FOR F-15 AIRCRAFT

Mr. ANDREWS. What is the current status of the contract definition phase of the F-15? What companies are engaged in this effort?

Mr. HANSEN. The current status is that technical proposals are due at the end of this month. The cost proposals are due the end of August. The contractors have just recently been redirected to submit their cost proposals to a schedule with less concurrency and with test-demonstration milestones. We have indicated that in order to comply with this we would consider giving them a slight additional time to get in their cost proposals if necessary. So the cost proposals may be delayed a little bit.

CONTRACTORS DEVELOPING ADVANCED TECHNOLOGY ENGINE

Mr. ANDREWS. What engine manufacturers are engaged in the advanced-technology engine effort?

Mr. HANSEN. You ask what contractors are on the airframe. They are North American, Rockwell, McDonnell-Douglas, and Fairchild-Hiller. The engine manufacturers are G.E. and Pratt & Whitney.

EFFECT OF FUNDING CONTRACT DEFINITION PHASE ONLY

Mr. ANDREWS. As seems to be common practice these days with aircraft development programs, the selection of a contractor and commencement of development is scheduled to take place at the first of the year. Why couldn't this program be slipped 2 or 3 months and Congress fund you in the fiscal year 1970 bill only for the contract definition phase completion and withhold the appropriation by further funds until the contract could be reviewed in detail prior to your execution of it?

Mr. HANSEN. That could be done. It would have two effects: One would be that it would increase the R.D.T. & E. cost because it would increase the period of time at which you have to pay the sustaining contract definition cost of the three contractors. The other thing is, it would delay the availability of the airplane. As we said earlier, we visualize a gap of something on the order of ——— in which the Soviets will have a fighter airplane which is superior to anything that we can send to get it.

SOVIET FIGHTER AIRCRAFT THREAT

Mr. ANDREWS. You are designing this F-15 now to take care of anything the Soviets have today?

Mr. HANSEN. We are designing it to be superior to anything they have today.

Mr. ANDREWS. And for what length of time? The next 10 years?

Mr. HANSEN. ———. I think it would be imprudent for us to predict how long we would be able to maintain air superiority with what we are coming up with.

Mr. ANDREWS. They have moved mighty fast in the last 10 or 15 years in producing fighter aircraft.

Mr. HANSEN. That is right. That is why I think it is important that at the time we are doing it, we build the best one that we know how to build and can afford.

COST OF F-15 CONTRACT DEFINITION ONLY

Mr. ANDREWS. Now, getting back to that other question, if the procedure we discussed were to be followed, how much money would be required for fiscal year 1970 just for the completion of contract definitions? You may have to supply that for the record.

Mr. HANSEN. Yes, I think we will have to.

(The information follows:)

FUNDS FOR F-15 CONTRACT DEFINITION

The total system Contract Definition for fiscal year 1970 funding presently committed on fixed price contracts with the three airframe contractors is $15.4 million. This total figure is not shared equally by the three systems contractors; therefore, it is difficult to state accurately what funding would be required beyond December 1969 since a negotiation with each contractor would be required. However, if one assumes that the average monthly funding rate that presently exists could be expected beyond the end of this year, the average cost per month for system contract definition would be approximately ——— million.

NEW AVIONICS FOR F-15 AIRCRAFT

Mr. ANDREWS. To what extent will new avionics be required for this aircraft?

General MCNICKLE. We have avionics contractors working now. Actually, these will be improved avionics, particularly the radar.

Mr. ANDREWS. That cost is already in there.

General MCNICKLE. The avionics are in the F-15 costs already given.

Mr. LIPSCOMB. Most of it is in there?

Mr. ANDREWS. In other words, that is in the flyaway cost of ———?

General PITTS. Yes.

Mr. ANDREWS. That will include whatever avionics go into the plane?

General MCNICKLE. Yes.

Mr. HANSEN. That includes the avionics but not the missiles.

Mr. ANDREWS. We understood that.

My question originally was, What will that plane cost when it is ready to fly away with everything except the missiles or anything else you hang on it?

INITIATION OF F-15 PRODUCTION PROGRAM

At what point in the development program will you initiate fabrication of production aircraft?

Mr. HANSEN. That point is not yet determined. We have a strawman development program which is being supplied to the three airframe contractors to project to them the idea that we are seeking. The Air Force wants to identify the areas of greatest technical risk and the tests which must be performed to assure that specific performance has been successfully achieved at that time. If the specific performance was successfully achieved, then there would be incremental funding released for production of the particular parts which had been proven. The exact development milestones and test are to be determined by negotiation after we get in the proposals during the period of evaluation and negotiation.

Mr. ANDREWS. I wish you would elaborate on that when you correct your remarks.

Mr. HANSEN. Yes, sir.

(The information follows:)

F-15 DEVELOPMENT VERSUS PRODUCTION

In essence, this method should provide the Air Force quantitative data generated from the development and test programs before large sums of production funds are committed. The Air Force anticipates that the proposed 20 aircraft that will be used to conduct the category I and category II testing will be committed at the outset of the development program. This commitment actually provides for eight aircraft that will be procured with production (3010) funds. Commitment to large numbers of aircraft beyond the 20th aircraft (21st and subsequent) would be dependent on the success or failure of the system contractor to meet the preestablished, contracturally binding, development milestones. However, it must be recognized that it will be necessary to commit to some small quantity of production subsequent to the 20th aircraft in order to keep the contractors development team and their associated production capability intact until adequate test data is obtained.

As to initiation of fabrication for production, the following time schedule in terms of leadtime can be used as a good approximation:

	Months before flight
Long-leadtime items and raw materials	27
Fabrication and subassembly	20
Structural assembly	15
Final aircraft assembly	6
Ramp checkout of systems	1

ESTIMATED INITIAL OPERATING CAPABILITY

Mr. ANDREWS. What is the estimated initial operating capability date for this aircraft?

General MCNICKLE. We have a target of ———. However, we are not going to move on that until we meet the technical milestones and accomplishment points. Then we will go on, so that it is not a magic date.

Mr. ANDREWS. The target date you have in mind now is ———.

General MCNICKLE. Yes.

MODIFICATION NECESSARY TO MAKE F–15 CARRIER SUITABLE

Mr. ANDREWS. If at some point in time, for some reason, the Navy decided they needed a new air superiority fighter in a hurry, is this aircraft carrier capable? Is the structure such and is the size such that it can be flown off a carrier?

Mr. HANSEN. I am sure about the size because it is smaller than the F–14. Structurally, I don't know.

Mr. JONES. We have not included additional structural weight for carrier landings but this would have to be a modification added back into the airplane. Obviously it would increase the structural weight.

Mr. ANDREWS. Would that have to be done for carrier operation of the aircraft?

Mr. JONES. Yes, sir, it would.

Mr. ANDREWS. Deck landing is very strenuous.

Mr. JONES. There have been other Air Force airplanes that have been made carrier-suitable and this airplane would have to be also.

TRANSPORTATION OF THINGS

Mr. ADDABBO. Explain the request for $6.2 million for "Transportation of things" as reflected on page 5 of the justifications. What is the basis for the estimate?

Also what is the basis for the estimate of $906,000 for "Transportation of things" in the reimbursable program?

(The information follows:)

TRANSPORTATION OF THINGS

The $6.2 million provides for first and second destination transportation charges, by commercial carriers, MSTS, and the Airlift Service Industrial Fund for personnel, materials, and cargo including charges incident to transportation, such as tolls, demurrage, refrigeration, etc. This estimate is based upon prior year experience projected through the budget year.

The $906,000 for transportation of things in the reimbursable program is primarily related to the National Aeronautical Space Agency's share of transportation charges incurred at the Eastern Test Range.

Mr. ANDREWS. Without objection, the committee will adjourn until Monday.

TUESDAY, JUNE 24, 1969.

Mr. MAHON. Gentlemen, we will continue our hearings on the Air Force research, development, test and evaluation budget request for fiscal year 1970.

F-111 AIRCRAFT

FAILURE OF WING CARRY THROUGH BOX DURING FATIGUE TEST

Mr. HANSEN. In the interests of keeping you and your committee informed, we would like to report that just a short time ago we were told that the wing box of the F-111 has failed its fatigue life test under vibration and stress. The specification fatigue test requirement for the F-111 is 16,000 equivalent flying hours. This demonstration would assure the use of the F-111's for at least 4,000 hours with very low probability of a fatigue failure. After the initial problems with the F-111 wingbox last year, the aircraft were limited to from 2.0 to 3.5 G's at different conditions. One goal for this latest test was to demonstrate at least 8,000 hours to remove this load factor limitation, then continue the testing to 16,000 hours. The wing box failed at an equivalent 7,920 hours and a decision is being considered to remove the restriction on aircraft that are configured similar to the test specimen. The Australians still hold the position that aircraft acceptance will be based on demonstration of the full 16,000-hour requirement.

Mr. SIKES. Can you tell us something of what this may hold for the future? Does it mean you would probably have to devise an alternative corrective procedure for the problem or does it mean that you are going to retest, using the same correcting device that you now have; or can you make any predictions at this time?

Mr. HANSEN. These are very good questions, Mr. Sikes. The only honest answer we can give you right now is that we really don't know.

Mr. SIKES. What would be the time element if the tests were to be rerun?

General MCNICKLE. I would say it would be a minimum of 120 days before we get this test sample out.

Mr. FLOOD. Who is making the test?

Mr. HANSEN. General Dynamics, Fort Worth, for the Systems Project Office.

PROBABLE EFFECT OF FAILURE ON AUSTRALIAN ORDER FOR F-111'S

Mr. SIKES. Does the reluctance of the Australians to accept anything less than 16,000 hours mean that they are on the verge of canceling their order?

General MCNICKLE. My guess is that we would show our confidence in the system since there are only four cycles remaining in completing

this thing at ——— G's. My guess is that they will recommend release for flight at the handbook limits because this is a long-term fatigue problem. We have only one airplane that has as much as 500 flying hours and 20 that are around 300 hours. Up to almost 2,000 flying hours, we don't feel this is any problem. This problem is associated with fatigue life and not static structural strength.

Mr. SIKES. That doesn't answer my question about Australia. Do you think they are likely to cancel their order as a result of this situation?

General MCNICKLE. We hope to be able to show them a satisfactory structure once we get this stub of the box out of the test rig——

Mr. FLOOD. By fatigue do you mean metal fatigue?

General MCNICKLE. Yes, sir.

Mr. SIKES. Haven't the Australians evidenced some lack of satisfaction with this plane anyway?

General MCNICKLE. I think there is a faction and I think it is probably in the minority party that have expressed concern. I think the Australian Air Force and the Government——

Mr. SIKES. Do you mean they have problems with minority parties, too?

General MCNICKLE. Yes. To return to the structure though, this was a completely different failure than we have had before and had nothing to do with the previous fatigue failures which originated at a hole drilled through the structure. We will get the experts to look closely at this item for credibility of our testing technique when we get it disassembled.

Mr. SIKES. You don't think this is going to justify the headlines of another colossal Pentagon failure which is almost certain to be in evidence tomorrow morning?

Mr. HANSEN. No, sir. I think if it were not for the history that the F-111 program has had, this particular event wouldn't have shown up any place except in a test report.

With respect to the Australians, here again we are just guessing but I have talked to their Chief Defense Scientist, Mr. Wills, who had been visiting in the United States, and Mr. Brooks, their defense science attache in Washington. I don't think this would have any implications with respect to their cancellation.

I think this will certainly harden their position about requiring the 16,000 hours. That requirement very likely will require some additional redesign and if it is done for the Australians, very likely we would want to do it, too. However, I can't emphasize too much that we are second-guessing the experts who are really looking at this issue and who will come in in the very near future with their recommendations.

Mr. SIKES. Is it your current feeling that this is not a matter of really great concern in that it almost met the flight release requirements which had been outlined?

Mr. HANSEN. Yes, sir, that is correct for flight release to handbook limits.

Mr. SIKES. You would have no reluctance to approve the use of the aircraft with the corrective device installed?

Mr. HANSEN. Based on what I know about it in this preliminary sense at this time, I would say yes. I would expect the program office

to recommend the release of the airplane, to apply it to the handbook values.

The reason I hesitated a little in answering your original question, Mr. Sikes, is that the Australian issue is a complicating factor. Essentially the test result says—if we understand it all correctly—that the Australians were really right in believing that to be very assured, that they were going to get 4,000 hours of life in their aircraft that it should be tested to a total of 16,000 hours before acceptance. I think this would be their point of view, but we have to recognize that they have a very delicate political situation in their country and they can't solve all their problems on the basis of strictly technological evaluation.

A–X Aircraft

Mr. Sikes. Gentlemen, let's take up the proposed A–X aircraft, another new aircraft program, which is to be a specialized close air support weapons system. You are requesting $12 million in fiscal year 1970 for the initiation of the effort. The justification book indicates that no funds were programed for this effort in fiscal year 1969; $2.5 million was requested last year and Congress did not specifically reduce this item. What was done with the $2.5 million?

OSD refused to approve contract definition in fiscal year 1969

General Pitts. Mr. Chairman, we haven't received OSD approval for contract definition in 1969. Therefore, we are unable to use the money. As an alternative, we planned to limit the program to studies during 1969 but these were postponed until 1970, and we reprogramed the $2.5 million in two separate actions to support other requirements. One reprograming action 69–39 approved December 31, 1968 to the tune of $1.5 million, and reprograming action No. 69–87, March 25, 1969, for $1 million.

Mr. Sikes. Did you fail to get OSD approval last year?

General Pitts. Yes, sir.

Mr. Sikes. Do you now have it?

General McNickle. Yes, sir. Not in contract definition, but they have agreed with the airplane and with the program we have laid out for the $12 million.

Other new aircraft programs preferred over A–X

Mr. Sikes. Among your new aircraft programs, does the A–X have a relatively low or relatively high priority?

General McNickle. We think that the F–15 is more important and also the B–1. However, we feel the A–X is badly needed. We deferred LIT in favor of A–X and the correspondence General McConnell has had with General Johnson, before the General retired, indicates the Army feels it would be a good airplane.

Mr. Sikes. Among the new aircraft upon which development is being initiated in fiscal year 1970, if one had to be eliminated, would it be the A–X?

General McNickle. We would prefer to keep the F–15 and the B–1 over the A–X.

ATTACK AIRCRAFT IN DOD INVENTORY

Mr. SIKES. I would like to have a list of the attack aircraft now in the active inventory of the Navy, the Marines, and the Air Force. Include in this listing the aircraft which are used in an attack role, such as the F–4, even though they are designed as fighters.

(The information follows:)

ATTACK AIRCRAFT AF/NAVY/MARINE CORPS

Following is a list of attack aircraft currently in the inventory of the Air Force, Navy, and Marines. Several of the aircraft listed are present in very small numbers:

Air Force—A–7,[1] A–37, F–4, F–100, F–111, A–1, A–26, B–57, T–28.
Navy—A–4, A–6, A–7, F–4, F–8.
Marines—A–4, A–6, F–4.

[1] A–7 initial operational capability is scheduled for ———.

REQUIREMENT FOR NEW ATTACK AIRCRAFT

Mr. SIKES. Since these attack aircraft are available will you list for the record your reasoning for developing a new attack aircraft?

(The information follows:)

REASON FOR DEVELOPING NEW ATTACK AIRCRAFT

Many of the aircraft presently listed in the attack role such as the A–1, A–26, F–100, B–57, and T–28 have been in the inventory for more than 15 years and are being lost through age and/or attrition. Of the rest, none were specifically designed for close air support. The A–37 is being procured only as an interim CAS aircraft and is limited in payload, loiter, and range capabilities. The A–7 is a multipurpose aircraft designed for both interdiction and close support. However, it is more expensive than the A–X, has less range with equal payloads, and requires long hard surfaced runways from which to operate. The F–105, F–111, and A–6 were designed as high speed attack aircraft for the interdiction mission. Even though they can be used for the CAS role their design characteristics for the interdiction mission limits their capabilities for performing the CAS mission. The A–X is being designed specifically for the CAS role and will have outstanding characteristics for operating under low ceilings and visibilities that prohibit operations of the high speed and high cost jet attack aircraft such as the F–105, F–4, and F–111.

A–X CAPABILITIES COMPARED WITH OTHER ATTACK AIRCRAFT

Mr. SIKES. To what extent is this aircraft proposed to fill the role which was to be filled by the so-called Coin aircraft, later known as the OV–10, and which apparently was not fully suited to the mission for which it was designed?

General MCNICKLE. The A–X has considerably more capability. It is really the replacement for many of our systems presently performing the CAS mission, such as A–1, F–100, and the A–37 and, if I might mention the Cheyenne.

Mr. SIKES. What are the capabilities of the proposed A–X—how do they compare with the A–7 attack aircraft?

General MCNICKLE. The A–X would be much more maneuverable; it would be able to operate under low ceilings and visibilities, more

like the A–1. It has STOL characteristics where the A–7 requires long runways.

PROPOSED A–X AIRCRAFT CHARACTERISTICS

Mr. SIKES. Provide a list of the characteristics for the record.
(The information follows:)

A–X CHARACTERISTCICS

The A–X will be a single place, twin turboprop aircraft with outstanding STOL characteristics, excellent maneuverability, and a high order of trade-off of payload, radius, and loiter. Some of the significant characteristics follows:

Operating Weight, Empty (lbs)---------- ———
Internal Fuel (lbs)---------- ———
Max Gross Wt (lbs)---------- ———
Max Payload (lbs) w/Full Int Fuel (FIF)---------- ———
T.O. Dist (Gnd Roll, S.L., Tropic Day) (ft)---------- ———
With 5,000 # Payload, FIF---------- ———
Max T.O.G.W---------- ———
Max Speed, w/pylons, S.L. (KIAS)---------- ———
Type Gun/Rounds---------- ———
Ferry Range (NM) w/o IFR---------- ———

ESTIMATED TOTAL DEVELOPMENT COST OF A–X

Mr. SIKES. Can you give us your best estimate of the total development cost?

General PITTS. It is about ——— million, sir.

PROPOSED A–X INVENTORY

Mr. SIKES. How large an inventory would you want to procure?

General BOYLAN. Mr. Chairman, the Air Force objective force includes ——— wings of A–X. Now, this is important to understand. The objective level of force structure of the Air Force. The current program approved by DOD authorizes 23 wings. At the objective level of some ——— wings ——— A–X wings would be in the active structure. ——— wings would be in our special operating forces and ——— wings in the Air National Guard.

Mr. SIKES. How many aircraft is that?

General BOYLAN. That would be on the order of ——— aircraft. The total procurement would be approximately ———.

ESTIMATED TOTAL PROCUREMENT COST

Mr. SIKES. What is the estimated total procurement cost, including spares, initial spares, and special transport equipment?

General BOYLAN. The program data shows a gross flyaway at $1.08 billion. Peculiar support of $78.8 million is required and $171.3 million for initial spares for approximately ——— aircraft.

Mr. SIKES. How much will that be per copy of the aircraft?

General BOYLAN. The gross unit flyaway is estimated at ——— million.

PROPOSED A–X COMPARED WITH A–37 AIRCRAFT

Mr. SIKES. For the record, give us the principal differences of the A–X and the A–37 which you are now procuring.

(The information follows:)

DIFFERENCES BETWEEN A–X AND A–37

Although costing more, ——— versus $0.416M flyaway, the A–X will have capabilities which the A–37 cannot achieve. Survivability, lethality, range, payload, loiter, maneuverability, flexibility, forward basing, growth potential, and cost effectiveness are some of the A–X characteristics which makes it vastly superior to the A–37. For example with full internal fuel it can carry ——— the ordnance payload on a ——— mission, operating from a ——— airstrip, and loiter for ——— as long as the A–37. It can also takeoff in ——— with almost ——— of useful load. The A–37 is a good filler aircraft to supplement the present forces and as an interim A–X. We have demonstrated this in SEA. To replace present systems with the A–37 though, would seriously degrade our tactical flexibility and capabilities, while the A–X will materially improve our worldwide close air support mission capability.

PROPOSED INITIAL OPERATIONAL CAPABILITY

Mr. SIKES. What is the time schedule for this program if it is funded?

General MCNICKLE. We can have an IOC of late 1973.

Mr. SIKES. When do you plan the initial operational capability of the aircraft?

General MCNICKLE. 1973. That depends on contract definition in the early seventies.

Mr. SIKES. How long will the development program require?

General MCNICKLE. Almost 3 years.

Mr. SIKES. To be completed at what specific time?

General MCNICKLE. Development will be completed in 1973 and then we will have production.

AIRCRAFT EQUIPMENT DEVELOPMENT

Mr. SIKES. Turning to Aircraft Equipment Development, you are requesting $14.5 million for this program in fiscal year 1970, compared to $15.5 million in fiscal year 1969 and $12.2 million in fiscal year 1968.

NEW PROJECTS AND MAJOR ACCOMPLISHMENTS IN FISCAL YEAR 1969

For the record describe the new projects which you want to fund for the first time. For the record tell us the major accomplishments in this area in fiscal year 1969.

(The information follows:)

A/C EQUIPMENT DEVELOPMENT—NEW PROJECTS AND MAJOR FISCAL YEAR 1969 ACCOMPLISHMENTS

Project 2713 for the development of aircraft flight instruments will begin work on (1) vertical scale instrumentation to provide airspeed and altitude information in the cockpit to enhance flight safety under adverse weather conditions. Planned applications include F–15 fighter and B–1 (AMSA) bomber; (2) fluidic instrumentation to measure pressure ratios of jet engines for accurate information for takeoff and cruising power conditions. This instrument will provide a direct indication of performance to the cockpit; (3) new central air data

computer will utilize solid state techniques for improved reliability and service life. It will replace the electromechanical units which process altitude, ram air pressure, static air pressure, and air temperature information for cockpit display.

Project 3324 was initiated with component improvement funds and the definition phase is being completed. The first funding from the aircraft equipment element will procure the design, fabrication, installation and part of the cost of flight testing on B–52H. The A/C integrated data system is a trouble shooting, malfunction identification and recording system for isolation of faulty units for replacement in flight or post flight. Fault isolation equipments are being used on civil transports, military airlift aircraft and are in experimental trials on strike aircraft. Project 3324 is the first time it will be used on a bomber type.

Pave Gat for B–57G (Project 2701) is a follow-on to the Pave Gat for Tropic Moon II, which is serving as the proof-of-practice project. It will provide a ——— weapon for striking truck targets ———. This equipment will allow the commander a choice of various options of opreational weapons: ———.

The F–4 Wild Weasel funding initiates the project to design and integrate the necessary avionics of an advanced fire control system ———.

Tasks under Project 1822 will include improvements to munitions, ordnance equipment, and communications gear. Candidates efforts for fiscal year 1970 are (1) communication relay pod, (2) an improved timing device for M117 bomb when fitted with retarders, (3) rocket booster for 20-millimeter ammunition, (4) a fuze for use on extender type bombs carried in multiple ejection racks and (5) an exterior wrapping for improved fragmentation of the MK 82 bomb.

Rescue ranging equipment, Project 3006, for development of gear to locate a downed aircrew man.

AC130A Trim test, Project 3007, to test and validate the application of ECM equipment for the AC–130A aircraft.

The major accomplishments in fiscal year 69 were:

The correlation bombing equipment development will provide improved combat effectiveness and navigation for normal and adverse weather conditions. ———.

First flights of the AGM–79 missile were successfully conducted. The second set of trials is underway and will be completed this summer. ———.

The F–4E Downlook radar project was started to develop and flight test a modification to the F–4 radar to provide the ability to detect targets in a ground clutter environment. Downlook capability requires the elimination of ground clutter, e.e., interference, which presently obscures the target when the F–4 is attacking from above. Two competing technical approaches are being investigated; we plan to select one for prototype development in fiscal year 1971.

The work to ensure the effectiveness of the AC–130A Side-Firing Gunship aircraft for night attack includes the following projects: ———.

Each of these projects has been planned to provide an equipment that will ensure that the gunship effectiveness is not downgraded by enemy "counteraction" continued and reasonable utilization of this class of aircraft.

The Night Avionics equipment development for OV–10 FAC/SCAR aircraft was initiated. It applies the technology of night vision devices for night surveillance missions. This equipment will be used to increase effectiveness of airborne forward air controller (FAC) in detecting, identifying and marking targets. ———.

The Night Rescue project for the HH–53 helicopter was started. It will provide equipment for rescue of downed airmen during darkness. Night vision equipment, terrain following, and navigation equipments will give us this capability.

PROJECT RED FLAME II

Mr. SIKES. What is Project Red Flame II for which you are requesting $3.3 million?

General MCNICKLE. ———. We picked up development on this from ARPA and we are carrying it on now. ———.

PROJECT BLACK CROW

Mr. SIKES. There is an increase from $220,000 to $550,000 for Project Black Crow. Describe this project and your requirement for the funds.

General MCNICKLE. ———.

Mr. SIKES. Questions on these items?

PROJECT RED FLAME II

Mr. FLOOD. In that item before Black Crow, Red Flame II, I didn't hear the last part of the answer. Do you remember what you said?

General MCNICKLE. It was a project started in ARPA. We picked it up.

———.

MISSILES AND RELATED EQUIPMENT

SHORT-RANGE ATTACK MISSILE (SRAM)

Mr. SIKES. Turning to Missiles and Related Equipment, for the Short-range Attack Missile, SRAM, there is a request of $84.7 million in the revised budget. The original January budget requested $67.7 million. The fiscal year 1969 program carried $43.3 million. It is now estimated that $135.3 million will be programed for SRAM in fiscal 1969 including the reprogramings.

I would like to have you comment on the difficulties which have led to these increased costs and tell the committee in what areas costs have increased.

SRAM COST INCREASES DUE TO PROGRAM SLIPPAGE

Mr. HANSEN. As you know, Mr. Chairman, the production phase of the SRAM has been delayed. This resulted from some difficulties in the development. I would say there are three principal areas involving additional cost. One was difficulties with the development of the motor itself. Another was just the fact that the development program has to be carried for a longer period of time because of the difficulties. The principal area of difficulty had to do with the very large number of changes that were required as a result of the fact that the airplane, the missile itself, and the warhead, were all being developed concurrently. As a problem showed up and required a design change such as the inlet on the FB–111A or the bomb bay doors, or the Mark II fire control system portions——

TECHNICAL PROBLEMS ENCOUNTERED IN SRAM DEVELOPMENT

Mr. SIKES. Have you had to go back to the drawing board to redesign some of the major components of this system?

Mr. HANSEN. Yes, sir, we have.

Mr. SIKES. Are you on safe ground now? Do you think the program can continue and be developed as visualized? In other words, are we out of the woods? Have we overcome the difficulties?

Mr. HANSEN. We have with us today, Mr. Chairman, in the back row, Colonel Horne, who has responsibility in the SRAM program. I would like to refer that question to him if I might.

Mr. SIKES. We would like very much to have his comments.

Colonel HORNE. Mr. Sikes, the main problem from a technical standpoint has been the SRAM motor, which is a two-pulse motor, and is a motor which we feel that the technology has been stretched a little bit on. Consequently, we have gone back to the redesign of this motor.

On the firings of the redesigned preliminary flight readiness test configured motor, in the last 29 shots we have attempted, we have

had but ——— failures. On those failures, we feel now that we are able, by X-ray, to tell why these particular motors did fail ———.

We have fired motors that we predicted would fail and they did fail, and we picked motors we thought would work and they worked. We will have the first launch with the B–52 at Holloman in mid-July.

TOTAL PROGRAM SLIPPAGE

Mr. SIKES. What kind of slippage have you had in this program?

Colonel HORNE. Slippage because of the motor was around 9 months. Slippage caused by cancellation of the production contract will be an additional 12 months which will give us a total of 21 months slippage.

Mr. SIKES. You don't sound as optimistic as you might.

Colonel HORNE. We will know a lot more about that after the launch from the B–52. That particular launch, of course, is being watched very carefully. We are taking all the safety precautions we can take. We will delay the firing of the missile when it comes out of the bomb bay to around ——— to give us a margin of safety. We will just have to wait and see if that launch is good. If it is, our confidence will go up considerably at that point.

PUSHING STATE OF THE ART IN SRAM MOTOR DEVELOPMENT

Mr. SIKES. Have we had trouble with state-of-the-art problems? Is this a little too advanced for our capability, or was it just a trouble-ridden program?

Colonel HORNE. I think the only area is the state of the art required to build this small motor in a compact body. That is the only area where the state of the art was stretched.

Mr. SIKES. Who is the contractor?

Colonel HORNE. The prime contractor for the whole program is Boeing. The subcontractor for the motor is Lockheed.

CANCELLATION OF PRODUCTION CONTRACT WILL INCREASE COST

General MCNICKLE. Mr. Chairman, when the decision was made not to pick up the production option in March, there was no question it was a good decision. However, it does mean that R. & D. costs will go up because of the costs that are not going to be borne by production. There will be an increase in cost.

REASONS FOR SRAM PROGRAM COST INCREASES

Mr. SIKES. What is the current estimate of the total cost of development?

Colonel HORNE. $413.4 million, plus $8.7 million for contract definition.

Mr. SIKES. How does this compare with the original cost estimate?

Colonel HORNE. The original cost estimate was $161.6 million; the original estimate for contract definition was $6 million.

Mr. SIKES. That would appear to be the highest percentage of cost overruns that we have had. Is this weapon worth it?

Colonel HORNE. The total increase in the Boeing contract amounts to $253.7 million, of which $60 million is true overrun, and engineering changes amount to $193.7 million, which includes a $3.6 million performance incentive for radar cross section. The biggest part of the increase is related to the F–111 interface and the nonavailability of the F–111 for test purposes. That accounts for $122.7 million of the total $193.7 million.

Mr. SIKES. Is the weapon worth it?

Colonel HORNE. Yes, sir. We feel that we have to have the SRAM for the B–52 to survive against the SAM missiles.

Mr. SIKES. If you had any idea you would run into these costs or these problems, would it not have been preferable to reevaluate your requirements and attempt to come up with a substitute, or did you?

Colonel HORNE. No, sir. I think the need was so evident and the problem of the motor, of course, has only been in 1968—late 1967 and 1968. At that point in time we felt that the motor should be redesigned and made to operate satisfactorily.

Mr. SIKES. General McNickle, would you comment on that?

SRAM INTERFACE WITH FB–111 AIRCRAFT

General MCNICKLE. Sir, once the problems became apparent we were well down the road and there was no real alternative nor could we go back and say, "Let's start over again."

I think one big problem was on the interface, the first FB–111 with the Mark I, and then the changes related to the Mark II avionics. When they cut back on the FB–111 buy to two wings of FB–111's, had we known earlier maybe we would not have put SRAM on the FB–111's, but we need it for the B–52 and need it badly. Right now it looks like it is coming along well.

Mr. HANSEN. Mr. Chairman, I think we need to reemphasize the point that we made about this difficulty in having the airplane and the missile and the warhead all under development at one time. When we talked about the so-called overrun on this contract, I wouldn't really call that an overun in the usual sense. These are engineering changes to the original plan that were necessary because the framework within which the design was being made was a changing framework, so when the framework changed, this program had to change and there were engineering change costs associated with that.

Mr. ANDREWS. In other words, you had to delay production and you still have it in R. & D.?

General MCNICKLE. And we will not go into production before April.

IMPACT OF CHANGE IN BOMBER FORCE STRUCTURE

Mr. ANDREWS. Is this the full explanation of your SRAM problems?

General BOYLAN. May I amplify the Secretary's comments with two points? The SRAM program originally was oriented to the bomber force which consisted at that time of 14 squadrons of FB–111's, and 17 squadrons of B–52–G/H's. The program was oriented to the FB–111 first and the B–52 second. the FB–111 program had some slips and then had a massive change.

Mr. ANDREWS. Yes, we all know about the problems in F–111 program.

General BOYLAN. That is one of the principal impacts on the SRAM development program from the standpoint of development cost.

Mr. ANDREWS. Will the SRAM still be placed on the FB–111?

General BOYLAN. It is being engineered for the FB–111.

NO ALTERNATIVES TO SRAM MISSILE

The second point has to do with the alternatives. Every study that has been made, I think, shows that the U.S. bombers penetrating Russia would require a weapon of this type. As you know, we have the Hound Dog. It is a longer range, less accurate missile. The Skybolt program is behind us. That was a long-range missile. This one is designed to get the bomber into the target, to kill the terminal defenses.

Broadly speaking, there is no alternative to this type of missile. An alternative would have been to cancel this program and start a new engineering effort for the same type missile.

Mr. ANDREWS. I was going to ask you if you had an alternative to the SRAM?

General BOYLAN. No, sir.

Mr. ANDREWS. SRAM will give you an entirely new capability?

General BOYLAN. This will maintain the capability of our bombers to penetrate the Soviet defenses.

Mr. ANDREWS. What do you have today in operation comparable to the SRAM?

General BOYLAN. We have nothing. We have the Hound Dog, which is a longer range cruise missile.

Mr. ANDREWS. Will SRAM have an atomic warhead?

General BOYLAN. It will have an atomic warhead.

Mr. ANDREWS. And designed primarily to knock out antiaircraft——

General BOYLAN. Surface-to-air missile defenses.

Mr. ANDREWS. The SAM missiles?

General BOYLAN. That is correct.

Mr. ANDREWS. I think you or some Air Force witnesses told us recently that as of today North Vietnam is very, very heavily fortified with surface-to-air missiles.

General BOYLAN. Yes, sir.

IMPACT OF DELAYS IN FB–111 AND MARK II AVIONICS PROGRAMS

Mr. LIPSCOMB. Why do you put so much stress on the fact that the FB–111 didn't give you capability to test SRAM, and therefore you had what we call cost overruns? Why didn't you go ahead with the B–52 G and H tests?

General BOYLAN. The answer is a technical answer. The program was technically oriented in a time-task series to develop the engineering for the interface with the FB–111 first.

The test airplane wasn't available, but at that time the total program for the FB–111 had not been cut back. So, every indicator was that this was still the way to go. So delays in the program interface started occurring in the FB–111 relationship.

Mr. LIPSCOMB. Did I understand that the delay in the FB–111 program cost $122.7 million?

General BOYLAN. One of the factors.

Colonel HORNE. If you switch from the Mark I to the Mark II, which we did back in June 1966 in the FB–111, that is about the time the SRAM program started and as problems developed in the Mark II program, they impacted on the design and development of the SRAM missile. This in turn then caused the changes in the B–52 because the missile was designed to be carried by both aircraft and it would be the same missile. No changes in the missile itself. Just the black boxes and the hookups in the two different airplanes would be different. Those changes in the FB–111 and the availability of the FB–111 aircraft for testing has also impacted to the place where the Government has a $122 million additional engineering change cost to the program.

Mr. LIPSCOMB. What will the proposed AMSA use?

Colonel HORNE. This missile.

Mr. LIPSCOMB. The SRAM?

Colonel HORNE. Yes, sir.

Mr. LIPSCOMB. And the so-called Mark II system?

Colonel HORNE. The avionics system in the FB–111 that would launch this missile is the Mark II–B avionics system. The B–52 is a different inertial guidance system which will be used to launch the missile.

Mr. LIPSCOMB. I don't believe that a reader of this record will have a very clear idea of how this interface problem cost $122 million. I certainly do not understand it. We are talking about a tremendous cost overrun, or whatever you want to call it. Just because the FB–111 didn't come through, the SRAM is costing us—what is the total cost overrun?

Colonel HORNE. $193.7 million in engineering changes, and an over-target cost to the Government of $60 million.

Mr. LIPSCOMB. I just don't get the point.

Colonel HORNE. The development schedule, for example, has been delayed on the FB–111 approximately 1 year now because of non-availability of the airplanes. You might recall when the airplane was grounded for the wing box——

Mr. LIPSCOMB. Well, what SRAM costs are going ahead? If the FB–111 is not available, what are we paying for in the SRAM program—what are we getting? Are we just pouring money into the SRAM program now waiting for the FB–111 to become available?

Colonel HORNE. No, sir, we feel the program now is back on track and the number of changes that were being made have decreased very dramatically in the last few months and, as I indicated earlier, we are approaching the first launch from the B–52 which will give us good information on the performance of the missile. We feel that the technical problems with the motor have been overcome and the program appears to be on pretty firm ground at this time.

Mr. LIPSCOMB. What I am trying to get at is why it is costing us so much more money. The delay in the FB–111 and Mark II avionics programs, and not having a test aircraft, costs the SRAM program $122.7 million.

Mr. HANSEN. No, sir, we are not saying that.

Mr. LIPSCOMB. That is what I have been hearing.

Mr. HANSEN. We are saying that the net of all of the additional work that had to be done in connection with changes in the interface added up to some number like that. Originally on the FB–111 only the SRAM was to be carried. A requirement for mixed stores necessitated addi-

tional wind tunnel tests, load analysis and separations testing. The new inlet lines, in April 1968, were caused by the FB–111 engine inlet change, which is called a modified triple plow 2 inlet.

Mr. LIPSCOMB. Just take one of those. Was the engine inlet change something that the Air Force wanted? Why was it necessary to change the design of the engine inlets?

Mr. HANSEN. This was an inlet change to change the performance characteristics of the airplane so that it would meet its performance specifications. It was part of the development program of the airplane.

General MCNICKLE. There were engine compressor stalls.

Mr. LIPSCOMBS Who was responsible for that problem? The Air Force, the contractor, or the designer?

You know, we are having a problem with cost overruns, or cost increases, whatever you want to call them. Percentagewise, the SRAM program we are now talking about has as great a cost overrun as any we have heard about.

Now, maybe there is a reasonable explanation as to why we have such an enormous cost overrun, or price increase, on the SRAM missile system, but I have yet to hear one.

You are telling me now it is because of a change in the design of the FB–111 engine inlet.

Mr. HANSEN. No, sir. I am just trying to enumerate some examples.

Mr. LIPSCOMB. That is one of them?

Mr. HANSEN. It is one of a very large number of changes.

Mr. LIPSCOMB. Who is at fault? Is it the Air Force? The designer? The contractor? How do we get into such a situation?

Mr. HANSEN. I think the answer to that is very complex. It starts out by perhaps being overly optimistic about what you can do. Then in the development program we find out a particular specification isn't met, so an analysis has to be made to determine what we do to fix that.

When we fix one thing in a complex, modern weapons system, it affects other things. For instance, as we change the inlet, it changes the aerodynamic flow and this changes the aerodynamic characteristics of air going across the missile, its separation characteristics, the loads on its structure; all that analysis and testing work has to be redone.

I think to place the blame we have to say it is simply because all of us collectively aren't smart enough to know how to do it absolutely right the first time and if we did we wouldn't need a development program; we could just design it and go straight into production.

General MCNICKLE. We would like to put in the record a rundown of the changes that add up to the total.

SRAM CHARACTERISTICS

Mr. SIKES. I would like to have that, and for continuity of the record, I would like to have the characteristics of the SRAM and the reasons for its desirability.

(The information furnished the committee is classified.)

SRAM INTERFACE WITH FB–111 AIRCRAFT

Mr. SIKES. Now, would you tell me something of the differences which are required for SRAM which would be used in the B–52 in comparison with one for the FB–111 or the AMSA?

General McNickle. The SRAM is compatible with each airplane. That was one of the earlier problems, to make sure the missile could be loaded on the two airplanes. The avionics of the airplane are different and the missile interfaces of the airplanes are also different, but the missile itself is to be a standard missile for either airplane.

General Boylan. Mr. Chairman, this is the basic point we were attempting to get across to Mr. Lipscomb in this earlier conversation. It is the interface. It is the airplane part of the FB–111 program that has changed in various degrees, and that have impact on the missile program itself. The missile is in two parts. The missile fires and the black boxes and communications and electronics equipments on the airplane permit it to be fired. It is this combination that has been one of the principal causes of the research and development slip and the additional cost.

SRAM MOTOR DEVELOPMENT PROBLEM

Mr. Flood. Couldn't the entire missile be made by the same contractor? There isn't that much technical knowledge or know-how involved, is there? This question was raised with the Navy on the 3T development when they were having trouble in the control area. Now, why can't these long-haired jokers at Boeing make the motor?

Mr. Hansen. I can answer that question, sir. The motor is made by the Lockheed Propulsion Co., which used to be the Grand Central Rocket Co., and was acquired by Lockheed. Boeing has no motor division of their company.

Mr. Flood. Why not?

Mr. Hansen. They simply never chose to buy or develop one to my knowledge.

Mr. Flood. So, therefore, the business manager of Boeing does not want to get in the motor business but he gets the contract anyway for the entire missile.

We stand by and miss target dates because his motor subcontractor doesn't come through. As a condition precedent in the award of a contract on a missile of this type, why can't somebody say:

Let's stop this. On this next contract it will be awarded only to people who can do both at the same time themselves.

Why have "A" on the east coast and "B" on the west coast doing separate and distinct things, identified with the same weapons system, and they can't get together and can't do it, and we are delayed and delayed and delayed and delayed and it costs the Government money. It was years with the 3T's.

Mr. Hansen. I am trying to think if there are other companies that do combine both of these capabilities. I believe I am correct in saying we would be in a sort of a sole source——

Mr. Flood. Is there one company that does?

Mr. Hansen. Lockheed is the only one I know of that does both airframe and motor work.

Mr. Flood. If only one company does what you want, then a single-source contract is not immoral or illegal or improper or anything else. It is what we want done. It will be cheaper. It will be done in faster time. I don't care whether it is Lockheed or Joe Zilch and Company. I am sick and tired of these delays on these missiles systems

ever since we first started them, and I was here when we first started them. There is always delay. If it isn't one side of the fence, it is the other. There is always something wrong with one. It occurs to me it is near the time when we should decide, "We are going to have a missile system. Who is going to make it?" Not four companies, not two companies. "Which one of you people can make the following missile system we want?"

IMPACT OF FB-111 ON SRAM COST INCREASES

Mr. SIKES. It has been testified that the SRAM missile for the FB-111 aircraft and the B-52 aircraft is the same missile. It has also been testified that additional cost was met in the SRAM program because of delays in the FB-111 aircraft and delays in testing of the SRAM missile caused by the delay in the aircraft.

Why couldn't the test program have been reoriented, utilizing the B-52 aircraft, which has been available, so that these additional costs were minimized?

Mr. HANSEN. The missile is designed for the most severe requirements that it has to be able to meet. The FB-111 aerodynamic requirement is the most severe requirement and therefore designs the missile and sets the test requirements.

We wind up in the end with one missile that will go on all aircraft, but it has to meet the most severe conditions that are put on it by any one of the applications for it. Therefore, if the situation which puts the most severe requirement on it changes, this requires reevaluation, at least, if not redesign of the missile.

Mr. FLOOD. There is a missing link here someplace and I believe it is in your shop. I don't expect procurement people or operations people to have any answer to this, but some place in R. & D. there is a missing link which, down through the last 15 years, should have, in my judgment, made my question unnecessary today. Every time we have a weapons system of this high sophistication—and the more sophisticated, the more the problem, naturally—we always get the same problem.

One thing is always ahead of the other. For the life of me, at this late date in research and development—not just Air Force; research and development at the Defense level down through all branches of the service—I am getting to the point now where I can't understand when somebody gives birth to a missile system why aren't you presented with the accouterment in toto, not have the legs one month, the arms the second month, and the ears the third month, and then because there is a miscarriage, we have to start all over again.

This gets to be a little tiresome and very, very expensive. Why can't they give birth to one of these pigeons in the normal process?

Mr. HANSEN. I understand what you are saying, Mr. Flood, and I share your concern. Let me point out the development program on one of these things with arms and legs is alleged to have taken millions of years. These are very complex, interrelated mechanisms so the type problems you are talking about would not necessarily be avoided by having one company do it all.

What happens is that we will run into a problem in one area and then to make the changes to fix that problem other things are affected.

Then we decide what we do to fix that problem and that may affect other things. This is interface, or system engineering.

We will all grant that systems engineering is the very toughest thing that we have to face today and the more complex the problems get, the tougher it is to do the systems engineering job.

Mr. FLOOD. R. & D. gets billions of dollars from us; we believe you and we give you billions to develop a missile system. But you don't get the things put together in one shot; one missile system at one time by one producer. Why not?

Mr. HANSEN. Well, the analogy I think is more related to production, making sure you have all the pieces and they fit together as comes out the door. In the development program is the time to find out that if you do one thing a certain way to meet a certain requirement, and it doesn't meet the requirement, you have to change it. The change that you make very seldom is self-contained, but most frequently that change will affect some other element of the system. For example, to change the inlet for stall performance on the airplane, the aerodynamic flow is changed, which changes the load on externally carried devices. This is just a simple example of these interfaces.

Mr. FLOOD. Let me give you an example, a simple example. For a long time rubella—German measles—has been producing 20,000 or 30,000 mentally retarded and deformed children every couple of years. A great tragedy.

Two weeks ago the Department of Health issued a license for a vaccine which will eliminate, to all intents and purposes, rubella. German measles will be removed as a fear and no longer will 30,000 children be born every 2 years deformed or mentally retarded.

The Public Health people came up with a vaccine. They have had the same problem you have. Worse. Much worse. They finally stopped it.

Why don't you stop this? Why don't you get a vaccine?

Mr. HANSEN. If we are smart enough, we will. I hope while I am still in this office that I can ask for an appropriation for a research program to have a vaccine to stop interface problems.

Mr. FLOOD. I hope you get your hope.

SRAM UNAVAILABLE TO MEET TEST SCHEDULE

Mr. SIKES. Was the SRAM missile available for testing with the B-52 aircraft on schedule?

Colonel HORNE. No, sir. We had a slippage of 9 months because of the motor problem. As I indicated earlier, we planned the first launch for around the 15th of next month.

Mr. SIKES. Would the SRAM missile have been available for testing on the FB-111 aircraft on schedule if the aircraft had been on schedule?

Colonel HORNE. No, sir; it would not have been. The test for the FB-111 will not be until October.

PREDICTED SRAM EFFECTIVENESS

Mr. ANDREWS. Do you know enough about the SRAM to know whether or not you could knock out a SAM with it, or do you just hope you can do it?

Colonel HORNE. Yes, sir; we think that all the other performance criteria will be very closely met. The only degradations that we have right at the moment is ——— than we had hoped for. The accuracy we feel will be as good as predicted. One area where it is performing better is in the radar reflectivity. It would be much less than originally calculated.

Mr. ANDREWS. What is the radius of destruction?

Colonel HORNE. ———. You certainly could knock out a SAM site with that type of thing.

Mr. ANDREWS. It would take one SRAM for each SAM site?

Colonel HORNE. Yes, sir.

Mr. ANDREWS. How many SRAM's will a B–52 carry and how many will an F–111 carry?

Colonel HORNE. The B–52 ——— and the FB–111 ———.

ESTIMATED PROCUREMENT COSTS

Mr. ANDREWS. You have a ballpark estimate on the cost of the SRAM once you get into production?

Colonel HORNE. No, sir; not at this time. We are trying to get a cost figure from the contractor so we can put in for the production program which we hope to start next April.

Mr. SIKES. If you don't know the cost per copy, how do you know we can afford this device?

Colonel HORNE. I hesitate to give you a "guestimate" until we get some type of realistic price from the contractor. We had estimates earlier that indicated SRAM would cost in the neighborhood of ——— per missile.

Mr. SIKES. Provide for the record what is the currently estimated total procurement cost of the SRAM missile system? How many missiles are included in your presently planned procurement? How does the cost and number of missiles programed compare with the original estimate? Give us your best estimate at this time of the cost per copy.

(The information follows:)

SRAM MISSILE

There is no approved SRAM procurement program at this time.

The Air Force will soon request authority to procure a total of ——— missiles over a period of 5 or 6 years. These ——— missiles are estimated to cost $412 million ———. In addition to the flyaway missiles, the Air Force will request authority to procure SRAM related training equipment, technical data, ground equipment, and spares at a cost of $180 million. The Air Force will propose to modify 17 squadrons of B–52's and four squadrons of FB–111 aircraft for SRAM capability for $444 million including aircraft equipment, spare parts and labor. The total cost of this Air Force proposed SRAM procurement program is $1,036 million. The annual operating cost for the above defined SRAM force is estimated to be $40 million.

The original contract provided an option for ——— SRAM and the modification of 14 FB–111 squadrons at a cost of $93.5 million. Under this option the unit cost of SRAM was ———.

SRAM TO BE CARRIED BY AMSA

Mr. SIKES. The descriptive summary does not indicate there is any plan to utilize SRAM on AMSA, yet there has been testimony to the fact that this may be done. What is the present plan?

Mr. HANSEN. The present plan is to have AMSA carry for SRAM. I believe it is ——— the AMSA is designed to carry.

OTHER WEAPONS TO BE CARRIED BY AMSA

Mr. SIKES. Are there other weapons which will be used on AMSA?

Mr. HANSEN. Yes, sir.

Mr. SIKES. What are they?

Mr. HANSEN. Before we discussed the subsonic cruise armed decoy.

Mr. SIKES. Any others?

Mr. HANSEN. Basic provisions for a bomber defense missile are planned in the event this is required at a later date.

General BOYLAN. And, of course, the normal gravity, or lay-down nuclear weapons.

Mr. SIKES. What official in the Air Force is now directly responsible for the SRAM development program?

General BOYLAN. Colonel Faulk.

BREAKDOWN OF SRAM COST INCREASES

Mr. SIKES. What kind of contract do you have for SRAM?

General BOYLAN. Fixed price. It was total package and when we did not pick up the option it is now a fixed price contract.

Mr. SIKES. Tell us what the total cost overruns have been and to what degree the cost overruns have been borne by the Government and to what degree by the contractor, for the record.

(The information follows:)

The short range attack missile (SRAM) contract is a fixed price incentive fee with performance incentives (FPIF-P). The contract has a flexible share arrangement on an 80/20 basis whereby the Government is responsible for 80 percent of the overtarget cost and the contractor is responsible for 20 percent of the overtarget cost up to the contract ceiling. The contract ceiling is 130 percent times the target cost. The contractor is responsible for 100 percent of cost above contract ceiling.

The total program estimate by fiscal year is:

[In millions of dollars]

	Fiscal year—						
	1967	1968	1969	1970	1971	1972	Total
Basic contract	43.81	65.72	30.16	3.61	——	——	——
Overtarget cost	0	11.87	34.37	13.24	——	——	——
Engineering/changes studies/schedule changes	1.32	26.33	65.42	63.75	——	——	——
Termination liability	1.97	0	0	0	——	——	——
Credit termination	0	(1.97)	0	.....	——	——	——
Performance incentive	0	0	0	0	——	——	——
Total contractor	47.10	101.95	129.95	80.6	——	——	——
Associate and other	1.00	3.35	5.35	4.1	——	——	——
Total requirements	48.10	105.30	135.30	84.70	——	——	——

A detailed breakdown and explanation of the engineering changes/studies/schedule changes is presented later.

The performance incentive is associated with the reduced radar cross section being demonstrated on the development contract.

The associate and other requirements are specific, test center support, wind tunnel time, Government furnished equipment, et cetera, funded with SRAM funds but not part of the Boeing contract.

The amount of overtarget cost per year estimated in the above fiscal year cost breakout includes only the Air Force share—80 percent—of the total overtarget

costs. Under the flexible share arrangement of the contract, the total overtarget costs which exclude all Government authorized changes, are estimated to be $75 million, of which the Air Force share will be $60 million and the contractor share will be $15 million. Since the Air Force estimate assumes that the basic contract and all authorized engineering changes, schedule changes, and studies will be at contract ceiling at the end of the contract, any overtarget costs in excess of the $75 million must be entirely the responsibility of the contractor.

INITIAL OPERATIONAL CAPABILITY FOR SRAM

Mr. SIKES. I think we have already gone into this, but for continuity I will repeat it.

For the record, what is the currently estimated initial operational capability date for SRAM?

General BOYLAN. Based on an estimate of that on April 1, 1970, we will have a contract award, the predicted IOC will be ——— for the initial squadron of FB-111 and the initial IOC will be ———, for the B-52 force.

IOC means initial operational capability.

COST GROWTH VERSUS COST OVERRUN

Mr. FLOOD. General, are you going to reply to Congressman Sikes' question concerning what part of that SRAM contract cost increase you call "cost growth" and what part "cost overrun"? I am fascinated by this exercise in semantics I am getting now from the DOD. A new hat has been added. Now it is no longer "cost overrun" since the hassel this year on overruns; it is now two things—cost growth as distinct from cost overruns. I want to hear the answer to that one. It is cost growth and cost overrun, two separate and distinct animals. So when you answer Mr. Sikes question on that contract, show how much of the cost increase is cost growth and how much is cost overrun.

General MCNICKLE. Yes, sir.

(The information follows:)

SRAM COST OVERRUN VERSUS COST GROWTH

The SRAM development contract incorporated a specific baseline for each of the SRAM carrier aircraft configurations, the aircraft's performance including the avionics, and the availability of these aircraft as Government furnished property to the SRAM contractor. Under the contractor's total package and correction of deficiencies responsibility for the total combined B-52/SRAM system, and the FB-111/SRAM including the interface specification, the Government became liable whenever the Government side of the interface specification or its inability to furnish equipment as specified in the contract could not be met. Therefore, the SRAM development contract cost growth above original target price has been caused by two principal reasons:

a. Various technical problems encountered during development have required more effort to solve than had been originally estimated.

b. Design changes and schedule availability changes in Government-supplied interfacing equipment have caused redesign and rescheduling of SRAM system components.

TECHNICAL PROBLEMS

Discussing first the areas of technical problems, the major example is the missile rocket motor. Although progress is now being made, the motor subcontractor faced very serious problems in late 1967 and the first half of 1968. Solving these problems involves effort which has run the subcontractor's costs over the ceiling of the subcontract. Under the incentive sharing arrangement of the subcontract, the prime contractor must pay a portion of the costs overtarget up to the ceiling. Such payments then become a cost contributing to the prime's overrun. The technical problems with the rocket motor have delayed

the first powered missile flight test from August 1968 to a current schedule of July 1969.

All the major development subcontractors on the SRAM program have encountered over-target costs which contribute to prime contract costs. Such costs, being the direct responsibility of the contractors, do not change the prime contract target or ceiling prices. The Government pays a portion of these costs up to the prime contract ceiling in accordance with the cost sharing provisions of the contract. Costs over the ceiling price are paid solely by the contractor.

INTERFACE AND SCHEDULE PROBLEMS

The second area of cost growth is that associated with Government-directed changes. Such changes can be grouped in several categories: change in design of Government-furnished interfacing equipment, change in time availability of Government-furnished support such as test aircraft, change in type of Government-furnished supplies, change in test facility capability, et cetera. In the case of SRAM, the major Government-directed changes have been in the FB-111A interface design and in the schedule availability of F-111A and FB-111A aircraft to support the SRAM flight test program. The interface between the SRAM and the FB-111A avionic system (MK IIB) involves the complex integration of two inertial and digital computer systems. Development of the MK IIB was initiated at about the same time as SRAM. The concurrent development relationship of the two systems has thus necessitated frequent design changes to insure compatibility as both designs have evolved into operating hardware. From the point of view of the SRAM contract, the MK IIB interface is Government-furnished and changes thereto are Government directed.

Test aircraft for the FB-111A/SRAM flight test programs are provided by the Government and operated by General Dynamics under the F-111A contract. The test aircraft are therefore a Government-furnished service as far as the SRAM contract is concerned. Various developments in the F-111 program have caused the availability of test aircraft for SRAM to slide significantly since the start date of the SRAM contract. These changes in aircraft availability have required rephasing and stretch-out of the SRAM test program. When program changes are caused by Government actions such as described above, the contractor is entitled to negotiated equitable adjustment in target cost, target profit, and ceiling price to reflect the cost impact of the Government's action.

The determination of responsibility as between the Government and contractors for the cost increases discussed above has not yet been determined and will be resolved by negotiation.

Following is the current Air Force estimate of final development contract cost to the Government and the final program cost:

	Millions
Target price	$143.3
Changes:	
FB-111 interface and schedule	———
FB-111 support	———
Warhead/AEC	———
1970 range frequency change and new capability (SRAM hardness study, permissive action link study, simultaneous carriage of mixed munitions, operational test launch, etc.)	———
B-52 carrier associated changes	———
Government-furnished property substitution	———
Anticipated but undefinitized changes	———
Total	190.1
Incentive for improvement in performance	3.6
Anticipated overtarget cost to Government	60.0
Total estimated contract cost to Government	397.0
Other efforts paid by SRAM funds not on Boeing contract, AEDC, test range, support, etc	16.4
Total estimated program cost	413.4

The estimated cost of changes ($190.1 million) are related to the interface and schedule changes discussed above. Since these changes are directed by the Government these are costs which must be borne by the Government. The estimated overtarget cost ($60 million) is the Government portion of the cost increases due to unforeseen technical problems discussed above.

From an original Boeing target price of $143.3 million, changes and cost growth now make the estimate at completion $397.0 million. The original total program cost estimate ($161.6 million, excluding the estimate of $6 million for contract definition) has grown to $413.4 million (also excluding contract definition costs of $8.7 million). In either case the only part of the final estimates that is over the target cost is $60 million.

FIRST POWERED SRAM TEST FLIGHT

Mr. SIKES. When do you anticipate the first live launch of the SRAM missile from the B–52?

Colonel HORNE. July 15, next month.

Mr. SIKES. The first live launch from the FB–111?

Colonel HORNE. October this year.

Mr. SIKES. How do these dates compare with the estimate given the committee last year?

Colonel HORNE. We were predicting February–April on the B–52 and April–June, I believe, on the FB–111.

NO OFFICIAL DEFINITION OF "COST GROWTH"

Mr. ANDREWS. Is it correct to say that cost growth is another way of describing inflation?

General MCNICKLE. I do not believe there is any official definition.

General PITTS. Cost growth includes among other things inflation. It is things that happen to a contract that are not the fault of the contractor. Cost overrun on the other hand——

Mr. ANDREWS. I understand the overrun.

Mr. FLOOD. Inflation is one thing, but of all the things that might happen to the poor guy and so many things can happen——

General PITTS. Acts of God.

Mr. FLOOD. Sure don't forget God. I am sure He pays special care and attention to create problems for you and the contractor. But, as Mr. Andrews suggests, in the whole package, including an act of God, who goes out of His way on a busy day to hamper this contractor with one of His acts, there is also inflation.

General PITTS. Part of it, yes, sir.

Mr. FLOOD. Well, what is included in cost growth?

General PITTS. Change orders instigated by the Government that causes him to do something different.

Mr. FLOOD. That is your fault.

General PITTS. Yes, sir; but for a valid purpose. Increase in the program, such as doubling the number of a particular system you are buying.

Mr. FLOOD. That is your fault.

General PITTS. Yes, sir; but again for a valid purpose.

Mr. FLOOD. Don't forget our old friend overrun.

General PITTS. That is different.

REASON FOR FUNDING INCREASE IN FISCAL YEAR 1970

Mr. SIKES. Do we understand the difficulties from the ——— solid rocket motor have been corrected?

Colonel HORNE. Yes, sir; we think the rocket is performing as predicted now.

Mr. SIKES. There is increased funding for the program in fiscal 1970. What is the reason for that?

Are there other difficulties?

Colonel HORNE. No, sir; not at this time. The cost increase in 1970 is primarily the increased time we used for development on the whole program. The main impact has been the delay caused by the availability of the motor.

Mr. SIKES. Are there questions on my right on SRAM?

SRAM TO HAVE ONLY NUCLEAR CAPABILITY

Mr. EVANS. Does this carry conventional as well as nuclear warheads?

Colonel HORNE. Only nuclear.

Mr. EVANS. The only way we can knock out SAM is with a nuclear warhead?

Colonel HORNE. With this particular development, yes.

General BOYLAN. Excuse me, that is the only way we can knock out SAM from a B–52 would be with the SRAM missile. There are other missiles for general purpose force fighter aircraft that can attack SAM's and destroy them with conventional warheads.

Mr. SIKES. The only capability this missile will have is a nuclear capability.

General BOYLAN. Yes, sir.

Mr. ANDREWS. You are not saying that the only use of SRAM would be to strike antiaircraft?

General BOYLAN. No, sir.

Mr. FLOOD. There are a lot of questions I would like to ask about SRAM but it would take the rest of the week. The minute you tell me, Colonel, that this is the only pigeon we have to attack SAM sites that shuts me up. What am I going to say after that?

Mr. SIKES. Mr. Minshall.

SRAM PROGRAM COST INCREASES

Mr. MINSHALL. What was the original cost estimate of this entire SRAM program?

Colonel HORNE. $161.6 million.

Mr. MINSHALL. How much overrun have you experienced as of today?

Colonel HORNE. $193.7 million cost growth.

Mr. MINSHALL. Overrun?

Colonel HORNE. Over-target cost to the Government of $60 million.

Mr. MINSHALL. Call it whatever you will.

Colonel HORNE. Yes, sir.

Mr. MINSHALL. What percentage increase is that.

Colonel HORNE. 148 percent overall program growth and about 15 percent over target cost to the Government.

Mr. MINSHALL. I believe as Mr. Lipscomb already pointed out that is one of the highest cost overruns we had.

Isn't that one of the highest cost overruns you have had percentage wise?

Colonel HORNE. As of the list I have seen.

Mr. MINSHALL. How far behind schedule is it?

Colonel HORNE. Nine months behind the development schedule and the IOC will be some 21 months behind.

Mr. MINSHALL. A moment ago you said you think you have the problem solved with this motor.

Colonel HORNE. We will not know until we have the powered launch in July?

Mr. MINSHALL. Then you can know for sure.

Colonel HORNE. We will have a lot more confidence.

Mr. MINSHALL. Or are you going to come back here and say we will know more in September?

Colonel HORNE. We will have more confidence after the powered launch than we have at the present time.

Mr. MINSHALL. You will either have more confidence or less confidence.

Colonel HORNE. It is a very important launch.

General MCNICKLE. More.

Mr. MINSHALL. Will you report to this staff at least how this launch makes out?

Colonel HORNE. I certainly will; yes, sir.

Mr. MINSHALL. I told the Navy once I wanted to see the first landing of an F-111B on the carrier. My good friend Dan Flood said you just canceled that test and I did. They rescheduled it. I wanted to be there.

General MCNICKLE. They had it.

Mr. HANSEN. They had that test.

Mr. FLOOD. Yes; they held it later on the west coast. Did you just use the phrase "overtarget" as distinguished from "overrun"?

General BOYLAN. That is a contract term.

Mr. FLOOD. Did you give birth to another one? Cost growth, overrun, overtarget: What is the difference?

General BOYLAN. The overtarget is the contract term.

Mr. FLOOD. Not an Air Force term.

General BOYLAN. I do not think the Air Force invented it.

Mr. FLOOD. Now, what is this above overtarget costs?

General PITTS. On certain type contracts we have what we call a target cost and a ceiling cost. The target cost is what we estimate the weapons system will come in at.

Mr. FLOOD. Guerrillas could never hide like the Air Force.

General PITTS. This is a DOD term. It applies not only to Air Force but Army and Navy.

Mr. FLOOD. That does not purify it. That makes it worse.

General PITTS. This is an attempt to protect the Government.

Mr. HANSEN. It is not limited to DOD. It also applies to NASA and AEC, for instance.

Mr. SIKES. Define it.

Mr. FLOOD. Isn't the term "sanitize"? You have heard that.

General PITTS. Yes, sir.

Mr. FLOOD. That is a DOD term.

General PITTS. DOD uses that.

Mr. FLOOD. Are you sanitizing it now?

General PITTS. No, sir, I am trying to tell you what target costs and ceiling costs are and how they affect what the Government pays for weapons systems. A target cost is that cost which the particular components of the DOD, the service, feels that a weapon system is going to come in at. A ceiling price or cost is that cost beyond which the Government is not liable for payment. The difference between target and ceiling is what the Government is liable for on a share basis. In this particular contract the share basis between target and ceiling is an 80 percent Government pay, 20 percent contractor pay. The 20 percent that he shares of the additional cost reduces his profit up to ceiling. Beyond ceiling he pays all the overceiling costs. It is on a 100 percent contractor share at that point, the contractor pays all of it. Does that explain it?

Mr. FLOOD. Yes, something like someone is going to sell a piece of land and the Government appraises it at $30,000. The lawyer says one of two things, 10 percent of the original $30,000 and 15 percent if we get you anything above $30,000. In between the two points.

General PITTS. Yes, sir, something like that.

Mr. FLOOD. Maybe I understand it now.

MINUTEMAN PROGRAM

Mr. SIKES. We will take up the Minuteman program.

There has been considerable discussion in recent weeks on the Minuteman program and its problems. Is there someone here, Mr. Secretary, who can bring us up to date on recent developments in the Minuteman program?

Mr. HANSEN. Yes, sir. We have Gen. Ken Schultz, who is the director of the Minuteman program.

Mr. SIKES. General, will you bring the committee up to date on the status of the program, and any new problems that have been uncovered?

General SCHULTZ. Mr. Sikes and gentleman, I cannot tell you how much I appreciate that I was in town and Secretary Hansen and General McNickle asked me to come along. I welcome it as an opportunity because I read the newspapers and look at the television, too. I have seen the press and the quotes of overruns, overtargets, overceiling, and all the other, all of which I do not find the case in the Minuteman program. To start out positively there are a thousand Minuteman missiles out in the force right now.

MINUTEMAN IN-COMMISSION RATE

——— are Minuteman I and ——— Minuteman II.

The in-commission rate of Minuteman I is ——— percent. ——— percent of them are in strategic alert right now. Minuteman II, the in-commission rate is ——— percent. The ——— percent of the ——— and ——— percent of the ——— are out there ready to do their job right now.

Mr. SIKES. This appears to be extraordinarily high, if you don't mind the interruption. I do not think I have ever heard figures that

high on missiles before. Is there something new in the way of maintenance that we have not heard about that permits this?

General SCHULTZ. No, sir. It is the reason why I spoke up to be sure you all heard my appreciation. It is not new, and it is something that should be heard. If it has not been, I certainly welcome the opportunity to tell you. The goal for that in-commission rate for Minuteman I when the system was developed was ——— of them. That is all that was required of that system. Then later, when it proved well, it went up to ———. As I say, it is achieving ———. That is ready to go out in the field, running, unmanned in a thousand holes. That is what the country has right now. The in-commission rate of the Minuteman II was ——— initially, and it is ——— right now. Minuteman II and I are running out there and can do the job. The job has varied quite a bit in time. When the Congress and the country decided to build Minuteman it was a massive retaliation missile with one target, one booster out there, and very simplified control.

Since that we have ——— targets on the Minuteman II ——— on the Minuteman III and I will give you, I hope, a success story on in a moment. The penetration capability against ——— changes in the Russian anti-ballistic-missile system have been postulated. ——— of the Minuteman II out in the field today have pentration aids on them in the field turned over to SAC, at the present time. I said I would mention Minuteman III. On the 16th of August, 1968, we flew the first ——— Minuteman III. It was ——— successful. One year earlier the flight had been scheduled for that date. In summary, before I hear your questions, the Minuteman system, Minuteman I which is in the field, Minuteman II which is in the field, and Minuteman III in development, have seven flight tests to date, does not have any problems, either in cost, performance, or schedule. Those are some overall statistics as we know the program at present.

Mr. SIKES. Will you compare in-commission rate with reliability rate?

General SCHULTZ. Yes, sir.

In-commission rate includes reliability. Let me be specific. The most complicated part of the missile is the guidance section. Currently across the fleet the Minuteman I guidance systems have a mean time between failure, an average before one breaks, of over 8,000 hours. Minuteman II, which has a much more complicated system on it presently across the fleet has about 3,300 hours mean time between failure on any missile. You can keep the missile in commission by merely having enough logistics that every time it breaks you change one. In those in-commission figures there is counted the time it takes to change components like guidance cans, electric systems, and so forth.

Have I made that clear?

WARHEADS AND RANGE OF MINUTEMAN MISSILES

Mr. FLOOD. That is an excellent statement and I would like you to follow it for the record, give us the type of warhead on the Minuteman IIIs, and the range of Minuteman I, II, and III.

General SCHULTZ. Yes, sir.

The Minuteman I has MK 11 and 11–A reentry vehicles on them.

Mr. FLOOD. What does that mean?

General SCHULTZ. It is merely a designation. I will tell you what their yield is and it will be better. It is like a number, like an F–111. It happened to be given that designation. It is a warhead that weighs about ——— pounds and has ——— megaton of yield in it. That is on all Minuteman I.

Mr. FLOOD. And the same thing for Minuteman II and III, including the range for Minuteman I, II and III.

General SCHULTZ. Yes, sir. The range on the Minuteman I can be anywhere in from about ——— out to ——— miles, roughly.

Minuteman II has a MK 11–B and C. I will explain in a minute what those designations are. It is a ——— yield weapon, the same ——— which I explained. Its range will go out to ——— miles. The difference for the RV MK–11 and 11–A and 11–B and C reentry vehicles are these: I think it is pertinent to an earlier question you had, Mr. FLOOD. As the Russians put up anti-ballistic-missile defenses, they would shoot at our incoming warheads with their nuclear weapon. It was felt in the early days, back 10 years, that the kill mechanism from those antiballistic missiles will be blast or the fireball which would come out and destroy it. So we would make the reentry vehicle structurally sound to sustain that effect. Then, as the scientific community got smarter in the days of our atmospheric testing and intelligence work, we found out that when nuclear explosions take place, not only is the blast from the fireball a destroying influence but there is a lethal envelope from radiation which comes off, gamma rays, neutrons.

We had to change the fusing and electronic circuitry in the reentry vehicles so it would be safe at a reasonable distance from an interceptor. That was the change. This relates to one of your earlier questions. In my definition that is a cost growth. The Government had to pay something to get that shielding, but when it built the original one it did not know that. Having done that, there later developed a new problem as recently as 1964 or so; there is also another phenomena when a bomb goes off, called electronic magnetic pulse. This says there are electromagnetic effects that come from a weapon and any metallic object acts as an antenna to these impulses. It is current which is generated by the electromagnetic field which will burn out parts. We had to change the reentry vehicle again and put in there the capability, filters, or shielding devices, so this would not destroy it. With each of these that did cost extra money, we have an enhanced capability with much more confidence and we test them underground.

MINUTEMAN III

Minuteman III will have up to ——— reentry vehicles on it, and they are MK–12, a different designation. The 12 will have ———. They are smaller in yield, but there are ——— of them. They go on a bus. After the third stage burns out it flies around up to 3 million feet above the earth, or 600 miles, and through maneuver, with little engine, with guidance and propulsion working in unison, ——— will deploy those ——— RV's to ——— different places.

Mr. FLOOD. This is what you called MIRV?

General SCHULTZ. Yes, sir.

Mr. FLOOD. What do the initials stand for?

General SCHULTZ. The multiple independently targeted reentry vehicle. I do not know who invented the acronym but the T was left out somehow. It means multiple independently targeted reentry vehicles. Each one is going to a different place off one booster. Additional to that, the system is built to have the capability to put ——— clouds of chaff. Chaff ——— which when a radar looks, would indeed confuse with the RV. And an enemy defense, seeing this come in, would have to expend ——— interceptors against that one booster we had shot. The chaff will ——— feet. If there are terminal interceptors below to make an engagement below ——— feet, the system has a capability of carrying ——— decoys which can be put on this machine and will emerge from the chaff and exhaust his terminal interceptors when he comes in.

Mr. ANDREWS. You mean the Minuteman III MIRV?

General SCHULTZ. Yes, sir. ———.

Mr. FLOOD. Within cost?

General SCHULTZ. Yes, sir.

Mr. FLOOD. Did this committee ever issue a medal? We better issue one to these people.

Mr. SIKES. Wait a little while.

General SCHULTZ. Let me give you the statistics. You heard the target costs on contracts and ceiling costs and others. I was in town on a different thing and the Secretary and General McNickle were kind enough to bring me over, and I did call back home and run off on a computer how we did on $2.5 billion of current face value contract, and we have less than two-tenths of 1 percent overun on just under $2.6 billion worth of current value contract. I am pleased and flattered that the Government allows me to run a billion-dollar-a-year business for it, since that is what Minuteman resources are, which the Congress has given.

Mr. FLOOD. I don't think the subcommittee could do it as well.

General SCHULTZ. I do it with 500 people, military and civilians, and the technical systems engineering contractor who helps me to do the integration job. So the total payroll of people I can count on, including secretaries, are 2,000 people.

Mr. FLOOD. You have certified to us that as you testify you are of sound memory and mind and understanding as you stand right here.

General SCHULTZ. I am of sound mind and memory at this time certified in my last physical examination.

MINUTEMAN PROGRAM COST INCREASES

Mr. SIKES. This has been a very interesting discussion. However, there have been allegations of a $4 billion cost overrun on Minuteman.

General SCHULTZ. Yes, sir.

Mr. SIKES. Are you prepared to discuss that?

General SCHULTZ. I would indeed welcome the opportunity.

Mr. SIKES. You were hoping that I would ask the question.

General SCHULTZ. I expected it would come up, sir. There has been a change from certain original estimates, and I have cost extracted them and have them right here, to what is in present appropriations

by numbers that one can make as large as $4 billion. Let me be quick to add the last estimates to the Congress and in what we are doing on the program, you neither bought the same thing, nor the same numbers of things, nor did you buy them at the same or precise times that you originally contracted for.

Mr. SIKES. You are saying that while there has been $4 billion, or whatever the figure is, in additional cost, it is not cost overrun, but changes ordered by the Government.

General SCHULTZ. Changes in cost, performance, and schedule. These are dictated very nicely by three circumstances which does not say any part of the Government has folly in its design. This main deterrent system of the country, this Minuteman missile, is very sensitive to national policy, to the threat of Russia, and to technology. Some of the earliest estimates, and I purposely mentioned when we built Minuteman I it was a massive retaliation weapon—press the button and all the missiles went—that changed to a controlled flexible response, in which we pick our targets. We can shoot a number of missiles, and we can have debates if a nuclear holocaust should come. That required changes in that system. The technology I have already covered. The world got smarter, not only this country, in what a nuclear explosion does, and the weapon had to be hardened. The first Minuteman that were made were soft missiles in a hole. If they came out and a bomb went off within ——— kilometers they would have fallen down.

Mr. FLOOD. By hardened, you mean in a hole and covered?

General SCHULTZ. I mean two things. I mean hard in the silo with the door shut and hard to blast, heat, radiation effects, and the EMP effect, all of which had to be added. When we dug the hole, it was for blast primarily. Those changes had to go into the technology. But the missile itself was not hardened. If you opened the door and you had 200 in flight and one weapon went off in ——— kilometers you would lose all your weapons. Therefore, it had to be hardned against this new proven effect. That was a change that was put into the missile: The threat I have talked about, the ABM.

In 1965 the Russians put in a terminal defense around Leningrad. Two years later they knocked it off and they had a May Day Parade and showed a Galosh missile in Russia and we saw radars going around Moscow for area defense. We had built a penetration offense to get into the Leningrad defense. When those were changed, those had to be discarded and you made a new type of penetration to go against the existing threat.

Mr. SIKES. Are you saying that the changes that have been made stayed within the original cost estimates?

General SCHULTZ. Yes, sir; within normal proportions of the kinds and numbers I have shown.

Mr. ANDREWS. What you are saying, General, is that today we have an entirely different ballgame from what we had to start with.

General SCHULTZ. Yes, sir.

Mr. ANDREWS. You have not had an overrun on the cost of the new equipment in this new ballgame.

General SCHULTZ. That is exactly right. We started out to buy a Model T and said it would cost that much and we got a brandnew 1969 Cadillac.

Mr. ANDREWS. You consider what we have today far superior to what we started with?

General SCHULTZ. By order of magnitude and capability of performing the job against known threats, known technological advances which have accrued in time. There is one other thing I did not mention. There have been constraints put on Minuteman, being a large consumer, a billion dollar a year business. When the Government said we are going to take $3 billion out of the Department of Defense budget in a given year, both the legislative and executive branch, you can bet a program director who gets a billion a year is a prime target.

Mr. Laird said this year that our deployment rate is not going to be ——— Minuteman III's, it will be ———. If you buy those over the same period of time you get off optimum production rate and you will pay more for unit cost for them and you will pay more total cost. General Ferguson had the McKinsey Co. come in for 4 months and live in my SPO and they found nothing wrong, we have a financial management system that will cope with these directions and will do it right. It is not fair on the other side to have figures which are not representative of the facts appearing from these hallowed halls to a television in California in a matter of 10 hours saying Minuteman has $4 or $5 billion overrun.

Mr. ANDREWS. We are talking about a different situation.

General SCHULTZ. Yes, sir.

UNIT COST OF MINUTEMAN II MISSILE

Mr. ANDREWS. Let me ask you one final question. How does the cost of the Minuteman III compare with the cost of the new Poseidon missile that the Navy has for the atomic-powered FBM submarines, or do you know?

General SCHULTZ. I am not an authority on the cost of Poseidon missiles, so I would prefer not to answer.

The Minuteman II cost—and again cost of a missile alone—the numbers which have been presented to Congress in the past are $2,284,000.

Mr. ANDREWS. Per missile?

General SCHULTZ. Yes, sir.

Mr. ANDREWS. Does that include everything, R. & D.?

General SCHULTZ. No, sir.

Mr. ANDREWS. That is the hardware that goes into the Minuteman missile.

Mr. PHILLIPS. Yes, sir.

Mr. ANDREWS. I understand it is the cost of the missile.

Mr. PHILLIPS. Just the airborne missile, sir.

PENETRATION CAPABILITY OF MINUTEMAN

Mr. MINSHALL. Do you think the Minuteman we have in silos today can penetrate the known Soviet ABM system and as it will exist in the next few years?

General SCHULTZ. Yes, sir. I feel confident. It is looked at by the Air Force scientific advisory board people. It is looked at by the President's Scientific Advisory Council and others. On the basis of their opinion and our own test experience it will. Let me try to reinforce that answer. When we fire from Vandenberg out to Kwajalein, we have the sensors of the Army out there, and we have Lincoln Lab, part of MIT, big

radars out there. Those are good diagnostic radars and can look at the chaff clouds and can see if they can find what the acquisition of our targets is.

We know what an interceptor will do from the developments of the Army and some of our own work. Based on that, we feel that indeed the system will get through. Let me caution. This is sensitive to how many you have. That is the question, and what the leadtime is for us to have more capability into his targets, as opposed to how many interceptors he wants to field over there. We are playing an exhaustion game with him. We must have him shoot interceptors at our decoys and exhaust his stack to get ours in. There is leakage in between. The best systems analysis people in the country seem to feel we can get in against a threat which is lower than the expected threat or the expected threat in this time period. My job is the design development, and acquisition and production of the missile. I am not a systems analysis man. I think the Chief and the Secretary in their statements have their war gaming people who probably can give you a more complete answer.

MIRV DEVELOPMENT FOR MINUTEMAN III

Mr. MINSHALL. If Minuteman can penetrate the Soviet ABM system now and in the foreseeable future, then why do you go ahead with our MIRV system?

General SCHULTZ. It is time phased and it depends on what he has over there. It is time phased against how quickly he deploys that threat over there.

Mr. MINSHALL. How far down the road are you with MIRV?

General SCHULTZ. The MIRV system has an initial operational capability date of ———. It is on schedule ———.

EFFECT OF SOVIET MIRV ON SAFEGUARD ABM SYSTEM

Mr. MINSHALL. If the Russians had a MIRV system in their missiles, do you think the ABM system we are contemplating in this country would be an adequate defense?

General SCHULTZ. I am not an expert in that area, sir. I know the Safeguard system, as announced, is not to cope with a highly sophisticated MIRV threat but I am not an expert in that area. It is not within the purview of things I have in my mission. If it is a thin defense, as I understand it, the Safeguard system, it would not cope with penetration aids of the highly sophisticated MIRV. That is an opinion of an individual, I am not responsible for that.

Mr. MINSHALL. Mr. Secretary, do you have any other opinions on that?

Mr. HANSEN. I think the whole ballistic missile with its penetration aids and the ballistic missile defense is a highly mobile technological area where the name of the game is to try to develop something that is a little better and guess what the other guy is going to do to counter that. Both sides are playing the same game. It is a matter of timing; to try to get in there with something in the way of a capability, and before he has the time to develop a capability to neutralize that you have something else coming along to keep him off balance. That is why we have to keep going with things like this

Minuteman system. If we kept the old Minuteman it would be of very little value now, I think.

Mr. MINSHALL. If the Russians come up with a sophisticated system such as we are developing, our present Safeguard ABM system will be obsolete. Do you agree with that?

Mr. HANSEN. I would agree that if we build the Safeguard system as we visualize it today, it is designed to go against the threat as we understand it today. If that threat becomes more sophisticated, the Safeguard would have to be uprated in its capability, or it would become out of date.

It is the old game of measures and countermeasures that just goes back and forth and you try to stay one step ahead of the game.

TOTAL COST OF MIRV DEVELOPMENT

Mr. RHODES. Mr. Secretary, do you have any figures as to total cost thus far for the development of MIRV? Second, the amount of money in the fiscal year 1970 budget for the MIRV system.

You can supply it for the record.

General SCHULTZ. I can give you gross numbers for the record, which include Mirv as part of the Minuteman II and III programs. The reason is that the numbers that come over here in the 1970 budget indicate $339.4 million R. & D. money for Minuteman. Some of that is working on a new Pen aid for Minuteman II. Some is updating some of the holes out there. That has to be broken out. I think it would be more accurate to furnish it for the record.

Mr. RHODES. That is fine. It is an important figure because, as you know, a lot of people are saying we should do away with Mirv and take the money and use it for other purposes. My own impression is that the amount of money we are spending on Mirv probably would not make much of a dent in some of these other programs. Is this generally true?

General SCHULTZ. In this year's appropriation, R.D.T. & E. money for Mirv and Minuteman III is two or three hundred million. It is that sort of number. What has been spent so far on it—and these are the ballpark numbers—we will supply it for the record—the total R.D.T. & E. budget for Minuteman II and III in 1970 is $399.4 million, excluding the new command and control system (MICCS), which is about $20 million more.

Mr. SIKES. Aren't you getting ——— warheads for one booster and thereby avoiding having ——— launch silos instead of one?

General SCHULTZ. Yes, sir. That was the original concept of Mirv, and a very good idea.

(The information follows:)

MIRV TOTAL COST AND FISCAL YEAR 1970 FUNDING

The Minuteman III system was developed to carry the MIRV MK-12 reentry system, or possibly a single large R/V. The Minuteman III system consists of:

1. The new MK-12 reentry system, which has MK-12 R/V's, decoys, chaff, dispensing mechanisms, a deployment module and a shroud.
2. A new postboost control system (PBCS) and an associated postboost propulsion system (PBPS).
3. An improved guidance and control (G. & C.) system.
4. A larger and more efficient third stage.

The fiscal year 1969 and prior year costs for the development of Mirv (MK-12 reentry system) have been $406.1 millions. The programed cost for fiscal year 1970 is $84.3 million.

Mr. ANDREWS. General, you made a wonderful statement. I have enjoyed it and appreciated it. Will it be classified or can it stay in the record?

General SCHULTZ. The comments I have made are classified.

Mr. SIKES. We would like to have this as nearly as possible stay in the record as given.

Mr. ANDREWS. We catch a lot of flak as members of this committee on these overruns, overtargets, overceilings, these cost growths, and we need something to answer these people. You made it perfectly clear to me when we talk about what you have today; it is just as far from what was done at the initiation of this Minuteman program as the east is from the west.

Mr. SIKES. Mr. Secretary, will you undertake to clear this statement insofar as you can as it was given because I think it was a very useful statement.

General SCHULTZ. Yes, sir. I have prepared one which is in General McNickle's office now.

Mr. HANSEN. You asked, Mr. Chairman, that in reviewing the transcript that we take special care to make sure we do not indicate anything as being classified unless it absolutely has to be.

Mr. SIKES. That is correct.

Mr. HANSEN. We certainly will do that. We try to do that on everything.

ORIGIN OF THE REPORTED $4 BILLION COST OVERRUN

Mr. SIKES. This figure of $4 billion still intrigues me. I would like to know where it comes from. Is the total cost of the Minuteman program $4 billion more than we envisioned when the program was undertaken?

Is that where the figure $4 billion comes from?

General SCHULTZ. I do not know where it comes from.

Mr. SIKES. How much more than we originally estimated is the Minuteman program going to cost?

General SCHULTZ. Would you bear with me and if I am too lengthy I will stop. This is the only way I know how to answer. Having heard this allegation we went to documented numbers in the file and said Minuteman I, what is the first number that evolved on Minuteman I in documented records? In 1958, including R.D.T. & E., military construction, and procurement, the number quoted was $1.839 billion. That was October 1958. The system—and that system is just about bought out—did cost $6 billion. That is where it may have come from. I do not know. That first number was for only eight squadrons of missiles. It was for 400 missiles. Later we went to 16 squadrons of missiles, double the buy.

EXPLANATION OF MINUTEMAN COST INCREASES

Mr. SIKES. That is what I want to get. You can do this for the record. I want a complete analysis of the program. I want to know in what instances the program cost more than was originally planned and why. Give us a breakdown step by step.

General SCHULTZ. Yes, sir, and the same breakdown will be done by Minuteman I, II, and III and what I heard on television is incorrect.

. . . . . .

Mr. SIKES. That is why we want the facts.

(The information follows:)

MINUTEMAN

There are 1,000 Minuteman missiles implaced in unmanned launch facilities in the continental United States. Three separate systems make up this total—Minuteman I, II, and III—and while they share a similar name, each is different. The costs of fielding each Minuteman system have changed due to changes in the threat, as national policy has changed and as the scientific knowledge of nuclear weapons has grown. To understand the effects, each system will be discussed separately.

The initial estimate for the Minuteman I program was made in 1958 and it totaled $1,593,400,000. Costs were only projected through 1963. Today, the Air Force is still expending funds to support this system and costs are projected to 1973 for a total of $6,052,400,000.

The first major change to the initial program estimate occurred when a revised threat dictated the schedule of the initial wing of Minuteman (located at Malmstrom AFB in Montana) be accelerated 1 full year. ———. Research and development continued and an improved missile was ready for the remaining Minuteman I force. The acceleration increased the cost of the program $895 million.

The next major program change related to force structure increases. National policy dictated an increase in the number of operational missiles. The initial approved program was for eight squadrons (400 missiles). This program was increased twofold to 16 squadrons (800 missiles). Also, there was developed a concept for continual testing of the total system which increased the total number of missiles produced. This concept, Follow-On Operational Testing, along with the force increases, added $2,600 million to the overall cost of Minuteman I.

Change in major policy from "massive retaliation" to "controlled flexible response" required changes in the command and control electronics so that the operational concept of the Minuteman force would enforce that national policy. Force improvement such as selective launch and stop launch, increase target selection capability, lighter guidance and control packages, safety, refinements in propulsion, and a new reentry system (Mark-11) were developed. These changes increased costs $840 million.

The last major factor of Minuteman I cost increase was the effort expended on the concept of deploying Minuteman missiles on America's railroad system. One hundred and twenty-four million dollars was spent on studying and development testing prior to its cancellation in December 1961.

The initial estimate of Minuteman II in 1962 estimated the costs through 1967 at $3,555,400,000. Costs today projected through 1975 are estimated at $5,145,900,000.

Force structure changes, including modernization increased costs $48.1 million. Initially, there were to be ——— Minuteman II in new launch facilities. Revised force structure limited new silos to 200 and converted all Minuteman I (800) facilities to Minuteman II/III configurations.

Reentry systems' improvements increased the program $342.3 million. Completely, new reentry vehicles (Mark-17 and Mark-11 B/C) and penetration aid systems (Mark-1 and Mark-1A) were designed to meet a changing threat. The Mark-17 was canceled prior to procurement but the Mark-11's were procured and installed in the field.

Due to the increased sophistication and complexity of the Minuteman II system, we were not able to achieve the high reliability rate on the early production guidance and control units (G. & C.). As a result, additional spares were procured to support the missiles on alert, in-line production improvements were made to those G. & C.'s not yet produced and selected retrofit changes were made to sets already in the field. This program, costing $90 million, was successful in that the reliability has improved greatly.

Due to technical difficulties and funding constraints, we have from time to time been directed to change schedules and accomplish efforts later than originally planned. These changes cost $157.6 million.

Other increases of $524.5 million are for such items as (1) improved capability and flexibility, (2) special test missiles, (3) single-manager safety pro-

gram, (4) improved auxiliary backup power system, and (5) range support. As we became more experienced with the Minuteman system, certain costs were identified in order to test and update the system and improve safety of its personnel. This figure reflects those costs.

The $2,709,200,000 initial estimate of the Minuteman III in 1965 projected costs through 1970 for ——— hundred missiles, of which ——— would carry the Mark-17 reentry vehicles.

The current program estimated at $4,232,700,000 through 1975 has ——— operational missiles, all with advanced reentry systems. The force structure change increased costs to $261.7 million.

Increased survivability costs $356.9 million. This consists of changes to the force as a result of our increased knowledge of a system survivability.

Technological growth caused increases of $394.1 million. The complexity and sophistication of the weapon system has led us into unexplored areas of development and production.

Major contract cost overruns totaled $54.3 million. The major portion of this overrun ($48 million) was caused by the extreme technical difficulties encountered by the post boost propulsion system contractor.

Force improvements cost $59.8 million. This includes changes to the force to increase the capability of the weapon system, primarily in providing additional flexibility and reliability.

Program schedule changes increased costs $354.9 million. Technical difficulties and funding constraints have caused corresponding directed changes in schedule and extensions of the program beyond the date originally planned.

Military construction increased $41.8 million due to the anticipated costs for Sentinel integration into the Minuteman program.

All of the above-listed factors total to the amount of cost increase associated with Minuteman. Reviewing the decisions today, one can question the necessity or the value of expending large sums of money and show cause why they should not have been made. But if one reviews each decision in light of the information available at the time the decision was made, it is difficult to find fault or justification to reverse the steps taken at that time.

Throughout the history and development of the Minuteman program, the Air Force has evolved the most comprehensive, efficient system of financial management of any weapon system in the Department of Defense. Many innovations in contracting and financial management now required by the Department of Defense for all services evolved from the Minuteman system of management. The control of configuration, in an atmosphere of evolving change, required a configuration management system unprecedented in any industrial or weapons system development. A system of procurement which could adjust to these many changes was a must for Minuteman. In any system of day-to-day cost control and accomplishment reporting there is required a parallel effort in financial management with the concurrent technological development. This was accomplished and is being accomplished today.

Mr. SIKES. Before I get into the committee questions, let me see if there are additional general questions on the statement which we have just heard. On my right.

POTENTIAL USE OF REPLACED MINUTEMAN MISSILES

Mr. ADDABBO. As Minuteman I's and II's are replaced by Minuteman III, is there any possibility of using Minuteman I's or II's as targets for testing the Safeguard ABM system?

General SCHULTZ. Yes, sir. That is underway and has been done partly. The Army at Huntsville regards some of those boosters as ideal to be launchers for their target vehicles against their radar and our program could be used for them. We are studying ways of using the boosters as space launchers to augment the scout capability and are working with NASA to determine uses for them. There is one other possibility, and this I would like in the record. Some of the

stages are used interchangeably. Since this Congress and presently the country is interested in overruns.

I will tell you about a billion dollars you got for nothing. The stages that were built for the Minuteman I and II were built for a 3-year life expectancy. We have them out there up to 7 years. We use the first stage interchangeably on the three missiles. The Air Force Logistics Command has turned in a cost avoidance item which is presented to another element of Congress or perhaps here, for $1.1 billion. We will get 10 years of life out of a motor we built for 3 years. If it had only lasted 3 years, the replacement cost from 1962 to 1970 would have cost the Government $1.1 billion more. Sometimes we fall short. There is one we are three and a third better than what the Government contracted for, and it can be documented we saved over a billion dollars because of that. In answer to your question, some of the stages are interchangeable. Indeed, some go off Minuteman I and go on Minuteman II. Other stages and complete missiles are being considered for use.

EFFECTIVENESS OF SOVIET SS–9 MISSILE

Mr. ADDABBO. With respect to the question of whether Minuteman III will be able to break through the Russian ABM system, I read in the paper and heard much discussion about the Russian SS–9 missile. If they have a MRV on this missile, what makes us think they could not penetrate the ABM system we are contemplating at the present time?

General SCHULTZ. I have already said I am not the most expert witness you can have on that. Being in the missile system, if the SS–9 is very worrisome because now he has more throw weight and if he can split that into targets and get into our missile field he can saturate a defense and with or without a defense, he has a pretty good first strike capability. These are of concern to me.

Mr. ADDABBO. Thank you very much.

I have no further questions, Mr. Chairman.

Mr. SIKES. Are there further questions on my left?

A–X AIRCRAFT

Mr. MINSHALL. There are several questions, Mr. Chairman. Have you discussed earlier today this A–X aircraft program?

General MCNICKLE. Yes, sir.

Mr. MINSHALL. Are you going ahead with that?

General MCNICKLE. We hope so.

Mr. MINSHALL. What are you going to get out of it that the present Coin aircraft does not provide?

General MCNICKLE. A short takeoff and carry about four times as much and stay in the air about four times as long.

Mr. MINSHALL. What priority do you give this program?

General MCNICKLE. A relatively high priority, but it is behind the F–15 and the B–1. We think the correspondence between General Johnson and General McConnell indicates that the Army thinks we ought to have it.

Light Intratheater Transport (LIT) Aircraft

Mr. Minshall. What is this light intratheater transport (LIT) aircraft that you are asking for this year for a million dollars?

General McNickle. That is only technology and we put that behind that A-X.

Mr. Minshall. What kind of aircraft is this?

General McNickle. It would probably be a tilt wing transport.

Mr. Minshall. Swing wing?

General McNickle. Tilt wing. We are going to do some technology work on the big prop.

Mr. Minshall. I guess we went into that a couple of weeks ago.

General McNickle. Yes, sir.

Mr. Minshall. That is all.

Mr. Davis. Would you provide us for the record with a brief statement as to the organizational background and the work to be performed by the Lincoln Laboratory in the amount of approximately $29 million, Mitre Corp., to the extent of about $29.5 million and Aerospace Corp., in the amount of appr .mately $75 million?

(The information follows:)

Lincoln Laboratory.—The laboratory was organized in July 1951 as an integrated organization operated as part of the Massachusetts Institute of Technology (MIT). The contract was, and continues to be, on a cost reimbursement basis.

The mission of the Lincoln Laboratory is to carry out a program of research and development pertinent to national defense with particular emphasis on advanced electronics, radar, communications, physics, and information processing. The technical program under this project has been divided into two general areas, general research and space communications. The fiscal year 1970 program will continue to pursue the research, development and demonstration of advanced technology in general research and satellite communications programs such as ABRES, radar technology, communications satellites, communication systems advanced studies, general research—integrated circuits, radar physics, data systems, solid state devices and ballistic missile penetration and discrimination.

The Department of Defense programs are under a contract administered by the electronic systems division (ESD) of Air Force Systems Command.

Mitre Corp.—Incorporated in July 1958 under the laws of the State of Massachusetts as a nonprofit corporation. The contract was, and continues to be, on a cost-plus-fixed-fee (CPFF) basis.

Mitre provides advanced planning support, and systems engineering/technical direction (SE/TD) of funded programs. The advanced planning role includes the technical analysis of requirements; formulation of objectives and innovative plans; and the formulation of systems performance and design criteria. The SE/TD role provides technical advise and independent problem solving capability during systems acquisition. Specific activities include: development planning related to the over the horizon radar for CONUS defense, Advanced Airborne Command post, exoatmospheric radiation detection system, command control and communications for strategic defense and offense operations, tactical satellite communications systems. Systems engineering/technical direction related to tactical air control system, airborne warning and control system, special purpose communications and Advanced Airborne Command post.

The Department of Defense programs are under a contract administered by the Electronic Systems Division (ESD) of Air Force Systems Command.

Aerospace Corp.—Incorporated in June 1960 under the laws of the State of California as a nonprofit organization. The contract was, and continues to be, on a cost-plus-fixed-fee (CPFF) basis.

Aerospace was made responsible to provide technical support for advanced systems analysis; planning, research, experimentation, and systems engineering/technical direction (SE/TD); and general technical supervision in the field of Air Force space and ballistic missiles systems. The fiscal year 1970 program

provides for many diversified activities including: Development planning for such systems as post boost vehicle, advanced strategic weapon system, ——— multipurpose synchronous station. Systems engineering/technical direction on communications satellite program, TITAN III space booster, ——— and advanced ballistic reentry system.

The Department of Defense programs are under a contract administered by the space and missile systems organization (SAMSO) of Air Force Systems Command.

Mr. DAVIS. Then if you would identify and provide a brief explanation for the record of Red Flame II, Half Flask, Grasshopper, Clear Sky, and you will have to tell me how you pronounce this, Pacgat. Will you do that for the record?

(The information provided the committee is classified.)

(Discussion off the record.)

Mr. ANDREWS. Are there further questions? If not, the committee will adjourn until 10 o'clock tomorrow.

WEDNESDAY, JUNE 25, 1969.

MINUTEMAN

Mr. SIKES. The committee will come to order. We will resume our discussion of the Minuteman program for which $339.4 million is being requested for fiscal 1970. Approximately $2.3 billion has been programed prior to this year for Minuteman development and another $532 million is anticipated for its total development cost of $3.2 billion.

MINUTEMAN DEVELOPMENT COSTS

Can you tell us how this total cost compares with comparable earlier estimates for the concepts now included in the Minuteman program of the total cost of the Minuteman development program? This should be broken down between Minuteman I, II and III.

I think you may as well do that for the record. I think it would be rather involved.

Mr. HANSEN. Yes.

(The information follows:)

MINUTEMAN DEVELOPMENT COSTS—COMPARISON OF ORIGINAL AND CURRENT ESTIMATES

[In millions of dollars]

	Original estimate	Current estimate	Difference
Minuteman I	991.6	2,095.3	1,103.7
Minuteman II	613.2	1,380.6	767.4
Minuteman III	960.2	1,787.1	826.9

Actually, $2,326.5 million has been programed prior to this year (fiscal year 1970) for Minuteman II and III and another $841.2 million is programed for a total development cost of $3,167.7 million.

Again it should be noted that there have been significant changes between the program envisioned in the original estimates versus those of today. These include major adjustments in program force structure, weapon system configurations, schedule adjustments and weapon system capabilities.

MINUTEMAN DEVELOPMENT SCHEDULE

Mr. SIKES. Is the Minuteman development program now on schedule?
General SCHULTZ. Yes, sir, it is, and I will break that down.
Mr. SIKES. For the record.
(The information follows:)

MINUTEMAN DEVELOPMENT

The Minuteman III Weapon System is a growth version of the earlier Minuteman systems using the same first and second stages, and essentially the guidance system used on Minuteman II. The MIRV capability is achieved by adding a ——— which contains the missile guidance system, and the MK 12 reentry system, together they comprise the "bus" which operates much as a fourth stage. Because of the increased weight of the bus, Minuteman III will also have a new third stage. The development of this weapon system was initiated in the spring of 1966 and is progressing normally at the present time. The MK 12 R/V is a new system both in size and capability, therefore, its flight testing began much earlier than other parts of the Minuteman III system. ———. Some problems were encountered but were rapidly corrected and the corrections verified. Later (in August 1968) the all-up version of Minuteman III began its flight test program. ———. There are 20 more Minuteman III test flights scheduled over the next 12 months (9 from ETR and 11 from WTR). This is decidedly not a high risk program and no serious problems are anticipated.

PROGRAM SLIPPAGE

Mr. SIKES. There has been no slippage?
General SCHULTZ. It depends on which schedule is laid down.
As of a year ago there was a slip in the program. The slip was occasioned primarily by budget constraints. The program was moved out first 5 months and subsequently another 6 months, for a total of 11 months. This changed the initial operational capability which we defined the other day to ——— for Minuteman III. That means ——— operating missiles in the silos.
There has been 11 months slip, sir, but that schedule was laid down in the fall of 1967 and is still current as of today.
Mr. SIKES. Was the budget consideration the only reason for the slippage?
General SCHULTZ. The question is subjective in that if it had remained—the development program was very tight and the first estimate for IOC ——— was. Whether we would have met that or not is subjective, sir, in the fact that we slowed down some of the development to conserve funds. Whether it would have been ready or not ——— cannot positively be answered other than opinion.
For Minuteman II, the schedule which was laid down some 3 or 4 years ago, called for the completion of the force modernization, the change from Minuteman I by June of this year, this month. That was completed early this month and is on schedule. So the II is definitely on schedule.

PROCUREMENT WHILE UNDER DEVELOPMENT

Mr. SIKES. As was true in procurement, most of the funds required for Minuteman in fiscal 1970 are related to Minuteman III rather than Minuteman II. In connection with the procurement hearings, the committee was given a figure of $489 million for that part of the "Missile procurement, Air Force" appropriation identified with Minuteman III.

This included modifications and spare support. It was also indicated that $255.6 million is requested for Minuteman III development, test, and evaluation in fiscal 1970. This would indicate that there is a great deal of concurrency in the Minuteman III development and procurement programs.

Now, we have had problems in similar attempts in other programs to develop and procure simultaneously. Can you prudently spend $489 million for procurement on Minuteman III when a great deal of work remains to be completed on the development program?

I want you to think very carefully on your answer.

General SCHULTZ. This has been considered before decisions were made and I will indeed, Mr. Chairman, consider my answer.

As I said yesterday, we have flown the missile seven times. It should fly again tomorrow. ———. We did lose one missile ———. We will fiy the missile 28 times total, 21 more times. Those flight tests will be accomplished before the IOC ——— which I mentioned.

There is this degree of concurrency, the production leadtime is about [deleted] months. If it all works and we had not started to produce the component, then indeed you are going to have a big break in production.

There is one other factor I think that R.D.T. & E. money, and I speak only from my program control end in a program office, the R. & D. "3600" money primarily is for 1 year sort of development effort. It should be obligated in a year and cover the work that is planned for a year.

The "3020" production money is usually spent over about 3 years something like that. So our buy is time phased and even though the production money is committed and obligated, the actual procurement of those items and paying for them can happen 3 years from the day you sign that contract in that appropriation. There is this degree of concurrency in that.

I think the Air Force—this has been presented through the Secretary of the Air Force level—is quite confident we are on very firm ground on fielding that system at that time and with minor changes when it hits the force. That is the course we are pursuing.

I hope that has been responsive to your inquiry. It has been a long answer. I do not think the answer can be given more concisely.

Mr. SIKES. I understand and I appreciate the fact that you did give some detail in your answer. But in a simple yes or no answer: you are confident, you have no misgivings about the concurrency of development and procurement on Minuteman III at this time?

General SCHULTZ. No, sir. And if I might add, and having heard you just say the committee should be informed, and General McNickle asked me to make this point, there has been in the newspaper currently this incident at Rocky Flats where the plutonium comes from.

The Air Force, General McNickle and the whole Air Force, was advised yesterday that that impact will not cause us any problem either. ——— the people in the Defense Atomic Support Agency and AEC figure they can deliver us those warheads. That was the component we last month were quite concerned about.

We have to have those packages by ——— down at the ——— people who put the heat shield around it, and we are advised in writing now that we can anticipate getting those.

The story in the paper yesterday, I think, was about a month outdated in that it said it is going to impact both Poseidon and the Minuteman. I think that has gone away. It was the one that concerned us most; I think it is gone.

Mr. SIKES. Mr. Secretary, do you have the same confidence in the situation insofar as concurrency of procurement and development on Minuteman III is concerned?

Mr. HANSEN. Yes, sir; I do.

Mr. SIKES. Do you, General McNickle?

General MCNICKLE. Yes, sir. I believe it is essential to the Nation's security to proceed in this fashion.

Mr. HANSEN. I would like to say that with any concurrency there is some risk. I am personally experienced in a program in which, after over 500 missiles had been produced and after over 300 had been flown using the same component, a failure occurred. The analysis of that failure showed that at any point the failure potentiality existed. My point is that I do not think you can ever, by separating R. & D. and production, completely remove the possibility that you may run into some kind of a problem. I think it is a matter of balancing the risk against associated costs. In this case I am very confident that the risk we are taking is low and is properly balanced with the problem of costs that would exist if we had a gap between the development and the production.

MINUTEMAN II AND III FLIGHT TEST PROGRAM

Mr. SIKES. Thank you. For the record I would like for you to describe the Minuteman flight test program for fiscal 1969, tell how many Minuteman II flights have taken place, the result of those flights, how many Minuteman III flights have taken place, and the results of those flights.

(The information follows:)

MINUTEMAN II AND III FLIGHT TEST PROGRAM

During fiscal year 1969—to June 25, 1969—the following results were achieved in the various Minuteman II and III flight test programs:

Minuteman II:	
Launched	10
Success	———
Failure	———
Partial	———
Minuteman III:	
Launched	8
Success	———
Failure	———
Partial	———

Analysis has been conducted on each of the flight failures indicated. In most cases, the causes have been identified and actions are being or have been taken which should prevent recurrences.

In the entire Minuteman II program there have been 72 missiles launched of which ——— have been successful.

TRW ENGINEERING AND TECHNICAL SUPPORT CONTRACT

Mr. SIKES. Information submitted to the committee indicates that $71.1 million is programed for fiscal 1970 for general support related to the Minuteman III program. How much of this money is for en-

gineering and technical direction support furnished by Thompson-Ramo-Wooldridge?

General SCHULTZ. We have not negotiated our contract yet, but the estimate is, from our independent cost estimating, around $25 million and I feel confident we will be able to negotiate that number out.

Mr. SIKES. What would you get under this contract in terms of man-years of technical effort?

General SCHULTZ. We would get about 540 man-years of MTS's, members of the technical staff, and those equate to a head count of about 3 to 1 if you include the support people with them and all. So it is somewhere around 1,600 total people the way the books are kept on the SE/TD contractors.

MINUTEMAN III GENERAL SUPPORT

Mr. SIKES. You are asking for $71.1 million and you say this contract will involve $25 million. Does that mean all of the $71 million will not be required?

General SCHULTZ. Oh, no, sir. That category of budget is concerned with many of the hardness tests, the vulnerability and hardness effect which I tried to discuss a little bit yesterday, some reliability studies and is——

Mr. SIKES. For the record, give us what other items are included in the general support category and spell them out.

General SCHULTZ. Yes, sir.

(The information follows:)

MINUTEMAN III GENERAL SUPPORT PROGRAM

The following is a breakout of the Minuteman fiscal year 1970 R.D.T. & E. items of general support:

	(*In millions*)
Thompson-Ramo-Wooldridge	$25.0
In-place hardness testing	15.0
In-flight hardness testing	18.5
Arnold Engineering development center testing	2.0
First destination transportation	0.5
Underground tests	0.7
ETR/WTR range support	1.6
TRAP[1] aircraft	1.0
R/V[2] facility VAFB	1.4
Survivability studies	1.8
Reliability studies	1.1
Miscellaneous	2.5
Total	71.1

[1] Tracker analysis program.
[2] Reentry vehicle.

AIR FORCE USE OF TRW

Mr. ANDREWS. What will the TRW people do for the $25 million? They have been in this picture for years, have they not?

General SCHULTZ. Yes, sir; and it has been controversial for many years.

The Air Force organically just does not have the capability to do it alone with fellows like me. I am an engineer, by training and other things, but we do not have enough specialized people to go control a billion dollar a year business. We have three choices.

One is to augment it with civil service, and we have done that in some cases and on some programs. To use so-called not-for-profit, like the Aerospace Corp. and Mitre, or to use Thompson-Ramo-Wooldridge, as is done in Minuteman.

It evolved this way: When Minuteman was started, we needed a contractor, which was brought up yesterday and discussed here, a competitive contractor who had the capabilities in the field of propulsion, mechanics, electronics, nuclear physics, almost all of the discipline of engineering and science, and there was not one we could find that way. This was in the 1958 time period. Ramo and Wooldridge, who were two very recognized scientists and engineers, formed a company called STL, a Ramo-Wooldridge company. That company attracted engineers and scientists who could work with the Air Force people and integrate these efforts of the Minuteman, which is kind of different than the SRAM we were talking yesterday and the C–5.

We do not have a prime contractor, as I tried to explain why we could not get one. If you did have a prime contractor and you paid him to write the engineering criteria and approve the specifications on all of the articles, the layout of the test program, analyze the engineering results from flight and ground tests, to give the engineering and scientific approval and sanction to what was being done by the respective builders and developers, you would have to pay, in my opinion, a great deal more if you went out and hired a prime contractor to do it.

The function there is how you are going to do it. On a billion dollar a year budget, our program expends over $3 million a day, Saturday and Sunday included. If you just gave that much money to somebody to manage, you would have to pay people to manage it. In this highly complex job we found that working with a system engineering and technical direction contractor was better and TRW came on board in that role.

FUTURE NEED FOR TRW

Mr. ANDREWS. We understand the type company they are; but do you not see the end of R. & D. on your Minuteman III?

General SCHULTZ. Our Minuteman III——

Mr. ANDREWS. My concern is, Are you going to continue to need a company like TRW, which is a very expensive contractor, from now on for Minuteman III?

General SCHULTZ. No, sir.

Mr. ANDREWS. Or do you see the end of the need of their services?

General SCHULTZ. We have a 5-year budget plan. Part of the overrun we are talking about is that Minuteman was, the development job and acquisition job, was originally scheduled to be done in fiscal year 1972. It goes out to fiscal year 1974 at the present time.

Mr. ANDREWS. On Minuteman III?

General SCHULTZ. On Minuteman III; yes, sir.

And there is some Minuteman II R. & D. Still continuing; like new penetration aids.

Mr. ANDREWS. From what you say then, we may expect to need the services of a company like the TRW through 1974?

General SCHULTZ. Yes, sir; with phase down as the budget phases down.

HISTORY OF TRW MINUTEMAN CONTRACTS

Mr. ANDREWS. How long have they had a contract in connection with Minuteman missiles?

General SCHULTZ. If you go back through the evolution of the company, since the inception in 1958.

Mr. ANDREWS. So the TRW has been with you in connection with Minuteman missiles since 1958?

General SCHULTZ. Yes, sir.

Mr. ANDREWS. Would you provide for the record the amount paid TRW each year since 1958 for contracts?

General SCHULTZ. Yes, sir.

Mr. ANDREWS. Do they have any other Government contracts in addition to the Minuteman contract?

General SCHULTZ. It is a large corporation. They have other contracts with NASA; I believe they have other contracts with the Air Force in other divisions and plants.

Mr. ANDREWS. But their contract just for Minuteman is $25 million?

General SCHULTZ. Yes, sir.

Mr. ANDREWS. How did you arrive at that figure, General?

General SCHULTZ. We arrive at it by what is known as a technical operating plan in which we decide how much technical support we need in our development effort, the research effort, and how much support we need in the production effort.

Mr. ANDREWS. It is a negotiated type of contract then?

General SCHULTZ. Yes, sir.

Mr. ANDREWS. And there is no competition for that type of contract?

General SCHULTZ. No, sir.

Mr. ANDREWS. Supply that table for the record on how much they have been paid in connection with the Minuteman program.

General SCHULTZ. We will indeed, sir.

I might add there is an exclusion clause in the TRW work statement that they cannot bid on building a motor or guidance set because they have prior knowledge.

Mr. ANDREWS. All they furnish is technical advice? They do not produce any hardware?

General SCHULTZ. That is correct.

Mr. ANDREWS. All right.

(The information follows:)

PAYMENTS TO TRW FOR MINUTEMAN

The Air Force contracts with Thompson-Ramo-Wooldridge Corp. (TRW) for system engineering and technical direction (SE/TD) in two categories: (1) development engineering and (2) nondevelopment engineering. The first category is R.D.T. & E. support and is funded in the 3600 (R. & D.) account. The second category is engineering support in the production area (i.e., configuration control, interface control specifications and drawings, etc.), and is funded in the 3020 (missile procurement) account. The following table gives the break-

out of what TRW has been paid in fiscal year 1969 and prior years and the estimate for fiscal year 1970:

[In millions of dollars]

	Fiscal years—													
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	Total
3600	2.9	7.0	11.5	16.4	26.4	24.2	22.0	13.9	15.7	15.7	20.6	25.1	[1]24.7	226.1
3020					2.1	2.4	2.4	10.4	8.9	9.7	11.1	13.1	[1]12.8	74.9
Total	2.9	7.0	11.5	16.4	28.5	26.6	26.4	24.3	24.6	25.4	31.7	38.2	37.5	301.0

[1] Estimated.

FUNDS FOR OPERATIONAL BASE LAUNCH PROGRAM

Mr. SIKES. For the record, tell us what funds are included in the fiscal 1970 budget and under what line items for implementation of your proposal to launch Minuteman missiles from operational silos on full-range flights to target areas in the Pacific.

(The information follows:)

Included in the fiscal year 1970 budget are $9.2 million of R.D.T. & E. funds for the Minuteman II portion of the operational base launch (OBL) program. This is for development of a dummy reentry vehicle with a self-contained telemetry and destruct system. Additionally, $2.5 million are included for a similar effort for the Minuteman III, MK 12 system.

LAUNCHES FROM OPERATIONAL SILOS

Mr. SIKES. Have any Minuteman missiles been fired from operational silos heretofore?

General SCHULTZ. If you consider the dummy 7 second missiles, yes, but this is an answer which requires clarification. There have been no operational missiles fired from our operational SAC missile wings. We launch only from the Western Test Range. The President has, however, been advised that we contemplate shooting out of Halmstrom AFB, Mont., and fire across the Western States. Certainly that is something the whole country has to consider, and therefore, how much is in the budget I do not know exactly because the decision has not been made whether we will do it.

Mr. SIKES. How many have been fired from operational silos heretofore?

General SCHULTZ. Again I cannot give a specific number without this explanation.

When we built the test wing at Vandenberg, those silos are identical with the silos out in the 6th operational wing and they are fired by SAC crews.

Mr. SIKES. Is it from Vandenberg that the firings have been made?

General SCHULTZ. How many have we had? We fired Minuteman II, probably 50 of them, and Minuteman I, probably 150 of them.

Mr. SIKES. From Vandenberg.

General SCHULTZ. About 50 Minuteman II's. Seventy-four Minuteman I's, and 66.

Mr. SIKES. Put that answer in the record.

(The information follows:)

To date we have fired a total of 178 Minuteman I missiles and 52 Minuteman II missiles from Vandenberg AFB.

Mr. SIKES. Tell me this: According to press reports there have been a number of attempts and a number of failures at operational launches. Do you want to discuss that?

General SCHULTZ. Yes, sir. Because of the implications of shooting this missile out even with the warhead off, the public is understandably concerned about missiles flying over them. In 1965 there was devised a way you could take the first stage of the rocket and allow only 7 seconds of burning of the propellant in so it would go up a mile and fall out about a mile.

We went to Ellsworth AFB, S. Dak. and fired one of those. It was a Minuteman I and it went up and came down and started a grass fire. The missile was obviously not completely representative of what was ordinarily in the hole so some of the operational realism had gone away, but at least there was an attempt to show that, yes; it fired out of a given hole.

In 1966, two 7-second firings were attempted from Grand Forks, N. Dak. to simulate Minuteman II. These were not successfully fired for the reason that it was in the time period when we had some less than expected reliability of the guidance system staying in commission.

The missiles went out of commission and they were not fired. Those two were aborted.

On August 14 of last year there was an attempt to launch the third time. Senator Young was up there, I was standing very near to him at that time. And the missile was counted down and the door blew open and everything checked out, but the missile did not come out of the hole and there was quite a bit in the press about it. It was found subsequently in posturing this hybrid missile that the umbilical cord, which looks like a plug—it has 51 pins on it—one of the pins got bent when it was inserted.

Mr. SIKES. Regardless of the reasons for the failures, this is not a very reassuring picture. What is going to happen when you have to use those things?

General SCHULTZ. I want to relate one more incident. That was August 14. It took us about a week to find out it was a bent pin. You see, it was not the exact kind of missile that you want the reassurance on and we do either, it was a hybrid missile, jerry-rigged, for this test. Therefore, when we found out it was August 23, and I was in the Secretary's office, and he said, "I want to see if we can get one fired." Not those words probably, but anyhow, the message was there.

In 7 or 8 days, by the first of September, we went over to Vandenberg and fired that short run successfully. It has been demonstrated.

The present controversy is this, Mr. Chairman: We have evolved a method by which we can take one of the missiles out in the force, any one of the operational missiles, and it has been given the acronym MOMS, modified operational missile. All we do with that is take the igniters off the propellant stages. We can send the signal from Washington or Omaha or wherever is necessary and blow the silo doors off and be sure that the electronics in the hole and the electronics and hydraulics in the missile do work right down to the point that you would light the first stage.

The reliability of that igniter is unity, like a shotgun shell. So far it has never failed on us. You could then take that missile out of the hole and take it over to Vandenberg and put it in another hole where you did not have to fly across the Western States and fire it, and putting these two together from an engineering standpoint would add a great deal of confidence.

Because of the failures experienced with the short round, the seven second ones which did not go off, there are pressures which say we want to see one of those short rounds go off. However, each costs almost as much money as regular missiles to make because it takes special tooling and all to make the device. Yet after that expense, the result of the firing will not indicate any degree of confidence in our missile force since it is not like any missile in the force.

I think these considerations plus the consideration of what the population would think of a missile going over them plus the hazard analysis, leaves this question up in the air, and from paper I have seen it is clear up to the presidential level at the present time.

Mr. SIKES. Mr. Andrews?

Mr. ANDREWS. General, do I understand you have had three tests or three attempts at tests from silos in North Dakota?

General SCHULTZ. That is correct.

Mr. ANDREWS. And all three malfunctioned?

General SCHULTZ. Yes.

Mr. ANDREWS. That is what disturbs me and has for years.

General MCNICKLE. It disturbs me too, Mr. Andrews, but I would point out that they were not Minuteman missiles that failed.

Mr. ANDREWS. What were they?

General MCNICKLE. They were test items made to simulate first stage ignition. They were the equivalent weight of a missile but with only 7 seconds of first stage propellant. They were not operational missiles.

General PITTS. It might be good if General Schultz would describe exactly what composes the 7-second missiles. They are jerry-rigged devices not like the missiles in the hole.

General SCHULTZ. The upper stage of that so-called 7-second missile the stages are made of concrete, they are just the weight on top of them to test out the shock. It is concrete.

WILL MISSILES WORK IF NEEDED

Mr. ANDREWS. We all hope and pray it will never be necessary to push the button on those silos, but if that time were to come, there is a grave doubt in my mind as to how many of them would come out of those silos and go to the target. That is the big question in my mind.

You told us yesterday Minuteman I missiles are about ——— percent in place and the Minuteman II about ——— percent in place.

General SCHULTZ. ———.

Mr. ANDREWS. And here you tried three times to get a missile out of the silo in North Dakota and you failed each time. If that time to push the button ever comes, you are not going to have time to fix a fuse or take the missile to Vandenberg to be fired. We will have had it if those missiles do not get out of the silos.

General SCHULTZ. If I might comment on that, sir, with the in-commission rate figures I gave, these are countdown and flight relia-

bility numbers. They are taken from all of our component tests and our actual flight tests.

For Minuteman I, where I said ——— percent is the incommission rate, the countdown and flight reliability demonstrated is over a hundred Minuteman I flights is ———. Therefore ——— percent of those ——— incommissions have been tested on a broad base of a hundred-some missiles.

Mr. ANDREWS. What makes you think that most of them will get out of the silos when you press the button when you failed to get three out of there pressing the button?

General SCHULTZ. That is the second point. It was not the same missile we are trying to get out of the silo. It was engineering experiment to try and come close to realism rather than shoot the real one up. We have shot the real one out of silos in the Cape and out of the silos at Vandenberg, which are identical.

Mr. ANDREWS. They are in use all of the time?

General SCHULTZ. Yes, sir.

Mr. ANDREWS. You have not yet used any of them up there in North Dakota or Montana?

General SCHULTZ. No, sir; we have not fired one out of the hole.

Mr. ANDREWS. And you will never know the reliability?

General MCNICKLE. We will not be absolutely positive of the "hole" operation until we use it. But we can and do take the operational missiles to Vandenberg and put them in a hole and shoot them there. That has given us a very high level of confidence in the missile itself and the hole we use is the same as the operational holes.

PLAN TO FIRE FROM OPERATIONAL SILO

Mr. SIKES. Do I understand your plan is to make firings in fiscal 1970 out of the hole in North Dakota and Montana.

General SCHULTZ. Yes, sir, Mr. Chairman.

Mr. SIKES. And you have to get permission to fly across the Western States in order to do so.

General SCHULTZ. There is a plan——

Mr. SIKES. And that permission has not been forthcoming?

General SCHULTZ. Agreed, sir.

Certainly it will take the Congress of the United States to agree that we can do it. There is a plan we could fire——

Mr. SIKES. Heaven help you.

General SCHULTZ (continuing). We could fire in ———.

We picked Malmstrom because you have to fly over fewer places. If the first stage burns properly and the second stage burns through 54 seconds, if anything happens after that it will all fall in the ocean. It it aborts for any reason short of that, we have fly-out corridors, there is a destruct system so that one of those stages which is like a bomb does not fall on a city.

Mr. ANDREWS. What kind of permission did you have when you attempted to fire the simulated missiles out of the silos?

General SCHULTZ. Since they were within the confines of the area we knew they were coming out of, the permission—I am not privy to who all was asked. Certainly it was through the Secretary of Defense, who knew those would be shot. But it was not going over private

property. It was in an acquired military reservation. We knew it was going up and down. In effect, I guess there is no difference in an artillery range or something else.

Mr. SIKES. How many test flights do you seek to have during fiscal 1970 which would be the equivalent of operational tests?

General SCHULTZ. The plan is for about ——— going out of Montana. Whether that is the request which came over to Congress one of these other gentlemen might know better than I. But the engineering plan of how one might do it and get a reasonable statistical base to give greater comprehension——

Mr. SIKES. Where is the request at this time?

General SCHULTZ. To my knowledge, the Secretary of the Air Force has forwarded it to DOD and I have seen letters from Mr. Laird I believe to the President, and from Mr. Laird back to the Air Force, asking us for hazards analysis data.

Mr. SIKES. It has not come to Congress then?

General SCHULTZ. I do not think so.

Mr. SIKES. Why would it be necessary to come to Congress?

General SCHULTZ. We would need the money, one. And two, certainly the people whose States are going to be fired over and other people would want the sanction from their representative here in Washington, I presume. I am sure we cannot do it unless we get the money.

Mr. SIKES. Do you realize that will be a junior ABM dispute if it ever got to Congress?

General SCHULTZ. It could be. However there are precedents.

General MCNICKLE. Airplanes fly over all sorts of populated areas and once this missile gets airborne and on a ballistic path I do not think the hazard would be as great as an airplane.

Mr. SIKES. There are a lot of headlines to be made out of an issue of this sort.

General MCNICKLE. Yes, and I would hasten to add that these missiles would not have warheads.

PRECEDENT FOR TESTS

General SCHULTZ. There is a range I used to run in Green River, Utah, and it fires 407 miles down to White Sands, N. Mex.

We fired that missile over a hundred times and it goes up a couple of hundred thousand feet. It is a four-stage rocket and bends over and accelerates coming into the White Sands range. That was started about 1966, I guess, and there had to be evacuations of people down the flight path of that thing and the airlines could not fly over and the trains had to stop. The whole flight takes 7 minutes.

The Army likewise has a Pershing range out in Utah and they fire down into White Sands. So firing missiles across private property has been done in this country.

SAFETY FACTORS

Mr. SIKES. Is there a safety factor involved? Are you apprehensive about the safety of the operation insofar as the people underneath the flight pattern are concerned.

General SCHULTZ. There are casualty expectations data which have been studied for about 3 or 4 years now. This is not a new topic.

The fly-out corridors which would be used are picked to take the least inhabited areas and get out and still make the flight successful.

Then, depending on when it could possibly fail and how big the pieces were and how many folks were down there, there are expectation numbers.

Mr. SIKES. I presume you have researched this problem to the point that you feel as certain as people can be of mechanical and electronic devices there would be no accident.

What are the percentage chances of accident?

General SCHULTZ. I would use the countdown and flight reliability figures which are used from all of our flight tests. So far it is just short of about ——— percent of the time the thing would work and get to its target. So that the expectation that we would use is probably ——— percent of the time.

Mr. SIKES. That means ——— might fall in somebody's backyard.

Mr. HANSEN. That is not the right answer.

Mr. SIKES. I think that ought to be cleared up because that is a very important factor.

Mr. HANSEN. This is the overall reliability from one end to the other, but when you are looking at the probability that failure would occur at that time in the flight and in a way that would drop something on the continental United States off the military reservation, that probability is very low.

Mr. SIKES. How low?

Mr. HANSEN. If that happens, the possibility that it would drop and hit a person or a cow or anything which would cause significant damage is much lower. We can supply this information for the record—my recollection is that this probability is of the order of one chance in a million or more.

Mr. SIKES. I assume you would not undertake this unless you felt full confidence that no accident would occur which might involve personnel.

Mr. HANSEN. Yes.

Mr. SIKES. Will you provide for the record what those chances would be according to your calculation?

Mr. HANSEN. Yes, sir.

(The information follows:)

CHANCES OF ACCIDENTS IN MINUTEMAN TEST FIRINGS

Our calculations indicate that the expectation of a casualty occurring from full range launch from a selected silo in Montana would be about one chance in ten thousand. The chance of a fatality, on the other hand, is one-tenth of that, or one in one hundred thousand. These numbers are predicated on having range safety components on board the missile.

Mr. SIKES. In that connection, what special instrumentation range safety components do you believe would make these tests relatively safe, and would you supply that for the record?

(The information follows:)

We plan to include in all operational base launches a range safety instrumentation package which provides the capability to accurately track the flight of the missile and to destroy it in flight should it begin to deviate from its assigned course.

1970 MINUTEMAN FLIGHT TEST PROGRAM

Mr. SIKES. Describe for the record the proposed fiscal 1970 flight test program in support of the Minuteman. How many flights are programed and what is the primary objective of each?

(The information follows:)

There will be 20 R. & D. test flights (nine from ETR and 11 from WTR) of Minuteman III during fiscal year 1970. The primary test objectives are:

(*a*) Evaluate performance of stage III powered flight.

(*b*) Evaluate performance and capability of the LGM-30G PBV to deploy R/V's, decoys and chaff to single and multiple targets.

(*c*) Measure ———.

(*d*) Compare ———.

(*e*) Measure the accuracy of the LGM-30G missile guidance and control system during its boost and post-boost environment.

(*f*) Evaluate the performance of the MK 12 R/V's.

The fiscal year 1970 Minuteman flight test program includes 40 Minuteman II operational tests, three Minuteman II follow-on operational tests and 19 Minuteman I follow-on operational tests. The primary objective of an operational test is to gather reliability and accuracy data on a recently deployed weapon system. The follow-on operational test program is designed to maintain surveillance over the reliability of a weapon system that has been deployed in the field for a significant period of time.

MINUTEMAN INTEGRATED COMMAND AND CONTROL SYSTEM (MICCS)

Mr. SIKES. Before I yield for questions, let me get into the Minuteman integrated command and control system since they are closely related.

Why was the integrated Minuteman command and control system effort moved from Minuteman squadrons line item to a separate line item?

General PITTS. That resulted from an OSD decision, sir, to separate this program element from the overall Minuteman program element, and it was done under a program change decision No. F-8-136 of December 26, 1968.

Mr. SIKES. Why was this done?

General PITTS. It would be an assumption. No reason was given. The assumption would be to provide greater visibility for this important segment of the Minuteman program.

Mr. SIKES. For the record, describe this effort. Tell us why a new command and control system must be developed.

General PITTS. Yes, sir.

(The information follow:)

The requirements for MICCS is to provide an increased command and control capability for the Minuteman system in the following areas.

(*a*) Increased computer capacity capable of coping with increasingly sophisticated weapon system functions.

(*b*) A secure two way data link between launch control facilities and silos.

(*c*) Remote insertion of target data into the missile from the launch control facility as opposed to the current system which requires time and resource consuming effort to perodically penetrate each of the thousand silos. As Minuteman III enters the force with its MIRV capability, targeting becomes much more complex. MICCS will enhance the capability to fully utilize the flexible and responsive features of the entire weapon system.

(*d*) The basic building block for the command and control system for the hard rock silo program.

(*e*) Necessary command and control interface between the Minuteman weapon system and the Safeguard ABM sysetm if required.

COST OF MICCS PROGRAM

Mr. SIKES. It is indicated that $12.5 million was programed for this effort under the Minuteman line item of fiscal 1969. Can you tell us what funds were spent on this effort previously?

General PITTS. None prior to 1969, sir. We had the $12.5 million in 1969 and none was spent prior to that. Because of delays in the initia-

tion of this program, the $12.5 million has been reduced to $4.0 million for fiscal year 1969.

Mr. SIKES. What is the estimated total development cost of the new command and control system.

General PITTS. We estimate the total development cost to be ——— million.

Mr. SIKES. Over what period of time?

General PITTS. Four years.

Mr. SIKES. What are the estimated costs in the area of missile procurement and military construction if this new system is implemented? You can provide that for the record.

(The information follows:)

COSTS OF NEW MINUTEMAN COMMANDS CONTROL SYSTEM

The procurement funds associated with the above figure of ——— million is ——— million. This would provide the capability for all 1,000 silos.

No identifiable construction is involved.

MICCS AS RELATED TO SAFEGUARD

Mr. SIKES. How closely related is this program to the Safeguard ABM system?

General SCHULTZ. The new Minuteman integrated command and control system, if developed, sir, will have the electronic and computer capability to accommodate the Safeguard or any other defense system. It is not the primary purpose of the system, but in developing it the basic task is done, so if the defense is overlaid, then the communication between the defense and offense computer and command and control networks will go through this device.

Conversely, on the other hand, if you put a defense on and do not have this thing, you have to use something else. If you have this, you already have a capability to do it.

Mr. SIKES. Let me be sure I understand you.

Would this program be required if there was no Safeguard system?

General SCHULTZ. Yes, sir.

Mr. SIKES. General Schultz, I want to say that you have shown a very fine grasp of your subject and the committee is very pleased to have had you here as a witness.

I may say also, Mr. Secretary, that it is refreshing when a witness does show this very thorough grasp of the subject and is able to speak effectively about his program.

General SCHULTZ. Thank you.

Mr. SIKES. Questions on missiles.

Mr. ANDREWS. Mr. Chairman, I would like to concur in the statement made about the general.

General SCHULTZ. Thank you.

ATLAS MISSILE

Mr. ANDREWS. What has become of the old Atlas-type missile? Are any of them deployed?

General BOYLAN. We maintain 54 Titan IIs in our missile force. This will gradually reduce over the years as continuing operational tests are made on them. There are no Atlas missiles in the picture now.

Mr. ANDREWS. How did you get rid of them?

General SCHULTZ. The Atlas went through a D, E, and F series, and was a strategic deterrent missile. When it phased out in the course of history it became the launch vehicle, with new system redundancies, for the NASA Mercury program. We put the first astronauts up on an Atlas. Since then other R. & D. programs in the Air Force have used the Atlas for launch of ballistic missiles and space payloads.

Presently there is a program called ABRES, advance ballistic reentry system. It is a line item in the budget. The launch vehicle for research and development on penetration aids, new types of advanced reentry vehicles and so forth, use a number of those old or what are called "wheatfield" Atlas's, still today. They are still launched out of Vandenberg.

Mr. ANDREWS. You are using them for test purposes?

General SCHULTZ. Yes, sir.

TITAN II MISSILES

Mr. ANDREWS. And you say you have 50 Titan II missiles?

General BOYLAN. Fifty-four Titan II missiles deployed.

Mr. ANDREWS. Are they in hardened silos?

General BOYLAN. Yes.

General SCHULTZ. Little Rock, Ark., Tucson, Ariz., and Wichita, Kans.

Mr. ANDREWS. Do they have atomic warheads?

General BOYLAN. Yes, ——— megatons.

Mr. ANDREWS. How long will they be used?

General BOYLAN. We project currently the Titan force, as I mentioned earlier, to decrease slightly as we fire them out, but we will have Titan's in the structure through ———. At that time we project about ——— Titan's in the force structure.

Mr. ANDREWS. So at the present time your missile is the Minuteman?

General BOYLAN. Principally.

Mr. ANDREWS. That is in production?

General BOYLAN. Yes.

FUTURE MISSILE DEVELOPMENTS

Mr. ANDREWS. What do you see beyond your Minuteman III, General McNickle?

General MCNICKLE. We see more sophisticated reentry vehicles and we are working on advanced missile technology for a missile with greater throw weight. The hard rock silo is being configured so that it could take the larger and more advanced missile as well as the present Minuteman III.

Mr. ANDREWS. How long do you expect to have Minuteman III as your primary missile?

General MCNICKLE. For as far as we can see into the future at this time. But I should caution Mr. Andrews, that Minuteman III is not the ultimate weapon although I am sure it will have a long life.

Mr. ANDREWS. That is all.

Mr. SIKES. Mr. Davis?

REDUCTION IN FUNDS FOR MICCS

Mr. DAVIS. What is the significance here as far as we are concerned with the downward revision of this Integrated Command and Control System from $36 to $20 million.

General SCHULTZ. It was a DOD levy cut and primarily affected the development time, and when you can get it out into the force. It pushed it out, it stretched the development time I think by about ———.

We were asked to catch a given squadron when the Minuteman III went in and for budget constraint said, "Well, you can skip that one. Catch the one after that and you will not need this much money in a given year."

So it stretched the program—that is really what it did, the development program.

Mr. DAVIS. It is not in any way related then to the modification of the Sentinel system into what we call the Safeguard system?

General SCHULTZ. I think the Safeguard system IOC is 1973 or some such date and with this development we can just barely catch that capability. You will have to in the succeeding years, depending on how the Safeguard decision goes, accelerate that deployment to work with the defense element if it is overlaid.

But as I stated earlier, it is not tied intrinsically and solely to this defense. It is for other reasons as well.

MICCS AS RELATED TO SAFEGUARD

Mr. DAVIS. I notice in your justification on page 97, you gave as one of the reasons for the establishment of the Integrated Command and Control System the deployment of the Sentinel system. This led me to believe there might be a rear defense connection between the modification of Sentinel and the reduction in the budget.

General SCHULTZ. Whether it is Sentinel, Safeguard or NIKE expanded or what kind of defense, if we have offense missiles and defense missiles generally co-located ———, those electronic systems have to talk together.

The MICCS system is built modularly. Computers will be 8,000 word modules for the expansion capability, so that if a heavier defense goes in, you put more modules in the inherent design so the two can communicate. The command and control unit is being designed in this manner.

Mr. DAVIS. General McNickle, you look like you want to add something to that.

General MCNICKLE. There were considerable discussions at the time and what General Schultz has said is that whether Safeguard, Sentinel, or whatever it is, you have to have something to tie this together. Whether you call it battle management or something else, you have to have your offense, your defense, your warning and so on tied together so that they get the word at the same time and know what each other is doing.

REDUCTION IN MINUTEMAN FUNDS

Mr. DAVIS. In the Minuteman program there has apparently been no revision from the original estimated budget but it does appear that there is about a $65 million reduction from the current fiscal year. What does that mean to us? Does that mean that we are easing our effort or does it mean that sufficient progress has been made so that we can taper off a bit?

General MCNICKLE. It means two things, Mr. Davis. First, it reflects the normal progression of development and indicates that we have passed our peak development year on Minuteman III. Second, the fiscal year 1970 request is reduced by the amount for the Minuteman integrated command and control system which is a separate item in fiscal year 1970. These are the reasons for the reduction.

Mr. DAVIS. That is all, Mr. Chairman.

NIKE TARGETS

Mr. SIKES. Under Nike targets the amount programed for fiscal years 1968 and 1969 was $7 million. For fiscal 1970 you are requesting a $1 million increase. Why is there a requirement for this increase?

General MCNICKLE. Actually, the $1 million was taken out last year as part of our adjustment to the Expenditure Control Act. This request goes back to the $8 million level in supporting the Army.

Mr. SIKES. That isn't exactly an answer. Why is it necessary that you have that amount of money?

General MCNICKLE. The $8 million is to provide the Army with the necessary reentry measurements and targets for use with their Safeguard system. This is a DOD program which is assigned to the Air Force for execution.

ADVANCED WEAPONS AND APPLICATIONS

AIR FORCE WEAPONS LABORATORY OPERATION

Mr. SIKES. Under advanced weapons and applications there is an increase of $300,000 in the Air Force Weapons Laboratory operation for fiscal 1970. You are requesting $5.4 million for fiscal year 1970, and $5.1 million was programed for fiscal 1969, and $4.1 million in fiscal 1968. To what extent is this increase associated with civilian pay increases?

General MCNICKLE. $200,000 is for the pay of 18 additional civilians required for an assessment of the survivability of our systems in the event of a nuclear engagement, and the other $100,000 is for computer equipment.

Mr. SIKES. How many civilian personnel are assigned to this laboratory? Provide that for the record. Also give comparable numbers for the last 2 years.

(The information follows:)

CIVILIAN PERSONNEL AIR FORCE WEAPONS LABORATORY

For fiscal year 1969, civilian personnel employed in the laboratory equated to 289 man-years.

Comparable civilian personnel data for prior years was:

Fiscal year 1967, 279 man-years.

Fiscal year 1968, 282 man-years.

HIGH ENERGY LASER PROGRAM

Mr. SIKES. The program presented to the Congress last year for advanced weapons and applications totaled $6.8 million. The justifications this year show that $8.3 million was programed in this area. Why are those increases necessary in fiscal 1969 and fiscal 1970?

General MCNICKLE. The biggest reason is the additional effort we are putting on the high energy laser program. This program is building up and that accounts for the higher number of civilian personnel in this program. There is also a program there that is just getting under way in civil engineering technology. It will support the construction, operation, and maintenance of Air Force facilities.

PERSONNEL ASSIGNED TO WEAPONS LABORATORY

Mr. SIKES. For the record, tell us how many military personnel and civilian contract personnel are assigned to the Weapons Laboratory.

(The information follows:)

MILITARY AND CONTRACT PERSONNEL ASSIGNED TO AIR FORCE WEAPONS LABORATORY

The Air Force Weapons Laboratory was assigned 550 military personnel as of June 11, 1969.

The Air Force Weapons Laboratory does not use personal service contract employees.

AIR FORCE WEAPONS LABORATORY

Mr. SIKES. For continuity in the record, tell us something of the work that is being done there and the accomplishments.

(The information follows:)

DESCRIPTION OF WORK AND ACCOMPLISHMENTS AT THE AIR FORCE WEAPONS LABORATORY

The Air Force Weapons Laboratory's prime mission is to develop the technology for Air Force systems in the following areas: Nuclear weapons effects; nuclear survivability/vulnerability; nuclear weapons applications (concept evaluation, arming and fuzing, weapons support, and safety); civil engineering; and high energy lasers.

The accomplishments of the Air Force Weapons Laboratory include:

(*a*) The high explosive simulation technique (HEST) for simulating air induced ground shock.

(*b*) Laser triggered switching of high energy pulses for electromagnetic pulse simulation.

(*c*) Improved weapon support technology.

(*d*) Nuclear safety evaluation of all Air Force systems used for nuclear weapon delivery.

(*e*) Fuzing evaluation for advanced reentry vehicles.

ROCKET PROPULSION

AIR FORCE ROCKET PROPULSION LAB

Mr. SIKES. Under rocket propulsion you are requesting $28.7 million for fiscal 1970 as compared with $26 million in fiscal 1969 and $24.8 million in fiscal 1968. Approximately $2 million of the increase is for the Air Force Rocket Propulsion Laboratory operation. Tell us something about this operation and the reason for the increase.

Mr. HANSEN. The principal part of the increase is because of the change in the funding for the AEDC, Arnold Engineering Development Center. The Rocket Propulsion Laboratory does use the facilities of AEDC; and, because of industrial funding, money has to be put in the budget here to pay for the services.

Mr. SIKES. What work is performed there?

Mr. HANSEN. This is the Air Force's center for rocket propulsion technology work. It is located in a remote area of Edwards AFB. Included in the facilities are a number of test stands. They test fire experimental and full-scale engines and do solid and liquid rocket engine component and system development work.

ACCOMPLISHMENTS OF LAB

Mr. SIKES. For the record, tell us some of the recent accomplishments of the laboratory.

(The information follows:)

PERSONNEL DATA AND ACCOMPLISHMENTS OF ROCKET DEVELOPMENT LABORATORY

A few recent accomplishments of the Rocket Propulsion Laboratory include:

(*a*) The development of an improved 2.75-inch rocket to replace the one being used extensively in Vietnam. The new rocket provides greater impact velocity, and greater single shot accuracy than the present round.

(*b*) The development of a method of treating the surface of deteriorating solid propellant grains, such as Minuteman motors with liquid Freon to increase their shelf life and extend their environmental capability.

(*c*) The development of a new monopropellant hydrazine attitude control system for Titan III transtage to provide greater reliability.

(*d*) Continuing effort on post boost propulsion systems, starting with the development of the beryllium motor casing used on the Minuteman III system and continuing through the development of candidate liquid and solid systems for our next generation ICBM's.

(*e*) Continuing efforts in general technology ranging from the development of higher energy propellants, the investigation into nuclear survivability, investigation into long term storability, and investigation into low cost propulsion systems.

PERSONNEL ASSIGNED TO LAB

Mr. SIKES. Also for the record, tell us how many civilan personnel there are, the estimated cost of their salaries, the number of military and contract personnel assigned to the laboratory for fiscal 1968 and 1969 and the proposed for 1970.

(The information follows:)

The following table shows the number of civilian personnel, the estimated cost of their salaries, and the number of military and contract personnel assigned to the laboratory.

	Fiscal year—		
	1968	1969	1970
Number of civilian personnel (average)	459	481	469
Estimated cost of civilian salaries (millions)	$5.402	$5.956	$5.932
Number of military personnel	306	306	306
Number of contract personnel	67	65	40

LIQUID ROCKET TECHNOLOGY

Mr. SIKES. There is a request for an increase of $750,000 over the sum provided for the current fiscal year for liquid rocket technology. The Air Force in propulsion systems for its ICBM's is oriented toward solid rocket motors. NASA does extensive work in the area of liquid rocket engines. Could not the Air Force depend on NASA for developments in this area?

Mr. HANSEN. No, sir. NASA is not doing any of this work. The effort that takes place in the Rocket Propulsion Laboratory is very closely coordinated through one of the committees of the Joint DOD-NASA Astronautics and Aeronautics Coordinating Board. For instance, one of the main programs in rocket propulsion is the high pressure hydrogen-oxygen engine development which is partially funded by NASA. Another effort is a flourine-hydrogen engine for very high specific impulse capability for upper stage use by both services. While NASA doesn't furnish any money for that development, they are watching it very closely. I can assure you from personal knowledge that there is no duplication in the areas here with what NASA is doing.

Mr. SIKES. What are you going to do with these engines?

Mr. HANSEN. The high pressure engine development is aimed at bringing along the technology for an engine which would be suitable for use in a recoverable spacecraft or reusable booster. The very high energy engine development is the Aerospike concept, which Rocketdyne is developing and that is for the purpose of producing an upper stage which would have a very high capability to maneuver in orbit.

DUPLICATION OF NASA EFFORT

Mr. SIKES. The point is, from the committee's standpoint NASA appears to be doing these exact same things. This seems to constitute duplication. Can you check that out?

Mr. HANSEN. I am personally very familiar with this area. It is the one I have been working in for years. A part of the Rocketdyne contract was a subcontract to Convair, which was done under my direction. I am familiar with this area and NASA is not working in these areas. NASA did the development of the hydrogen-oxygen engine that is used in the Saturn vehicle, but those are pump-fed engines. This particular development by Pratt-Whitney that I mentioned is a high pressure engine which burns the propellants in two stages, has certain more modern features, and is completely sanctioned by NASA. NASA agrees through an AACB Propulsion Subpanel that this development should be conducted and they are not doing any work in that area.

Mr. SIKES. Is all of the effort in the liquid rocket technology item and the next three line items under rocket propulsion done under contract?

Mr. HANSEN. Yes.

Mr. SIKES. Is all of the in-house work under rocket propulsion included in the first line item for laboratory?

Mr. HANSEN. Yes.

1969 CHANGES TO ROCKET PROPULSION

Mr. SIKES. The budget presented to the Congress last year indicated a requirement for $32.1 million for fiscal year 1969 in the area of rocket propulsion. This year you show that $26 million was actually programed in fiscal year 1969. What program changes were made to cause this funding change? Provide that for the record.

(The information follows:)

CAUSES FOR PROGRAM CHANGES IN FISCAL YEAR 1969 FUNDS FOR ROCKET PROPULSION

The reduction of the Rocket Propulsion Laboratory budget from $32.10 million to $26.07 million in fiscal year 1969 resulted in the following program changes:

[In thousands of dollars]

Project number and title	Task number	Amount of reduction
3058 Liquid rocket technology:		
Liquid fluorine components	02	180
Liquid fluorine turbomachinery	03	310
Diffusion bonded tankage for postboost propulsion systems	05	200
In-space thermal management	06	50
Liquid fluorine gaging	06	200
Attitude control system feed	06	125
Long-term ground hold for cryogenics	06	300
Liquid PBPS thrust chamber	06	500
3059 Solid rocket technology:		
Aluminum hydride propellant development	01	382
Air launched propulsion development	01	228
Thrust vector control for air launched missiles	03	370
Controllable air launched missiles	04	350
Environmental test and control	04	200
End burning technology	04	250
ICBM minimum throttling development	04	150
3148 Liquid and solid propellant technology:		
Burn rate modification of solid propellants	03	200
Aluminum hydride ingredient modification	04	340
Aluminum hydride propellant supply	04	465
Ultraenergy concepts	06	100
5730 Advanced propulsion techniques:		
Air augmented flight test vehicle	01	500
Controllable gas generator	01	500
Hybrid motor development	02	130
Total		6,030

ADVANCED PROPULSION TECHNIQUES

Mr. SIKES. What is included in the project entitled "Advanced Propulsion Techniques", for which you are requesting $2.1 million?

General MCNICKLE. There are a number of items here. Variable thrust, air-augmented rocket, propulsion system for the Sandpiper target missile, altitude simulation test techniques, these are the main ones.

Mr. SIKES. For the record, tell us what some of your accomplishments have been.

(The information follows:)

ACCOMPLISHMENTS ADVANCED PROPULSION TECHNIQUES

Some of the accomplishments in the project entitled "Advanced Propulsion Techniques" include:

(*a*) The development of a low-cost hybrid propulsion system capable of variable thrust operations over an 8:1 range for burn times up to 7 minutes. This system was successfully flight tested at altitudes up to 77,000 feet and mach numbers as high as 2.5 in a Sandpiper target missile.

(*b*) The development of a hybrid controllable gas generator for future use in an air augmented Sandpiper to improve the low altitude capability of this target missile.

(*c*) The development of a 51-percent boron solid propellant for use in air-augmented missiles.

(*d*) The development of a 73-percent boron slurry propellant for use in air-augmented missiles. All propellants have been demonstrated in direct connect tests.

(*e*) The design and continuing development of a controllable solid gas generator for future air-launched missile application.

(*f*) The demonstration of a shrouded rocket with a lift/drag (of the shroud) of about 1.5, with only minor losses below mach 1, and with thrust augmentation as high as 2 above mach 1.

AIR-LAUNCHED MISSILE PROPULSION

Mr. SIKES. Under air-launched missile propulsion, there is a request for $1,278,000 for a new project entitled "Air-Launch-Missile-Propulsion." Will you describe this program?

RAMJET PROPULSION

Mr. HANSEN. This is an advanced ramjet propulsion technology program that is aimed primarily at the application of a long-range, cruise-type air-launched missile.

Mr. SIKES. We have had a number of programs in ramjet propulsion. Is this something different? Is it a new concept? What is the justification? Provide it for the record.

(The information follows:)

DESCRIPTION OF AND JUSTIFICATION FOR RAMJET PROPULSION TECHNOLOGY

The air-launched missile propulsion program is not a continuation of a past development but an extension of the ramjet concept through the use of advanced fuels and advanced propulsion developments. Although the ramjet concept is not new, it has not been demonstrated for volume limited, extended range, and extended altitude applications. The program emphasizes advanced ramjet concepts; that is, the slurry and liquid fueled ramjet as well as the solid or slurry fueled air augmented (ducted) rockets. ———. This program will provide the propulsion technology for future applications to a bomber defense missile or a dual-purpose bomber defense air-to-air/air-to-ground missile. ———.

Mr. SIKES. What other ramjet propulsion efforts are included in R.D.T. & E., Air Force programs?

Mr. HANSEN. This is the only Air Force ramjet program that we have in advanced development.

Mr. SIKES. Mr. Preston.

Mr. PRESTON. What programs are there in areas other than advanced development?

Mr. SIKES. Provide that for the record.
(The information follows:)

OTHER RAMJET PROPULSION EFFORTS

The ramjet propulsion efforts, other than the advanced development program, are in the Air Force's exploratory development program. Its objective is to develop technology for advanced air breathing systems. This area includes subsonic and supersonic combustion ramjet concepts and composite propulsion cycles which extend from takeoff through the hypersonic speed regime. The effort is a reflection of the need for accelerating the rate of progress being made in this technical area. Because of the increased speed of aircraft to be intercepted and the improved defenses of the areas to be penetrated, propulsion technology is required for advanced systems such as short- and long-range air-to-air and air-to-ground missiles, a bomber defense missile, and an advanced manned interceptor.

One of the new programs which is the composite ramjet engine technology program, will investigate the critical components in a proposed propulsion system combining turbine and ramjet modes which is capable of operation from takeoff to mach 4.5 at 90,000 feet. Another effort is the development of advanced components for a boron slurry fuel system needed for a high mach number, low-altitude advanced penetration aid missile.

TACTICAL AIR-TO-GROUND MISSILE X-3

Mr. SIKES. Under the tactical air-to-ground missile X-3, there is a request for $3 million; $2 million was programed for this effort in fiscal 1969. Is this designed to lead to a specific new air-to-ground missile or is it a group of studies or analyses which might apply to any number of future air-to-ground missiles?

General MCNICKLE. This program is primarily to prove out the feasibility of guidance systems which could lead to a new AGM.

ALL-WEATHER CAPABILITY

Mr. HANSEN. A particular feature of this one is the all-weather capability which we do not now have.

Mr. SIKES. It is a specific missile?

General MCNICKLE. It could lead to that; yes, sir. It is aimed at an ultimate application that would be a specific missile with all-weather guidance.

Mr. SIKES. How would it compare with missiles now in inventory or under development in both the Navy and the Air Force?

General MCNICKLE. It would be the only tactical missile with an all-weather guidance system. One missile that could be close to it is the Navy's Condor which is a long-range, standoff missile ———. The AGM-X-3 would be a missile with a ——— mile range, whereas the Navy's Condor is about ——— miles; a warhead of ——— pounds versus the Navy's ——— accuracy in clear weather would be about the same. ———.

Mr. SIKES. The project listing indicates that $6.5 million was programed on this effort in fiscal year 1968. The descriptive summary indicates that no funds were spent on this program in fiscal year 1968 and prior years. Which is correct?

General PITTS. The description summary is correct, sir. There was a mistake in the project listing due to the similarity of the two names. That $6.5 million should have been on the Maverick line in the project listing.

Mr. SIKES. What present tactical air-to-ground missiles would the new one replace?

General MCNICKLE. As I mentioned, Mr. Chairman, it really will not replace any. It would provide a new capability since we do not have a missile at the present time which is all weather.

COST TO DEVELOP NEW MISSILE

Mr. SIKES. How much does it cost the Air Force to develop air-to-ground missiles such as the Maverick? Take some recent developments. I would like to get the probable cost of the new missile by looking at costs of missiles recently developed or now under development. Is that feasible?

General MCNICKLE. Yes, sir. We have made an estimate that it will cost on the order of ——— million to develop an AGM-X-3. We will list for the record, if you desire, some other developments such as the Maverick, which is a much shorter range missile.

Mr. SIKES. All right.

(The information follows:)

Some typical R.D.T. & E. costs for various air-to-ground missiles are as follows:

	Millions
AGM-45A (Shrike)	$83.6
AGM-65A (Maverick)	128.9
AGM-78B (Standard ARM)	107.2

ADVANCED ICBM TECHNOLOGY

Mr. SIKES. Under advanced ICBM technology, you are requesting a 100-percent increase; $10 million is programed for the current fiscal year and $20 million is requested for fiscal year 1970. Why is this?

Mr. HANSEN. Primarily, this increase in funding is involved with nuclear hardened guidance, advanced postboost system definition, postboost propulsion, system survivability, and survivable radio guidance system. For example, in the survivable radio guidance system, we are moving to a test hardware phase on a new guidance system that gives us a much greater nuclear hardness and much greater accuracy than we have now. Up to this time they have been largely on paper and now they are moving into the phase where they want to build some hardware to test.

Mr. SIKES. Mr. Preston.

Mr. PRESTON. Would you tell the committee just what is involved in this proposed new guidance system, how it achieves the hardness capability you mentioned?

Mr. SIKES. Is there anyone here who has the facts?

Mr. HANSEN. We would have to furnish that.

Mr. SIKES. Provide it for the record.

(The information follows:)

HARDNESS CAPABILITY FOR PROPOSED ICBM GUIDANCE SYSTEM

The survivable radio guidance system (SRGS) is an in-flight correction system which overlays the missile inertial guidance system and provides significantly improved missile accuracy. It is estimated that a guidance-only contribution to weapon system CEP of ——— can be achieved with SRGS in combination with

a high-quality inertial guidance system. The SRGS has potential application on Minuteman and advanced ICBM.

The SRGS has an ——— for present systems. The hardness level is achieved by applying nuclear hardening technology to component design ———. This level of hardness is complemented by other elements of the advanced ICBM technology program which are establishing a technology base for hardened, accurate high-quality inertial guidance systems. ———.

NEED FOR ADVANCED ICBM

Mr. SIKES. At a point in time when the Minuteman III development effort is far from completion why should we be spending so much money on an advanced ICBM?

Mr. HANSEN. I think we should. I mentioned yesterday the game of measures and countermeasures. The other guy builds a higher wall. If you want to get over it you have to be working on a longer ladder. Because the leadtimes are very long, we identify things where we think improvement is needed. Some improvements that we are talking about can be introduced into the Minuteman III system. For instance, the survivable radio guidance system can be an improvement in Minuteman III itself. The work in the Hard Rock Silo is now nearer to an actual application phase. I think we have to keep planting seeds of what we think we want down the line quite a few years. This is important so as to arrive at the point where we have done the preliminary work necessary to move on with the schedule desired in the programs where this work is needed.

OFF-THE-ROAD MOBILE ICBM'S

Mr. SIKES. Will a part of this $20 million be spent examining off-the-road mobile concepts for ICBM?

General PITTS. Yes, sir; about $200,000 in 1970.

Mr. SIKES. What is the objective there?

General PITTS. Basically, two subtasks: one, to define the preferred weapon system command-control-communications to be used with off-road mobile basing and another, a preferred land navigation system for the mobile concept. For those two tasks, $200,000 is included.

COMPETITIVE DESIGN PHASE FOR ADVANCED GUIDANCE SYSTEM DEVELOPMENT

Mr. SIKES. For the record, would you describe the competitive design phase of the advanced guidance system development which is listed as an item causing the increase in fiscal year 1970.

(The information follows:)

DESCRIPTION OF COMPETITIVE DESIGN PHASE FOR ADVANCED GUIDANCE SYSTEM DEVELOPMENT

The advanced guidance system competitive design is a ——— year guidance system development to provide a nuclear hardened highly accurate guidance system. The system will be hardened to ——— and capable of achieving a guidance CEP of ———. It is planned to select three industrial contractors to conduct this effort. This number of contractors was selected since the technical complexity of this system is such that the Air Force could realize significant benefits from having the option of selecting the best design from a broader tech-

nical base. In addition, this approach will provide a competitive base for any future procurement.

Each contractor will design and fabricate five flight-worthy guidance systems. These systems will undergo both nuclear radiation testing and performance testing. The end result will be a highly accurate nuclear hardened guidance system for use in Minuteman or an advanced ICBM.

SHORT-RANGE TACTICAL AIR-TO-AIR MISSILE

Mr. SIKES. On the Short-Range Tactical Air-to-Air Missile for which you are requesting $14 million in fiscal year 1970, the so-called Dogfight missile which is designed to be carried on the F–15 aircraft, is that the one?

General MCNICKLE. Yes, sir. It is primarily for the F–15. However, we are looking at our present inventory of fighter aircraft as we design this new missile.

STATUS OF DOGFIGHT MISSILE DEVELOPMENT

Mr. SIKES. What is the status of the development program?

General MCNICKLE. It is still in concept formulation.

Mr. SIKES. Would you tell us in detail about the requirement for $14 million.

General MCNICKLE. First, we are going to complete a number of studies and tests. We have a comparative seeker test which requires ——— a propulsion flight test study which uses ——— acquisition aids test, ——— a 3-dimensional simulation, ———.

Mr. SIKES. For the record, tell us in some detail what you are trying to accomplish.

(The information follows:)

REQUIREMENT FOR DOGFIGHT MISSILE

The fiscal year 1970 program as now planned is given below. This plan has not been fully approved as yet so it is still subject to revision.

(*a*) F–15/AIM–82A Interface Analysis: This is a trade off study presently being conducted with each of the three F–15 contract definition contractors (with funded inputs from qualified missile manufacturers) to determine optimum missile location and resolve airframe, engine, and aircraft design requirements interrelated with those of the AIM–82A. This was fully funded with fiscal year 1969 funds and is only given here to provide a logical and sequential beginning for the fiscal year 1970 effort. This task will be completed August 1, 1969.

(*b*) Comparative Seeker Tests: This task is a program of ground and captive flight testing of advanced guidance concepts available in industry. This program was partially funded with $0.3M fiscal year 1969 funds and will be completed with ——— fiscal year 1970 funds ———.

(*c*) Acquisition Aids Tests. These tests will define the optical and electronic acquisition aids for all ordinance on the F–15. ——— fiscal year 1970 funds is programmed for this task which is to begin in August 1969.

(*d*) Propulsion Flight Testing: This is an advanced development program on propulsive steering. This effort is being done by the Navy with Air Force support. ——— fiscal year 1970 funds are required to complete this program in ———.

(*e*) Seeker Technology Advancement: This is an advanced development program on approximately four of the more promising seekers culled from seekers tested under task b. above. ——— has been allocated for this work from fiscal year 1970 funds.

(*f*) Missile System Analysis Computer Simulations: This will be a problem to verify present cost effectiveness data on this missile with a more sophisticated approach. ——— has been allocated for this effort to begin in July 1969 ———.

(g) Missile System Definition Phase: This will be a three-contractor effort to derive system concept and preliminary specifications for the missile and its subsystems. F-15/AIM-82A acquisition and lock-on requirements will also be derived as a result of this task. Proposals for the follow-on development phase will also result from this task. ——— fiscal year 1970 funds ——— per contractor have been allocated. This task should begin in November 1969 and finish by ———.

(h) Competitive Advanced Development Phase: This is a two-contractor advanced development effort culminating in a flyoff in ———. Based on this flyoff competition, one production contractor would be selected. The balance of our fiscal year 1970 funds ——— will be expended on this effort. The two contractors for this task will be selected from the three submitting proposals on the previous task (Missile System Definition).

DEVELOPMENT COST OF DOGFIGHT MISSILE

Mr. SIKES. How accurate do you feel the estimated $90 million total cost of development to be?

General MCNICKLE. We feel it is more like ——— million right now. On these estimates I would like to say that in the early stages—when we have recognized and validated the requirement—we make a cost estimate on the basis of the minimum program that will satisfy the requirement. As we move along, we fund additional tasks to be performed or new capabilities which should be added, and these cost more money.

Mr. SIKES. Is this cost growth?

General MCNICKLE. Those estimates were made last year. As we moved along and got further data, we decided to pursue a different development program which included a greater number of R. & D. missiles in a fly-off competition prior to production.

Mr. ANDREWS. Could you give us a round figure about how much inflation has cost you percentagewise in your R. & D. program?

General MCNICKLE. It is quite significant in our overall R. & D. program. Some of our people made a study and estimated that since 1964 our R. & D. dollar—and some of it varies, in the electronics industry it is more—there is about a one-third reduction in the purchasing power of our money.

Mr. ANDREWS. In other words, inflation has eaten up about a third of your budget?

General MCNICKLE. We are getting less R. & D. and paying more for it.

Mr. SIKES. Has the contract for development of the missile been awarded?

General MCNICKLE. There is no development contract as yet. As a part of our proposed development program, we are going to have a flyoff and then award the production contract.

DOGFIGHT PROCUREMENT PROGRAM

Mr. SIKES. If the development program is successfully completed, what will be the procurement program as you see it now?

General MCNICKLE. It could be as many as ——— missiles.

Mr. SIKES. At what cost?

General MCNICKLE. About ——— a missile, but that is just an estimate without benefit of the development program.

Mr. SIKES. And the total cost? Provide that for the record.

General PITTS. It would have to be a ball park estimate.

(The information was provided to the committee and is classified.)

Mr. SIKES. Is the ——— figure the projected unit flyaway cost?

General MCNICKLE. Yes, sir; that is our estimate at this time.

Mr. SIKES. When do you anticipate they will be available for test and when will they be available for inventory?

General MCNICKLE. They would be available for inventory in ——— and for test in ———.

Mr. SIKES. What kind of guidance system do you propose?

General MCNICKLE. The primary candidates are electro-optical and infrared.

Mr. SIKES. What aircraft will they be used on?

General MCNICKLE. The F–15 would be the primary user.

Mr. SIKES. Could you use them on existing aircraft like the F–4?

General MCNICKLE. Yes, sir.

Mr. SIKES. Would expensive modifications be required for use on present aircraft?

General MCNICKLE. No, Mr. Sikes, I don't think so. As an example, we are keeping the F–4 in mind as we develop this new missile.

NAVY DEVELOPING SIMILAR MISSILE

Mr. SIKES. Does the Navy plan to use this missile or do they have a development of their own?

General MCNICKLE. They have a similar missile called Agile.

Mr. SIKES. Why two?

General MCNICKLE. D.D.R. & E. is watching these two programs, sanctioning these two programs, and letting each go along. It is my understanding that they will make a decision at the proper time as to which missile ought to go.

Mr. SIKES. Do you anticipate the likelihood that the better missile will be selected at some point in time?

General MCNICKLE. Yes, sir. This would not be unlike the approach taken with the Standard ARM, the Air Force and the Navy pursued these missiles and D.D.R. & E. made the decision in favor of the Navy Standard ARM. That is the way it went.

Mr. SIKES. I believe you said you anticipate completion of the development program in ——— and operational capability in ———.

General MCNICKLE. Completion in ———. We would have missiles for test in ——— and ———, and inventory in ——— to go with the F–15.

Mr. SIKES. What are the performance characteristics sought for the new missile, for the record?

(The information was provided to the committee and is classified.)

ADVANCED BALLISTIC REENTRY SYSTEM

Mr. SIKES. Under "Advanced ballistic reentry systems" you are requesting $121.4 million for fiscal 1970. This is a $16 million increase. What part of it is associated with the new procedure in the funding of the Arnold Engineering Development Center?

Mr. HANSEN. $6.1 million.

Mr. SIKES. What is the amount of the actual increase?

Mr. HANSEN. $16 million, less the $6 million, or about $10 million.

IMPORTANCE OF PROGRAM

Mr. SIKES. The program has been continuing for a number of years at approximately $100 million a year. Isn't it time for some decrease in funding in that area?

Mr. HANSEN. No, sir; I don't think so. This is a national program that applies to all of our strategic missiles and their penetration capability. I consider that, with the national concern that we have of measures and countermeasures and ballistic missile deterrents and counterforces for those, this is an extremely important area. In fact, its funding has been decreasing steadily from $160 million in fiscal year 1965. I think it is appropriate rather that it be increasing and I think this is an area that we ought to spend as much money on as we know how to spend intelligently. I do not really look for this to decrease because it is the game of ever trying to develop more sophisticated methods of sending the warheads in, more sophisticated decoys such as chaff and various other things. I think it is an extremely important area. This is a national program with the Air Force as the executive agency. It supports ballistic reentry devices for all services.

Mr. SIKES. In that connection, in fiscal 1969 $118 million was programed in the Air Force at the time their witnesses were before the committee. The justifications now before us indicate that the programed fiscal 1969 level is $105 million. That would indicate some reductions were then in order and possibly are again in order. Could there be a similar reduction in the fiscal 1970 program without serious consequences?

Mr. HANSEN. Well, I don't think that the amount requested should be reduced; it is my personal belief it should not be reduced and it should not have been reduced last year.

Mr. SIKES. Was harm done by the reduction last year?

Mr. HANSEN. I cannot say necessarily that harm was done because the progress in this program is time phased. I don't think we eliminated anything, we merely delayed doing some things until this year. Whether or not harm is done depends on when we have to use these devices and what capability of devices we have at that particular time. I don't know how we can forecast that. I do think we should press ahead with these efforts. Some of the things that we want to do, for instance, are to test ——— so that we can increase the versatility by which we can target. I think these are things that we should get on with as rapidly as we can. I would personally resist very strongly any effort to decrease the funding on the ABRES line.

BUDGET DEVELOPMENT

Mr. SIKES. How do you arrive at a budget request in this area? In other words, is it based on a number of specific activities?

Mr. HANSEN. Yes; it is. The budget is built up from a very significant number of smaller items. I have that here. It is a fairly lengthy list.

Mr. SIKES. I think it would be well to submit that for the record.

(The information was provided to the committee and is classified.)

Mr. HANSEN. But we do approach it from the point of view of trying to figure out the specific things which should be done and then build up the price from that. It is not a level of effort where we

say "Let's spend like $100 million this year" on this program. It is "Let's figure out what we are smart enough to know how to work on productively and see how much that costs," and build up the budget in that way.

IN-HOUSE AND CONTRACTOR EFFORT

Mr. SIKES. What part of the money in the ABRES program is expended in-house and what part under contract?

Mr. HANSEN. The large majority of it is contracted. Of this particular year's request, $6.1 million is planned for in-house effort and the remainder of $115.3 million is planned to be spent with contractors.

Mr. SIKES. Who are your major contractors?

Mr. HANSEN. Such companies as Avco, Atlantic Research, McDonnell-Douglas, Lockheed and Philco-Ford.

Mr. SIKES. Are these generally continuing contracts?

Mr. HANSEN. No. Each of these contracts is for a specific task. It tends to kind of come out like that because the next things that we think of are along similar lines. We therefore tend to go back to the same companies because they have been working on this kind of problem. They understand what needs to be done and therefore, they tend to submit the best proposals. But, they are competitively proposed.

AVOIDANCE OF CONTINUING CONTRACTS

Mr. SIKES. How do you avoid continuing contracts? How do you seek to avoid continuing contracts in which the contractor seems to acquire a vested interest that gives him occasion to continue to participate in a development program to the exclusion of others and to the exclusion of new blood and new capabilities?

Mr. HANSEN. That is a very good question.

Mr. SIKES. Treat it in some detail for the record, but tell us briefly at this point what your thinking is on it.

Mr. HANSEN. We have to continue to work hard to encourage companies to come in and participate competitively when they are competing against a company which has already been doing a particular type of work. This company therefore has had the benefit of Government funding and gaining very great familiarity with a particular area. We do have among the companies that I mentioned capability to do similar things and there is competition among them. But in a very real sense in this kind of business, it is a little bit like it is with the big three in the automobile business. It is difficult for somebody new to break in unless they want to spend a very significant amount of corporate funds in developing facilities and know-how in their people in order to be able to be a good competitor. So I guess our concentration is to make sure that we at least have a few companies that are willing and have the capability to fight it out with each other to do these jobs.

General MCNICKLE. It actually costs us R. & D. dollars to develop and sustain more than one source. There is necessarily high concentration in these specialized tasks and we try hard to keep some semblance of a competitive market structure so that when we need production sources there is still competition.

Mr. ANDREWS. How do you mean that, General; you have to finance the competitor?

General MCNICKLE. Yes, sir; to some degree.

Mr. ANDREWS. Some of these companies get locked into your programs and you cannot even kick them out as long as you need their services.

General MCNICKLE. That can and has happened, but we try to work with other contractors too.

Mr. ANDREWS. In other words you finance a competitor?

General MCNICKLE. Yes, sir; we will assist in developing a competitor because competition provides a wider choice, often a better product and lower prices. But with these highly specialized products we will always have few sellers.

Mr. ANDREWS. You finance him into the competition and then he gets locked into your program.

General MCNICKLE. Well, that is true, but even if you only have two sellers, that helps. The market structure for major weapon systems is characterized by few sellers and even fewer buyers. We do not like to see any fewer sellers than there are now.

Mr. HANSEN. I believe in the ABRES case that we are talking about here, if you will recall the kind of companies involved—Avco, Atlantic Research, McDonnell-Douglas, Lockheed, Philco-Ford—I believe I am correct in saying that any one of these companies could do all of the ABRES work. Now, instead of giving the whole job to one of them, it is broken down into pieces, and each of the tasks are competed. Some effort is made to try to keep several companies involved so there will be competition and the work will not gravitate to one company.

Mr. SIKES. Was the MIRV concept developed under this program or under the Minuteman program?

Mr. HANSEN. I cannot answer that.

General MCNICKLE. My source says it started in the hardware phase in the ABRES program and moved into the Minuteman program. I am not sure where the original idea was conceived.

STRATEGIC BOMBER PENETRATION

Mr. SIKES. Under the heading of Strategic bomber penetration, a new program, there is a request for $3 million. Will you tell us about this program?

General MCNICKLE. Yes, sir. This is very similar in intent to the ABRES program but it is focused on penetration aids for manned aircraft. It is intended to develop the technology before we would develop an actual system, the same thing that we do in the ABRES program for missiles.

OTHER BOMBER PENETRATION PROGRAMS

Mr. SIKES. What other programs are designed to enhance the penetration of strategic bombers is included in the fiscal 1970 R.D.T. & E. budget?

General MCNICKLE. Two programs. One of them is the Penaids for manned aircraft, and the other is the subsonic cruise armed decoy or SCAD. The former is all electronic countermeasures work and the latter is developing the SCAD.

Mr. SIKES. Is it altogether correct to place this program under advanced development? It would seem that the studies and analyses which are principally involved may be exploratory development programs.

General MCNICKLE. It could be. I think it is somewhat arbitrary where you draw the line. We feel it is closer to advanced development, but it could be called exploratory development.

Mr. SIKES. What level of funding do you foresee for this program over the next 3 or 4 years?

General MCNICKLE. We have a tentative layout of $3 million for 1970, and then———million a year through 1973.

TACTICAL AIR-TO-GROUND MISSILES (MAVERICK)

Mr. SIKES. Under tactical air-to-ground missiles you are requesting $39.6 million for the further development of the Maverick. At this point I would like to ask you to describe for the record the characteristics of the Maverick, what it is designed to accomplish.

(The information follows:)

MAVERICK—CHARACTERISTICS AND DECISION

The Maverick which is a rocket boosted, automatic television guided air-to-ground missile is being designed and developed for the efficient destruction of small hard stationary or moving targets such as tanks, armored personnel carriers, field fortifications and reinforced concrete buildings. This missile will weigh approximately 500 pounds with a single pass kill probability of ——— based on a ——— hit probability and a ——— mission reliability. Mean miss distance of Maverick will be ——— feet against targets of ——— feet maximum linear dimension. Maverick mode of operation will permit the carrier aircraft to launch and leave with a range of ——— feet to ——— nautical miles.

MAVERICK COST AND SCHEDULE FOR DEVELOPMENT

Mr. SIKES. $44 million was programed for this missile in fiscal year 1969, $26.7 million had been programed under a different title in fiscal year 1968 and in prior years. How does the presently estimated development cost and time schedule of the Maverick missile compare with the original cost and time schedule?

General MCNICKLE. We have definitized the contract with Hughes at a target price of $94.5 million, and the total development program is estimated at $122 million. We are still carrying the same operational date as when we signed the contract. This line has contained other missile work than the Maverick. There was $14 million in fiscal year 1967 for the Air Force work on a Standard ARM that I mentioned earlier. The contract with Hughes is actually for a target price of $94 million, and there is an additional $28 million in the Maverick program test support.

General MCNICKLE. The original estimate was $84.3 million and we now have a $122 million program. That is about $6 million less than is indicated in the descriptive summary after the $13.9 million for other than Maverick work is removed from both estimates.

Mr. ANDREWS. That is up about $38 million?

General MCNICKLE. Yes.

Mr. ANDREWS. Since when?

General McNICKLE. Since last year's estimate when we did not yet have the program definitized.

Mr. ANDREWS. Approximately one year?

General PITTS. If I could help out, that original estimate was made back at budget submission time in the fall of 1967. They did not definitize this estimate until July of 1968.

Mr. ANDREWS. What about overruns?

General McNICKLE. We have not had any, Mr. Andrews, at least not yet.

Mr. ANDREWS. That $122 million estimate is not too firm, is it?

Mr. HANSEN. It is a contract target price plus the test support money. Before it was a Government estimate, now it includes a contract number between the Government and the contractor.

Mr. ANDREWS. A firm contract?

Mr. HANSEN. Yes.

CONTRACT ESCALATION CLAUSE

Mr. ANDREWS. Have you any provision for escalation, any escalating provisions in the contract to take care of inflation, cost growth, overrun?

General McNICKLE. Only normal inflation.

Mr. ANDREWS. What do you figure that normal inflation is?

General McNICKLE. I don't know this specific contract, but normally it is about 2 to 4 percent.

Mr. ANDREWS. Put something in the record about the escalation clause in the contract.

(The information follows:)

Upon request of the contractor or the Government, but not more often than once each calendar year, the Government and the contractor will negotiate and adjust target costs and ceiling prices based upon provisions set forth below:

1. The target cost and ceiling price shall be subject to revision once each year commencing with calendar year 1970 pursuant to the provisions of this clause, to reflect abnormal fluctuations in the price levels for any of the contractor's elements of cost in that year.

2. Elements of cost shall be deemed to mean allowable and properly allocable expenditures, or full or partial payment for:

a. Labor costs—including but not limited to tool or test equipment labor, manufacturing labor, sustaining or engineering labor, overhead associated with the above, material burden, and G and A expenses.

b. Material costs—Including but not limited to engineering materials, tooling materials, purchased tools and manufacturing materials and purchased parts.

c. Subcontract and other costs—Including but not limited to subcontracts for components, assemblies or subassemblies and all allowable expenditures not including above.

3. The cost indices to be used in revising target cost and ceiling price shall be based on indices and averages of the Bureau of Labor Statistics of the U.S. Department of Labor and shall reflect the following:

a. The labor cost adjustments shall be based upon the average annual or latest monthly rate, whichever is greater, of the "Hourly Earnings of Aircraft and Aircraft Parts Production Employees," as then represented in the Bureau of Labor Statistics Bulletin 1312-4, table C-2, divided by $3.30 which represents the average for 1968.

b. The Materials Cost Index for a given year shall be the composite of the annual average or latest month, whichever is greater, of wholesale price indices prepared by the Bureau of Labor Statistics of the U.S. Department of Labor weighted by:

(1) Explosives (currently identified as Code 0672)—20 percent.

(2) Nonferrous metals (currently identified as code 102)—20 percent.

(3) Electrical machinery and equipment (currently identified as code 117)—60 percent.

c. The Subcontract Cost Index for a given year shall be deemed to mean a composite of the Labor Cost Index and the Materials Cost Index for that year weighted 70 percent and 30 percent respectively.

4. An abnormal fluctuation with respect to a given year shall be deemed to be an increase or decrease in any of the following indices for that year over or under the projected Index figure set forth below:

[In millions of dollars]

	Over	Under
Labor cost index:		
1970	115.8	109.3
1971	121.5	112.6
1972	127.6	115.9
1973	134.0	119.4
1974	140.7	123.0
1975	147.7	126.7
Material cost index:		
1970	108.2	101.0
1971	110.2	101.5
1972	112.2	102.0
1973	114.2	102.5
1974	116.3	103.0
1975	118.4	103.5

SUBCONTRACT COST INDEX

This index is a composite of the Labor Cost Index and the Material Cost Index weighted 70 percent and 30 percent, respectively.

5. In recognition of the fact that the Bureau of Labor Statistics occasionally modifies its method of computation and selection of components, either party may request consideration of alternate indices provided that the old index is no longer available. Either party may request the assistance of the Bureau of Labor Statistics of the U.S. Department of Labor in deriving a mutually acceptable method of comparison.

6. The amount of revision with respect to any period shall be computed by:

(a) Determining the labor costs, material costs, and subcontract and other costs respectively for that period.

(b) If the actual index for any element of the above categories of costs in any year is either over or under the projected values stated in 4.0 for that year, then:

If such actual index number in any year is above or below the projected index value for that year, the percent by which the actual index number is greater or less than the projected number shall be multiplied by the element of cost incurred and the product shall be added to or subtracted from the target cost and ceiling price in the same ratio that original ceiling price bears to original target cost. The target profit shall not be adjusted by reason of this clause.

TYPE OF CONTRACT

Mr. ANDREWS. Any way you figure it, your estimate has gone up nearly $88 million in 12 months?

General PITTS. Yes; but remember, again, I said that was an estimate prior to definitizing the contract. Once they definitized, I think General McNickle is saying that we do not expect that estimate to change right now.

Mr. ANDREWS. You said you had a firm contract. That does not mean a fixed-price contract, does it?

General MCNICKLE. I do not think so.

Mr. ANDREWS. What type contract is it; cost-plus?

General MCNICKLE. No; it is a fixed-price incentive fee contract with Hughes for a target price of $94.5 million.

Mr. ANDREWS. Was it negotiated or by competitive bidding?

General McNICKLE. The development program was competitive, and Hughes won.

Mr. ANDREWS. How many companies bid on it?

General McNICKLE. Two.

Mr. ANDREWS. What was the other company?

General McNICKLE. North American-Rockwell.

Mr. ANDREWS. How much lower was Hughes than North American?

General McNICKLE. I do not have that.

Mr. ANDREWS. Would you please provide the committee with that information?

General McNICKLE. Yes, sir.

(The information was provided to the committee.)

Mr. ANDREWS. What was the contractor's estimate of the cost at the time of the letter contract? Supply that for the record if you do not have it.

(The information follows:)

A letter contract was not used in the Maverick program. The contractor's target price of $94.5 million is the only contractual price for the R.D.T. & E. on Maverick.

SHARING OF COSTS OR SAVINGS

Mr. ANDREWS. Under this fixed-price incentive fee contract, you are subjected to whatever inflationary costs occur for the life of the contract,

Mr. HANSEN. That isn't exactly correct. In the fixed-price incentive contract there is a target cost and target price that is negotiated and then a sharing ratio between the Government and the contractor up to a ceiling, and if there is more cost, for whatever reason not directed by the Government, whether it is escalation or underestimating or unforeseen difficulties, or whatever, that additional cost gets shared in accordance with the cost-sharing formula. The only case where the abnormal escalation would come in would be a clause in the contract which is special, that says that if there is more than a certain amount of growth in cost which is due to the national economic inflationary factors, we will then reopen the price for that. As we said, we do not know specifically what that clause is in this contract but we will provide that for the record.

(Clerk's note: The information appears on pages 589 and 691.)

General PITTS. An interesting point in these type contracts also is the fact that if there is an underrun on the traget cost, that is, if the contractor brings in the prouct cheaper than the target price, there is a cost-sharing arrangement whereby the Government gets back a share of the money saved.

Mr. ANDREWS. How long has it been since you have had a situation like that?

Mr. HANSEN. I know of one personally which I was involved in before I came to my present job. There was a fairly significant—for the size of the contract—underrun of which the Government got back 60 percent. The contractor kept 40 percent. The amount of the underrun was in the order of $2 million on an approximate $70 million contract.

Mr. ANDREWS. That is refreshing.

Mr. ADDABBO. That is the exception that proves the rule.

INCREASED DEVELOPMENT COST

Mr. ANDREWS. The justification material supplied to the committee last year in support of the fiscal year 1969 budget indicated a total development cost of the Maverick missile of $98.3 million. The total development cost indicated this year is $142.8 million. This is a very substantial percentage increase. What difficulties have arisen in this development program to account for this increased cost?

General MCNICKLE. This goes back to my previous answer that we have now definitized the contract. The $142.8 million includes $14 million of prior years' money that was used for the Standard Arm. It was funded in this same program element line. We estimated total Maverick development cost at $122 million and this compares with an estimate of $84.3 million. It is $6 million less than when the books were made. The $84.3 million was an earlier estimate and the $122 million includes a firm contract figure of $94.5 million with Hughes.

Mr. ADDABBO. How do you explain the $38 million differential between an estimate and a firm bid? Are we that far off in our estimates?

General MCNICKLE. Some of the difference is explained by extending the contract definition phase with two contractors; some is explained by placing more stringent requirements on the system; and some is explained by requiring a more extensive flight test program than was originally contemplated. Then, there are the inflationary pressures which had built up between the time of our estimate and the date of the contract.

Mr. ADDABBO. But this is $38 million. It is not a $10 million difference.

Are our Government estimators so far inferior to company estimators?

General MCNICKLE. It is not exactly the same missile. We did increase some of the performance requirements. It takes into account some of the changes for better system performance. A more extensive test program which I would like to detail for the record. It is not exactly the same program that went with the earlier estimate.

Mr. ADDABBO. You had better have the detail because when someone reads this record they are going to say that the Government estimate was $84 million but we went out into the market and agreed to pay $122 million. You are going to have to show us something in order to be able to justify this because we have to go to our colleagues and justify it.

General MCNICKLE. I will.

(The information follows:)

REASONS FOR DIFFERENTIAL BETWEEN ESTIMATE AND CONTRACT PRICE

In the fall of 1967, the R.D.T. & E. portion of the 5-year defense plan contained a program element titled "Tactical Air-to-Ground Missiles." This program element provided a total of $98.2 million; $13.9 million for interim ARM (fiscal year 1967) and $84.3 million for Maverick development. During the period between fall of 1967 and the beginning of operational development in July 1968, studies and test efforts were conducted by Hughes Aircraft Co. and North American-Rockwell in which the present development program was established. These tests and studies led to changes in procedures, system performance requirements, and hardware quantity and type which are now incorporated in the development program with Hughes Aircraft Co. The breakout

of each change and corresponding increase to the estimated program cost follows:

	Millions
Improved guidance system development	$3.3
Additional testing to meet increased reliability requirement	7.1
Increased number of test missiles	6.6
Increased number of launcher adapters	.2
Revised configuration and quantity of captive pod trainers	1.8
System engineering changes to accomplish increased guidance accuracy, improved safety engineering, and configuration management	4.8
Contract definition extension	2.0
Government furnished material	.3
Increased data requirements	3.7
Training requirement	.6
Allowance for engineering changes	2.9
Increase due to stretchout of program	4.9
Total increase	38.2

These changes increased the Maverick development program to $122.5 million. An additional increase of $6.4 million was made to the "Tactical air-to-ground missiles" program element to provide for anticipated changes to Maverick in future years.

The following table summarizes the increases discussed above:

[In millions of dollars]

	Original estimate	Revised estimate	Difference
Maverick	84.3	122.5	+38.2
Future changes to Maverick	0	6.4	+6.4
Interim arm	13.9	13.9	0
Total program element	98.2	142.8	+44.6

USES FOR MAVERICK

Mr. ANDREWS. How does this Maverick compare with the Navy Condor missile?

General MCNICKLE. The Condor is a big missile, whereas this is a small one. The Condor has a large warhead and a range of about ——— miles, whereas the Maverick has a small shaped charge warhead and a maximum range of ——— miles which is suitable for a small land target such as a tank. The Maverick will have a flyaway target cost of ——— and a target price of ——— for the first ——— missiles. The Condor costs about ———. They are for different purposes.

Mr. ANDREWS. What do you have in your arsenal now comparable to the Maverick?

General MCNICKLE. We do not have a missile with the characteristics of the Maverick. The closest thing we have is the guided bombs but they do not have the speed, the range, or the penetration capabilities of the Maverick.

Mr. ANDREWS. What is the purpose of this missile; against tanks?

General MCNICKLE. Tanks, pillboxes, hard tactical targets.

Mr. ANDREWS. You are not replacing any presently used missile with Maverick?

General MCNICKLE. We do not have a guided rocket with a hard target kill capability.

Mr. ANDREWS. Is this similar to Bullpup?

General McNICKLE. No, sir, it is not very similar to Bullpup. It is longer range and it will have a lot better kill capability than the Bullpup.

Mr. ANDREWS. Will it have an atomic warhead?

General McNICKLE. No.

MAVERICK COST OPTIONS

Mr. ANDREWS. I think you have answered the next question: What is the currently estimated total procurement of Maverick missiles anticipated? You said it would be ——— each.

General McNICKLE. It depends on the quantity you buy. We have three options in the contract.

Mr. ANDREWS. What are they?

General McNICKLE. The unit target price for option A, which is for ——— missiles, associated containers, launcher adapters, AGE, training data, and long leadtime items is ——— each; option B for the next ——— missiles is ——— each; option C for another ——— missiles is about ——— each.

Mr. ANDREWS. ———.

General McNICKLE. Actually ———. Between the three I gave you, it would average about ——— for the missile only in the first ———. If you buy the last ——— it is about ——— per missile. If you buy only ——— with all the support equipment it is ——— each.

Mr. ANDREWS. You gave me the median?

General McNICKLE. I gave you the ——— target cost on the first ——— missiles, I probably should have given you about ——— for the entire ——— which includes the last ——— at about ——— each.

Mr. ANDREWS. That indicates you want ——— of them, because for the last ——— missiles you could get them at ——— per missile.

General McNICKLE. Yes, sir.

Mr. ANDREWS. After having spent $122.8 million on the R. & D. program?

General McNICKLE. Yes, sir. We would plan to spread that much R. & D. over a buy on the order of ———.

Mr. ANDREWS. If that contract does not escalate 25 percent more in the next year, like it did in the past year.

General McNICKLE. Well, we have a fixed price incentive fee contract now; before, we had an estimate for a lesser development program.

Mr. ANDREWS. But you gave us the idea that you have an escalation clause in that contract to take care of cost growth, inflation, overrun, or whatever you want to call it.

General McNICKLE. Yes, sir; I am sure we do; but it would come in downstream to take care of abnormal escalation.

Mr. ANDREWS. Now, when you pay ——— per missile, if you buy ——— missiles you are not taking into consideration the R. & D. cost of the missiles, are you?

General McNICKLE. No, sir. These are production options that we have with the contractor. They are separate from the development contract.

Mr. ANDREWS. Suppose you get your contract for R. & D. at $122 million and you get ——— missiles, what would that add to the ——— cost per missile if you buy ———. Figure it out and put it in the record.

What plane will you use these missiles on?

General MCNICKLE. On the F–4, and the A–7.

Mr. ANDREWS. How about the F–111?

General MCNICKLE. No, Mr. Andrews, we do not now plan to use the F–111 with the Maverick.

Mr. ANDREWS. Will there have to be any modification of the planes to use the missile?

General MCNICKLE. There will have to be some.

Mr. ANDREWS. How much will that cost? Do you have any opinion?

General MCNICKLE. No, sir.

Mr. ANDREWS. For the record, what will the total cost per missile be, counting the R. & D., the modification of the planes, and the purchase price of the missile? Give us the total amount and then the unit cost per missile.

General MCNICKLE. Yes, sir.

(The information follows:)

The costs to develop the missile, produce ——— and modify ——— F–4D, F–4E, and A–7D aircraft are given below.

R.D.T. & E. cost	$122,500,000
Production ———	235,300,000
Aircraft modification	16,625,000
Total	374,425,000

MAVERICK PERFORMANCE OBJECTIVES

Mr. ANDREWS. What are the present performance objectives of the Maverick development program?

General MCNICKLE. A range of ——— miles against small, hard stationary or moving targets, tanks, armed personnel carriers, field fortifications, concrete buildings. It is going to weigh approximately 500 pounds, with a kill probability of ——— and a mission reliability of ——— and a mean miss distance of ——— feet against targets with a maximum linear dimension of ——— feet. Its mode of operation will permit the aircraft to launch and leave. The pilot does not have to track the missile into the target as he does with the Bullpup.

Mr. ANDREWS. Does the missile lock onto the target?

General MCNICKLE. Yes.

Mr. ANDREWS. Briefly, how, in layman's language?

General MCNICKLE. It has a TV in its nose and the pilot has a monitor. He sets the TV on the target and then the missile tracks that target from launch to impact.

Mr. ANDREWS. Once he releases it?

General MCNICKLE. The missile stays locked on to the target and the launching aircraft is free to leave or find another target.

Mr. ANDREWS. Is there a possibility of jamming it?

General MCNICKLE. No, sir; at least no easy way.

Mr. ANDREWS. Is it an all-weather missile?

General MCNICKLE. No, sir.

Mr. ANDREWS. The pilot must see the target before he fixes it on the lock?

General MCNICKLE. Yes, sir.

CHANGES IN PERFORMANCE OBJECTIVES

Mr. ANDREWS. Have there been any changes in the performance objectives from those originally planned?

General MCNICKLE. No, sir; other than those I mentioned. We are demanding higher reliability.

Mr. ANDREWS. In other words, have you had to downgrade the performance of the missile because of the problems which have arisen?

General MCNICKLE. No, sir; we have not downgraded it since we laid it down in 1968 in the contract.

Mr. HANSEN. No problems have arisen.

Mr. ADDABBO. Going back to the difference between the estimate and the contract price—one of the reasons for the increase was because of changes. Now you say there have been no changes. Have there or have there not been any changes?

General MCNICKLE. Since we have gone on contract; no. We have a fixed price and we have not made any changes.

Mr. ADDABBO. All changes were made prior to the contract?

General MCNICKLE. Prior.

Mr. ADDABBO. After your first estimate but prior to the signing of the contract.

General MCNICKLE. That is right.

Mr. ANDREWS. You made changes prior to the contract?

General MCNICKLE. Yes.

Mr. ANDREWS. What occasioned the changes? Did you upgrade or downgrade the capability?

General MCNICKLE. We increased the performance requirements and we expanded the test requirements. Other than that, I do not know of any.

(Clerk's note: For additional information see pages 691 and 692.)

Mr. ANDREWS. The Maverick development program is under a total package procurement contract. To what extent have cost overruns in this program been shared by the Government and the contractor?

General MCNICKLE. We have not had any overruns, Mr. Andrews, but it would be a 70–30 sharing arrangement between the target price and the ceiling.

Mr. ANDREWS. Who picks up the 70 percent?

General MCNICKLE. The Government picks up the 70 percent up to the ceiling—that is our maximum liability.

Mr. ANDREWS. The contractor picks up 30 percent?

General MCNICKLE. Yes. Over the ceiling, the contractor picks up all of it.

Mr. ANDREWS. Picks up all over ceiling costs?

General MCNICKLE. Yes.

Mr. ANDREWS. What is the estimated date for initial operating capability for this missile?

General BOYLAN. ———.

PLANNED USE FOR MAVERICK

Mr. ANDREWS. Would you have a need for this missile in South Vietnam today?

General BOYLAN. The missile would have utility in South Vietnam. That is not its principal purpose for development. There are hard points, pillboxes, similar structures that the missile, being a penetrating missile, could attack successfully. ———.

Mr. ANDREWS. If the war is still with us when you have this missile in operation—and I predict the war will be with us for many years, but that is just my thought, we are not fighting to win—but if the war is still going on, would you have the need for this missile, and would you use it?

General BOYLAN. Yes, sir; absolutely. If the war is still being prosecuted in South Vietnam when this missile enters the inventory, I am personally confident the Air Force would test the missile under field conditions.

Mr. ANDREWS. You have pillboxes in South Vietnam today?

General BOYLAN. Of a sort.

Mr. ANDREWS. What are you using to knock them out, what weapons?

General BOYLAN. They have bunkers, and so forth. We are using all types of weapons, B–52 strikes through fighter-bombers with iron bombs, as well as rockets. Napalm, as well, is used.

Mr. ANDREWS. What has been the most effective?

EFFECTIVENESS OF B–52'S

General BOYLAN. Based on the information and reports I have seen, I would say against the type of fortification, talking about caves, bunkers, et cetera, in South Vietnam, the B–52 has been the most effective. This is principally because many of the structures are not only hidden by foliage, but hidden by trees. The intelligence report gives you really an area target and B–52 successfully attacks that type of target.

Mr. ANDREWS. How do your B–52 pilots spot these targets?

General BOYLAN. The B–52 pilot, per se, does not spot the target. He is under very precise radar control. The target is pre-identified through intelligence and by other means, visual by the forward air controller type or by reconnaissance. The target is identified. The B–52 strike is laid on. The number of aircraft assigned to each target is predetermined but can be modified in the air as well as targets changed while they are airborne. But they fly a pattern which is generally the same. They leave certain departure points and are vectored by precision radar to a precomputed bomb release point. The accuracy of this type of radar bombing is, I would term it, "fantastic." It is very precise. The confidence in the precision is such that, as you know, B–52 strikes were used in areas like Khe Sanh, they have been used in relatively close proximity to not only our forces but the civilian population as well.

Mr. ANDREWS. They are most effective if they can hit the target; no question about that.

General BOYLAN. Absolutely, sir.

Mr. ANDREWS. Now, this Maverick would not be an effective weapon for anything in the jungle?

General BOYLAN. Not against a trench or a cave.
Mr. ANDREWS. You have to have a picture of the target?
General BOYLAN. Yes, sir.
Mr. ANDREWS. All right, gentlemen; we will adjourn until 2 o'clock.

AFTERNOON SESSION

AIM 4–D GROWTH

Mr. SIKES. The committee will come to order.
We are now ready to consider the AIM 4–D growth project for which $2.7 million is requested. Will this amount complete the program?
General MCNICKLE. Yes, sir.
Actually, this program has been renamed and is now called air-to-air missile improvement and the $2.7 million will give the AIM 4–D growth a ———.
Mr. SIKES. How successful has the program here?
General MCNICKLE. It is just getting started now. In fact, we just signed the contract on the 16th of May.
Mr. SIKES. Have there been any real accomplishments to date?
General MCNICKLE. Not yet. We just signed the contract.
Mr. SIKES. For the record, supply some information on what you expect to accomplish, the purpose, characteristics.
General MCNICKLE. Yes, sir.
(The information was provided to the committee and is classified.)

HARD ROCK SILO DEVELOPMENT

Mr. SIKES. The fiscal year 1969 budget proposed a $38 million effort in the Hard Rock Silo program in fiscal year 1969. The current justification indicates that only $25 million was applied to the program in fiscal 1969. What accounts for this change?

REDUCTION IN 1969 FUNDING

Mr. HANSEN. It is the change in the schedule. It was decided to stretch out the program.
Mr. SIKES. Is this deliberate or was it slippage?
General PITTS. It was a decision made to develop a demonstration prototype installation first. We would then have a silo that could be deployed. This would reduce the program from $38 million to $25 million. Since that time, the program has further been reduced to $23 million because the hard rock site survey work for operational silos has been accomplished with funding out of the O. & M. appropriation.

EXPLANATION OF PROGRAM

Mr. SIKES. This is still somewhat new to a great many people. Tell us at this point just what you propose to do and the reasons for it.
Mr. HANSEN. The plan is to have the hard rock test which demonstrates the ability of the Hard Rock Silo concept to withstand the blast and other effects of nearby explosions. Then, based on the presumption that those tests are satisfactorily passed, we would have the option to

go ahead with a program of drilling new holes for the Minuteman in hard rock and moving the sites to those holes.

Mr. SIKES. This, of course, is a major undertaking. It is going to cost a great deal of money. What is the reason back of it? Is it felt it is essential for the protection of the missiles?

Mr. HANSEN. Yes, sir. We assume that some incoming reentry vehicles are targeted on the Minuteman silos and with increasing guidance accuracies will get through. Therefore, in order to preserve the retaliatory capability of our Minuteman system, we consider we should have an appropriate ——— equivalent hardness silo capability.

Mr. SIKES. Is this coordinated with Safeguard? Would you require both?

Mr. HANSEN. Yes, sir; the two are complementary. The presumption is that Safeguard would not be able to stop all of the incoming RV's. For those that come through, we would have to have a certain amount of ability to survive them in order to preserve the desired retaliatory force.

Mr. SIKES. I would suggest you expand on these answers when the record comes down to you.

Mr. HANSEN. Yes.

(The information follows:)

HARD ROCK SILO

Defense and hardened silos are complementary. The U.S.S.R. has the choice of employing its nuclear payload in one of two ways, either relatively large reentry vehicles with relatively high yields which implies fewer reentry vehicles or smaller reentry vehicles with smaller yields in greater numbers. If we counter their large reentry vehicles with defense, then their move is to the MIRV and penetration aids to attempt to defeat our defenses by force of numbers and deception. However, if our silos are hardened, the reentry vehicles which penetrate the defense (for example, by exhaustion) must be large. Hence, the combination of defense and hardening forces the U.S.S.R. with a need to have both many and large reentry vehicles. These conflicting requirements present them with an economic dilemma.

NEED FOR BOTH SAFEGUARD AND HARDROCK

Mr. ADDABBO. As the chairman says, it would seem if you have the hard silo you do not need the Safeguard. You say if the Safeguard does not take care of it, the hardened silo will. If the hardened silo will protect the missile, why do you need Safeguard?

Mr. HANSEN. It depends on the size of the Safeguard system. It is a matter of balance between hardening of silos and size of a defensive force that is provided. An attempt is made in the thinking to size a Safeguard force and the hardening so there will be an economic balance between them to minimize the overall cost of protecting the retaliatory force.

Mr. ADDABBO. What would be the cost of a hardened silo as compared to anyone of the ABM missiles we are speaking of?

General MCNICKLE. It costs about $6 million to build a silo in hard rock and install an existing missile.

Mr. ADDABBO. What does it cost to develop the missile?

Mr. HANSEN. I think we are oversimplifying the problem because I think even a Hard Rock Silo can still be killed if the accuracy of the incoming RV and the yield of it are high enough.

Mr. ADDABBO. Then you do not need the hard rock if it can be killed off?

Mr. HANSEN. The hard rock is to keep it from getting killed with a near miss.

Mr. ADDABBO. What would be a near miss?

Mr. HANSEN. I do not know whether I can quote a number on that.

Colonel GROSSMILLER. The Hard Rock Silo is based on the capability of the SS-9 possibly achieving with MIRV a CEP of a ——— or less.

Mr. LIPSCOMB. When did you develop that kind of an expectation?

Colonel GROSSMILLER. ———.

Mr. LIPSCOMB. When did you introduce the SS-9 into the problem?

Colonel GROSSMILLER. Any enemy missile that would have the capability of placing a warhead of about ——— yield within ———.

Mr. ADDABBO. You believe Russian missiles do have an accuracy of at least ———?

Colonel GROSSMILLER. It is possible they could have that accuracy in the time period we are speaking of in the 1970's; yes, sir.

General PITTS. Our Minuteman III is being developed to achieve ——— circular error probable—CEP. ———.

Mr. ADDABBO. According to your information, is the SS-9 warhead larger than our contemplated warhead on our MIRV?

General PITTS. Yes, sir. I believe the SS-9 has a 25-megaton warhead.

THE 1970 SCHEDULE

Mr. ADDABBO. You are requesting a hundred percent increase in fiscal year 1970. How firm is your request for $50 million for the Hard Rock Silo program in fiscal year 1970?

Mr. HANSEN. Based on the schedule we are operating to and the plan we have, that seems to be a good number.

Mr. LIPSCOMB. What is the plan you have?

General PITTS. We requested $80 million for fiscal year 1970, Mr. Lipscomb, and we were reduced to $50 million, which caused the program to slip. I do not know if you were here when I stated that the program had been reduced previously to go for a prototype installation demonstration before committing to production of the operational system. The program has been reduced from $80 to $50 million in this year's budget, which results in slipping the full scale prototype test from ——— to ——— and the initial operating capability from ———.

We feel $50 million is firm if we want to hold to those schedules. We have already slipped them.

SITE SURVEYS

Mr. LIPSCOMB. It is my understanding that you are now in an investigation for sites.

General PITTS. Yes, sir.

Mr. LIPSCOMB. Where are you on that?

General PITTS. The site surveys are going on now.

Mr. LIPSCOMB. How firm is your program for 1970? I have been under the impression that you have not yet been too successful.

General PITTS. Pardon me, sir?

Mr. LIPSCOMB. I have understood you have not been too successful in finding the sites or the hardened ground. You are still looking for enough suitable sites.

General PITTS. In addition to the site survey, some contracts have been let for development.

I will ask Mr. Jackovich.

Mr. JACKOVICH. The information I have is that a contract was awarded to TRW for systems engineering and technical direction on the program in May of 1968. Boeing was also awarded a contract in August of 1968 for engineering support and I understand an additional contract was recently awarded on this program.

Mr. HANSEN. A facility contract to Bechtel.

Mr. LIPSCOMB. But the contracts are awarded on what? The last I heard on the program was that an investigation was underway looking for sites and for the proper materials in those sites where you could do the work.

Mr. JACKOVICH. Site surveys are to be completed under current schedule by ———.

Mr. LIPSCOMB. The site survey?

Mr. JACKOVICH. The associate contractor has been selected. That was in May of 1969.

Mr. LIPSCOMB. For what work have the contractors been selected?

General PITTS. For system engineering of the Hard Rock Silo system, sir, based on a projected completion of the site surveys and selection of appropriate sites by ———.

PROTOTYPE DEVELOPMENT

Mr. LIPSCOMB. Has the decision been made and instructions given to go ahead on the Hard Rock Silo program?

General PITTS. For a prototype.

Mr. LIPSCOMB. Where is that site for a prototype located?

General MCNICKLE. We have not selected the site yet.

Mr. LIPSCOMB. For what are the contracts being made?

General MCNICKLE. We have tested the closure with an explosion. We will test the upper 65 feet of the silo ———. We have a test in preparation with a direct induced ground shock as well as ——— pounds per square inch of air blast. A simulation test with a full scale prototype silo is scheduled ———. But we are testing components of that right now.

Mr. LIPSCOMB. Do you know that we are going ahead with Hard Rock Silo?

General MCNICKLE. For deployment, Mr. Lipscomb, we do not. We have approval to go ahead with one, a prototype.

Mr. LIPSCOMB. Was that approved by OSD?

General MCNICKLE. Last year; yes, sir.

Mr. LIPSCOMB. And you are funded for that one?

General MCNICKLE. Yes sir, we are funded through fiscal year 1969 and we are requesting the fiscal year 1970 funds at this time.

General PITTS. We previously spoke to the 1969 estimates which were originally $38 million and they are now $25 million. It was brought out that the reduction was to go for a single prototype silo first, and having demonstrated that, then go to full development of a system.

So those fiscal year 1969 funds will start us toward the one prototype system. The fiscal year funds are needed in order to maintain the schedule I iterated a few minutes ago. We had asked for $80 million. The answer to the question, Is this a firm estimate, is "Yes," if we want to maintain that schedule.

Mr. SIKES. What will one hole cost furbished and ready to use?

General PITTS. I have an estimate here for the full-scale prototype of $278 million.

Mr. SIKES. What is included in the prototype?

Mr. JACKOVICH. Our estimate for the Hard Rock Silo is $278 million. That includes the whole command and control system, and the other mechanisms and associated gear that would go into the hole.

Mr. SIKES. Does the follow-on site cost as much?

General PITTS. No, sir; $6 million apiece.

Mr. SIKES. Why should this one cost so very much more?

General MCNICKLE. The $6 million is on the basis of ——— holes, it would be $6 million per Hard Rock Silo.

PROGRAM BASED ON INSUFFICIENT INFORMATION

Mr. LIPSCOMB. Overall the Hard Rock Silo development program is still unclear. The cost of the prototype is $278 million, according to the estimate that was just given. Then there was a cost per hole of $6 million on a ——— hole program.

What total program are you anticipating embarking upon at this point? What total cost to completion do we have on it? ——— holes at $6 million each?

Why do we need ——— holes or should we have ——— holes? Is this an example of coming to Congress and starting out on a massive program with very little details being given to the committee? At this time there are some sort of a site survey, or site selection teams going around the country looking for the proper granite in which to place holes. It seems what we are doing is starting a $278 million project for a prototype hole plus a program of $6 million per hole. And I just cannot conceive that $6 million a hole is a correct figure.

General MCNICKLE. We have no approval to deploy these, we are asking for funds to develop and test the prototype hole.

Mr. LIPSCOMB. Why do we even need that hole until we get a program which would indicate where we might be going?

General MCNICKLE. The reason for the one hole is to find out whether or not the hard rock will provide the anticipated protection. This is the direction the program has had.

Mr. LIPSCOMB. And what effort has been made to find it out without digging a $278 million hole?

General MCNICKLE. We have tested the closure already.

Mr. LIPSCOMB. You have been conducting tests in holes down in Mississippi or Louisiana?

General MCNICKLE. Tunnels and so on.

Mr. LIPSCOMB. So there are various kinds of testing already going on. Will that not provide the basis to determine if we really need the program before we embark on another $50 million this year and another $220 million next year?

Do we really need this? I think you know I am for adequate defense, but I just cannot see embarking on a $278 million program with as little information as you are willing or able to give us now.

Mr. HANSEN. I think we came at it from the other direction. There was a concept to put Minuteman in hard rock sites. Before advocating such a program we want to build one, make a rather comprehensive

setup to test it, and make sure that it will really do what we have estimated from analysis.

Now, the number ——— refers to ——— the actual number again comes out of a consideration of how much of the capability has to be reasonably assured to be enough of a retaliatory force and whether it is ——— I guess can be subject to some additional argumentation, but I know there has been analysis that says a reasonable number out of the thousand total to make hard would be ———.

NEED FOR HARD ROCK PROGRAM

Mr. LIPSCOMB. Has there been an analysis made recently to determine if we need a Hard Rock Silo program? A lot of things have happened in the last 12 months.

General PITTS. Yes, sir.

Mr. LIPSCOMB. And was the decision made that we need a Hard Rock Silo program?

General PITTS. This is the considered opinion of the Joint Chiefs of Staff. It is their proposal.

Mr. LIPSCOMB. As of how long ago?

General PITTS. For the funding for this budget?

Mr. LIPSCOMB. That was November 1968?

General PITTS. Yes, sir.

Mr. LIPSCOMB. At the latest?

General PITTS. If you will, this is like a "fly-before-you-buy" approach on this system: In other words, to prove the feasibility prior to going to full scale deployment of the entire system.

Colonel GROSSMILLER. This is an expansion of my SS–9 discussion, but any missile capable of throwing, I said ——— —I want to correct that, it is ——— megatons within ——— nautical miles—you are going to need about ——— p.s.i. to withstand that. They predict if a missile throws three weapons of ——— which would be ——— megatons, against one target, we could still withstand with ——— p.s.i. an effective CEP over ——— nautical miles.

As you know, the Hard Rock Silo originally came as part of the advanced ICBM program, that we had proposed. This was ——— psi for that missile. When the go ahead was not approved for the advanced ICBM, we wanted to improve the survivability of the postulated missiles we will have during the 1970 time period, which will primarily be the Minuteman III, we decided to look at the Hard Rock Silo to support it.

This test program is probably the cheapest way to insure confidence in the minds of civilian decisionmakers that we can develop something this hard. We have confidence from the engineering studies that it can be done.

NEED FOR BOTH SAFEGUARD AND HARDROCK

Mr. LIPSCOMB. If you are going to develop a massive Hard Rock Silo program beginning with a $278 million prototype, what is the necessity of going ahead with any antiballistic missile system such as the Safeguard? That is a question for the Air Force to answer and if you want to do it, here, go right ahead. I would like to hear it.

Colonel GROSSMILLER. I believe in this instance we would need to put 1,000 missiles in harder silos if we did not have an ABM capability.

First, the ABM will give you an opportunity to withstand a small attack, give time for decisionmakers to decide what firing order they are going to want to have with our ICBMs, and how we will fire them, whether they will go out in a salvo or go out in a time ripple that they can select based on the type of attack that we are under.

With a hardened rock silo, if the Soviet or any other enemy warheads were to come through the ABM, at that time we would be able to withstand a hit of up to ——— nautical miles and still retaliate with our offensive force.

Mr. LIPSCOMB. Do you think that we need both?

Colonel GROSSMILLER. Until we can positively prove that one is more effective than the other, I believe we do need to test both.

Mr. LIPSCOMB. What is your timing on your test prototype, providing you ever find the site to put it in.

General PITTS. ——— with IOC if that proves out to ———.

Mr. LIPSCOMB. Is the Air Force supporting the antiballistic program of Safeguard?

General PITTS. Yes, sir.

Mr. LIPSCOMB. To your knowledge is there any indication of the Department of the Air Force opposing or indicating opposition to the Safeguard in order to push the Hard Rock Silo development program?

General PITTS. Not that I know of.

Mr. HANSEN. No, sir.

As I mentioned before, we think these are complementary. I don't think the point that the hard rock does not provide protection against a direct hit has been emphasized enough. If their accuracy got sufficiently better, even the hard rock would not protect the retaliatory capability. So you protect it with a combination of kills of incoming RV's and the ability to withstand near misses. To depend entirely on a Safeguard system to kill every incoming RV and not let anything at all get through, is probably a pretty unreasonable requirement.

I think it is generally unreasonable to protect the Minuteman force entirely by hardening. I am sure that the most economical solution for protection of a reasonable retaliatory capability is to have a combination of these two—some hardening and some active defense.

Mr. ADDABBO. Will the gentleman yield?

Mr. LIPSCOMB. Yes.

CIRCULAR ERROR OF PROBABILITY (CEP) ACCURACY

Mr. ADDABBO. Would it not be just as unreasonable to presume that every one of the Russian missiles that got through would be a direct hit?

Mr. HANSEN. Yes, I think it would be unreasonable to assume every one would be a direct hit.

Mr. ADDABBO. So we would still have some Minuteman ready for retaliatory action?

Mr. HANSEN. I think based on our estimate of their technology it would be reasonable to believe they would be able to get a CEP of

like ———. And ——— CEP with our present silo hardness would knock it out. With the Hard Rock Silo, it would survive a miss of that distance. Thus, although a larger number of "direct hits" are unlikely, we could expect many near misses, near enough to destroy our present silos.

Mr. ADDABBO. What do you base these estimates on of CEP's?

General PITTS. On our capability, sir, and I think with all prudence we have to make the assumption that with their demonstrated technology so far they would be able to achieve a comparable CEP.

Mr. RHODES. What CEP would it take to knock out a rock hardened silo?

General PITTS. Colonel Grossmiller has testified to a ———.

Colonel GROSSMILLER. No.

Mr. RHODES. This is the present silo.

Colonel GROSSMILLER. That is ——— megatons on a direct hit. Twenty-five megatons, I believe I said ——— nautical miles.

Mr. HANSEN. While he is checking that, I might point out that earlier we said that the objective of our advanced ICBM guidance system was to produce higher accuracy and I do not think I said the number, but the number ——— is the objective accuracy. If they were to be able to produce that kind of an accuracy, they would be able to knock out a hard silo.

Mr. RHODES. In other words, if one of their missiles with how many megaton capacity came within ——— the results would be to knock out a rock hardened missile?

Colonel GROSSMILLER. I have one value that does not answer it specifically. One we provided in previous testimony was the lethal radius for SS–9 missile, with 25 megaton warhead against a ——— p.s.i. Hard Rock Silo was ——— natutical miles. So that would get it, 25 megaton.

Mr. RHODES. If the SS–9 were to be fired with a 25-megaton warhead at one of our present sites, what would the CEP have to be in order to knock it out so we can get a comparison as to the difference?

Colonel GROSSMILLER. I know our criteria for site selection when we made them was ———. So it would be on the order of I would say ——— nautical miles.

Mr. RHODES. As against CEP of ———.

Colonel GROSSMILLER. ———.

Mr. RHODES. Off the record.

(Off the record.)

Mr. RHODES. How far into the hard rock will you have to penetrate in order to get the required p.s.i. of hardness?

Mr. HANSEN. We will have to furnish that for the record.

General MCNICKLE. I think it is about ——— feet, however.

(The information follows:)

The depth of the silo is a function of the missile size. In order not to preclude the use of a larger missile in the future, we plan to make the silo launch tube ——— to ——— feet in diameter and up to ——— feet deep. Some surface rock must be removed if it is weathered in order to have the top of the silo and its closure situated in competent rock.

Colonel GROSSMILLER. The particular site is to be designed to take a larger sized missile, advanced ICBM, as well as the Minuteman III.

PROTOTYPE SILO

Mr. RHODES. Where will you put this experimental silo?

General MCNICKLE. The rock they have located so far which appears to be adequate is in ———. The site for the prototype silo will be selected this summer.

Mr. RHODES. Are you going to fire a bird out of that? Would that not be part of your experiment to make sure a bird will come out of it?

General MCNICKLE. No, sir.

Mr. RHODES. Why would you not do that? What good is the hole if you do not know whether or not a bird will fly out of it?

Mr. HANSEN. The test on the hole is to conduct a final phased series of blasts over it to produce a simulation of the effect of nearby bursts.

Mr. RHODES. I may not have all of the facts and probably do not. But you had difficulties getting a Minuteman to fly out of a silo up in North Dakota.

General MCNICKLE. Those were seven second test articles made to simulate missiles, they were not real Minuteman missiles.

Mr. RHODES. Would it not be part of any prudent test to not only test the hardness but to test the operational facilities of your bird as married to this particular silo? You are not going to ask us to build a new missile to fit this silo, are you?

General MCNICKLE. No, sir.

Mr. RHODES. You had better not.

Mr. ANDREWS. I assume that it will be modified or changed in some way.

General MCNICKLE. The holes are being engineered to take a Minuteman III, but they would also be able to accept a follow-on missile.

SILO MODIFICATION

Mr. ANDREWS. Let me ask you this question: Are the silos the Minutemen are in today the original ones that were built for them?

General MCNICKLE. Yes, sir; but many of them have been extensively modified.

Mr. ANDERWS. But you have had only one hole?

General MCNICKLE. Yes.

Mr. ANDREWS. Did you not beef up some of those silos after they were first constructed?

General MCNICKLE. We hardened missiles and holes.

Colonel GROSSMILLER. They did some modification to take care of suspension systems, and so forth, but not as far as pouring more concrete or beefing it up as far as steel is concerned or something on that order.

Mr. ANDREWS. In other words, you have them in the original hole today?

Colonel GROSSMILLER. Yes, sir.

PLAN FOR 1969

Mr. SIKES. I think there is some confusion about the purposes for which the money is being expended. Will you give us a breakdown of what use you are making of the $23 million being expended in fiscal 1969? Do you have that before you? Give us the main items at this point and complete the list for the record.

General MCNICKLE. I have a listing of 1969 if you would like it, or I can put it in the record.

Mr. SIKES. Give us the principal ones.

General MCNICKLE. $5.6 million for system engineering and technical direction and development of the hard rock specifications, $5.1 million for systems definition and studies, $2.4 for engineering design and development of the Hard Rock Silo equipment, $1.4 for preliminary system concept and facility design, and $8.5 for supporting technology such as rock test 1 and 2, structures, closures, silos, antenna, cable, and so on.

The total is $23 million.

Mr. SIKES. In each case provide a definition of what it is that is included by the terms.

General MCNICKLE. Yes, sir.

(The information follows:)

HARD ROCK—1969 FUNDS

Our original estimate of costs by contract was: TRW $5.6 million, Boeing $7.5 million (two contracts, $5.1 and $2.4 million), facility contractor the Bechtel Corp. $1.4 million, and $8.5 million for numerous technology contracts. Because the facility contract was awarded late $0.9 million of the $1.4 million was placed on this contract and $0.5 million was placed on the Boeing and technology contracts due to revised fiscal year phasing. The current breakout by contract is: TRW $5.6 million, Boeing $7.9 million, Bechtel $0.9 million, and technology $8.6 million.

TRW Inc., was awarded a contract for system engineering/technical direction (SE/TD) in May 1968. TRW's responsibilities in fiscal year 1969, were mainly the development of the Hard Rock Silo specification and criteria documentation, preparation of the request for proposals and work statements for the facility and command and control associate contractors and SE/TD.

The Boeing Co., was awarded an engineering support contract in August 1968 with responsibilities for Minuteman interface definition. Boeing was awarded an engineering development contract in April 1969 for installation and test support with related functional task and to start development of Minuteman III/Hard Rock Silo hardware such as: Missile shock isolation systems, missile mount and shock isolated silo floors. The Bechtel Corp., was awarded the facility contract in May 1969. Bechtel will initiate the design process for the prototype silo in fiscal year 1969. Some examples of numerous technology contracts that are underway are: Survivable antennas, silo closure field tests, hardened facility design, ground motion calculations, and power system studies. In November 1968, we tested a full scale silo closure, hardened antennas, and buried communications cables in the first large scale test at ——— air blast overpressure. All the test items survived the environment with no major problems. Work is underway now for the next test in this series to be conducted in ———. Field surveys to locate hard rock areas were initiated in fiscal year 1969 and are complete near ———. Work is continuing in other areas of the country.

PLAN FOR 1970

Mr. SIKES. What do you propose to do with the $50 million being requested for this year? Give us the same breakdown, a general one at this time, and a complete one for the record.

General MCNICKLE. There is $10 million for Bechtel Engineering, $18 million for Boeing, $9 million for TRW, $1 million for alternate

facility contractor, power environmental control system $1 million, the command and control contractor, $8 million, and $3 million for numerous other technology contracts.

Mr. SIKES. What are you going to get for the money?

General MCNICKLE. I will have to provide that for the record.

Mr. SIKES. I am surprised you do not know.

I think we had better postpone the rest of this discussion until the witnesses on your side, Mr. Secretary, have had a chance to study it, and be in better position to respond to the questions of the committee.

Mr. HANSEN. I am sorry I did not think ahead to this subject before we let General Schultz get away. It is his project.

Mr. SIKES. We will take them up again tomorrow.

General PITTS. I think I can give some of the answers.

Mr. SIKES. I prefer to wait until tomorrow when we can get more detail.

(Clerks note: Subsequent to the hearings the Air Force provided the following additional information:)

HARD ROCK—1970 FUNDS

The $11 million is for Bechtel Corp. (the power and environmental control development is now under Bechtel), $18 million for Boeing, $9 million for TRW, $1 million for the alternate facility contractor, $8 million for the command and control contractor, and 3 million for technology.

The fiscal year 1970 efforts of these contractors are: TRW will continue in their system engineering/technical direction role. Boeing will continue in their Minuteman hardware effort, the Bechtel Corp. will continue the facility development working on such designs as: The silo closure and actuator, silo design, environmental control system, electrical power system and shock mounting of facility equipment. We plan to award a contract this summer for an alternate facility contractor to look at alternate facility concepts and materials. During fiscal year 1970 we will award a contract for the Hard Rock Silo command and control (C. & C.) system. We plan to choose two contractors for a design competition phase of 6 months with final contractor selection in January 1970. The C. & C. contractor's job will be to integrate the Minuteman integrated command and control system (MICCS) and the Strategic Air Command's communications systems into the hard rock silo design. The technology efforts will be completed in fiscal year 1970. The second large scale ——— test of silo designs will be accomplished in ———. This test will include direct induced ground shock as well as air blast shock. Hard Rock Silo will have the upper 65 feet of a silo and closure, two one-half scale silos, an alternate closure design, antennas and cables in this test. System design review is scheduled for March 1970.

Site surveys, begun in fiscal year 1969, will also be completed in fiscal year 1970 with $8 million of O. & M. funds.

WESTERN TEST RANGE (WTR)

Mr. SIKES. Turning to the Western Test Range, you are requesting $68.5 million, an increase of $10 million above the $58.5 million program for fiscal 1969. The justification states that the increase is provided to begin development of a "new impact scoring capability for Minuteman." Why is the new scoring capability required, and what is it?

IMPACT SCORING CAPABILITY FOR MINUTEMAN

General MCNICKLE. It is in order to score the ——— reentry vehicles.

Mr. SIKES. You have no present capability for that?

General MCNICKLE. No, sir.

Mr. SIKES. What do you have to do to provide this capability?

General MCNICKLE. We have to be able to put in a scoring capability so we can get data at the various ranges that these reentry vehicles come in. The program includes instrumentation, communications, and facilities for the support of the Minuteman III launches ———.

WESTERN TEST RANGE LAUNCHES

Mr. SIKES. For the record, compare the number of missile and space flight launches at the Western Test Range in fiscal year 1968 and 1969 with those anticipated in fiscal year 1970.

(The information follows:)

In fiscal year 1968 there were 93 missile and space launches. In fiscal year 1969 there were 82 missile and space launches. There are ——— missile and space launches planned for fiscal year 1970.

FEDERAL ELECTRIC CONTRACT

Mr. SIKES. What part of the $68.5 million is for the Federal Electric contract?

General MCNICKLE. $23.3 million.

Mr. SIKES. What is that contract?

General MCNICKLE. It is for services similar to those provided by Pan-Am and RCA for the Eastern Test Range.

Mr. SIKES. What is that?

General MCNICKLE. Support activities of all kinds.

MULTIYEAR INCREASE FOR MINUTEMAN COSTS

Mr. SIKES. Is the $10 million for the Minuteman III a one-time requirement?

General PITTS. No, sir; it is not a one-time requirement. The program will last for several years, sir.

INCREASE IN OPERATING COST

Mr. SIKES. Do you anticipate for fiscal 1971 a lower operating cost of the Western Test Range?

General PITTS. No, sir.

Mr. SIKES. Higher?

General PITTS. Yes, sir.

Mr. SIKES. Why?

General MCNICKLE. We will have more of our launches on the Western Test Range.

General PITTS. Basically, for the additional capability of scoring, Mr. Chairman, which we just spoke about in a few previous questions.

Mr. SIKES. Mr. Lipscomb?

EFFECT OF MOL CANCELLATION ON WTR

Mr. LIPSCOMB. Will the cancellation of the MOL program make any difference to the Western Test Range program?

Mr. HANSEN. Yes; I am sure it will.

Mr. LIPSCOMB. In answer to the chairman's question, about the operating costs of the Western Test Range in fiscal year 1971 it was indicated they would be higher.

Mr. HANSEN. I do not think that included the effect of the MOL. We have General Stewart here with us to talk about the MOL program.

Mr. LIPSCOMB. This is just a question on the operation of the Western Test Range.

Mr. HANSEN. I think we have factors of the additional downrange support required ——— which tends to make the program more costly, and we will have the elimination of the MOL planned activity which will tend to make it less costly. How those two balance out to a net I think we really cannot say right now.

Mr. LIPSCOMB. Is that all you want on this?

Mr. SIKES. No.

What is the overall picture? Will the overall cost be more or less for the western test range in fiscal 1971?

General MCNICKLE. We are putting in downrange installations ——— but whatever buildup we may have needed for MOL, in 1971 and beyond, will not occur now.

Mr. SIKES. You have not cranked in the impact of the MOL?

General MCNICKLE. We have not cranked that in here because it does not affect fiscal year 1970. We have the MOL project officer here to discuss the overall MOL reduction.

Mr. LIPSCOMB. You might have an increase you have not cranked in for the testing of the Spartan and Sprint.

Are they not going to do some testing?

Mr. HANSEN. Yes.

Mr. LIPSCOMB. That is on the Western Test Range?

Mr. HANSEN. Maj. Gen. Jim Stewart is with us, who has been planned. There was a slight increase, I think $1 million, in the Air Force share of target costs for this coming year.

Mr. SIKES. Now do you want to discuss the impact of the MOL cancellation on the cost figure on the western test range?

Mr. HANSEN. Maj. Gen. Jim Stewart is with us, who has been the director of the MOL program.

I might say in a general way before he starts that he is still up to his ears in trying to evaluate just what this cancellation means. But, I think he can answer these questions as authoritatively as we have answers available. I would like to ask him to answer the questions concerning the impact on the anticipated costs for the Vandenberg operation.

Mr. SIKES. All right, General Stewart.

General STEWART. The impact on the Western Test Range of the cancellation of MOL is actually going to be very slight. As you know, Mr. Sikes, the Western Test Range starts with launch sites at Vandenberg and is mainly aimed toward measuring ballistic missiles. The Western Test Range would have contributed tracking support during the launch phase of MOL and then all of the orbital phase would have been supported by our tracking stations that are elsewhere in the world, and support all of our polar orbiting satellites.

So I think that summarizes it there. Little impact or activity in 1971 and 1972 for that portion of the Western Test Range located at Vandenberg Air Force Base, and virtually no impact on the other elements of the Western Test Range.

Mr. SIKES. But you are not now in position to provide dollar figures on the impact?

General STEWART. No, sir; I will give you a figure for the record.
Mr. SIKES. All right.
(The information follows:)

The impact of the MOL is estimated to be a reduction of $125,000 in fiscal year 1970, $1,576,000 in fiscal year 1971, and $400,000 in fiscal year 1972.

DUPLICATION WITH EASTERN TEST RANGE

Mr. SIKES. You have the Poseidon testing on the Eastern Test Range ———. Why is it necessary to have duplicate test capability for the same weapons on the Western Test Range?

Colonel GROSSMILLER. The primary problem is distance that we will fire the Minuteman III, and that is an ICBM of course, whereas Poseidon is much lesser distance ——— nautical miles versus over ———.

Mr. SIKES. What is the distance to Ascension Island on the Eastern Test Range from the launch site?

Colonel GROSSMILLER. I do not have that mileage.

Mr. SIKES. How much?

Colonel GROSSMILLER. I cannot say. The Eastern Test Range is used for R. & D. testing of Minuteman. Western Test Range is used primarily for operational testing.

Mr. SIKES. This is more than ——— miles, is it not?

Colonel GROSSMILLER. I cannot positively say.

Mr. SIKES. General, do you know?

General STEWART. Approximately 4,000 miles.

Mr. SIKES. We like to avoid duplication when it is possible.

Mr. HANSEN. Ascension Island is not equipped with the type of instrumentation that is necessary to score ———.

Mr. SIKES. When you have a range which ——— the extension of that range should be more economical than the construction of a new one.

Mr. HANSEN. We have a range out the other way also. It is just that the terminal impact area is not in the right place. It has to be properly placed for the Minuteman III ———.

(Clerk's note: Subsequent to the hearings the Navy provided the following information:)

The R. & D. test program conducted on the Eastern Test Range is on one launch azimuth and at one range; specifically, 4,400 nautical miles from Cape Kennedy to the MILS net at Ascension Island. Similarly, on the Western Test Range, launches are from Vandenberg to Kwajelein. These tests leave open the question as to whether there are some significant biases if a missile is launched at other azimuths and ranges. Recent tests and an evaluation study conducted by Institute for Defense Analyses (IDA) concluded that it is very important to determine if such biases exist, and this can be done only by launching on different azimuths to different impact points.

While ETR has an outstanding capability for measuring missile parameters for developmental testing, multiple azimuth and range firings of MM III from fixed facilities are not possible. Poseidon is fired from a movable platform, however, which can select both range and azimuth into the ETR impact areas. The ——— complexes which will be availble at WTR will permit more selectivity both range and azimuth for developmental testing of MM III.

Additionally, operational testing facilities already exist at WTR, and these will be used for operational testing (OT) and follow-on testing (FOT) for both missile reliability and missile crew training for MM III.

WTR EMPLOYMENT

Mr. SIKES. For the record, tell us how much military personnel and contract personnel are employed in connection with the Western Test Range, how many Government civilian personnel are paid from this project.

(The information follows:)

There are 216 military and 2,339 contract personnel employed in connection with the Western Test Range. A toal of 458 Government civilian personnel are paid from this project.

REDUCTIONS RESULTING FROM COMPLETED PROGRAM

Mr. SIKES. To what extent are there reductions in the total operating costs on the western test range when programs are completed?

In other words, it seems that when we have built up the cost of operation for a project on a test range, the completion of that project makes no reduction in cost of its operation.

Can you point to any reduction in operating costs in future years on the Western Test Range which are contemplated?

General MCNICKLE. Yes, Mr. Sikes, last year we retired one ship, six items of test equipment, three computer-related equipments, one radar and one missile impact location.

Mr. SIKES. For a reduction of how much?

General MCNICKLE. I do not have the dollars. I will supply it.

Mr. ANDREWS. How many men?

General MCNICKLE. I do not have it.

Mr. ANDREWS. Supply it for the record.

General MCNICKLE. Yes.

(The information follows:)

REDUCTION IN COST/WESTERN TEST RANGE

Excluding the ship, the capital investment for the deactivated equipment is $4,100,000. A total of 40 people were involved in operating these equipments for an annual cost of approximately $400,000. Although these people were no longer used for this equipment, they were used for new range requirements and to fill normal attrition vacancies at the range.

The capital investment for the ships, the USNS *Richfield*, was $18 million. The yearly operating cost for the ship was $1,200,000. The ship and crew have been returned to MSTS resources. Our budget for this item was adjusted.

Mr. HANSEN. I might say there is a formal procedure under the commander of the western test range to periodically hold reviews of the facilities versus the programs that are current and in the planned phasedown of those programs to forecast what facilities will be able to be closed down. They then follow up and close them down when they are no longer required.

The range people are very sensitive to this particular requirement to get the systems out of operation when they are no longer needed

because they are pushed pretty hard to try to get their operating budget down.

Mr. SIKES. Other questions on the Western Test Range?

EASTERN TEST RANGE

Mr. SIKES. On the eastern test range you are also requesting an increase of about $9 million above the sum programed for fiscal 1969. How much of the increase is due to ship modification in support of Poseidon?

SHIP MODIFICATIONS FOR POSEIDON

Mr. HANSEN. All of the $10 million is to modify one range ship to support Poseidon.

Mr. SIKES. Is only one ship involved?

Mr. HANSEN. Yes, sir.

Mr. SIKES. Describe the modifications that are required. Do that for the record.

(The information follows:)

The ship will be an existing range ship modified to support the telemetry, command/control and communications requirements of the Poseidon OT/FOT program. It will be used as the down range support ship (DRSS) and will be stationed approximately 100 miles down range of the launch point. ———. The major costs are involved in new instrumentation and ship habitability modifications.

Mr. SIKES. Where will the modification be done?

Mr. HANSEN. It will be done at a shipyard which we will determine through competitive bidding. We do not know yet.

Mr. SIKES. Do you have a time problem on this?

General MCNICKLE. No, we have not. We do have on aircraft that provide an alternative method of providing the support when the ship is laid up.

Mr. SIKES. Should this not be charged to the Poseidon program rather than to the Eastern Test Range?

General MCNICKLE. It could be, but the reason it is charged to the test range is because that is the way it was originally set up. The Air Force was put in charge of the range, this ship is run by MSTS, but budgeted by the Air Force. It could just as well be charged to Poseidon.

General PITTS. It is a national range and the Air Force is executive agent for that range, sir.

Mr. SIKES. Why do you need this ship modification for the Poseidon program. Is that the only requirement?

General MCNICKLE. Yes, sir, it is to put in a compatible telemetry system and command destructor.

NASA SUPPORT OF EASTERN TEST RANGE

Mr. SIKES. In past years the committee has pressed for a greater sharing of the cost of the operation of the Eastern Test Range by NASA. I would like for the record NASA's support for the past 5 years, the Air Force support, what is projected for fiscal 1970.

(The information follows:)

The following has been the total Air Force cost of operating the Eastern Test Range (all appropriations) for the past 5 years are estimated for fiscal year 1970. NASA reimbursements to the Air Force are also shown.

[In millions of dollars]

Fiscal year	Air Force	NASA
1970	208.8	38.3
1969	198.9	42.2
1968	213.8	24.9
1967	231.7	28.3
1966	224.1	26.5
1965	224.2	11.5

Mr. SIKES. Has the Air Force realistically pursued the matter of a greater contribution from NASA.

General MCNICKLE. Mr. Chairman, I think you are aware that NASA and the DOD could not agree. The Bureau of the Budget set up some tentative ground rules and we are still operating under them.

Mr. SIKES. Did they improve the Air Force position or not?

General MCNICKLE. We do not think NASA pays enough.

Mr. SIKES. Did the new ground rules improve the picture for the Air Force?

General MCNICKLE. No, sir.

Mr. SIKES. It did not?

The Air Force is pretty effective in getting what it needs, sometimes in getting what it wants. Why is it you have not done better in this instance?

Mr. HANSEN. There has been a great deal of negotiation. I know that for a fact.

Mr. ANDREWS. What is the reason you cannot negotiate effectively?

General MCNICKLE. The negotiations escalated to Secretary McNamara and the Administrator of NASA. They could not agree so the Bureau of the Budget was appointed to set some arbitrary figures.

Mr. ANDREWS. Is not the issue relatively simple, a question of money?

Mr. HANSEN. The question is how do you extrapolate the previous experience to determine what is a fair share.

Mr. ADDABBO. Is it not a fact the budget feels it is easier to get money for defense than NASA programs?

General MCNICKLE. At the time it was set up, NASA had lots of money.

Mr. ADDABBO. When was it last reviewed?

General MCNICKLE. Two years ago.

Mr. SIKES. How many NASA launches are scheduled in fiscal 1970 and how many Air Force launches for the same period?

Mr. HANSEN. In fiscal 1970, we have scheduled 13 NASA launches, ——— Air Force launches and ——— Navy launches, or a total of ——— launches.

Mr. SIKES. What were the comparable figures for fiscal 1969?

Mr. HANSEN. NASA 17, Air Force 11, Navy 29, for a total of 57.

Mr. SIKES. What part of this does Navy pay?

General MCNICKLE. DOD pays for the Navy and Air Force. This is really not Air Force money, it is DOD money, but it is in our budget.

This makes our budget look big since we have ETR, WTR, and the satellite control facilities. It is not really Air Force money, it is Department of Defense money in our budget. As you can see, the Navy has the preponderant workload.

PAN AMERICAN CONTRACT

Mr. SIKES. What part of the $160.9 million requested is for the Pan-Am contract?

General PITTS. $72 million in 1970, sir.

Mr. SIKES. For the record, give the comparable amount in the previous 2 years.

General PITTS. Yes.

(The information follows:)

	Million
Fiscal year 1969	$74.8
Fiscal year 1968	88.9

ETR EMPLOYMENT

Mr. SIKES. I would like a listing for the record at this point of the number of military personnel assigned to the Eastern Test Range, the number of Government civilian employees, and the number of contractor employees.

(The information follows:)

The number of military, civil service, and contractor personnel assigned to, and whose salaries are paid by the Air Force Eastern Test Range are as follows:

Military	2,054
Civil service	2,419
ETR contractors	8,279

PAN AMERICAN CONTRACT

Mr. ANDREWS. Mr. Chairman, I think we ought to get a little information on the type of contract that Pan Am has. How long have we had that contract. Is it a self-perpetuating contract or is it negotiated periodically. Is the contract opened up for bids? Was it a low bid contract initially?

Can you answer those questions briefly now or do you want to put it in the record?

Mr. HANSEN. Some of it I can answer now. If the others cannot, we will get it for the record.

The Pan Am contract has gone on for many years. It is negotiated on an annual basis. To my knowledge it is not competitively opened up each year.

Mr. ANDREWS. Have any other contractors expressed an interest in the work or the contract?

Mr. SIKES. They would not get very far.

Mr. HANSEN. I am sure other companies would be very interested, but it is very difficult for someone else. This is a situation like Mr. Sikes mentioned this morning where one company is established with the people and the organization and therefore it is simpler and cheaper for them to do it for another year.

Mr. ANDREWS. You mean, they are locked in?

Mr. HANSEN. Yes. That is recognized in the fact that the fee on that contract is relatively lower than it is on just the regular type of contract. It is a cost plus the relatively low fee.

Mr. ANDREWS. In cases like this where there are a lot of employees, the employees have been doing the same thing on the job for years; as a matter of fact, when the contract changes to a new company, isn't the only thing that changes is the front office.

Mr. HANSEN. No. I do not think you can completely say that. If you are asking if another company was awarded the contract and the previous contractor laid all of their people off, wouldn't they go work for the new contractor, I think the answer is no. I would say that the majority of them would; but I think that some would elect to transfer to another activity of the same company rather than lose the seniority rights which they have in their company and go some place else.

Mr. ANDREWS. Put in the record the amount of the contract for the last 5 years with Pan American.

(The information follows:)

PAN AM CONTRACT

The amounts of the negotiated contracts with Pan American for the last 5 years are as follows:

Fiscal year:	
1969	$102,097,000
1968	107,060,000
1967	117,305,000
1966	124,284,000
1965	112,353,000

Mr. MINSHALL. Would you yield? How big an operation is this in dollars and people involved with Pan-American? Could you tell us a little bit more about it?

General MCNICKLE. $88.9 million NAO in fiscal year 1968, going down to $74.3 million in fiscal year 1969 and $72 million estimated for fiscal year 1970. This covers the DOD portion, which is in the Air Force budget and the remainder of the total contract amount is reimbursed with NASA funds.

Mr. MINSHALL. How many people?

General MCNICKLE. 8,279 contractor personnel.

LAUNCH PARTIES

Mr. SIKES. Who pays for the parties when there is a successful launch, as for instance the moon shot? I understand the parties were quite elaborate. Who pays for them? I know the U.S. Government pays for them, but through what channels and in what guise?

Mr. HANSEN. I cannot speak for Apollo parties, but I know for those missions in which I have been involved the contractors involved in those parties pay for them out of profit.

Mr. ANDREWS. Out of what?

Mr. HANSEN. Out of profit.

Mr. MINSHALL. Not out of pocket, but out of profit.

Mr. SIKES. Would that not indicate that they are making a little too much profit?

Mr. HANSEN. No, sir.

Mr. SIKES. I will tell you why I asked the question: I have had letters from people who have been to the launchings. They said that they were impressed with what was accomplished but shocked at the lavishness of the parties which followed. They assumed it was all coming out of Uncle Sam's pocket in one way or another.

Mr. HANSEN. No, sir. I am very confident that that is not so. I will speak of one that I am personally familiar with, but I know the rules and guidelines that apply there apply at other places. For example, in the Lunar Orbiter program, which was a very successful one, at the completion of the last launch there was a launch party which was sponsored by my company. It was paid for out of my entertainment budget which was paid for out of profit. This expenditure was considered to be justified in terms of the motivation that it provided for excellence of efforts on the part of the launch crew. I do not know of anybody that ever had a launch party for a failure.

Mr. ANDREWS. Doctor, I do not want to argue with you—I couldn't. You win the argument.

Mr. HANSEN. I have lost a lot. I lose arguments rather frequently. Please feel free.

Mr. ANDREWS. You say it is not Government money; it is profits from doing Government business, however?

Mr. HANSEN. Yes, sir.

Mr. ANDREWS. Now, it wouldn't take me long to convince myself how to trace these profits back to the Government. I assume they can be charged off as income tax expenses? Now, you know they could.

Mr. HANSEN. I can't answer that.

Mr. ANDREWS. The Government loses there, too. I assume that if you have enough profit to give a big party—and I am for parties—but if you have enough profit to give a big party maybe you are making too much profit and again the Government is paying. But I do not want to argue that. That is just my opinion.

Mr. RHODES. If the gentleman will yield, if this expenditure is not the type of expenditure which could be deducted from taxable income; then I, if I were a stockholder of the company, would raise cain with the company.

Mr. HANSEN. I cannot answer yes or no. I assume it is deductible as a business expense.

Mr. Andrews. You know it is.

Mr. RHODES. I would certainly hope so.

Mr. HANSEN. But I am an engineer, not an accountant or a tax lawyer.

REVIEW OF CONTRACTOR COSTS

Mr. SIKES. What screening does the Air Force or Department of Defense do to insure that costs by Pan-American or any other contractor are kept at the lowest reasonable level? Since the fees are so very low in these contracts, the profit is low, conceivably costs could be high and the costs could include a lot of things such as part of the operation of the home office, training area for personnel, a lot of things could be written into the costs which the Government would pay for. Now, what is the screening that is done to insure that no illegitimate costs are included in this operation at the expense of the Government?

Mr. HANSEN. One of the things that is done is to require a separate burden center.

Mr. SIKES. What is that?

Mr. HANSEN. That makes the unit of Pan-American that is at ETR separately accountable as to their expenses, and to have all of their overhead expenses under the immediate auditability and supervision of the local contracting officer and his staff. In other words, they do not share any common overhead pools with Pan-American operations located elsewhere from ETR.

Another element of this is that since this is a service-type contract, it is supervised in some considerable detail by the ETR Air Force people.

Mr. SIKES. You feel that you have adequate control and there are no abuses?

Mr. HANSEN. Yes, sir. To my knowledge, there is no abuse.

Mr. SIKES. That is, those which are substantial abuses.

Mr. HANSEN. It is negotiated based on a description of the task and how many people are necessary on an annual basis. I know that if the contractors that are there feel there are more Pan-American people on their site than they think are necessary, they will complain about that.

Mr. SIKES. Do you actually get such complaints?

Mr. HANSEN. A review is made. I made such a complaint. It was reviewed and appropriate action was taken. So from that one incident I would say that the Air Force is certainly responsive if someone suggests that some manning isn't entirely necessary.

DEACTIVATION OF UNNEEDED ETR FACILITIES

Mr. SIKES. Will some of the range facilities not be needed in 1970 due to the completion of programs?

Mr. HANSEN. Are you talking about at ETR now?

Mr. SIKES. Yes.

Mr. HANSEN. Yes. There is a system called ———. There is also one range instrumentation ship called the *Coastal Crusader*, which is scheduled to be deactivated in the second quarter of fiscal 1970.

Mr. SIKES. Tell us what the savings will be, for the record.

(The information follows:)

——— The annual operating cost of the range instrumentation ship *Coastal Crusader* was estimated for fiscal year 1970 to be about $1.570 million dollars. Deactivation during the second quarter of fiscal year 1970 should save about one-half that amount.

FALCON MISSILE

Mr. SIKES. Under the Falcon Missile, does the Air Force have a contract wtih the Hughes Aircraft Co. for the design, fabrication and testing of a new model of the AIM Falcon designated the H Model?

H MODEL

General MCNICKLE. Yes. This is the program I mentioned previously to ———.

Mr. SIKES. Where is this program in the project listing?

General McNICKLE. It is listed as AIM–4D growth, but it is now called Air-to-Air Missile Improvements System.

Mr. SIKES. For how much money? Supply it for the record.

(The information follows:)

The fiscal year 1970 development effort will cost $2.7 million. ———.

CRITICISM OF FALCON MISSILE

Mr. SIKES. It has been reported that combat pilots have been highly critical of the performance of the Falcon missile in Southeast Asia. Is this borne out in official Air Force reports?

General McNICKLE. Yes, sir. The AIM–4 was developed as an air defense interceptor missile and we adapted it to tactical use and encountered some difficulties. It would not stand the "G" of the turns. We now have an AIM–4D–H model which seems to have corrected the deficiencies.

MILITARY ASTRONAUTICS AND RELATED EQUIPMENT PROGRAM 949

Mr. SIKES. The committee will now consider military astronautics and related equipment program 949. What was this known as previously?

HISTORY OF PROGRAM

General McNICKLE. Program ——— but that was some time ago.

Mr. SIKES. What is that? I am trying to get some continuity in the record so that people reading it will know what we are talking about.

General PITTS. ———.

Mr. SIKES. The request is for $73.7 million for further development efforts. You are also requesting substantial sums in procurement. If you need this much money for development, would we not be hasty in allocating large amounts for procurement?

Mr. HANSEN. I think the division between development and procurement is somewhat arbitrary. As compared to some of the things we talked about in the missile programs where you might build 10,000 or so, these are more like ——— in that the development effort itself results in an initial operational capability. ——— Then the program beyond that is considered to be production but the entire program involves a relatively small number of units.

DEVELOPMENT COSTS

Mr. SIKES. What sum is estimated to be required for completion of the developmental effort?

General PITTS. About ——— million, including fiscal year 1970 and subsequent years.

Mr. SIKES. What is the presently estimated total development cost?

General PITTS. About ——— million, including prior year programs.

Mr. SIKES. How does this compare with earlier estimates?

Mr. HANSEN. In 1968 it was estimated at $320.2 million with $304.7 million designated for development costs. The current estimate for total program cost is ——— million; development cost for phase I, ——— million; development cost for the next two phases is currently estimated at ——— million. ———.

Mr. SIKES. For how long a period do you anticipate having to spend large sums under R.D.T. & E. in this program?

General MCNICKLE. ———.

Mr. SIKES. What procurement and military construction costs have been and will be associated with this program?

General MCNICKLE. Do you want that for the record?

Mr. SIKES. Yes.

(The information was provided to the committee and is classified.)

PROGRAM 417

Mr. SIKES. You are requesting $9.5 million for program 417. What is this?

(Discussion off the record.)

Mr. SIKES. Is this a continuing program or do you expect completion at a certain date?

Mr. HANSEN. This would be a continuing program.

Mr. SIKES. What is the total estimated cost?

Mr. HANSEN. The estimated cost through fiscal 1972 is ——— million.

Mr. SIKES. How does this compare with earlier cost estimates?

Mr. HANSEN. There have been no changes from earlier cost estimates on this program.

DEFENSE SATELLITE COMMUNICATIONS

Mr. SIKES. You are requesting $20.8 million for Defense Satellite Communications as compared with $8 million programed in the current fiscal year. What is the status of this program?

Mr. HANSEN. The Phase II program was approved in June of 1968. We solicited proposals competitively. Proposals were received and evaluated and about 2 or 3 months ago TRW was selected for the satellite task. They are now proceeding with the satellite design. Fiscal 1970 funding covers the effort for the next full year for both the spacecraft and boosters.

Mr. SIKES. What does the current program include which justifies the large increases shown?

Mr. HANSEN. This is due to the program moving into the hardware phase, and that in this fiscal year there are only 3 months of the satellite hardware contract whereas the next fiscal year has a full year of the satellite development.

PHASES I AND II

Mr. SIKES. Have you completed Phase I of the Defense Satellite Communications effort?

Mr. HANSEN. Yes, we have.

Mr. SIKES. Describe Phase II of this program.

Mr. HANSEN. Phase II is four satellites, each weighing 900 pounds. They are high-powered. Each has two narrow beam antennas and a wide beam antenna. The initial Phase II launch is scheduled for early 1971.

Mr. SIKES. How does the system compare with Phase I in operational capability?

Mr. HANSEN. Phase II is more powerful by several hundredfold over Phase I. ———.

Mr. SIKES. What does that mean; what will it do?

Mr. HANSEN. In effect, it is a follow-on for a later period of time. Being more powerful it produces more reliable communication and more secure communication ———.

Mr. SIKES. I would like to have for the record the total anticipated development and procurement costs of Phase II, the principal performance objectives of Phase II, the development and procurement schedule for Phase II.

(The information follows:)

PHASE II/DEFENSE SATELLITE COMMUNICATIONS

The estimated total costs of the DSCS Phase II Space Segment are:

	Million
R.D.T. & E. total	$33.8
Investment total	100.1
Total	133.9

These estimates which include all development, production, launch services, general systems engineering and technical direction costs for six DSCS Phase II satellites are subject to some adjustment as the program progresses. (Four operable satellites in orbit will constitute the Phase II system).

The principal performance objectives for the Phase II satellites are:

Effective radiated power: ——— watts on the earth coverage, antenna; ——— watts on the narrow beam antennas.

Bandwidth: ——— MHz.

Reliability (Meantime-to-failure): contractual ——— years; goal ——— years.

Telemetry and command: ———.

Orbit: ———.

The major milestones in the development and procurement are:

Event	Original	Forecast/actual
Direction received	September 1968	September 1968.
RFP released	October 1968	October 1968.
Contract definitized	February 1969	March 1969.

Event	Original	Forecast/actual
Preliminary design review	July 1969	July 1969.
1st article compliance	1st quarter 1971	1st quarter 1971.
Satellite delivery	1st quarter 1971	1st quarter 1971.
Launches (2 satellites/launch):		
Launch 1	1st quarter 1971	1st quarter 1971.
Launch 2	———	———.
Launch 3	———	———.

PHASE III

Mr. SIKES. Is there any money in this request for phase III of the program?

Mr. HANSEN. No.

RELATIONSHIP TO TACTICAL SATELLITE

Mr. SIKES. How does this program relate to the tactical satellite communications program for which you are requesting $8 million?

Mr. HANSEN. The tactical satellites tend to be more complex and larger. They are for a different purpose. The tactical communications satellites are designed to operate with the simplest possible ground terminals and, therefore, there is more capability and complexity built into the satellite itself. The defense communications satellite system is more of a trunkline type of system and has more powerful and complex ground stations and handles the main line. The tactical satellite system employs a highly flexibility communication capability between very large numbers of terminal points.

POINT-TO-POINT SATELLITE COMMUNICATIONS

Mr. SIKES. The justification material furnished the committee last year did not show a line item entitled "Defense Satellite Communications." Was this program included under the line item which is designated "Point-to-Point Satellite Communications" at that time?

General MCNICKLE. Yes.

Mr. SIKES. What was the reason for the change?

General MCNICKLE. The point-to-point element was for R.D.T. & E. It was changed to include a broader variety of costs—and procurement—each in its own place, but under the name "Defense Communications System."

Mr. SIKES. The justification material last year indicated a total estimated cost of the point-to-point satellite communications development program of $16 million. The justification material this year for the defense satellite communications program indicates a $33.8 million total estimated development cost. What is the relationship between these figures?

General MCNICKLE. The initial estimates for phase II were not really defined when last year's budget was made and when the development concept paper came out. The DCP had several alternatives in it, and laid out what was entailed as far as phase II was concerned. Based on that DCP, and the subsequent definition, $33.8 million is our best estimate of the cost, as far as we know it at this time.

WEATHER RESEARCH

Mr. MINSHALL. Mr. Chairman, if I may ask several questions at this point.

General and Mr. Secretary, I am concerned over how much money our Government is spending on weather, and weather research, in one form or another. Now, in addition to your efforts there is FAA efforts, the Navy's efforts, ESSA's efforts, and that comes to a figure of approximately $600 million per year, not only for research but actual weather forecasting and all of this. Yet it is virtually impossible——

Mr. SIKES. And the weather isn't getting any better.

Mr. MINSHALL. They are putting all this input into getting information but they are not putting anything into the effort to getting the information out to the public in a form that results in good weather forecasts. Frequently in Washington you cannot get good weather forecasts from day to day.

Now, those who fly and who have boats are more aware of this than others. Accordingly, I would like to ask you: Here on page 1 of your

project listings you have defense research sciences, atmospheric sciences, $14,772,000. I want to know more about that program.

I also want to know more about these programs on page 2 where you have atmospheric sensing techniques, weather radar techniques, satellite meteorology, weather modification, upper atmospheric chemistry and physics, and so forth, These all relate, I believe, to weather forecasting or research and development thereof, do they not?

Mr. HANSEN. No; I don't think you can say that.

Mr. MINSHALL. What are these for, then?

Mr. HANSEN. This is research in all the properties of the atmosphere through which we fly. Some are related to weather.

Mr. MINSHALL. What is the purpose of all this? In next year's budget, you have something close to $18 million or $20 million just for research and development. Now, that is a ball park figure.

Mr. HANSEN. Well, we are concerned, for instance, with pressure, density, composition, reactions, transmissibility of infrared ——— and understanding of ultraviolet radiation.

Mr. MINSHALL. Where does that come in this budget? How much of that $18 million or $20 million is that phase of it?

Mr. HANSEN. This is atmospheric sciences. I think that is the $14 million number. Now, we have electronic density, energy distribution, electric fields, currents, conductives. These are all things that have to do with the communication to and from aircraft; the buildup of static electricity, emissions, and so forth.

Mr. MINSHALL. What are you learning that you don't already know?

Mr. HANSEN. We hope that everything that we are learning is things that we do not already know. I hate to think that we are going over again what we have already done. It is our intent to only seek new knowledge.

Mr. MINSHALL. What is wrong with your aircraft transmissions today? You talked about static electricity and aircraft communication.

Mr. HANSEN. Our requirements steadily become more severe as we have more and more aircraft in the air and as we fly higher and faster.

Mr. MINSHALL. You have been doing this for many years.

Mr. HANSEN. We worry more about how we would survive in areas of increasing nuclear effects.

Mr. MINSHALL. Are you contracting this $18 million out; are you doing it in-house; how are you doing it?

Mr. HANSEN. It is a combination. Some of it is in-house, some of it is done by the universities.

COORDINATION OF WEATHER R. & D. WITH OTHER AGENCIES

Mr. MINSHALL. I wish you would spell it out in much more detail for the record, if you would, please, because I am getting increasingly concerned about the research and development overlap that you are spending on weather, FAA, ESSA, Navy, and even, yes, the Army; and I think there are some other agencies of Government that are in on it.

Mr. ANDREWS. The Weather Bureau.

Mr. MINSHALL. Interior.

Mr. RHODES. The Interior Department I think is spending considerable sums of money and considerable effort on weather modification. I would like to have submitted for the record some statement as to the means of liaison, communication that you have with other agencies of Government who are in this particular area so that we can make sure that there is not any duplication of effort.

Mr. HANSEN. We will supply that for the record.

Mr. MINSHALL. The National Science Foundation is doing the same thing. You are all in the act. It is a total of $600 million a year, in that ball park, for weather and weather research. To me, that is fantastic when you consider what the weather reports turn out to be.

Mr. HANSEN. Yes, sir. I understand your concern. You would like for us to furnish for the record more information on specifically what we do under these line items.

Mr. MINSHALL. In response to Mr. Rhodes' inquiry, what your liaison is also.

Mr. HANSEN. And what the liaison is with other Government agencies that are doing research in the atmospherics area.

Mr. RHODES. And weather modification.

Mr. HANSEN. Yes.

Mr. MINSHALL. I mean from ground level up to 40,000, 50,000 feet, however high they are going.

General MCNICKLE. We are going higher than that.

Mr. MINSHALL. I am thinking of your phase of the operation. I understand you have certain things to do with your satellites, and all the rest.

General MCNICKLE. You are interested where there might be an overlap?

Mr. MINSHALL. Yes. NASA is in the act, too.

I just wonder if everybody knows what the other guy is doing.

Mr. HANSEN. It is a worthy concern. Let us dig into that and furnish something for the record.

Mr. MINSHALL. On another committee on which I serve we will have the FAA before us, and also we will have the Navy research and development people here. I wish you would all get your heads together on it.

General MCNICKLE. D.D.R. & E. also, Dr. Foster.

Mr. MINSHALL. It is a terrible price to pay for weather reports that we get.

Mr. ANDREWS. Several years ago I was on another subcommittee and we handled appropriation for the Commerce Department and Weather Bureau. I was amazed to learn that the Air Force is spending more on weather than the Weather Bureau.

Mr. HANSEN. That is understandable.

General MCNICKLE. We have the hurricane trackers, and so forth.

Mr. ANDREWS. Weather is weather, whoever studies it.

General MCNICKLE. They are very zealous in guarding their prerogatives. I think you will find there are hard and fast lines that are drawn.

Mr. ANDREWS. Mr. Minshall's point is well taken; namely, that the Government is spending too much money on weather. You all get the same kind of reports in certain areas. You can tell here whether it is going to rain or not——

General MCNICKLE. No.

Mr. ANDREWS. You can make the prediction. But under these modern day predictions I can do as good a job. The odds are 20 percent that it will rain, that is what they say. Well, that is like Mother Hubbard, it covers everything and touches nothing.

Then they say the chance is 60 percent. Of course, if it is raining, then the chance is 100 percent, it is raining, now.

Mr. MINSHALL. Off the record.

(Discussion off the record.)

Mr. SIKES. Provide the information requested for the record.

(The information follows:)

Air Force weather research, development and modification programs are part of the Defense Research Sciences (6.1), Exploratory Development Environment program (6.2), Advanced Development (6.3), Engineering Development (6.4), and Management and Support (6.5). The Air Force fiscal year 1970 budget for these weather programs is $5,405,000 and is comprised of 18 projects. Two projects are in basic weather research and are a part of the Atmospheric Sciences subelement under the Defense Research Sciences (61102F). These two projects are "Meteorological Research" and "Research on Cloud Physics," both totaling $1,220,000. Seven projects are in exploratory development (62101F): Aircraft Meteorological Sensors and Techniques (6020—$300,000); Atmospheric Sensing Techniques (6670—$350,000); Weather Radar Techniques (6672—$400,000); Satellite Meteorology (6698—$280,000); Micrometerology (7655—$185,000); Variability of Meteorological Elements (8624—$190,000); and Free Air Circulation (8628—$270,000). One program is in Advanced Development (6.3); National Clear Air Turbulence Program (63226F—$1,600,000); one program is in Engineering Development (6.4): Expendable Remote Observation Weather Station (7045—$150,000); and two programs are in Management and Support (6.5): Test Range Meteorological Support (6682—$310,000); and Range Refraction Effects (6684—$150,000).

Weather operation is managed by the Environmental Science Services Administration (ESSA) for the Federal Government and by the Air Weather Service for the Air Force. The fiscal year 1970 Federal budget for weather operation is $342,017,000 and for the Air Force, $144,349,000.

Weather modification was managed by the National Science Foundation (NSF) until September 1, 1968. It is now managed by the Interdepartment Committee for Atmospheric Sciences (ICAS), which monitors the overall Government program. The Federal budget in fiscal year 1970 for weather modification is $11,774,000, and the Air Force portion is $230,000. This effort is contained in project 7605, 62101F.

The weather program is coordinated with other Government departments through four agencies established by Bureau of Budget Circular A-62. These agencies are the Interdepartmental Committee for Atmospheric Sciences (ICAS), the Interdepartmental Committee for Applied Meteorological Research (ICAMR), Interdepartmental Committee for Meteorological Services, and the Interagency Committee for World Weather programs.

The Air Force presents its complete program in environment, of which weather is a part, to Department of Defense, who in turn presents it to ICAS. This executive committee operates under the Federal Committee on Science and Technology (FCST). Participating agencies are the National Science Foundation, Department of Commerce, Health, Education, and Welfare, Atomic Energy Commission, State Department, Federal Communications Commission, Department of Agriculture, Department of Defense, National Aeronautics and Space Administration, Department of Interior, and Department of Transportation. Observing agencies include the Office of Science and Technology, National Academy of Sciences, Bureau of the Budget, and the Office of the Federal Coordinator. The representative from the latter is the head of the second coordinating committee—Interdepartmental Committee for Applied Meteorological Research (ICAMR). This committee addresses the entire program on weather and is composed of the Department of Agriculture, Atomic Energy Commission, Department of Commerce, Department of Defense, Department of Transportation, Health, Education and and Welfare, National Aeronautics and Space Administration, National Science Foundation, Department of Interior, and three observing agencies: Bureau of the

Budget, Interdepartmental Committee for Atmospheric Sciences, and the Department of State. They monitor the overall Federal budget (fiscal year 1970) of $342,017,000 in weather operations and $81,557,000 in research and coordinate the weather research and the effort of ESSA. The third agency is the Interdepartmental Committee for Meteorological Services, which coordinates only weather operations. Its membership consists of the Department of Agriculture, Department of Transportation, Department of Commerce, Department of Defense, and National Aeronautics and Space Administration. Three observers also attend: the Department of State, Department of Interior, and Bureau of the Budget.

The fourth coordinating committee, the Interagency Committee for World Weather Programs, coordinates the Federal effort internationally as well as outside of the Government. This committee is made up of Atomic Energy Commission, Department of Defense, Department of Interior, National Aeronautics and Space Administration, National Science Foundation, State Department, and Department of Transportation.

The Air Force program is introduced to these committees via ICAS, which in turn distributes the program. Weather modification will follow the same route of coordination although an Air Force program on weather modification has not yet been submitted through the new system (ICAS monitorship since September 1, 1968).

Satellite Control Facility

Mr. Sikes. Under Satellite Control Facility there is a request for $37.2 million. This compares with $29.3 million in fiscal 1969 and $22 million in fiscal 1968. Now, they both are substantial increases. What can you tell us about the requirement for the increase; the reason?

General McNickle. In fiscal 1970, $500,000 is programed for component systems development for a 40-foot antenna system.

Mr. Sikes. $500,000. You have an $8 million increase. What is the rest of it, for the record?

General McNickle. There is an impact because of the MOL on that one.

Mr. Sikes. All right. You will have to provide it for the record, I presume.

(The information follows:)

Satellite Control Facility

The increase in R.D.T. & E. funding from fiscal year 1969 to fiscal year 1970 is due to the following:

	Dollars in millions
40-foot antenna component development	0.5
Annual O. & M. costs of recovery ships, the USNS *Longview* and *Sunnyvale*	3.9
Increase in number of civil service employees	1.0
Contract operation of new gas-turbine powerplant	1.0
Increase in tariffs for lease of commercial long-haul communication lines	1.5
Total	7.9

Impact of MOL Cancellation

The satellite control facility is a general purpose on-orbit support facility for all DOD satellite programs. The Manned Orbiting Laboratory was to have received similar type of support as do all other satellite programs using the same equipment and tracking stations on a time-shared basis. We estimate $135,000 of satellite control facility fiscal year 1970 funding as unique to MOL. These funds were intended primarily for augmenting communications support.

FORTY-FOOT ANTENNA SYSTEM

Mr. SIKES. What is the requirement for the new 40-foot antenna system?

General MCNICKLE. Wider band width reception requirement, and increases in the ——— handling capability for the satellite supported. These now exceed the capability of our present network.

Mr. SIKES. What is the estimated development cost total?

General MCNICKLE. $1 million.

Mr. SIKES. It is indicated in the descriptive summary that you plan replacement of all 14-foot antennas throughout the network in future years with a new 40-foot antenna. What will be the total cost of this replacement program?

General MCNICKLE. ——— million.

Mr. SIKES. For the record, spell out how much better you would be able to function; in other words, why it is necessary.

(The information follows:)

SATELLITE CONTROL FACILITY

The 40-foot antennas allow coverage of high altitude satellites not within range of the 14-foot antennas. When the 40-foot antennas are used on lower altitude satellites a greater bandwidth and greater data accuracy is possible (that is a greater volume of error-free data) than with the 14-foot antennas.

COST OF FACILITY

Mr. SIKES. Can you tell us how much has been spent for Satellite control facility since it was first funded?

General MCNICKLE. The Satellite control facility line totals $102.1 million from 1965 through 1969.

EMPLOYMENT

Mr. SIKES. For the record, tell us how many Government and civilian personnel are paid from this budget and how many contractor personnel; how many civilian personnel are assigned to the effort.

(The information follows:)

SATELLITE CONTROL FACILITY

It is estimated that in fiscal year 1970 the following number of Federal civilian personnel and contract personnel will be paid from the R.D.T. & E. budget at the satellite control facility:

Civil service	355
Contractors (man-years)	157

AIR FORCE SATELLITE FACILITIES

Mr. SIKES. How many satellite facilities are included in your worldwide network?

General MCNICKLE. Seven geographically dispersed tracking stations.

Mr. SIKES. Why is this entire effort funded in R.D.T. & E.? The workload appears to be operational rather than developmental.

General PITTS. I think that the work funded here is considered to be more R. & D. in nature than operational, and therefore, it is included in the R.D.T. & E. budget. The facility is under Air Force Systems Command whose operation is financed from the R.D.T. & E. appropriation.

FORTY-FOOT ANTENNA SYSTEM

Mr. SIKES. What would be the effect of denial of the development and procurement of the proposed new 40-foot antenna system? How adversely would you be affected? You have been operating with the 14-foot antenna system for some time.

General MCNICKLE. With the increasing ——— workload, it is estimated only ——— percent of the requirements can be met and that the 40-foot antenna system will allow them to be fully met.

Mr. SIKES. That is not quite clear to me. Why not? Couldn't you provide additional power for the 14-foot antenna to reach the satellite? Provide an answer for the record.

General MCNICKLE. The 40-foot antenna is much more sensitive than the 14-foot. One other advantage of the 40-foot antenna is that it can track low altitude satellites to ——— degrees above the horizon which you cannot do with the 14-foot antenna. The transmitting power we will have to look into. I do not have data on that, but I do not believe it is the controlling factor.

(The information follows:)

FOURTEEN-FOOT ANTENNA

It is technically feasible to increase the power to the 14-foot antenna to achieve the same transmission capability as the 40-foot antenna. However, costs for the higher power transmitters and antenna feed assemblies would probably be of the same magnitude as the entire new antenna. Additionally, the increased power would not improve the reception of signals from the satellites. The reception capability of the ground antenna is in direct ratio to the antenna aperture. The only other means of improving reception on the ground would be to increase antenna size and power on the satellite and this is prohibitively expensive.

REDUCTION IN 1969 FUNDING

Mr. SIKES. Last year the Air Force requested $34.2 million for this activity but only $29.3 million was programed. What was the effect of the reduction and what was eliminated?

General MCNICKLE. We actually had a slip in the requirements. Some of the deferred expenditures were the 40-foot S-band antenna and installation of the Indian Ocean ground station and spare support. The reduction was not appreciable.

Mr. SIKES. Will there be some slippage this year in any areas, similar slippage?

General MCNICKLE. No, sir.

TITAN III SPACE BOOSTER

NEED FOR FUNDING

Mr. SIKES. Under Titan III space booster, you are requesting $41.9 million in fiscal year 1970; $61.7 million was programed in fiscal 1969 and $50 million in fiscal 1968. The descriptive summary indicates that this is a continuing program and does not give a total estimated development cost of this program. The Titan III has been with us a long time. Why should we have to spend this kind of money year after year on Titan III space booster?

Mr. HANSEN. It has been with us a relatively small number of flights. I think the nature of space launch vehicles for the foreseeable future is that the so-called operational program has to be accompanied

by a product improvement program. The users have to be satisfied for each flight that the results and the checkout of the vehicle are satisfactory for their flight. If we run into a problem, the users say "Before we fly we want this fixed, and we want the fix put in on the next vehicle." I think really what you have to say is that there is an accompanying development program that is being carried out in connection with a limited operational program. I think that this is true even after a much larger number of vehicles than we have. For an airplane that is flown day after day, an improvement is not necessarily needed. That is because we have been flying airplanes for 50 years. I don't know whether that is a satisfactory answer, but I know from experience that every time we have a flight of a launch vehicle even though its works OK we find something that just barely works, so that we do not dare fly again until the marginal system or component is fixed.

EFFECT OF MOL CANCELLATION

Mr. SIKES Has there been an increase in the current Titan III program which is associated with the manned orbiting laboratory?

Mr. HANSEN. I think here we would like General Stewart to answer. I think the answer is that the MOL requirements have been included under the MOL program line. I would like to ask General Stewart to verify that.

General STEWART. That is correct, sir. The Titan III M program was funded entirely in the MOL line.

Mr. SIKES. None of the money under Titan III space booster is associated with MOL?

General STEWART. No, sir.

COST OF TITAN III PROGRAM

Mr. SIKES. You have already programed $984 million on the development of the Titan III. This is a huge sum for the development of a space booster that is based on an already developed Titan II ICBM. The job does not seem to be difficult enough to warrant this magnitude of continued annual expenditure. When you first presented the Titan III program to the committee what was the scheduled total cost of the program?

General PITTS. $745,500,000. That was back in 1963.

General MCNICKLE. Since that time, though, we added Titan III–D to the development program and stretched it out so that the development costs increased.

Mr. SIKES. Mr. Preston.

Mr. PRESTON. Considering those changes, how much money has been programed to the Titan III program, including funds associated with the MOL program?

General MCNICKLE. We would have to submit that for the record.

General PITTS. I can give you 1968 and prior; $922.4 million exclusive of the Titan III–M for MOL, Mr. Preston. Of course, in 1969 we had $61.7 million. The Titan III–M program costs, I think we would have to supply for the record.

General MCNICKLE. It is over $1 billion for the entire Titan III development program.

(The information follows:)

TITAN III COSTS

1. The R.D.T. & E. money which will have been expended on the Titan III developments through fiscal year 1974, starting with the basic program of $745.5 million first presented to the committee, will be $1,123.1 million. The breakdown that follows indicates the major reasons for the increases:

(1) Technical difficulties encountered during development of the Titan III A and C involving solid motor development, transtage, transtage attitude controls, and guidance system.

(2) "Stretch out" of the Titan III–C flight test program.

(3) Initiation of development of the Titan III–D.

(4) Improvements for the Titan III–C.

(5) Increase in contractor's incentive fees because of his performance.

(6) Modernization of the aerospace ground equipment.

(7) Performance improvement requirements and increased cost of launch support.

2. Of the above total of $1,123.1 million, $36.4 million was used to initiate the 7 segment solid motor program for MOL. The MOL program expended an additional $160 million to develop the 7 segment rocket motor, the 15:1 liquid rocket engine nozzle and T–IIIM peculiar AGE. Termination costs on the MOL program will increase this total to approximately $165 million. Except for the initial expenditure of $36.4 million, all T–IIIM peculiar costs were borne by the MOL program, although many of the improvements ensuing from T–IIIM have been incorporated into the rest of the Titan III family for the sake of commonality and better performance.

1970 PROGRAM

Mr. SIKES. Has the termination of the MOL changed the requirement for Titan III boosters?

General STEWART. Not at this time; no, sir.

Mr. SIKES. How many Titan III boosters are programed?

General PITTS. ——— Titan III–B's, ——— Titan III–D's, and ——— Titan III–C's. None of those are connected with the MOL program.

Mr. SIKES. I would like to have for the record a description of the activities of which you propose to carry out with the $41.9 million requested for fiscal year 1970. And also what is the Titan III launch schedule as currently foreseen?

(The information follows:)

TITAN III 1970 PROGRAM

1. The activities which are supported by the $41.9 million in fiscal year 1970 are separated into the following major elements:

	Dollars in millions
(*a*) Complete T–IIID development	14.4
(*b*) Provide continuing launch support and engineering services	17.7
(*c*) Pay remaining R. & D. incentive	2.7
(*d*) Conduct environmental testing	1.4
(*e*) Minor component improvements	3.8
(*f*) Modify and maintain ground equipment	1.9
Total	41.9

2. The current Titan III–C launch schedule for our presently procured 8 vehicles is as follows: four in fiscal year 1971; four in fiscal year 1972.

NOTE: In fiscal year 1970 we shall be completing modification to our ground equipment and facilities to accommodate the change over from the R. & D. configuration to the production configuration and no launches are currently scheduled in fiscal year 1970.

General MCNICKLE. The Titan III–C approved schedule presently includes procurement of ——— vehicles. One in fiscal year 1969, three in fiscal year 1970 and ——— in fiscal year 1971.

Mr. SIKES. When the Titan III program was initiated the committee questioned you as to the availability of a NASA booster which could lift the MOL. Do you feel that the man-rated boosters which NASA has developed are unsuitable for Air Force programs?

Mr. HANSEN. Yes, we do. The Air Force at the present time has no requirement for a man-rated booster. The only NASA boosters of comparable capability to the Titans are considerably more expensive. These are the Saturn 1-B's. This particular subject has been rather exhaustively reviewed in the joint launch vehicle panel of the NASA-DOD Aeronautics and Astronautics Coordinating Board. I think we can say clearly that there are no NASA boosters that will do this job.

Mr. SIKES. Off the record.

(Discussion off the record.)

Mr. SIKES. Questions at this point, gentlemen?

Thank you very much. The committee will adjourn and will reconvene at 10 o'clock tomorrow morning.

THURSDAY, JUNE 26, 1969.

Mr. ANDREWS. The committee will come to order. We have a long way to go, and if we want to get through we have got to get started and stay with it.

HARD ROCK SILO

DEVELOPMENT PROGRAM

Speaking again of the Hardrock Silo development, I believe you were to make a statement this morning about the project. We have under consideration the subject of the first hole which you estimate will cost $278.4 million. Now, who wants to make a statement in connection with the discussion of yesterday about the Hard Rock Silo development program?

Mr. HANSEN. Mr. Chairman, we will start out with Colonel Sherman who is here, and he will be assisted by John Walsh.

Mr. ANDREWS. We would be glad to hear from you, Colonel.

Colonel SHERMAN. Mr. Chairman, it is a pleasure to be here this morning.

The dollar figure which you have referred to, the $278 million-plus, is the cost for the Hardrock Silo development program which does, in fact, wind up with the test of a launch facility prototype, the silo, to verify in fact that we have achieved our design specification, our assigned goal. Now, included within those funds are moneys not only for the civil construction of a hole in hardrock, granite, or similar media, but quite a bit of money for the developments, modifications of present equipment to go into that facility to sustain the environment, of approximately ——— p.s.i. for survival. By that I mean the mechanical equipments that support the missile, the shock isolation, shock suspended floors on which the equipment is placed, the housing of the electronics which are the other major portions of the equipment that will go into that facility.

Mr. ANDERWS. You are talking about a prototypte. Do you mean, you are going to get your first hole and it will be useful for operational purposes after you have completed?

Colonel SHERMAN. Yes, that is correct. It can be useful for that purpose if we meet our specifications. That is the objective of the development program, the design and development of the program which is useful for deployment.

Mr. ANDREWS. They told us yesterday the huge cost, $278.4 million, is in fact for the first one and it will be the experimental hole.

Colonel SHERMAN. Actually, there are a series of tests leading up to that experimental hole or prototype, as we call it, Mr. Chairman. There are a series of what we call rock tests which involve the producing of both overpressure phenomena and direct ground shock phenomena.

Mr. ANDREWS. How long have you been talking about this project, the Hard Rock Silo development?

Colonel SHERMAN. I believe since late 1966 or early 1967.

COST OF PROGRAM

Mr. ANDREWS. How much money has been spent on the project to date? Put it in the record.

Colonel SHERMAN. Yes, sir.

(The information follows:)

HARD ROCK SILOS

$1.2 million was spent in fiscal year 1968. In fiscal year 1969 $23 million for R.D.T. & E. and $2 million for O. & M were programed.

Mr. ANDREWS. Do you have a ball park figure in mind now?

General PITTS. Through 1969, some $24.2 million has been programed.

BECHTEL FACILITIES CONTRACT

Mr. ANDREWS. What have you done with that money?

Colonel SHERMAN. Specifically, we have gone through our preliminary design studies leading then to the production of our request for the facility contractor, for the command and control contractor, and we have brought the facility contractor abroad.

Mr. ANDREWS. Who is the contractor?

Colonel SHERMAN. The Bechtel Co. for the facility.

Mr. ANDREWS. How did you make the contract with him?

Colonel SHERMAN. I will have to pass on that question.

Mr. ANDREWS. What type contract was it, General?

General MCNICKLE. I do not have that, either.

Mr. ANDREWS. Somebody ought to know.

General MCNICKLE. I am told a cost-plus-fixed-fee.

Mr. ANDREWS. Is it competitive?

Mr. HANSEN. Yes, sir.

Mr. ANDREWS. How many contractors expressed an interest in the contract?

Mr. WALSH. Six or seven expressed an interest, and I think about five bid.

Mr. ANDREWS. Did the low bidder get the contract?

Mr. WALSH. I believe so.

Mr. ANDREWS. What is he supposed to do under that contract? What was the amount of the contract; $24 million?

Mr. WALSH. No; the total contract involves about $50 million.

Mr. ANDREWS. You only had $24 million available, according to General Pitts.

Mr. HANSEN. This Bechtel contract was just awarded about a month ago. The amount of money in that contract is nearly all yet to be spent.

Mr. ANDREWS. How much money has been appropriated for this project since 1966 when you first got it underway?

General PITTS. For 1969 $9 million was apropriated for the advanced ICBM system. However, this program was not approved and was reduced to support only the Hard Rock Silo effort for $1.2 million. In 1969 I think we were appropriated $38 million, of which we plan to obligate some $23 million. The current program is $23 million for 1969.

Mr. ANDREWS. How much was that contract?

Colonel SHERMAN. I will have to put that in the record.

Mr. HANSEN. The Bechtel contract?

Mr. ANDREWS. Yes; that is the only one that we have discussed.

Mr. WALSH. The total value of the contract is about $50 million, of which $10 million is expected to be spent in fiscal year 1970.

Mr. ANDREWS. The amount of the contract was $50 million?

Mr. WALSH. Yes, about that.

APPROPRIATION HISTORY

Mr. ANDREWS. You had only appropriated about $39.2 million through 1969, as I understand.

Mr. WALSH. I have to check the detail on that. The expected value of the work to be done by Bechtel is $50 million. I believe we have contracted for the total on an option basis so that we cannot commit ourselves, obviously, to money we have not had appropriated.

Mr. ANDREWS. That is just what I was going to ask you, how you could make a $50 million contract when you have only had $39 million appropriated.

Mr. LIPSCOMB. What kind of a contract have you got? What have you contracted for?

Mr. WALSH. It is contracted incrementally in order that we do not obligate funds that we do not have.

Mr. LIPSCOMB. Let's have the picture of what you have done. Our justification book says that for fiscal year 1968 and prior you have $1.2 million and in fiscal 1969 it says in the book $25 million.

Mr. ANDREWS. He said $38 million.

Mr. LIPSCOMB. Yes, but in the book it says $25 million.

Mr. ANDREWS. How much did you get, General Pitts?

General PITTS. Sir, I explained yesterday that we had originally asked for $38 million in 1969, and that was reduced to $25 million by OSD and subsequently we have only programed $23 million because the $2 million for site survey was provided from O. & M. funding. So $23 million was provided in fiscal year 1969 against this program out of R. & D. funds.

Mr. ANDREWS. Let me see if I understand correctly the amount of money appropriated for this project; in 1968 it was $1.2 million?

General PITTS. For fiscal year 1968, of that $9 million appropriated, only $1.2 million was programed; $38 million was appropriated in 1969.

Mr. LIPSCOMB. Then you cut that to $25 million and used only $23 million.

General PITTS. Yes, sir. OSD in the apportionment, cut that to $25 million, and we have reduced this to $23 million, using $2 million of O. & M. funds for the site surveys.

CONTRACT IN EXCESS OF AUTHORIZATION AND APPROPRIATION

Mr. ANDREWS. Yet you made a contract for $52.8 million.

Mr. WALSH. To be funded incrementally, subject to the availability of funds. The first piece of it is actually approximately $900,000 of 1969 money, but we competed on the basis of the whole program, that is, the whole facilities contract.

Mr. LIPSCOMB. How much are you authorized for the hardrock silo program?

General PITTS. Presently in R. & D. for 1969, $23 million.

Mr. LIPSCOMB. That is the authorization?

General PITTS. That is our current program; yes, sir.

Mr. LIPSCOMB. No; what are you authorized in the authorization bill?

General PITTS. $38 million for 1969. We received authorization and appropriation for $38 million.

Mr. LIPSCOMB. Is that the total authorized program that the Congress has voted on, $38 million?

General PITTS. Plus the $1.2 million programed for 1968 and prior.

Mr. LIPSCOMB. So that which the Congress has authorized in authorization legislation is $39.2 million?

General PITTS. Yes, sir; with the understanding that the $9 million authorized for fiscal year 1968 was reduced to $1.2 million.

Mr. LIPSCOMB. You have made a contract with the Bechtel Corp., for a program that isn't authorized by Congress?

General PITTS. Sir, the contract has a standard clause that limits liability of the Government to the amount obligated by the Government, which is not greater than the amount authorized and appropriated. I think Mr. Walsh brought that out, that it is an incremental contract where there are options for each year.

Mr. WALSH. That is right. The problem is in competing the program. If we compete it piece by piece we cannot develop an adequate competition among the contractors or a rational program. We want to compete for the total.

Mr. LIPSCOMB. What I am getting to is that you have no program or no authorization to go out and compete for something.

Mr. WALSH. And the contractor understands this. He knows we only have 1 year's money available at a time and he is willing to compete on the basis of expectation that we will continue the program.

Mr. LIPSCOMB. What kind of a program did you tell him you were going to have?

Mr. WALSH. This program is just for the R. & D., just for the building of the facility portion of the first silo.

Mr. LIPSCOMB. Where did you get such an authorized program?

Mr. HANSEN. This contract is to design the civil engineering portion. It is part of the authorization that is included in the $39.2 million.

General BOYLAN. Mr. Lipscomb, may I add to that, please?

As you know, many of these projects which are initiating from a development program and have downstream implications, either for further development to a decision for production or through development because of high confidence into a system per se. The Department of Defense approves each program. This program necessarily would be spread over a number of years and it is against this Department of Defense program approval that the services come to the Congress to explain the full scope of the program and the yearly or incremental requirements for funding support. The Hard Rock Silo program is one of this kind. The Air Force cannot use in the first or second year the total value, dollar value of that program. It cannot put those dollars to work. The technology management which is being described continues over a period of years.

CONTRACT WITHOUT CONGRESSIONAL REVIEW

Mr. LIPSCOMB. Who determined that we were going to go into a Hard Rock Silo program?

General BOYLAN. The Department of Defense has approved the program through development. A decision for production has not been received from the Department of Defense, but, sir, this is similar to many other programs.

Mr. LIPSCOMB. It is similar to the F-14 program in the Navy where they have committed us to a production contract before Congress has even gone into it.

General BOYLAN. Mr. Lipscomb, there is no commitment to the Government beyond the increment that the Congress authorizes in support of the program.

Mr. LIPSCOMB. Here is an article which I read recently: "The Air Force picked Betchel Corp. of Vernon, Calif., a month ago," and this would be May 26, "to build a Hard Rock Silo prototype under a $41.8 million contract and is now negotiating with Lockheed Missiles & Space Co. on a shock-induced structural response effect, SISRE program, which is an effort to better define the material properties which are used as inputs in calculating structural response to weapon effects. This is expected to cost about $500,000 but will help form the basis for the prototype program."

General BOYLAN. Yes, sir.

Mr. LIPSCOMB. You don't even know what your structural problem is and yet you have got this contract and you say it is on an incremental basis. You are only going to spend $900,000.

General BOYLAN. But, Mr. Lipscomb, the point we are attempting to make is that management which this corporation will provide is required over the spread of years that constitutes the development effort.

I am certain, though I have not read the contract, that the contract specifies certain tasks to be completed by the contractor with funds appropriated and authorized by the Congress, and the commitment of the Government does not go beyond that.

CONTRACT TERMINATION PROVISION

Mr. LIPSCOMB. Supposing the Congress appropriates no further funds, what is going to happen?

Mr. WALSH. We will terminate the contract.

Mr. LIPSCOMB. At no termination expense?

General BOYLAN. We will terminate the contract.

Mr. LIPSCOMB. No termination expense; we just terminate the contract?

Mr. WALSH. That is the usual way of doing it. I say the usual case because an exception can be made on occasion but none has been made in this case. An amount for anticipated termination liabilities is ordinarily included in the contract increment. Of course, since the amount put aside for termination liabilities is an estimate, the precise cost of termination has to be determined by audit and negotiation.

General BOYLAN. There are other types of contracts that are very similar to this. For example, contracts for services at base level. It is not in the best interests of the Government to renegotiate every year for certain services.

Mr. LIPSCOMB. I do not think you should have negotiated for a contract until you got authorization from the Congress to go ahead with the Hard Rock Silo development program.

Mr. ANDREWS. I don't think any of you have answered the question that Mr. Lipscomb asked, namely, have the legislative committees of Congress authorized this project and, if so, how much has been authorized?

General MCNICKLE. Yes, sir; the Congress has authorized and appropriated funds for the Hard Rock Silo development.

General BOYLAN. Yes, sir, Mr. Chairman. May we review the record of the fiscal 1969 hearings, because I am certain there is a line item in there on Hard Rock Silo.

Mr. JACKOVICH. In addition to that, sir, I think we had an estimate in our descriptive summaries last year that indicated an estimated total cost for the development of this program that must have been upward of $100 million; something like $150 million to $160 million at the time.

Mr. ANDREWS. How much has been authorized for the project?

Mr. JACKOVICH. $38 million for fiscal year 1969. No funds will be obligated beyond that within the time frame—I should say $39.2 million which includes prior years as previously explained. In other words, the contract has the standard limitation-of-cost clause in it.

As the doctor indicated, if the program is stopped——

Mr. ANDREWS. Would you yield for a question? You have had an authorization by the legislative committee for $47 million, $9 million in fiscal year 1968 and $38 million for fiscal year 1969 for Hard Rock Silo. Now, you made a contract which you could call a conditional contract. The contractor agrees to perform in accordance with, or up to, whatever amount is appropriated as against the authorization. If there is no further authorization for the project and no further appropriation for the project, then the contract is terminated?

General BOYLAN. That is correct.

Mr. ANDREWS. It would have to be, unless the contractor wanted to work for free?

General BOYLAN. Yes, sir.

Mr. ANDREWS. Mr. Lipscomb.

Mr. LIPSCOMB. You say they are going to spend $900,000 in fiscal year 1969. Now, in case the Congress put a limitation in that, no further work be done on the silo development, you say that can be terminated without any cost to the Government?

General McNICKLE. Beyond the 1969 liability.

Mr. LIPSCOMB. $900,000.

General McNICKLE. For this specific contract. There are other contracts against the 1969 money.

Mr. RHODES. Will the gentleman yield?

Mr. LIPSCOMB. Yes; after this.

That is a specific statement by the Air Force, that is the way the contract is?

General McNICKLE. Yes; to the best of my knowledge.

Mr. RHODES. What you are saying, in effect, is that if we do not authorize or appropriate any more money than $38 million already authorized for fiscal year 1969 then this isn't a $41.8 million contract at all, it is a $38 million contract?

General PITTS. No, sir. It is for $900,000.

General BOYLAN. The value of his contract for the task to be performed by him during the fiscal year 1969.

General PITTS. He is just one of several contractors, Mr. Rhodes. This contract presupposes money is being appropriated in future years, like 1970. What is pertinent about that press release is the fact that it does not say all of those things. It just tells the total amount of the contract if we take it to completion.

SCOPE OF BECHTEL CONTRACT

Mr. RHODES. What do you buy for your $900,000?

Mr. LIPSCOMB. Plans to spend the rest of the money.

Colonel SHERMAN. Principally, the development work in support of the first series of tests scheduled to occur this coming fiscal year, rock test 2.

Mr. RHODES. You do not break any ground or drill any holes?

Colonel SHERMAN. No, we do not, sir. It is primarily software-type work, the production of some test equipment to support the early test program.

Mr. WALSH. Let me elaborate on that. There will be some construction of the rock test facility which is a subscale model of a portion of the silo, the closure of the silo. So there will be some breaking of rock that is visible to all and sundry. But that will not be the initiation of the construction of the facilities we are talking about here, the one hole. It will be a test program not covered by the Bechtel contract.

Mr. RHODES. Do you have any idea how much it would cost to complete the operation which is begun with this $900,000? In other words, the development costs plus the rock testing costs.

Mr. WALSH. The rock test itself costs approximately $8,500,000, most of which is fiscal year 1969 money; there is about $500,000 in fiscal year 1970 money to conclude the rock test. Now, in addition to that, some of the work which Bechtel will be doing is preliminary work, for subsequent rock tests; that would be of the order of $100,000 or $200,000.

Mr. RHODES. Will you clarify something? I understood all we are obligated for in 1969 was $900,000.

Mr. WALSH. To Bechtel. There are other people involved in the rock tests. As a matter of fact, most of this is being done through the Defense Atomic Support Agency.

Mr. RHODES. How much in total are we obligated for in fiscal 1969 for this entire project?

General PITTS. The program for 1969 is $23 million.

General BOYLAN. That is all the Department of Defense has authorized the Air Force to obligate against this program, $23 million.

Mr. RHODES. So the Congress has appropriated the funds and you will expend from appropriated funds $23 million in fiscal 1969?

General PITTS. For fiscal 1969; yes.

FISCAL YEAR 1970 PROGRAM

Mr. RHODES. What is the total program for fiscal 1970?

General PITTS. $50 million.

Mr. RHODES. That is the total?

Mr. WALSH. In R.D.T. & E.

Mr RHODES. In R.D.T. & E. for the hardrock?

General PITTS. Yes.

Mr. RHODES. Are there any other expenditures?

Mr. WALSH. There is $8 million additional in the site survey which comes from O. & M. funds.

Mr. RHODES. Are there any construction funds?

General PITTS. No.

Mr. RHODES. None for 1970 at all?

General PITTS. No.

Mr. RHODES. So there is $58 million in total being requested for fiscal 1970?

General PITTS. For fiscal 1970; yes, sir.

Mr. RHODES. Thank you.

BECHTEL CONTRACT

Mr. LIPSCOMB. How many man-hours or technical hours are you getting for the $900,000 from Bechtel?

Mr. WALSH. I couldn't give you an answer to that offhand. I can for the record.

Mr. LIPSCOMB. Would you, for the record, state what you are buying or getting for the $900,000 downpayment on this contract?

Mr. WALSH. Certainly.

(The information follows:)

HARD ROCK SILO/BECHTEL CONTRACT

The fiscal year 1969 funding on the Bechtel contract is $900,000. The following is a breakout of Bechtel and subcontractor efforts:

	Man-hours	Cost
Bechtel: Initiate facility design	37,300	$335,000
American Machine & Foundry: Trade-off studies; i.e., silo closure system, personnel access	12,820	200,000
Booz Allen, Applied Research, Inc.: System planning; i.e., configuration control planning, data management planning	2,140	60,000
Physics International: Survivability/vulnerability analysis, nuclear-effects analysis, laboratory tests	15,000	225,000
Ken O'Brien Associates: Site surveys	10,000	80,000
Total	77,260	900,000

ESTIMATED COST OF PROGRAM

Mr. LIPSCOMB. You mentioned that last year you had explained to the Congress or to this committee the Hardrock Silo program.

Mr. JACKOVICH. Mr. Lipscomb, I indicated that in our descriptive summary last year we indicated the total cost of development for this program.

Mr. LIPSCOMB. Would you tell us now what was the total cost that you estimated last year?

Mr. JACKOVICH. $152 million.

Mr. LIPSCOMB. This year you estimate the total estimated cost at $278.4 million?

Mr. JACKOVICH. Yes, sir.

Mr. LIPSCOMB. Can you explain this significant difference of $126.4 million increase in program in the last 12 months?

Mr. WALSH. I believe we can. The problem is that when the $152 million estimate was made, it was made without the benefit of a detailed track of the various elements of the program and the components which went into it. The inter relationships within the hardrock program, which at that time was not well defined, were not clearly thought out and it was considered to be an inexpensive test. The actual number of tasks involved in getting from the starting point to the availability of a test silo just had not been carefully considered. So probably the principal explanation of the large difference is that this early number was an initial estimate which was not based on a complete understanding of the components which would be required to make the program lead to a successful and credible silo development in which we had high confidence.

Mr. LIPSCOMB. Well, I, for one, do not have very high confidence in your estimating procedure for 1970, either. How accurate do you think the $278.4 million estimate is for total estimated costs now?

Mr. WALSH. Except for the effects of inflation which I discount for the moment, I would say that unless we discovered some new scientific phenomenon we are just unaware of, that this should be accurate within a few percent, 10 percent is probably a reasonable estimate of the accuracy of those numbers.

Mr. LIPSCOMB. I hope those that are present at least get the feeling of the point I am trying to make, that last year you gave us an estimated total cost figure of $152 million for the program and you described it. We went ahead and supported the program as described. Now a year later you come in with an estimated total cost of $278.4 million. You say you did not have all the facts to present to us a year ago. In other words, we now feel like you led us down the primrose path last year. Now, you want more funds, you have already made contracts, and it would seem you have already determined that we are going to go right along with your program, regardless of cost. Actually what we are embarking upon here is a billion-dollar program, in the billions in fact, and you apparently still don't have adequate information. Now, that is my personal opinion and I will not sit here and be led into these programs without adequate and definitive information.

We have had this occur time after time this year. Not just by the Air Force but by the Navy and by the Army as well.

Do you think that you have actually justified this program before this committee?

General PITTS. I think in retrospect, Mr. Lipscomb, we did a rather poor job last year based on a lack of knowledge of what we were getting into. I think that is what Mr. Walsh was trying to bring out, the fact that as we have gotten more into this it has become a much more complex task than we had envisioned.

Mr. LIPSCOMB. Before you get us so deeply into something, why don't you let the experts find out a little more for us?

General PITTS. That was what was done during this last year.

Colonel Sherman, do you have any words you want to add?

Colonel SHERMAN. No.

NEED TO APPRAISE CONGRESS OF PROGRAM CHANGES

Mr. RHODES. Will the gentleman yield?

In the first place, I think Mr. Lipscomb has spoken a great amount of wisdom here in what he has just said.

Just let me ask this: When you come before the committee and make a presentation, as you mentioned, General, last year, and you find later that the facts are not as they—the facts are not commensurate with the presentation that you have made before the committee, don't you feel it would be good procedure in the future to let the committee know that, and perhaps to come back and represent that particular part of the problem so that you don't then come up for your hearing the next year and have to take the kind of abuse that we are dealing out to you today?

It just seems to me that from a matter of good management and good relations with the Congress that you would do this. You know when things get off the track. Now, having us have to be surprised at these developments every year, as we are, why don't you let us in on the secret before?

Mr. HANSEN. Mr. Rhodes, I certainly agree with the point that you have made. Where a program changes by this kind of magnitude we should do as you say, and will orient ourselves in that direction in the future. In this particular program the initial decision as to how these tests should be carried out was that the prototype should be set up on a somewhat quick and dirty basis. It involved substituting a lot of simulated equipment and items that were readily at hand. Later it was considered that, for the tests to be really meaningful, it would be necessary to put the silo equipment in the hole for the test or the test would not give the confidence that it should to go ahead with production. There was a significant change in the philosophy of the tests which caused a significant change in the expense of the test. I would agree with you that for a change of this magnitude we should have brought a briefing over here to review what was wrong with the previous plan, why we wanted to do it a different way, and what was the revised estimated cost.

Mr. RHODES. Well, I feel also that you should do it where there are to be substantial overruns such as the SRAM. Now, I realize I have used a bad word in saying "overrun" but you know what I mean; where you are going to run into increases as high as 148 percent, it seems

to me that we should know this and not have to bring it out at the time of the budget hearings.

General McNICKLE. We have agreed to report to congressional committees on a quarterly basis the changes which have occurred in specific systems.

Mr. RHODES. Thank you.

COST VERSUS WORTH OF HARD ROCK

Mr. ANDREWS. Mr. Secretary, you said you admitted the study was quick and dirty——

Mr. HANSEN. No. I did not say the study was. I say the test was planned to be a minimal test, which I referred to as quick and dirty.

Mr. ANDREWS. Have you ever given consideration, or any of you ever given consideration, to the cost of a project vis-a-vis the worth of a project?

Mr. HANSEN. Yes, sir. That is what we try very hard to do. We now consider that the original tests that were planned would not provide sufficiently valid data. The present tests will give us a better assurance that we could go into a production phase before funds are committed to production.

Mr. ANDREWS. Are you still convinced that this hardrock project is needed?

Mr. HANSEN. Yes, I am.

Mr. ANDREWS. The costs, as you have indicated this morning, for the prototype are 148 percent higher in 1969 than you estimated in 1968——

Mr. HANSEN. Yes; I think so.

Mr. ANDREWS. What assurance can you give the committee that the cost growth of the project next year won't double the price tag you put on it today?

Mr. HANSEN. Well, we don't have any reason to anticipate that.

Mr. ANDREWS. You didn't last year.

General PITTS. Mr. Chairman, in response to your question about the value for the dollars we are asking for, I had a conversation coming over this morning with General Boylan, our Director of Programs, and I thought he had some particularly good words on this very issue that might be appropriate at this time for the record

Mr. ANDREWS. We need some good words in the record at this point.

General PITTS. Yes, sir.

HARD ROCK NEEDED AT ANY COST

General BOYLAN. Well, Mr. Chairman, there isn't anyone on this side of the table who can take issue with Mr. Lipscomb or Mr. Rhodes on the very real problem of having initial estimates that prove to be less than good by a magnitude. We certainly cannot take issue with that.

But I firmly believe that whatever the Hard Rock Silo program ultimately costs, is a cost that the Nation not only can afford but a cost that the Nation must absolutely bear.

Now, the Air Force has a great responsibility to get this program accomplished at minimal cost. But the issue here is basic to national security. It is the protection of our deterrent force.

Mr. ANDREWS. I understand that. It gives you more security for your embedded Minuteman missiles.

General BOYLAN. An increase in our ratio of hardness, of a factor of ———. In combination with other systems which are planned, it will significantly improve the security of our missile force.

Mr. ANDREWS. What are the systems?

General BOYLAN. The Safeguard system.

There are other measures included in this budget which have got to be pursued and studied carefully, including mobility. It is paramount that we must seek every means to secure the capability of our missile force.

The Hard Rock Silo program is one part of that. You know, we only have a very few options. We are basically in a passive mode. The Polaris program is an example of that; it includes dispersal, deception, cover by sea. Mobility is another example of the passive mode. The only two active capabilities or possibilities or options available to us are, first strike, which is certainly not in the national interest, and—I am using this broadly—the Safeguard system to kill the missiles out from the missile sites and the missile fields.

Under a concentrated attack I think anyone who thinks the problem through can see that with increasing Soviet accuracy in their missiles, the assured capability on their part to develop MIRV and the high megatonnage that they have demonstrated, that a significant attack against our missile fields will get through.

I think this has been an axiom since this war was, what was fallaciously called, an art.

Mr. ANDREWS. Is it true to say that our defense is based primarily on our retaliatory capability and the purpose of the Safeguard system and the hardrock system is to better secure our retaliatory capability?

General BOYLAN. Absolutely, Mr. Chairman. There cannot be any question about it.

Mr. ANDREWS. Our retaliatory capability consists primarily and almost solely of the Polaris system and the Minuteman system?

General BOYLAN. And the bomber system.

Mr. ANDREWS. And the bomber system?

General BOYLAN. And there are other means available to add security to the bomber force. This committee is aware of those, dispersal, airborne alert, et cetera. This is not possible, of course, with a missile system.

Mr. ANDREWS. Are there any other questions at this point?

NEED FOR CONGRESSIONAL REVIEW

Mr. LIPSCOMB. If I may, I would like to make additional comment.

General, you have seemed to imply that we must continue with the Hard Rock Silo program because it is for the protection and welfare of our Nation, that it is absolutely necessary in our defense.

General BOYLAN. That is my judgment.

Mr. LIPSCOMB. Yes. That is my feeling, too.

But then you added "regardless of cost" that we had to proceed. Now, this has been the assumption that I have gone on ever since I came on this committee in 1958, and I have depended to a great degree on the testimony that I have heard from that side of the table.

General BOYLAN. I understand, sir.

Mr. LIPSCOMB. The belief and feeling that I have held when I have gone to the floor of the House is that I was justifying for the Members, the need for an adequate defense of our country, and this is what it was going to cost. But during the past year some things have come out that have validity and that is, that this Nation in recent years has spent money for defense that did not buy any defense.

For instance when we pay for a $250 million overrun on the Navy, for ships, we are not buying any more defense. Now, the reason we are looking into this Hard Rock Silo program is because if we continue with a 1,000 Silo program we will be getting into a $6 billion or $7 billion program. This is the time we have to look at whether or not the costs are adequate and justified.

General BOYLAN. Absolutely, sir.

Mr. LIPSCOMB. So if we question how you give out a $41.8 million contract when you do not have authorization from the Congress we are doing it so that we can get a program on the right track, and it is not quarelling with the fact that we need an adequate defense of our country.

QUESTIONABLE NEED FOR HARD ROCK

Mr. RHODES. Will the gentleman yield?

Apparently, General, the rationale for the Hardrock project is that simultaneously in salvo the Russians are capable of firing enough SS-9's with 25-megaton warheads to pinpoint on the target to knock out enough Minuteman missiles to completely destroy our second strike capability.

Now, am I stating that accurately?

General BOYLAN. Mr. Rhodes, what I was trying to say is that our principal enemy has the capability to develop systems in the quantity, accuracy, and the yield to do exactly that.

Mr. RHODES. Well, General, if that happened you might as well forget it because if that many SS-9's with 25-megaton warheads land on this country the ball game is over.

General BOYLAN. No, Mr. Rhodes. This is the very key to deterrence. You must progressively drive the cost, drive the risk to him, drive the question of whether or not he can succeed, ever higher.

Mr. RHODES. Well, I agree with that.

General BOYLAN. And beyond the Safeguard, beyond the Hard Rock Silo, if we are unfortunate to never achieve in this world a nuclear arms control, there will be other developments that will increase our margin of security at the time that they are needed. This must be.

Mr. RHODES. Of course, I think you have completely underestimated the capability of the Polaris-Poseidon system as a deterrent.

General BOYLAN. I did not intend to.

Mr. RHODES. Any such strike as the type that you mentioned, I also think you have overestimated completely the Russians' capability to launch the type of a salvo attack which in all instances would be so perfectly targeted that it would have the effect that you anticipate. After all, in this business you have to balance the interests. You say this is completely necessary, to do this sort of project and have this sort of protection. General, I submit that is not your decision to make. That is the decision of the Congress and the President to make.

General BOYLAN. I certainly agree with that.

Mr. RHODES. To do this we have to balance the interests of all of the other things involved in the defense of this country.

General BOYLAN. I agree with you.

Mr. RHODES. I frankly am not at all convinced, not at all convinced that this Hardrock operation is either necessary or desirable, considering the fiscal situation the country is in right now. I am perfectly in favor of deploying an ABM system. I would probably be in favor of your developing a bird with a 25-megaton capability because, to me, that is more important than Hardrocking the relatively small Minuteman. I mean, if you are going to really keep up with the Joneses in this horrible game of nuclear war that we have, it seems to me that the area in which you are falling behind is in total megatonnage which any single missile can carry. But I am not saying I won't be convinced but my own opinion as of now is that this is just not necessary.

NEED FOR HARD ROCK SILOS

Mr. WALSH. I would like to comment a little on the question of the need for Hard Rock Silos as well as for ABM, Mr. Rhodes.

For one thing, you referred to a salvo of 25-megaton SS-9's, as being something you couldn't imagine the Soviets doing——

Mr. RHODES. I did not say that; I did not say that. I said I couldn't imagine them being able to do it successfully and have the effect that the general indicated they might have of knocking out our second strike capability because it would have to be almost pinpointed or within a circular error of probability that I do not think they can attain with that many missiles.

Mr. WALSH. Well, beyond that, I think that the specter of them having a thousand 25-megaton missiles is somewhat of an incredible thing to believe in. However, it does not take a 25-megaton missile to knock out a Minuteman Silo. Although the Minuteman Silos are moderately hard, ——— p.s.i., a 1-megaton warhead with a C.E.P. of the order of ——— can achieve a very high level of kill, of the order of 90 percent against a single Minuteman Silo. So that you see, now if we are talking about ——— warheads, quite a few can be placed on the nose of an SS-9 and hence you get this multiplicative effect whereby an individual booster can go at many silos and simultaneously be used to exhaust the interceptor arsenal associated with the defense.

Mr. RHODES. Let me ask you this: If this is so—and I am sure it is or you would not have said it—why didn't the Department of Defense or the Air Force tell us this back in the days when we authorized the hardening of these Minutemen sites? The hardening obviously is completely inadequate.

Mr. WALSH. At the time it looked like like the best we could achieve. Moreover, the projections of the achievable CEP's at that time were such that even ——— looked extremely optimistic. Time has progressed since then; it has been almost 10 years since we laid down the Minuteman I with the ——— p.s.i. silos and since that time technology has advanced to the state where we believe that ——— CEP's are indeed in the cards and they are the kind of thing that we are on the verge of achieving now.

Meanwhile, we also have learned more about the dynamics of the behavior of rockets, of silos, of structures under shock, such that we

believe we now can achieve a much higher level of hardness, a level of hardness which we did not believe we could achieve initially.

Now, you see, the fact that a 1-megaton warhead would weigh about ——— pounds and represents a significant threat to Minuteman means that many 1-megaton warheads put on top of an SS–9 would represent a threat both to many Minuteman silos and to exhausting the interceptors. On the other hand, if we harden the silos to the point where we have to use significantly larger warheads to achieve the same probability of kill instead of 1 megaton, something of the order of 5 megatons, or rather 10 megatons—roughly scales as the overpressure—then a single SS–9 could carry no more than perhaps ——— if that many, warheads and hence would not be able to exhaust an interceptor arsenal. Thus you achieve a situation where you essentially have whipsawed a potential opponent so that he would be unable either to kill your silos with a few big warheads, because these would readily be intercepted, or to exhaust your defense with many small warheads because if he has penetrated, after exhaustion, they would be able to do no damage. Now, this whipsaw effect is one which gives you a leverage on him so that he cannot possibly kill silos as cheaply as you can build them, despite the fact that we are talking about astronomical amounts of moneys in both cases.

Mr. RHODES. Well, I do not think there is any purpose to be served in any argument about it. But I doubt the capability in the immediate future of either the Russians or ourselves developing the multiple reentry vehicle concept to the point where you can get a ——— split from the warhead with a circular error of probability of the type that you mention.

Mr. WALSH. Well, our Minuteman III looks like it is achieving its goal of a ——— which is very close to ———. Now, it has a smaller warhead but that at least demonstrates that the guidance accuracy can be achieved and presumably, if we can do it, since we have no monopoly on technology in that regard, the Soviets could do it, too. Since they are using bigger boosters, they use bigger RV's and hence it is perfectly in the cards to expect them to do this. As a matter of fact, we have seen MRV tests. Now, the only question is how accurate are they? Our own tests demonstrate this accuracy is achievable.

BIGGER BOOSTERS

Mr. RHODES. Why aren't we moving toward a bigger booster?

General BOYLAN. Well, Mr. Rhodes, we are actually developing a technology through the various programs here which will permit this, if and when the decisionmakers, the President and others, decide that it is necessary.

(Discussion off the record.)

Mr. WALSH. One of the problems with a big booster is that you have the eggs in one basket, in effect. It is as easy to kill a big booster as it is to kill a little booster. So big boosters are vulnerable to a first strike, and this is why there are some advantages to using a booster which is smaller, provided you have a total number of boosters great enough to carry the total megatonnage you want. Of course, if you constrain yourselves to a thousand boosters and you need more megatonnage, then you need bigger boosters. This also indicates, perhaps, a clue to the Soviets' intention. Why are

they building big boosters if they are thinking of a second strike capability?

Mr. RHODES. Are the Russians hardening their silos to the extent that we contemplate in Hard Rock?

Mr. WALSH. ———.

Mr. RHODES. ———.

Mr. WALSH. That may be.

Mr. RHODES. If you are going to play this game of "how much does it cost" with the Russians, you ought to start talking about a bigger booster with a bigger warhead.

General BOYLAN. Another factor is at play, of course, and that is our national policy.

Mr. ANDREWS. Off the record.

(Discussion off the record.)

1970 PROGRAM

Mr. ANDREWS. Detail for the committee the various elements of your $50 million request. How much is for the engineering development effort by the Boeing Co., for example?

(The information follows:)

ENGINEERING DEVELOPMENT EFFORT

The following is a breakout of the Fiscal Year 1970 program by contractor or effort:

	Millions
TRW	$ 9
Boeing	18
Bechtel [1]	11
Alternate facility contractor	1
Command and control contractor	8
Numerous technology contracts	3
Total	50

[1] $1,000,000 for power and environmental control systems (previously shown separate) is now under Bechtel.

SILO TESTING

Mr. ANDREWS. What is encompassed in the $278.4 million program? This is an R.D.T. & E. program, so I assume that no procurement or military construction effort is included in this amount. Is that correct?

Mr. HANSEN. That is correct.

Mr. ANDREWS. Is there any procurement associated with this R. & D. cost?

General MCNICKLE. No, sir, this is a development program.

Mr. ANDREWS. For the $278.4 million, will you get a silo?

General PITTS. You would get a prototype silo; yes, sir.

Mr. ANDREWS. Would it not, for all practical purposes, be what you would have in the other silos?

Mr. WALSH. When you get a prototype silo, you get a test of the silo. You will find if there are any weaknesses that you can rectify and, when they are rectified, it will be identical with any operational silo.

Mr. ANDREWS. I am trying to learn whether or not that first prototype silo will be used operationally along with the others.

Mr. WALSH. We have every intention of doing so.

Mr. LIPSCOMB. When you test the silo, are you not going to destroy it?

Mr. WALSH. No; we are going to test it slightly above the design level, but not to destruction. If it is designed for ——— pounds per square inch, can you be sure what will destroy it? If we put a blast of ——— pounds per square inch on it, it will surely destroy it, with very high probability of destroying it, and we will not know at what level it really broke. We want to test it fairly close to the design level so we have assurance that we met at least that level.

Mr. LIPSCOMB. Last year we understood Mr. Flax to say when one does the test, one destroys the silo, or a good part of it.

Mr. WALSH. One of the problems of testing is that it requires, in order to focus the blast wave which is used in testing, a great overburden of earth. You bury the silo. So, you will have to dig it out again before you can use it.

I think he might have used the word "destroy" in that sense, although I am not precisely sure. We would not destroy it, because then we would learn very little. If we knew we could destroy it at ——— pounds per square inch, that proves nothing. We can also destroy present silos at that ——— pounds per square inch.

Mr. LIPSCOMB. This is in the record.

Mr. WALSH. Yes; I am trying to interpret what he must have meant. I think he meant we would just bury it.

Mr. HANSEN. I am reasonably confident that what he meant was that the test is one which the silo is designed to pass, but it may not if we are wrong. Therefore, we cannot guarantee that after the test the silo will be usable. But if after the test the silo is not usable, then clearly we are not ready to go to production until the necessary "back to the drawing board," work is done. I would assume then we would want to repair or rebuild the silo and test it again. We hope that would not happen.

The costs quoted are based on the assumption that the silo will be designed to meet the test, and that the test can be conducted and will be met.

COST PER SILO

Mr. ANDREWS. If you decide to proceed with the operational Hard Rock Silo program, what will be the procurement and military construction costs involved? Do you have any idea? Have you given it any thought?

General PITTS. It will be, as we testified yesterday, about $6 million per silo. Let us take an example of 100 silos——

Mr. ANDREWS. You told us yesterday that the cost of the follow-on silos would be $6 million. My question is: How much will it cost additionally to construct these silos with work which will be done by military construction?

General PITTS. That $6 million per silo cost that I just quoted you is all of the work necessary under the two appropriations, military construction and missile procurement, to configure silos.

Let us take an example. Let us say, 100 holes. One hundred holes at $6 million a hole is $600 million. That is an example. It would be up to decision authority, if we did go to production, as to how many Hard Rock Silos we would put in the ground to accommodate missiles

Mr. ANDREWS. When we are talking about $6 million, does that include everything?

General PITTS. Yes, sir.

Mr. ANDREWS. Communications, military construction?

General PITTS. Everything except the missile.

Mr. ANDREWS. Of course, we are not asking about that. It will be a one-package deal as far as the silos are concerned, $6 million?

General PITTS. Yes, sir.

General MCNICKLE. Land, construction of the silo, roads, support facilities, and aerospace ground equipment.

Mr. ANDREWS. And will be ready for the missile to go in?

General MCNICKLE. Yes, sir.

General PITTS. For example, on one wing of Minuteman III, we can break that by saying the military construction part of that $900 million would be $406 million, and the missile procurement, which would cover the aerospace ground equipment, would be $494 million.

COST OF MINUTEMAN III MISSILE

Mr. ANDREWS. Based on your best estimates today, what will be the unit cost of placing a Minuteman III missile in a Hard Rock Silo, including all associated costs?

General MCNICKLE. $6 million.

General PITTS. $6 million, yes, sir.

Mr. ANDREWS. That is for the silo, the figure we have been discussing. What will the missiles that go in that silo cost, the Minuteman III?

General PITTS. They are already in the inventory. Those assets are in hand or will be in hand. We will have the Minuteman III in the inventory.

Mr. ANDREWS. How much will they cost?

General PITTS. About ——— million per missile, plus the AEC costs of about ——— million for the warhead.

Mr. ANDREWS. So, the cost of the silo, including everything, with a missile, will be ——— million?

General PITTS. Yes, sir; about ——— million with the AEC costs. The ——— million is not additive to this program because that is part of another program.

SILO COMPLETION DATE

Mr. ANDREWS. I understand. We are talking now about the silos. You have told us repeatedly your estimated cost will be $6 million.

If this program receives the green light and everything goes well, when would you expect to have the ——— or more hard rock silos operational?

General PITTS. Let me approach it from this direction, Mr. Chairman. The initial operating capability, which would be the first squadron of missiles—I can correct this for the record—the first flight of 10 missiles, would be ——— if the prototype silo meets the test and we get production go-ahead, IOC for the first flight of missiles would be ———.

Mr. ANDREWS. When do you expect to get the prototype?

General PITTS. That prototype test is scheduled to be completed by ———.

HARD ROCK VERSUS ABM

Mr. ANDREWS. To what extent will the placement of a portion of the Minuteman force in Hard Rock Silos eliminate the need for ABM protection of Minuteman missiles?

Mr. WALSH. Again, this leaves you open to the vulnerability of being attacked by very large warheads that are highly accurate. So, it does not really eliminate the need for ABM protection, because now the Soviets are able to devote their payload to a small number, that is, essentially one on one, of very large reentry vehicles.

On the other hand, when you couple this with defense, then the defense can shoot down these reentry vehicles fairly simply.

Mr. ANDREWS. Would you guard the soft or the Hard Rock Silos with ABM?

Mr. WALSH. In terms of programing, first I would protect the soft ones, and then later the hard ones, based on how I think the Soviets could develop their capabilities with regard to both the accuracy they might achieve and the MIRV capability.

COST OF HARD ROCK VERSUS SUBMARINES

Mr. ANDREWS. How does the cost of placing missiles in Hard Rock Silos compare with placing ICBM's in submarines, the Poseidon, for instance?

Mr. HANSEN. We do not have the figures on the cost of ICBM's in submarines. I think maybe that is a question that should be addressed to the D.D.R. & E. people. I am reasonably confident they have made these analyses.

I think making this kind of comparision it ought to be made on some sort of 10-year operating basis, or something like that, where you have the cost of acquisition and operation.

Mr. LIPSCOMB. I think this question is very appropriate at this point. Would it be possible to request the Secretary to get this information and put it in the record at this point?

Mr. HANSEN. Yes, sir; I would be pleased to do that.

Mr. LIPSCOMB. By any chance is the information here with you now?

Mr. HANSEN. No, sir; it is not. To have Navy costs that could be vouched for, we would have to get them through D.D.R. & E.

Mr. LIPSCOMB. Was anyone aware that this question would be asked?

General MCNICKLE. Yes, sir. We do not have the information, we are not in a position to testify on the costs for the Poseidon system.

Mr. LIPSCOMB. You were aware that it would be asked?

General MCNICKLE. Yes, sir.

Mr. LIPSCOMB. You just did not get it. May I ask a further question, Mr. Chairman?

Mr. ANDREWS. Mr. Lipscomb.

APPROVED PROGRAM

Mr. LIPSCOMB. Do I understand you have 100 silo programs approved now?

General PITTS. No, sir. I used that as an example to answer the chairman's question on costs.

Mr. LIPSCOMB. Do you have approval of any silo program?

General PITTS. We have approval to go to a prototype silo only, and that is contingent upon funding authorization and appropriation by the Congress.

Mr. LIPSCOMB. At what level is that approval?

General PITTS. That approval is Secretary of Defense.

Mr. LIPSCOMB. All the way?

General PITTS. For the prototype silo development, yes, sir.

Mr. LIPSCOMB. But not the Bureau of the Budget.

General MCNICKLE. I personally feel we ought to do the R. & D. If some day we need to harden our silos to these high pressures, we would have some judgment as to what could or could not be done and at what cost. I certainly agree with the remark Mr. Rhodes made that it certainly ought to be reviewed and the trade-offs evaluated but I do think the R. & D. would give us answers that we might need at a later date.

Mr. LIPSCOMB. I agree that the R. & D. should go ahead, but I think we ought to have some idea how we are to conduct the R. & D. and where. We have carried this a considerable way this morning. As has been pointed out, the site survey program won't even be completed until December of this year. Is that right?

General MCNICKLE. Yes.

Mr. LIPSCOMB. Therefore, we do not now know the locations where we have hard enough rock for an adequate R. & D. program.

Colonel SHERMAN. We have 200 or 300 already which meet the criteria.

Mr. ANDREWS. You mean space for 300 silos?

Colonel SHERMAN. Actually core borings and suitability tests for 300 locations.

Mr. ANDREWS. Where is that?

Colonel SHERMAN. In Wyoming, that section of the State.

Mr. ANDREWS. Would you plan to put them all together?

Colonel SHERMAN. No, sir.

Mr. ANDREWS. You would disperse them?

Colonel SHERMAN. Yes, sir.

Mr. ANDREWS. How many would you put in one locality?

Mr. WALSH. That is one of the questions which is still under examination, balancing the rock availability and the command and control problem, and also the defense problem, against the cost and the rock availability.

Mr. ANDREWS. I want you to get for the record at this point a comparison between the cost of putting these missiles in Hard Rock Silos and the cost of putting ICBM's in submarines. A Polaris submarine carries 16 missiles. According to your estimate, it would cost $6 million for each hard rock silo. So, the cost of 16 missile sites under your proposed program would be $96 million. That is the figure we want you to compare with the cost of installing missiles in submarines.

Mr. WALSH. You referred to ICBM's in submarines. The Polaris or Poseidons are generally considered IRBM's in range, of shorter range than the ICBM's. The Navy has a program for a longer range missile. Do you want the comparison with the Poseidon or with the planned longer range missile?

Mr. ANDREWS. With the Poseidon. The Poseidon is just as effective a weapon as your Minuteman, is it not?

Mr. WALSH. In terms of what a given payload would do, it is approximately comparable, yes.

Mr. ANDREWS. We are talking about the damage done to the enemy. They pack just as big a punch with the Poseidon as you can with the Minuteman?

Mr. WALSH. I think for your purposes, that is a proper comparison.

Mr. ANDREWS. They can take care of the range situation. They are possibly not as vulnerable to attack.

Mr. WALSH. The Navy has developed some concern for their vulnerability. That is why they are proposing this longer range missile so they have a greater area of the ocean in which to range. I do not think that is what you had in mind.

(Off the record.)

Mr. WALSH. Secretary Hansen referred to the problem not only of the initial cost, but the operational cost, because the cost of operating submarines is considerably different from that of operating silos. I presume you would like that for your comparison, also.

(The information follows:)

COMPARISON OF HARD ROCK SILO COSTS WITH POSEIDON

The following information was obtained from the Office of the Secretary of Defense:

The adequacy of the data base and cost estimating relationships between hard rock silos and Poseidon make valid comparisons difficult to derive. With an equal cost force, based on 31 Poseidon SSBNs, 21 hard rock silos would compare to approximately 16 Poseidon missiles. This is based on ten-year system costs including R.D.T. & E., investment and operating costs. The presently programed force of 31 Poseidon SSBNs costs about the same as deploying 650 Minuteman III missiles in hard rock silos.

Each of these strategic capabilities have different strengths and weaknesses which should be considered in addition to the cost estimates. First, as a partial measure of effectiveness, the equal-cost Minuteman III force of 650 missiles (on day to day alert) would provide ——— times as many missile boosters, ——— warheads and ——— equivalent megatonnage than the force of 31 Poseidon SSBNs. Further, the command and control of the Minuteman force is not faced with the ——— complexities faced by the SSBN force. As a final issue, the SSBN alert force is less vulnerable to a surprise attack in the total war situation and, if targeted by Soviet nuclear weapons, would not result in additional megatonnage being delivered against the Continental United States.

COST TO ATTAIN SYSTEM ACQUISITION

Mr. ANDREWS. One of the listed objectives of your program "is to be in a posture to proceed with system acquisition."

What is involved in this and what part of the cost of the development program is attributable to this objective?

Mr. HANSEN. Mr. Chairman, approximately $57 million out of the currently estimated $286 million is for various aspects of system engineering which are necessary to have the design sufficiently definitized so acquisition can start.

I have a breakout of what the various tasks are. It is fairly lengthy. May I put that in the record?

Mr. ANDREWS. Supply it for the record.

(The information follows:)

COST DEVELOPMENT TO ATTAIN SYSTEM ACQUISITION

In order to protect an IOC we are doing the necessary system engineering work required to obtain a design for the silo system that will be sufficiently definitive to proceed with acquisition when required. We estimate that 20 percent of the program costs can be attributed to this effort.

BACKUP INFORMATION

[In millions of dollars]

Contractor/effort	Total program	System engineering
TRW:		
SE/TD	———	———
Directed studies	———	———
Boeing:		
Minuteman III interface	———	———
Test planning	———	———
Test technology	———	———
Shock isolation systems	———	———
Missile mounts	———	———
Suspended floors	———	———
Umbilical retract mechanism	———	———
Prototype design	———	———
Operational design consideration	———	———
Bechtel:		
Prototype facility design	———	———
Develop and test facility hardware	———	———
LF closure, debris removal, shock isolation of facility equipment	———	———
Operational design consideration	———	———
Command control:		
Prototype design	———	———
Radios	———	———
Cables	———	———
Consoles	———	———
Antennas	———	———
MICCS integration	———	———
Operational design consideration	———	———
Technology	———	———
Power/environmental control	———	———
Government-furnished equipment	———	———
Alternate facility contractor	———	———
Total	[1] 286.0	57.0

[1] This is the currently estimated cost through CDR.

Mr. ANDREWS. Questions on the Hard Rock Silo program?
Mr. Lipscomb.

HIGH EXPLOSIVE SIMULATION TESTS (HEST)

Mr. LIPSCOMB. Is the HEST program still being conducted?

Colonel SHERMAN. Yes, sir. There has been a series of high explosive simulation tests—HEST—conducted at several of the existing Minuteman facilities, and one in Minuteman launch control facilities.

In the case of the launch facilities, they were tests up to ——— p.s.i. In the control facilities, there were tests up to ——— p.s.i. overpressures. These same types of tests are coupled with direct induced high explosive simulation tests which take the air pressure with a ground shock and try to impose the conditions which we expect will be seen by a facility through a nuclear burst on that facility.

These are the types of tests on silos. It is very comparable, except for the additional step of the direct induced ground shock.

Mr. LIPSCOMB. Where is the HEST program financed in the budget request?

Colonel SHERMAN. For the existing Minuteman facilities, they are within the Minuteman program line item. For Hard Rock Silo, they are partially within the Hard Rock Silo program, and some of the preparatory work for these tests is within the budget of the Air Force weapons laboratory.

Mr. LIPSCOMB. The HEST program has involved construction?

Colonel SHERMAN. Yes, associated with the HEST programs on Minuteman, just the construction of a berm, which is the overburden, and the primacord.

For the test of the Hard Rock Silo program, we of course have to go in and prepare a test bed in a rock medium and then put the R. & D. structure in those locations for test purposes. That is not MCP money.

Mr. LIPSCOMB. In your presentation you are tying together the Hard Rock Silo development program and the HEST program.

Colonel SHERMAN. I am trying to bridge the relationship of high explosive simulation tests to hardened facilities. They had their origin in the Minuteman program to verify the hardness of those facilities. The same types of test will be used in the Hard Rock Silo program.

Mr. LIPSCOMB. Will you continue with the HEST program on the Minuteman I and II silos?

Colonel SHERMAN. We currently do not have any further tests planned in the future. Maybe an occasion will arise where we would want to do one for a specific reason. Right now we do not have any in next year's budget.

Mr. LIPSCOMB. Did you conduct any of these tests during 1969?

Colonel SHERMAN. The last one was in 1968.

Mr. LIPSCOMB. Were there any funds expended on the HEST program in 1969?

Colonel SHERMAN. For Minuteman?

Mr. LIPSCOMB. For the HEST program.

Colonel SHERMAN. The HEST is not a program element as such, Mr. Lipscomb. It is a test.

Mr. LIPSCOMB. I understand and I am trying to find out its funding requirements. Where is it and how much is it?

General BOYLAN. There was a HEST program associated with the Hard Rock Silo development program in November of 1968. Is that not correct?

Colonel SHERMAN. Yes.

General BOYLAN. That was conducted in New Mexico. As I understand the program, there is another test scheduled for ——— in Utah, which is associated with the Hard Rock Silo development program.

Mr. LIPSCOMB. How is HEST being financed right now?

Mr. WALSH. It is not a program but a technique.

Mr. LIPSCOMB. Where is the money coming from?

General PITTS. Mr. Jackovich can answer that.

Mr. JACKOVICH. HEST tests are financed from the R.D.T. & E. appropriation.

General PITTS. On the Minuteman line?

Mr. JACKOVICH. Within the Minuteman line, if it is related to the Minuteman program. The upcoming one whould be out of the Hard Rock Silo development program. The actual cost of any test that we have done within the Minuteman program is related to that program.

Mr. LIPSCOMB. How much did the HEST program cost and what is planned in the HEST program for fiscal year 1969 and 1970? You may put it in the record.

(The information follows:)

HEST PROGRAM COST

Five HEST tests have been accomplished in the Minuteman program, one demonstration test, three on silos and one on a launch control center. The hard rock silo program participated in rocket test I, a ——— psi test, last fall and will have structures in rocket test II which is scheduled for ——— DASA funded the development of the HEST environment for the Minuteman tests and the rocket test series. The cost associated with these tests follows:

[In millions of dollars]

	Through fiscal year 1969	Fiscal year 1970	Total
Minuteman/DASA	39.8	0	39.8
Rocktest I and II:			
DASA	7.3	1.3	8.6
Hard rock silo	7.1	.9	8.0
Total	54.2	2.2	56.4

MANNED ORBITING LABORATORY (MOL)

Mr. ANDREWS. Now we will talk about the Manned Orbiting Laboratory, MOL. What are the total sums which have been obligated and have been expended in the Manned Orbiting Laboratory program?

COST OF PROGRAM

Mr. HANSEN. Our witness for questions on the MOL will be Maj Gen. Jim Stewart, who has been the vice director of the MOL program. I would like to pass the questions to him.

Mr. ANDREWS. General Stewart, do you understand the question?

General STEWART. Yes, sir.

There has been $1.37 billion obligated; and as of May 31, Government disbursements or expenditures were $1.22 billion.

I think I would like to add a cautionary note, however, so as not to be misled by the latter figure. Because of the system of progress payments, the accounting, the billing, the verifying, the actual paying, Government expenditures lagged by a goodly number of months the actual contractor, subcontractor, and vendor expenditures, and our estimate on June 1 is that the contractor expenditures and earned fees were very close to $1.3 billion.

Mr. ANDREWS. My question again: What are the total sums which have been obligated and expended in the Manned Orbiting Laboratory program?

General STEWART. All money appropriated has been obligated, $1.37 billion.

Mr. ANDREWS. What about the $1.22 billion figure you gave?

General STEWART. Those are the checks written by the Treasury. I just cautioned you that those lagged the contractor expenditures by several months.

Mr. ANDREWS. Do you anticipate that all of that will be spent within the next fiscal year?

General STEWART. Yes, sir.

Mr. ANDREWS. So the total cost of the MOL program is $1.37 billion?

TERMINATION COSTS

General STEWART. Plus some termination costs that we will ask the Congress for additional money in fiscal year 1970.

Mr. ANDREWS. How much?

General STEWART. We are asking Congress for $125 million.

Mr. ANDREWS. That, added to the $1.37 billion, will be $1.495 billion?

General STEWART. Yes, sir.

Mr. ANDREWS. The program has been scratched?

General STEWART. Yes, sir.

Mr. ANDREWS. What did you receive for the $1.495 billion?

Mr. RHODES. Before he answers that question, may I ask a question? Is the $125 million a firm figure? Has this been negotiated with the contractor? Do you know this will be the cost, or is this the estimate of the Air Force at the present time?

General STEWART. It is our best estimate. Some termination costs will actually not be legally determined for a goodly time, perhaps 1 or 2 years. These are arguments over how much fee was the contractor entitled to. These are lesser amounts. It will be several years before termination is completely wrapped up.

Mr. RHODES. Is it really good strategy to ask for termination costs prior to the time you have determined exactly what they are? These contractors will have some idea of what they can get if you ask for that much money. I suggest the possibility, if they do not have any idea how much you are going to ask for, you possibly could make a more advantageous settlement.

General STEWART. I do not think it works quite that way, because there are firm commitments for work that was in progress that would have been delivered over the next few months. Part of your contract——

Mr. RHODES. Wait a minute. That goes into the part that has been obligated. That is in the $1.37 billion. Maybe I do not know what termination costs are, General. Maybe you had better redefine them for me.

EXPLANATION OF TERMINATION COSTS

General STEWART. All right, sir.

First is an area called noncancellable commitments, if you will. This is work in progress that would have been delivered up to several and many months ahead.

Mr. RHODES. Is this not part of the obligated portion?

General STEWART. Most of it is.

Mr. RHODES. What part of it is not?

General STEWART. I will give you one area that specifically is not covered in our contracts, a thing called special termination costs. This is severance pay for people, their accrued leave, their relocation costs, the costs of closing down the plant, of changing anything in the plant that has been changed purely for the convenience of and is usable only for this program, the shipment and disposition and storage and pres-

ervation of equipment and hardware. Those costs are not normally included in large contracts because you have just tied up a lot of obligating authority of the Government that is not working.

Mr. RHODES. Yes. You have just given the elements that anybody would expect to be included in termination costs. I am trying to determine what is it that we will have to keep buying which you mention as a part of termination costs, which I say should have been in funds that were already obligated? I do not want to get in an argument with you. I am just trying to understand what this is all about.

General STEWART. I gave you a list of things that tallies at least $75 million, things that I positively said were not included in contracts.

I think I must add one other point for you, also. This was not a complete and total and utter termination immediately of all aspects of the program. We need to phase some of the work over to other areas, some of it in the booster field,——— some of it will be acquired by NASA, and it will probably be in July before all MOL contracts have been totally terminated.

Some have been totally terminated to date; some have been partially terminated.

COSTS NOT RELATED TO TERMINATION

Mr. RHODES. You are going to give us a request for $125 million for termination expenses, $50 million of which has nothing whatsoever to do with termination expenses. All you are doing is starting new programs or putting it over into another program. Do not do that. This is not playing square with this committee.

General STEWART. I identified some $75 million that was specifically, clear cut outside of contract termination.

Mr. RHODES. There is no argument about the $75 million. I am talking about the $50 million.

General STEWART. Another portion of the $50 million is pure and simple termination costs.

Mr. RHODES. You had better elaborate for the record, because as of now, you have not made a very good case for $125 million.

General STEWART. There is another chunk of costs that is a transition cost, if I can call it that.

Mr. RHODES. Call it whatever you want, but I do not know what it means.

General STEWART. May I give you one specific example?

Mr. RHODES. Yes, sir.

General STEWART. We have continued several Titan III–M tasks in the Titan III–M development program. It had been planned in future production to incorporate some of the improvements that would have been made in Titan III as common items in the other Titan III boosters. We do expect to pick up some of those tasks in the Titan III program. We either must do that or we must reinstitute the production of other items. We have continued those.

Mr. RHODES. Put it under the Titan III procurement, and then we know what you are talking about, but do not call it termination costs or transition.

As I gather, the transition is an element of termination, and I am saying it should not be, in my opinion. I do not object to your doing

it, but I just want you to put it in the proper pigeonhole so we can understand it, that is all.

(The information follows:)

REQUEST TO CONGRESS FOR TERMINATION COSTS

MOL TERMINATION COSTS

The manned orbiting laboratory (MOL) program requires $125 million fiscal year 1970 NOA to provide for both normal contractor/subcontractor termination expenses and the additional costs associated with an orderly closeout of the project.

Contractor termination costs include such items as employee severance pay and relocation reimbursement, settlement expenses, and allowable post-termination operations—inventory, hardware, and equipment disposition, and so forth—and plant maintenance. The preponderance of termination activities should be completed by mid-fiscal year 1970; however, some matters—for example claim settlements, contract renegotiations, and so forth—may extend over a period of several years.

To insure the fullest possible utilization of the technology and hardware developed in the MOL program, those activities which have or may have application to other DOD or NASA programs are being closed out in an orderly, economical manner. For example, numerous subsystems and components being developed for the MOL Titan IIIM booster were also programed for future production versions of the Titan IIIB, C and D; this work is being continued under MOL contracts until it can be assumed by the latter booster programs. Certain other MOL contractor efforts were placed in a minimum expenditure status to permit NASA and appropriate Air Force elements to assess the desirability of incorporating completed and/or planned work in on-going programs; examples in this category include the MOL pressure suit, food and feeding system developments, the airborne computer, and waste management system.

Mr. LIPSCOMB. General, how do you intend to make the request to the Congress for these funds for termination, the $125 million? It is not before us now.

General STEWART. The Bureau of the Budget, in the Department of Defense budget, will submit an amendment to the fiscal year 1970 MOL line that currently is in your program, and they will submit an amendment and ask you to change it from $525 to $125 million.

Mr. LIPSCOMB. Do you know when that may be done?

General STEWART. It is in work. It has not gotten out of the Secretary of Defense Comptroller Office.

Is that a fair statement?

Mr. JACKOVICH. It is still under discussion, Mr. Lipscomb. The actual formal handling has not yet been decided in the Office of the Secretary of Defense. We still do not have a firm fix on it yet.

I think what General Stewart is indicating is that currently we have a request for $525 million, and he estimates that $125 million will be required for termination and transition, if you will, and other uses; $125 million is a portion of the original request.

General STEWART. I suspect I must rephrase my question. My office has asked that $125 million be left in the fiscal year 1970 line, and it obviously has not yet gotten out of the Secretary of Defense Office.

Mr. LIPSCOMB. It is probably fortunate that you brought it up, because I think there is the impression that we are just cutting out the MOL money that was requested in the original budget.

General STEWART. I know Mr. Laird in his statement to the Senate the day he announced that the MOL would be canceled, and Mr. Packard also, in his press conference, cautioned that not all of the

fiscal year 1970 money that had previously been requested for MOL would be saved.

Mr. LIPSCOMB. I am glad the Senate knows.

General STEWART. It coincided with his appearance before the Senate. Had he been appearing before your committee, I am quite sure he would have made exactly the same statement.

REASONING FOR CANCELING MOL

Mr. ANDREWS. After spending $1.370 billion on the MOL program, why was it stricken, General?

General STEWART. The primary reason it was stricken was to reduce fiscal year 1970 and future Defense spending.

Mr. ANDREWS. How much of the $1.370 billion, plus the anticipated $125 million for liquidating costs, totaling $1.495 billion, will go down the drain? I mean by that, spent for something you did not get? Give me a ball park figure.

General STEWART. Perhaps a billion dollars.

Mr. ANDREWS. One billion dollars. What amount of funds appropriated for fiscal year 1969 and for prior years for the MOL remain unobligated? What funds remain unexpended?

General STEWART. There are no unobligated funds, sir. Unexpended, I would give you my two answers.

One, if you look at Government expenditures, about $150 million have not been expended.

If you look at where the contractor expenditures are, it is perhaps $65 million.

(Off the record.)

MOL VERSUS UNMANNED SATELLITES

Mr. ANDREWS. What have been the specific major accomplishments that now permit the cancellation of the MOL and the accomplishment of MOL missions with lower cost unmanned satellites?

General STEWART. If you look back to when the MOL concept was announced in 1963 and the program actually approved in 1965, there have been major advances in almost every aspect you can think of, of unmanned space system capabilities, in sensors, in navigation, in ability to remotely control, in ability to automatically detect and correct malfunctions, in navigation, in data handling, stabilization of power, and so on.

I would shudder to single out any one and call it major. All together, there are tremendous advances.

Mr. ANDREWS. Can all of the missions of the MOL be accomplished with lower cost unmanned satellites?

General STEWART. I have to answer that no, because, you may recall, the objectives of MOL included the development of defense-oriented hardware for both manned and unmanned use, and we surely will not be able to develop the manned hardware.

Another objective was really to learn more about man in space for military purposes. What can be done better, under what circumstances, how much better, how much extra cost? That we will not learn.

Still another objective was to provide us an operational test bed for other possible applications of equipment as it became feasible and desirable.

Still one more is something man can probably do better than we can practically do in an automated sense. We will not do those kinds of things in the future.

Mr. ANDREWS. Are the unmanned satellites referred to in being, or must they be developed?

General STEWART. I would say in being for the most part, because the committee knows the Department of Defense has a pretty extensive unmanned program. We have some space systems in operational use, others in sort of flight test, if you will, and still others in development.

I think for the most part, they are in being.

Mr. ANDREWS. What are the projects or programs included in the R.D.T. & E. Air Force appropriation which support the MOL, either wholly or substantially, as their objective?

General STEWART. None wholly or substantially. All significant costs for MOL were included in the MOL line.

BENEFITS GAINED FROM MOL

Mr. ANDREWS. To what Air Force programs can knowledge gained from the MOL effort be applied, and to what NASA programs?

General STEWART. I partially answered that. We have a compresensive review underway to try to make sure that we do get maximum benefit.

Mr. ANDREWS. I wish you would put something in the record about that.

General STEWART. I would be delighted.

(The information follows:)

APPLICATION OF MOL KNOWLEDGE TO OTHER AF/NASA EFFORTS

Thus far in our review of MOL technology and hardware that might be applied to other programs, NASA has indicated an interest in our astronaut full pressure suit system, feeding system, waste management system, and parts of our environmental control system. Within the Air Force, we are considering picking up in other Titan III launch vehicle programs certain development efforts associated with the Titan IIIM MOL booster. Secretary Seamans has established an ad hoc group to conduct a comprehensive review of the MOL program to insure that maximum national benefit is realized from MOL hardware, technology, and experience. This effort will undoubtedly result in additional applications of MOL residuals as well as identitfy essential MOL work which must be carried out in other programs.

PROGRAMS RELATING TO MANNED SPACE EFFORT

Mr. ANDREWS. Does the Air Force have any other approved manned space programs?

General STEWART. No.

Mr. ANDREWS. What parts of such programs as "Aerospace Biotechnology," "Aerospace Propulsion," "Aerospace Avionics," "Space Experiments Support," "Advanced Space Guidance," and "Advanced

Space Power Supply Technology" are directed toward manned space efforts?

General STEWART. Approximately 15 to 20 percent of the aerospace biotechnology area is directed toward manned spaceflight, and I think the other areas are really generally applicable to either manned or unmanned spacecraft and aircraft.

Mr. ANDREWS. Elaborate on that in the record.

General STEWART. All right, sir. I would be glad to.

(The information follows:)

RELATIONSHIP OF CERTAIN PROGRAMS TO MANNED SPACE EFFORTS

Of the various technologies cited in your question, only the aerospace biotechnology area is man related. The other areas deal with the development of aircraft and spacecraft technologies that apply to new or improved hardware (e.g., space vehicles, power supplies, electronics, space and missile guidance system, etc.). These technologies would be generally applicable to either manned or unmanned spacecraft.

In the case of MOL there was little new technology involved except in the experiments area. Examples of new technology in MOL were largely a carryover from previous NASA work such as fuel cells, life support systems, and waste management system.

The program area of aerospace biotechnology is somewhat different than that of the other aerospace research and development program areas because its efforts are to develop information and technology concerning the "needs of man" and the "limitations of man" while operating in aeronautical or space manned vehicle. It also encompasses the development of appropriate technology for the provision of a safe living and working environment while operating the system. Space flight, in this case, only adds a few additional environmental factors to an already established program rather than causing a completely new and exclusive undertaking for space alone.

Therefore when one analyzes the details of the program element, aerospace biotechnology, one finds that most of the work units underway support man in both aeronautical and space systems. As the operations envelope of aeronautical systems has increased in speed, altitude, and in the demands upon the crewmen, the percentage of the study efforts in this program which support both aeronautics and space has increased with each annual audit. Conversely, the percentage which supports either single area exclusively has progressively decreased. Review of the program for the fiscal 1970 program indicates that approximately 15 to 20% of the proposed program supports manned space operations; approximately the same percentage is dedicated to exclusively aeronautical system support, the remainder of the study efforts will support either or both areas.

Mr. ANDREWS. The committee will adjourn until 2 o'clock, gentlemen.

AFTERNOON SESSION

Mr. ANDREWS. The committee will come to order.

This afternoon we continue discussing the MOL program.

PERSONNEL INVOLVED IN MOL PROGRAM

How many Air Force civilian and military personnel are involved in the MOL program?

General STEWART. 373 military, 136 Air Force civilians.

Mr. ANDREWS. How many contractor personnel are involved?

General STEWART. There were more than 13,000 associate contractor personnel on board early this month.

MOL COST INCREASES

Mr. ANDREWS. What part did cost increases play in the cancellation of the MOL? The original estimate given Congress was $1.5 billion. The estimate in the justifications this year is $3.1 billion. That is a little more than double.

General STEWART. To answer your question specifically, I think the primary reason that MOL was canceled was the one that I gave you, and this was the need to reduce Defense spending in 1970 and in future years. Of course, you have to conclude that cost increases were a factor because had we been able to follow the timetable we laid down in the fall of 1966 the program would have been much further along, would have cost less, would have needed less money in 1970 and 1971, and so on.

Mr. ANDREWS. According to these figures—and they are correct, I assume—the original estimate was $1,500 million and the most recent estimate was $3,100 million; was that big increase in cost estimate due in part to inflation or miscalculation?

General STEWART. May I take 1 minute? They are not quite apples and apples, though they are correct. We actually started hardware development in the fall of 1966. The program scope had been changed a little bit between then and 1965. Now, let me work from there. Our estimate was $1,980 million. The $3,100 million is correct. I will give you like four or five major reasons or causes for the difference between the $2 billion and the $3 billion.

We put slightly more sophisticated hardware as we went along. The Apollo fire caused us to go back and do some regrouping. We found that some items were flat going to cost more money than we thought they would. We found it was going to take us more time to do some of the development than had been estimated. We deliberately stretched the program out two or three times to make short-term savings, recognizing that it would cost us more in the long haul. There also has to be a chunk of inflation in there, but I sure couldn't attribute the bulk of the increase to inflation. That would be ridiculous.

MOL SCHEDULE SLIPPAGE

Mr. ANDREWS. Do you think that the original mission designed for the MOL program could have been accomplished if the program had been pursued to finality?

General STEWART. Yes, sir.

Mr. ANDREWS. The originally scheduled launch date of late 1968 had slipped by 3½ years. Did this play a part in the decision to terminate the program?

General STEWART. Let me sort of get apples and apples as I did in the last question. Really, our first reasonable launch date was late 1969, when we started hardware development. So it is like two and one-half instead of three and one-half. But this played a part in the decision to cancel it only indirectly because every time we stretched the program out the price did go up and it left more money ahead of us. I do not think the fact, though, that we would have had the MOL whether it was 2 or 3 years later than originally anticipated, that in itself was not a major factor in the decision to cancel it; no, sir.

Mr. ANDREWS. You say, if I understand correctly, but the main consideration was budgetary?

General STEWART. Yes.

EFFECT OF MOL CANCELLATION ON FEDERAL CONTRACT RESEARCH CENTERS

Mr. ANDREWS. What effect will the MOL termination have on your funding requirement for Federal contract research centers?

General STEWART. Well, when the program was canceled earlier, I think there were about 300 members of the technical staff at the Aerospace Corp. assigned to support MOL, and they were being financed with MOL funds. Some of these I know are needed in other Air Force programs that are supported by Aerospace and there undoubtedly will have to be some readjustments by Aerospace. This is under most intensive consideration by Aerospace, by General O'Neill at SAMSO, by the Secretary, and I think it is probably a month or more before the Air Force can give you the final total impact on Aerospace.

Mr. ANDREWS. What will the impact of the MOL termination be on in-house laboratories?

General STEWART. I do not believe there will be any impact of any consequence on the labs.

VANDENBERG MOL LAUNCH COMPLEX

Mr. ANDREWS. What will become of the MOL launch complex at Vandenberg Air Force Base?

General STEWART. This was within 2 to 3 months of completing the military construction phase and we are only partially hooking up enough items so that it makes sense to place it in a caretaker status, and that is what we are really in the process of doing.

Mr. ANDREWS. You have no need for completing it at this time?

General STEWART. Not beyond this stage, sir, and with not very much modification it can accommodate any number of the Titan III family. My personal feeling is that we will use it in the future but today it goes to caretaker status because there is nothing firm for it.

Mr. ANDREWS. What is the cost of the launch complex?

General STEWART. $31.1 million for the launch complex, military construction.

Mr. ANDREWS. Is that included in the figure you gave me of $1.37 billion total cost of the MOL program?

General STEWART. No, sir; it was not. I really only talked about research and development, test and evaluation money. It was not——

Mr. ANDREWS. So that is in addition to the other amount?

General STEWART. Yes.

Mr. ANDREWS. That would make the total cost of the program $1.4 billion, plus whatver termination damages you have to pay?

General STEWART. Yes, sir. As a matter of fact, let me add $5 million more of military construction money. There were $5 million in support facilities on Vandenberg Air Force Base proper, not part of the lauch complex. So, that the grand total of military construction is $36.1 million. This does not include the cost of the land added to Vandenberg, part of which was used for the MOL launch complex.

TOTAL COST OF MOL PROGRAM

Mr. ANDREWS. I wish you would put in the record at this point the total cost of the MOL program.

General STEWART. Yes, sir.

Mr. ANDREWS. If you can think of any other costs, include them also.

General STEWART. Yes, sir.

(The information follows:)

TOTAL AMOUNT SPENT ON MOL AND OTHER COSTS IDENTIFIED WITH MOL

Through fiscal year 1969 approximately $1.37 billion has been appropriated in the R.D.T. & E. appropriation for MOL which included the orbiting vehicle and the Titan IIIM launch vehicle. Approximately another $36 million has been made available for facilities at Vandenberg Air Force Base. ($31 million for the launch complex and $5 million for support facilities.) The addition to Vandenberg Air Force Base on which the launch complex was located was acquired for approximately $10 million. (This land was not acquired exclusively for MOL, but MOL was the first program to build a facility in the new area.) In addition several hundred thousand dollars have been spent at the Aerospace Medical Division the past several years on a task basis. Approximately 136 civilions, 301 officers, and 72 airmen were assigned to or supporting the MOL program when it was canceled.

The total cost of the MOL program including the estimated termination costs are summarized as follows:

	Million
R.D.T. & E	$1,370
In MCP (for launch and supporting facilities)	36
In MCP (land acquisition)	10
Termination costs	125
Total	1,541

Mr. ANDREWS. Is the MOL termination tied to any international agreement?

General STEWART. Not in any way.

SPACE SUITS AND LIFE SUPPORT SYSTEMS

Mr. ANDREWS. In spite of the fact that NASA has, over the years, programed $84 million for the development of space suits and portable life support systems, the Air Force has also been spending $4.2 million in this area. Most of this effort has been related to MOL. A recent $155,000 follow-on contract with Hamilton Standard is an example of such efforts. Will this work now be terminated?

General STEWART. With regard to the $155,000, this will be continued. This is a contract for the development of advanced suit technology. It is very closely coordinated to NASA, and I think it has general application to Air Force aircraft as well as space operations. This was not a part of the MOL program.

MOL BUDGET REVISION

Mr. ANDREWS. Is it the plan of the Administration to submit an amendment to the budget reflecting the MOL reduction?

General STEWART. Yes, sir. However, the method of accomplishing this revision has not yet been determined.

Mr. ANDREWS. How much?

General STEWART. My belief is that it will be reduced from $525 million to $125 million in fiscal 1970, sir.

Mr. ANDREWS. Will you inform the office of the Secretary of Defense that the committee considers any reprograming of MOL funds to be a matter of special interest requiring the prior approval of the committee?

General STEWART. Yes, sir. We have already done so.

Mr. ANDREWS. Is any increase in the NASA budget proposed as a result of the MOL termination?

General STEWART. Not to my knowledge.

Mr. ANDREWS. Any questions on the MOL program?

Mr. MINSHALL. I have no questions, Mr. Chairman.

BIOASTRONAUTICS

Mr. ANDREWS. With all of the NASA activity in the area of space medicine, including all of the research effort which made it possible for this country to orbit the moon and walk in space, and since the only Air Force manned space program has been terminated, why must the Air Force maintain an effort at the rate of more than $20 million a year in aerospace biotechnology?

EXPLANATION OF PROGRAM

Mr. HANSEN. Mr. Chairman, as General Stewart stated earlier, only about 15 to 20 percent of the effort on this line was supporting the MOL and man in space effort.

Mr. ANDREWS. What percentage?

Mr. HANSEN. Somewhere in the vicinity of 15 to 20 percent was supporting the MOL program, more generally a military man in space. The balance of these funds are for the solution of aeronautical system biotechnology problems, men in airplanes. This is all contained in 23 projects, five technical areas: Aerospace medicine, human performance, life support, biological sciences, and radio biology. Radio biology is the study of the effects of ionizing radiation on the human system. An example of that is the determination of postwarhead fallout dosages and resulting biological response. In summary, the large majority of this is not tied to what NASA is doing or to the MOL program or the manned program, but is in direct support of the Air Force's manned aeronautical mission. The portion which was alined just with MOL we would expect, as we revise our budget submission in regard to the MOL program, would be looked at again to make sure that the effort directly involved in the manned space flight would be taken out of this.

AEROSPACE MEDICAL DIVISION

Mr. ANDREWS. The major item in this project is for the Aerospace Medical Division operation for which you are requesting $13.1 million. This is an increase above the $12.5 million programed in fiscal 1969. What is the reason for this increase?

Mr. HANSEN. The principal reason for this increase is to fund the completion of a new facility for the Toxic Hazards Division of the

Aerospace Medical Research Laboratory at Wright-Patterson Air Force Base. This facility is a group of simulation chambers called Thomas Domes. They are used for toxicological investigations. This facility is the only one in the free world and is nationally recognized for its capability. These facility chambers permit altitude, atmospheric, and environmental simulations so that human and animal tolerance criteria may be established for people working with materials, fire extinguishants, chemicals, and propellants which may be toxic. These new materials also may cause environmental pollution, and research is being conducted with regard to that.

Mr. ANDREWS. You can elaborate in the record.

Mr. HANSEN. Yes, sir.

(The information follows:)

AEROSPACE BIOTECHNOLOGY—MEDICAL DIVISION

To elaborate on the previous input concerning the increase in fiscal year 1970 operating costs for the Aerospace Medical Division, the Toxic Hazards Division facilities at Wright-Patterson will be approximately doubled by addition of the four new "Thoms domes." The doubling of the facility size necessitates a corresponding increase in the use of supplies, etc.

In addition to the increase in these facilities there are other increased cost items that were not previously mentioned. For example, funding for maintenance of aircraft now must come from AMD operational funds. This cost was formerly funded elsewhere. The general cost-of-living increase is also involved in the difference between fiscal year 1969 and fiscal year 1970 funding figures.

MEDICAL DIVISION EMPLOYMENT

Mr. ANDREWS. How much of the $13.1 million is for the pay of civilian employees?

General PITTS. $9.6 million.

Mr. ANDREWS. How many civilian employees are paid from this account?

General PITTS. 822 man-years, which equates to an end strength of 823 civilians.

Mr. ANDREWS. How much of this money is for contractor personnel?

General PITTS. No funding for contractor personnel.

Mr. ANDREWS. How many military personnel are associated with this effort?

General PITTS. 1,035 man-years.

Mr. ANDREWS. Are they carried on the personnel account?

General PITTS. Yes, sir; in the military personnel account.

BIOTECHNOLOGY CONTRACTS

Mr. ANDREWS. Other than the item for the Aerospace Medical Division operations, are the rest of the line items under "Aerospace biotechnology" performed under contract?

Mr. HANSEN. I mentioned we had 23 projects. These are all under contract.

Mr. ANDREWS. List for the record the major contracts.

Mr. HANSEN. Yes, sir.

Mr. ANDREWS. Are the development of space suits included here?

Mr. HANSEN. No.

(The information follows:)

Project No. and title	Total contracts	Contracts more than $100,000	Contracts $50,000 to $100,000
6302—Toxic Hazards of Propellants and Materials	13	(1) 600K	
6373—Equipment for Life Support in Aerospace	14	.....	(4) 73K, 68K, 55K, 72K
7164—Thermal Effects and Altitude Protection of Aerospace Crewman.	8	.....	(2) 72K, 55K
7184—Human Performance in Air Force Systems	18	.....	(6) 99.9K, 62K, 53K, 54K, 52K, 58K
7222—Combined Stress Environment in Aerospace Operations.	14	(1) 250K	
7231—Biomechanics of Aerospace Operations	30	(1) 213K	(2) 90K, 67K,
7233—Biological Information Handling Systems	10	.....	(1) 57K
6301—Nuclear Flash and Laser Hazards (Biomedical)	4	(1) 138K	(2) 98K, 59K
6319—Procedures for Analysis, Modeling and Processing Aerospace Medical Data.	1	.....	
6320—Aerospace Bioinstrumentation	2	.....	
7753—Pharmacologic and Microbiologic Hazards of Aerospace Systems Operations.	1	.....	
7755—Medical Aspects of Aerospace Operations	9	.....	
7757—Radiobiology in Aerospace Operations	17	.....	(1) 66K, 60K
7758—Aerospace Physiology	17	.....	
7930—Atmospheric/Acceleration Criteria for Manned Aerospace Operations.	15	.....	
7996—Medical Equipment Development	4	(1) 142K	(1) 99.8K
6892—Biomedical Effects of Extremely Hazardous Air Force Environments.	8	.....	
6893—Effects of Unusual Environments on Performance	7	.....	(1) 50K
7756—Air Force Clinical Medicine	3	.....	
7801—Nuclear Radiation Hazards to Personnel	1	.....	
5877—Biophysical Measurement, Analysis, and Prediction of Ionizing Aerospace Radiations.	6	.....	

BIOTECHNOLOGY FOR SOUTHEAST ASIA

Mr. ANDREWS. The descriptive summary material indicates that one of the objectives of this program in fiscal 1970 will be "rapid and direct response to requirements generated in Southeast Asia." What requirements do you have in Southeast Asia in the area of military astronautics which involve aerospace biotechnology?

General MCNICKLE. One item was the air crew body armament. Another, maintenance of body temperatures in pilots. A water-cooled vest to keep the pilots cool in that tropical atmosphere.

Mr. ANDREWS. Are they in use today?

General MCNICKLE. Yes, sir.

Mr. ANDREWS. Water-cooled vests?

General MCNICKLE. Yes, sir.

Mr. ANDREWS. What reports do you have as to the use of them?

General MCNICKLE. I will furnish for the record those reports. If we do not have them, I will get them, but I know that they are used.

(The information follows:)

REPORTS ON WATER-COOLED VESTS IN USE IN VIETNAM

Reports from SEA indicate that the aircrew members in general responded favorably to questions concerning the body armor. For example, 89 percent of a group evaluated reported that the torso front neck fragmentation protection armor was very desirable, and the other 11 percent reported desirable. Evidently the neck portion of the body armor is looked upon as a most desirable feature.

The water-cooled vests are also in use in SEA and those tested and evaluated have been found to be especially desirable for those aircrew members on alert status in aircraft.

Another example was the evaluation of a drug for malaria control with respect to flying personnel. Actually, they ran tests on an Army development to determine if it would have a detrimental effect on flying personnel.

Another example was to investigate the cause for a number of injuries from ejection seats, particularly in the F–4. We found out that in the ejection, pilots were not straight up. After many tests, our people put a lumbar pad in the ejection seat and it took care of straightening the crew members before they took the stress of ejection.

AERONAUTICS RATHER THAN ASTRONAUTICS

Mr. ANDREWS. The question is, why do you fund these items under astronautics rather than aeronautics?

Mr. HANSEN. We do not understand the question, Mr. Chairman.

Mr. ANDREWS. Mr. Preston.

Mr. PRESTON. Why wouldn't this be in budget activity 2? This is related to aircraft and not to space programs, the items that General McNickle mentioned. These are aircraft-related efforts. This is military astronautics; the title would lead us to believe that it contains space-oriented efforts.

Mr. HANSEN. Well, this line is aerospace biotechnology. It was previously called bioastronautics. The name was changed because the effort is predominantly aeronautical rather than space.

Mr. PRESTON. Why isn't it then moved into budget activity 2?

Mr. JACKOVICH. That is probably where it ought to be. It shifts, depending upon the preponderance of the output from the program. I think initially it was predominantly space, and I thought it still was. We will take a look at it.

BIOTECHNOLOGY ACCOMPLISHMENTS

Mr. ANDREWS. What accomplishments can you point to from your aerospace biotechnology efforts over the past year?

General MCNICKLE. One item is a miniature pilot target display, a little TV which is attached to the helmet.

Mr. ANDREWS. Is that in use today?

General MCNICKLE. Yes, sir.

Mr. ANDREWS. Where?

General MCNICKLE. Not in Southeast Asia, but it is being developed and will go there just as soon as we can get it there.

Mr. ANDREWS. Explain it a little more in detail.

General MCNICKLE. It has a remote controlled TV camera. It is a screen that fits on the pilot's helmet. The display shows the airspeed and other flight information, so that the pilot can get instrument readings without looking down into cockpit or turning his head.

Mr. ANDREWS. In other words, he can keep his eyes straight ahead of him, he does not have to look at the panel board?

General MCNICKLE. Yes, sir.

Mr. ANDREWS. That can be helpful, can it not?

General MCNICKLE. Yes.

Mr. ANDREWS. Why?

General MCNICKLE. A lot of times when you want to make sure that you have not exceeded flight limitations as you continue the attack,

you need to keep your eyes on the target so anything that assists you in that regard would be a big help.

Mr. ANDREWS. How much was spent on that project, and where was it developed?

General MCNICKLE. I will have to provide that.

(The information follows:)

The helmet-mounted display which is a miniature television display was developed by Hughes Aircraft Co., for approximately $100,000.

Mr. HANSEN. May we go off the record?

Mr. ANDREWS. Off the record.

(Discussion off the record.)

General MCNICKLE. On laser usage, we have run tests to develop tolerances for milliseconds or seconds of exposure. This test data may be applicable to personnel to prevent eye damage, and to identify what the tolerances are.

Mr. ANDREWS. Put some more examples into the record, if you have any.

General MCNICKLE. I have a number more and I will put them in the record.

(The information follows:)

ADDITIONAL EXAMPLES OF ACCOMPLISHMENTS UNDER AEROSPACE BIOTECHNOLOGY

Flashblindness orientation training systems for pilots.
Establishment of safe exposure levels for four lasers of Air Force importance.
Developed photochromic dye materials for protective windshields and goggles.
Developed permeability selective membranes for CO_2 removal in closed environments.
Determined effects of body position on susceptibility to decompression.
Developed aircrew body armament for use in SEA.
Water-cooled vest for thermal control in hot (SEA) environments.
Space cabin materials testing for toxic substances.
Determined the safety of the antimalarial drug (Dapsone) in flying personnel.
Developed the aerobics physical fitness program.
Determined the rapid recovery of human performance after decompression affected by preconditioning.
Developed predictor display concepts for terrain following in simulator.
Developed long-line deployment techniques.
Developed model of retina demonstrating pattern recognition.
Developed model of inner ear demonstrating speech recognition.
Discovered the dynamic action of aerospace flight profiles on drug metabolism and activity.
Effects of altitude on susceptibility to infectious diseases.
Cardiovascular disease follow-up study on a controlled population for 17 years.
Improved nutritional quality for aerospace missions.
Established denitrogenation requirements for Apollo flights.
Determined that body metabolic response differs after zero G.

CHANGE FOR BIOTECHNOLOGY TO AEROSPACE BIOTECHNOLOGY

Mr. ANDREWS. Why was this effort redesignated "Aerospace Biotechnology" from its previous title "Bioastronautics"? Does this represent any change in function or is it just a name change?

Mr. HANSEN. Mr. Chairman, it was changed because this effort was predominantly in support of aeronautical systems rather than space systems. The name "Bioastronautics" applied only to astronautics and not aeronautics. The name was changed to Aerospace Biotechnology

so that it would be descriptive of efforts which was applicable to both the Aeronautical and the Space or Astronautical area. As we mentioned earlier, because the effort is predominantly Aeronautical it probably should be listed in another part of the budget.

Mr. ANDREWS. Any questions on Bioastronautics?

Mr. RHODES. No questions.

AEROSPACE PROPULSION

Mr. ANDREWS. How does this activity relate to the rocket propulsion effort under missiles and related equipment?

Mr. HANSEN. Aerospace propulsion relates to the air-breathing types of engines, whereas the rockets carry both the fuel and the oxidizer self-contained in the vehicle.

Mr. ANDREWS. Is the $5.7 million included here the total funding of the Aerospace Propulsion Laboratory operation?

General PITTS. Yes.

RAMJET TECHNOLOGY

Mr. ANDREWS. How does the Ramjet technology item for which you are requesting $5.4 million relate to the Ramjet work in the "air launched missile propulsion" project?

Mr. HANSEN. There is $5.4 million in exploratory development which is applied to advance component efforts. These are such components as the inlets, the combusters, the fuel controls, and nozzles. Once these items or components are established and technology developed then a complete propulsion system can be designated and developed. This integration of the components into a system is the task which is accomplished under the air-launched missile propulsion program.

Mr. ANDREWS. What is the basis of the increase in Ramjet technology from the $4.6 million in 1969 to $5.4 million in 1970?

General MCNICKLE. One of these new programs is the composite Ramjet engine technology program and it investigates critical components for the propulsion system combining the turbine and Ramjet modes, and to make it capable of operating from takeoff to ——— mach number at ——— feet. It is actually making a hybrid out of it. Another is the boron slurry fuel system for a high mach number advanced penaid system.

BORON SLURRY FUEL SYSTEM

Mr. ANDREWS. There is no such thing as reaching the end of the road in these research projects, in connection with different types of engines that you have?

General MCNICKLE. This may be one. Here is an example of where you are marrying two so that you take the advantages of one, and the other one keeps you going up.

Mr. ANDREWS. You are constantly trying to improve what you have?

General MCNICKLE. Yes, we are trying to go further.

Mr. RHODES. Of course, I understand and you understand exactly what the Boron Slurry Fuel System is, but there may be some people

reading this record who would not understand it. So would somebody please explain it for the record?

(The information follows:)

EXPLANATION OF BORON SLURRY FUEL SYSTEM

One of the most important design parameters considered in the design of a low altitude high Mach number vehicle is frontal area. For best vehicle (missile) performance, the frontal area must be kept to a minimum. One way of accomplishing this objective is through the use of a fuel that has high energy per unit of volume. Since boron has the highest energy per unit of volume of any known element, it is under investigation as a possible fuel for such vehicles. Boron is a solid. In order to pump and meter it, it is ground into a very fine powder and mixed with a suitable liquid carrier (usually JP-5) to form a slurry. The boron slurry, for best performance, wants to have the highest percent boron possible. The current slurries being developed are about the consistency of toothpaste, except that the boron slurry is quite abrasive.

Fuel tank expulsion systems, fuel lines, special metering methods and equipment, pumps, fuel injection nozzles and combustor development comprise the tasks being investigated under the project title of Boron Slurry Fuel System.

GAS TURBINE TECHNOLOGY

Mr. ANDREWS. For gas turbine technology, you programed $4.2 million in fiscal year 1968, $6.4 million in 1969, and are requesting $7.7 million in 1970. What is the reason for this steady increase?

General MCNICKLE. We have a number of objectives to meet. We are pushing to get lower specific fuel consumption, increased thrust-to-weight ratios, increased cycle flexibility and improved reliability of gas turbines. The increase in funds will permit us to accelerate the rate of progress we are making in this important area.

Mr. ANDREWS. What progress are you making?

General MCNICKLE. We have come up with an advanced technology engine for the F-14 and F-15. We have the AMSA engine demonstrators, engines for a heavy lift helicopter, work on quiet engine, and we are working on better components and even better performance from our engines.

Mr. ANDREWS. What other gas turbine development programs are included in the R.D.T. & E., Air Force appropriation?

General MCNICKLE. I have a listing here.

Mr. ANDREWS. Put them in the record.

(The information follows:)

OTHER GAS TURBINE DEVELOPMENT PROGRAM

The Air Force has other gas turbine development programs included in the R.D.T. & E., Air Force appropriation as follows:

1. TF30-P100 for the F-111.
2. The competitive demonstration for the Initial Engine Development for the F-15, the Air Force Air Superiority Fighter, which is a joint engine development program with the Navy.
3. The Advanced Manned Strategic Aircraft (AMSA) engine demonstrator competition.
4. The Advanced Turbine Engine Gas Generator (ATEGG) program which provides for advanced component testing of compressors, combustors and turbines in an advanced engine environment.
5. The Aircraft Propulsion Subsystems Integration (APSI) program which provides for development and environmental testing of engine components such as inlets, diffusers, fans, afterburners, and nozzles. It also provides the technical basis for compatible integration of the propulsion system and the airframe.

ARMY AND NAVY GAS TURBINE PROGRAMS

Mr. ANDREWS. What gas turbine programs are in the Army and the Navy R.D.T. & E. appropriation program?

General MCNICKLE. I have a listing which I will put into the record.

(The information follows:)

GAS TURBINE PROGRAM ON ARMY AND NAVY R.D.T. & E PROGRAMS

The Army has the following R.D.T. & E. gas turbine programs:

1. An advanced development program which includes competitive demonstrators of 1,500 shaft horsepower size. The GE-12 is the General Electric demonstrator and the ST-9 is the Pratt and Whitney demonstrator.
2. The Army also has an engine development program on the T-64-GE16 for the Cheyenne helicopter.

The Navy has the following R.D.T. & E. gas turbine program:

1. TF-34 for the VSX aircraft.
2. J-52 for the A-4 trainer version.
3. The Navy portion of the Initial Engine Development for the F-15/F-14 aircraft. This is a joint Air Force and Navy program.

Mr. ANDREWS. Is there any duplication in any of them?

General MCNICKLE. No, sir. I think it is well coordinated in D.D.R. & E. The Department of Defense has assigned specific areas to each service.

AEROSPACE PROPULSION LABORATORY

Mr. ANDREWS. How many personnel of all kinds are involved in the Air Force Aerospace Propulsion Laboratory operations?

General MCNICKLE. About 385, Mr. Andrews.

Mr. ANDREWS. Where is the laboratory operated?

General MCNICKLE. Wright-Patterson Air Force Base, Ohio.

Mr. ANDREWS. What is the cost of civilian and military personnel at this facility?

General MCNICKLE. About $4.8 million a year.

AEROSPACE GROUND SUPPORT

Mr. ANDREWS. What is involved in the $930,000 you are requesting for aerospace ground support under "Aerospace Propulsion"?

General MCNICKLE. I have breakouts with a number of subheadings here.

Mr. ANDREWS. Provide it for the record.

(The information follows:)

There are three major areas of effort being funded with the $930,000 requested for aerospace ground support under "Aerospace Propulsion." These three areas and the individual tasks being accomplished under each are listed below:

(a) Aerospace site support:
  (1) Aircraft maintenance dock.
  (2) Lightweight portable structures for shelters and hangars.
  (3) Prototype radio frequency interference attenuating enclosure.
(b) Fluid handling and environment control:
  (1) Hydrocarbon fuel filters.
  (2) Advanced hydrant system.
  (3) Dust separator.
  (4) Tactical fuel handling system.
(c) Aircraft checkout and status control:
  (1) Turbine engine foreign object damage analyzer.
  (2) Infrared-pattern generator.
  (3) Checkout computer.

Mr. ANDREWS. What part of the aerospace propulsion program is related to the MOL?

Mr. HANSEN. None of it.

THROTTLEABLE SOLID AUGMENTED ROCKET (TSAR)

Mr. ANDREWS. Are the funds for the TSAR (throttleable solid augmented rocket) carried under "Aerospace Propulsion"?

General MCNICKLE. No, sir; they are carried under "Rocket Propulsion."

Mr. ANDREWS. What is the difference between the TSAR and NASA's sterilizable and throttleable 400-pound thrust solid rocket motor?

General MCNICKLE. NASA's is for use in space, while the TSAR is a gas generator for use within the atmosphere. There is really very little similarity between the two.

Mr. ANDREWS. Questions on "Aerospace Propulsion"?

Mr. LIPSCOMB. No, sir.

Mr. RHODES. I would like to ask a question on the TSAR which is a very fortuitous name. What is the use of this motor? Does it have the faculty of being able to loiter? Why is it advantageous to have a throttleable rocket motor? You can furnish the answers for the record if you like.

General MCNICKLE. It would be used to provide different levels of thrust. I could provide more details for the record.

Mr. RHODES. I wish you would. It must have some use that I cannot contemplate.

(The information follows:)

ADVANTAGE OF HAVING A THROTTLEABLE/ROCKET MOTOR

The throttleable solid augmented rocket (TSAR) is planned for eventual use in long-range air launched missiles such as might be used for bomber defense or air-to-ground weapons. The present exploratory development effort will demonstrate the feasibility of throttling the gas generator used in this concept. The initial program will culminate in wind tunnel tests of the propulsion unit. The TSAR propulsion system requires high Mach numbers for efficient operation and as such is not expected to be used in vehicles requiring a loiter capability. Nevertheless, throttling a missile is advantageous to provide longer ranges, efficient operation over a variety of Mach numbers and attitudes, and to adjust flight velocities to a level where aerodynamic heating is no longer a problem.

AEROSPACE AVIONICS

REASON FOR INCREASE

Mr. ANDREWS. What is involved in the requested increase for aerospace avionics in fiscal year 1970? You are requesting $50.1 million as compared with $45.7 million in fiscal year 1969 and $49.8 in fiscal year 1968.

General MCNICKLE. In addition to the cost-of-living increase, there are several new projects. One is on new techniques for air-to-air identification of uncooperative aircraft. Another is new approaches for detection of low-flying aircraft in the presence of high radar clutter from the ground. A third is exploring ways to improve accuracy in the delivery of conventional weapons.

IDENTIFICATION OF UNCOOPERATIVE AIRCRAFT

Mr. ANDREWS. Just what are you doing in these three areas? Take the first one, identification of what?

General MCNICKLE. Noncooperative enemy aircraft.

Mr. ANDREWS. In other words, you buzz them and ask them for information and they refuse to answer; is that right?

General MCNICKLE. That's what we are trying to get away from. We are looking at other ways of positive identification.

Mr. ANDREWS. We have had systems for doing that for some time.

General MCNICKLE. Yes. We have had the IFF, but as you know, it is complicated and costly. But more important, when it is not working you cannot tell friend from foe.

Mr. ANDREWS. What do you propose to do with this project?

General MCNICKLE. We are looking at new techniques to try to find something simpler, something more reliable, and hopefully a less expensive way to get the identification information.

Mr. ANDREWS. Who is doing the work for you?

General MCNICKLE. Right now this is an in-house project, I believe.

Mr. ANDREWS. What is the next project?

DETECTION OF LOW-FLYING AIRCRAFT

General MCNICKLE. Detection of low-flying aircraft in presence of high radar clutter reflected from the ground.

Mr. ANDREWS. Explain that.

General MCNICKLE. We have a number of projects on this. We are looking for better ways to discriminate between low flying airplanes and the excessive amount of ground clutter characteristically displayed by most radars.

Mr. ANDREWS. He is too low to hit the screen?

General MCNICKLE. No, these low-flying aircraft are obscured by the radar returns from the ground. One way to find them is to detect their movement relative to the ground.

Mr. ANDREWS. How are you coming along with that program?

General MCNICKLE. We have made considerable progress. The F-15 radar is one that should benefit from this work.

Mr. ANDREWS. Who is doing the work for you?

General MCNICKLE. I don't recall the names. I will have to supply them for the record. We have two contractors.

Mr. ANDREWS. Provide the names of the companies for the record.

(The information follows:)

LOW FLYING A/C DETECTION—CONTRACTOR INFORMATION

Hughes and Westinghouse were awarded a radar development contract in support of the F-15 program in November 1968. This program is a fixed price program and will include a fly-off competition in mid-1970.

IMPROVED ACCURACY IN THE DELIVERY OF CONVENTIONAL WEAPONS

Mr. ANDREWS. What is the third project you mentioned?

General MCNICKLE. Improved accuracy in the delivery of conventional weapons.

Mr. ANDREWS. Explain that.

General MCNICKLE. This is a multiple approach to come up with the simplest, easiest way to get bombs on target. There are many possible approaches and we are trying to find the simplest, easiest way to come up significant improvements. We actually have quite a few projects here.

AIR FORCE AVIONICS LABORATORY

Mr. ANDREWS. You are requesting an increase of about a half a million dollars in the cost of operation of the Air Force Avionics Laboratory. What is the reason for this increase?

General MCNICKLE. We will be getting specialized lab equipment which makes up the difference over the projects I have described. The equipment relates to the 1968 military construction program which included an addition to the laboratory building and we are buying specialized equipment to go into this building before.

Mr. ANDREWS. Where is this laboratory located?

General MCNICKLE. Wright-Patterson Air Force Base.

Mr. ANDREWS. What part of the effort under "Aerospace avionics" is in support of the MOL program or other manned space plants?

General MCNICKLE. None, sir.

Mr. ANDREWS. The budget presented to Congress last year proposed $50.9 million for aerospace avioncs. The justifications this year indicate that only $45.7 million has been programed in this area. Are there some relatively low-priority items in the fiscal year 1970 estimate also which could be deferred?

General MCNICKLE. I would hate to see this area deferred. Major projects include areas of navigation and guidance, reconnaissance, aerospace communications, electromagnetic warfare, lasers, and other devices. We think this is funded at the minimum essential level.

AVIONICS LABORATORY EMPLOYMENT

Mr. ANDREWS. How many personnel are involved with the Air Force Avionics Laboratory at Wright-Patterson Air Force Base?

General MCNICKLE. About 567 government people.

Mr. ANDREWS. How many Government civilian personnel, contractor personnel, and Air Force military personnel are assigned to this facility?

General MCNICKLE. 482 civilians, civil service; 85 military, and 40 contractor.

Mr. ANDREWS. What is the cost of the military personnel, the civilian personnel and the contractor personnel at this facility?

General MCNICKLE. The civilian payroll is $8,250,000. There is $1 million for contractor personnel, and $1 million in military personnel appropriation for military pay.

COORDINATION OF AVIONICS PROGRAM WITH NASA

Mr. ANDREWS. NASA also has space avionics programs and must solve difficult problems in navigation and guidance and communications in space. What procedures are followed in coordinating your efforts in this area with those of NASA?

Mr. HANSEN. There are two principal things that we do. We have the NASA–DOD Aeronautics and Astronautics Coordinating Board which has a number of panels. That is a formal organization. It meets periodically and cross-reviews the programs to assure that each agency is aware of the programs of the other agency and that there is no duplication.

In addition to that, as I mentioned earlier in the hearings, we charge our laboratories formally with the requirement, in submitting their plans, that they indicate in these plans the total listing of all the Government agencies and industrial agencies or universities that they know of that are doing work in this field. This information includes how much money other agencies are spending, what they are doing, and what informal coordination we have with them, such as visits and coordination meetings.

BIONICS-CYBERNETICS TECHNIQUES PROGRAM

Mr. ANDREWS. Explain to the committee the function of the bionics-cybernetics techniques program for which you are requesting $300,000.

Mr. HANSEN. I will attempt to explain that, Mr. Chairman. I might just say that in apportionment-reevaluation considerations in mid-1969 the bionics-cybernetics program was deferred in favor of higher priority short-term projects. This change did not get picked up in the President's budget.

Mr. ANDREWS. Somebody is surely going to ask on the floor "What do you mean by bionics-cybernetics applications."

Mr. HANSEN. Very well.

Mr. ANDREWS. What could we say to them?

Mr. HANSEN. This is a matter of trying to devise equipment which simulate the learning processes involved in the human biological mechanisms. If we perfected this sort of thing it could be used in such avionics subsystem developments as sensors that will recognize shapes, figures, colors, self-adaptive flight-control systems, and things of that nature. The bionics are the nerve cells of the system and the cybernetics is the science of human servomechanism activity through the muscular and nervous system.

As we study and simulated the techniques by which the human system learns to do that and learn to simulate that with equipment, we think we can develop machines which will have the capability of retaining, learning and adapting to be able to carry out their missions.

Mr. MINSHALL. You mean, you just stick one of these things in the airplane and it flies it; is that your goal?

Mr. HANSEN. Well, I really don't know to exactly where this concept can lead. The immediate goals are much more simple than that. We have an autopilot, of course, which will fly an airplane in accordance with preset conditions. Our goal is to try to devise a machine which can sense a changing condition and adapt the way that it flies the airplane in accordance with that. The flight control application of bionics-cybernetics was of particular interest——

Mr. MINSHALL. Why would you have to study muscular systems? I don't follow that in connection with what you are trying to do.

Mr. HANSEN. Well, I perhaps overemphasized that. It is trying to learn from the mechanization of the human biological system how to build sensors and equipment utilizing sensors which will emulate the processes of the human biological system.

Mr. MINSHALL. An autopilot does that pretty much today, doesn't it?

Mr. HANSEN. Only in accordance with preset conditions. It has no ability to sense and to change those conditions.

Mr. MINSHALL. Couldn't you program something in the way of a computer in an existing autopilot by radio signal?

General BOYLAN. We do that in terrain-following.

Mr. MINSHALL. Yes. I don't follow this.

General BOYLAN. There the autopilot is getting a command, a direct command.

Mr. ANDREWS. From where?

General BOYLAN. From the radar that is programed to it.

Mr. RHODES. What is the difference between that and this? How would this bionics-cybernetics types of machine work? Where would the command come from?

Mr. HANSEN. I am not sure that I understand this concept well enough to explain it fully, but an example of a sensor is a radar sensor that senses where the ground is and tells you instead of continuing to fly straight and level that there is a bump there. It then programs a climb in altitude. This is a simple example that has already been done.

Mr. RHODES. Right.

Mr. HANSEN. The hope is that by continuing the study of this technique you would be able to develop additional sensors and techniques of adapting the ability to sense and to learn from what has happened. This information is stored for appropriate action in more complex situations.

BIO-CYBERNETICS FUNDING

Mr. MINSHALL. How much are you spending on this particular phase of the program? What are you asking for?

Mr. HANSEN. As I explained, we are not spending any.

Mr. MINSHALL. How much are you asking for?

Mr. HANSEN. Originally, $300,000 had been asked for work in this area.

Mr. MINSHALL. Originally? Have you changed your mind now? Are you not going ahead with it?

Mr. HANSEN. Yes.

Mr. MINSHALL. What are we discussing it for, if you are not asking for it?

Mr. ANDREWS. This budget does not show a change.

Mr. HANSEN. As I mentioned, this is a change which has taken place subsequent to the submission of the President's budget and would be made at apportionment.

The plan is to take the money that was in this area and put it in electronic warfare technology, tactical weapon delivery, higher resolution radar technology, low-altitude radar techniques, and vehicle defense and fire control. It would be split among those items.

Mr. ANDREWS. If we are asked questions on the floor about bionetics-cybernetics we can say that there is no money in here for this program and refrained from explaining it.

Mr. MINSHALL. I am relieved to hear your answer.

EXPLANATION OF BIO-CYBERNETICS

Mr. HANSEN. I have a statement here that if somebody said "We want you to try to explain it"——

Mr. ANDREWS. That is what we have been trying to get you to do.

Mr. HANSEN. The best I can give you is that techniques are studied which could evolve and be mechanized into hardware capable of functional applications involving learning, decisionmaking, self-organization and self-adaptation.

Mr. ANDREWS. Put that statement in the record and then put another statement in the record explaining that statement.

(The information follows:)

BIONETICS/CYBERNETICS

Bionetics-cybernetics is a field of activity that explores the capabilities of biological systems and attempts to duplicate these capabilities in military hardware of comparable weight and size. For example, various animals, which are biological systems, such as the frog and snake, possess a capability to detect moving targets and infrared radiation. Considering the size and weight of these animals, the capability they possess has great significance. If methods could be determined to duplicate their capabilities with military hardware of comparable size and weight, a large advantage would be realized for future military weapon systems. The same approach is also utilized for the biological system known as man. Therefore, this area of effort also involved the mechanization of capabilities such as learning, decisionmaking, self-organization, and adaptation to changing environments (self-adaptation).

BIO-CYBERNETICS PROGRAM CANCELED

Mr. LIPSCOMB. Do I understand the program is canceled?

Mr. HANSEN. It has never been started.

Mr. LIPSCOMB. You are not going ahead with the program?

Mr. HANSEN. No, sir.

Mr. MINSHALL. You would like to use the money in some other program, as I understand it?

Mr. HANSEN. Yes; that is correct.

Mr. LIPSCOMB. Mr. Secretary, in the project listing on page 15, "Project No. 4160, Bionetics-Cybernetics Techniques," it states: "fiscal year 1968 actual, $451,000; fiscal year 1969 estimated, $300,000; fiscal year 1970 estimate $300,000." Now, is that listing statement in this project book in error?

Colonel HOERMAN. This book went to press in late December-early January. The 1969 and 1970 numbers are point in time estimates. The 1968 numbers are correct, to the best of my knowledge.

Mr. LIPSCOMB. In other words, you had a program of bionetics-cybernetics techniques, $451,000 in 1968?

Colonel HOERMAN. That is right.

Mr. LIPSCOMB. I repeat my question: Has this program been canceled?

Mr. HANSEN. The program has been canceled.

BIO-CYBERNETICS RESULTS

Mr. LIPSCOMB. For the record give us the results of the $451,000 expenditure for fiscal year 1968.

Mr. HANSEN. Yes, sir.

(The information follows:)

RESULTS FROM PRIOR YEAR FUNDS IN BIONETICS-CYBERNETICS

The efforts accomplished in the bionics-cybernetics program have resulted in the definition of bionic sensors, and associated sensor data processing equipment, that may be used for the optimum control of flight vehicles. These devices are currently being utilized by other laboratories in the development of adaptive flight control systems and advanced variable geometry controls for aeronautical propulsion systems. The adaptive flight control system is a system that changes its performance characteristics as the environment changes during flight. It will also be capable of correcting various flight control system malfunctions as the flight progresses. The variable geometry controls for propulsion essentially changes the geometry of the engine to obtain maximum propulsion efficiency at all times.

OTHER AREAS OF DOD INVOLVED IN BIO-CYBERNETICS

Mr. LIPSCOMB. Do you know of any other area in the Department of Defense, either in the Army, the Navy, or in any agency or any of the special projects offices that is doing this very same work? Such as in ARPA, for example? Could we look for that?

General MCNICKLE. No, sir; but we can check it.

Mr. HANSEN. I am not aware of any other work in this area.

Mr. LIPSCOMB. You haven't turned it over as a mission for Project THEMIS, have you?

Mr. HANSEN. Not that I am aware of. We will check that.

(The information follows:)

According to the Office of the Director of Defense Research and Engineering (O.D.D.R. & E.) there is no similar bionic-cybernetics work elsewhere in the Department of Defense.

Bionics-Cybernetics has not been turned over as a mission for Project THEMIS.

Mr. ANDREWS. Off the record.

(Discussion off the record.)

Mr. LIPSCOMB. I was just looking at this revised project listing, Colonel. You mentioned that it was canceled subsequent to November. My book was revised in April of 1969.

Colonel HOERMANN. Those were only the changes made by the new administration, sir. We did not go back into all the numerous projects in the program. We did update the changes made by President Nixon and Mr. Laird. There were, I think, eight in that area.

Mr. ANDREWS. Are there any other changes that do not show in this justification?

Colonel HOERMANN. I don't know of any others of that type, sir.
Mr. ANDREWS. Check it and put something in the record.
Colonel HOERMANN. Yes, sir.
(The information follows:)

PROGRAM CHANGES IN BIONETICS-CYBERNETICS TECHNIQUES

There were a total of eight changes incorporated into the fiscal year 1970 budget detail by the new administration. All eight of these changes were incorporated in the revised project listing. These changes are summarized as follows:

Item	Former fiscal year 1970 program	Revised fiscal year 1970 program
Advanced manned strategic aircraft	77,184	100,184
Short-range attack missile	67,668	84,668
Minuteman integrated command and control	36,000	20,000
Program 949	62,719	73,719
Special activities	169,800	159,800
Manned Orbiting Laboratory	576,300	525,300
Defense subsystem development and demonstration	5,000	12,900
Airborne warning and control system	75,000	60,000

In addition, there have been several changes to the fiscal year 1969 project funding as shown in the budget detail which was provided. These changes were made pursuant to authority granted to the Air Force. There were no other changes to the fiscal year 1970 column of the fiscal year 1970 budget between its submission by President Johnson and President Nixon's revision.

BIONICS-CYBERNETICS APPLICATIONS

Mr. ANDREWS. How is this effort related to the "Bionics-Cybernetics Applications" project for which you are requesting $350,000?
Mr. HANSEN. My understanding is that that was canceled.
Mr. ANDREWS. Is it closely related to the bionics-cybernetics techniques?
Mr. HANSEN. Yes, sir. These were very closely related. In fact, I really don't know why these were ever initially two items.

AIR-TO-AIR IDENTIFICATION—FRIEND AND FOE

Mr. ANDREWS. Describe the new project "Air-to-Air Identification—Friend and Foe" for which you are requesting $435,000. What is the estimated total cost of this program? You touched on that briefly.
General MCNICKLE. This is the project I discussed earlier. The objective is to optimize noncooperative air-to-air IFF techniques. These techniques are to provide unambiguous identification of airborne radar targets, aircraft, at a sufficient range ———.
Present cooperative IFF systems can only identify transponder-equipped aircraft as friendly after actively interrogating them, as you suggested. Friendly aircraft with malfunctioning equipment, hostile aircraft and neutral aircraft cannot be distinguished.

LASER TECHNOLOGY

Mr. ANDREWS. You are requesting $2.6 million for "Laser Technology" and $1.4 million for "Laser Techniques for Aerospace Borne Applications." What are some of the objectives of this program and

what have been some of your accomplishments in this area? What contractors and in-house facilities are involved in this program?

Mr. HANSEN. The objective of the laser technology program is to develop and maintain a base in lasers and laser-related devices to apply to any mission where lasers do a better job than any other electronic technique. Some of these are electronic warfare communication, navigation and guidance, weapon delivery, fire control, reconnaissance, and surveillance. The program has provided the fundamental technology and devices that led to the laser-guided bomb, the laser line SCAN reconnaissance equipment, laser-alinement equipment, tactical fire control system and the high-powered laser projects.

Mr. ANDREWS. What contract and in-house facilities are involved in this program?

Mr. HANSEN. We have contracts with Hughes Aircraft, University of Minnesota, North American Rockwell, Hycon, Ohio State—there is quite a list.

Mr. ANDREWS. Put the list in the record.

Mr. HANSEN. Our in-house work is done at the Air Force Avionics Laboratory, Wright Field.

(The information follows:)

CONTRACTORS AND IN-HOUSE EFFORT/LASER TECHNOLOGY PROGRAM

On this program we have contracts with Hughes Aircraft, University of Minnesota, North American Rockwell, Hycon Manufacturing, Ohio State University, University of Michigan, Krystallis Inc., RCA, Texas Instruments, General Telephone and Electronics, IBM, Sylvania, Orlando Research Corp., General Electric, Varian Associates, Thompson-Ramo-Woolridge, American Optical, Westinghouse, Raytheon, LTV and Systems Research Laboratory.

The in-house facilities at the Air Force Avionics Laboratory include a holography lab, a gas laser lab, a non-linear optics lab, a high brightness laser lab, a spectroscopy lab, an indoor propagation range, a glass fabrication facility and a precision optics fabrication facility. The facility takes up approximately 25,000 square feet and we have 29 professional people.

Mr. ANDREWS. Any questions on Aerospace Avionics?

AIRCRAFT VERSUS SPACE ACTIVITIES

Mr. LIPSCOMB. Yes, Mr. Chairman.

In this classification, what part would you say is for space activities and what part is attributable to aircraft activities?

I get the impression from listening here and reading that it is primarily an aircraft program.

Mr. HANSEN. I think that is correct, sir.

Mr. LIPSCOMB. Why do we not fund it that way instead of aerospace? Would that not be better for all concerned?

General PITTS. I am looking at celestial guidance techniques, one which might be a space program. I think we addressed this earlier.

Mr. Jakovich, who is our Budget Division Chief in charge of R. & D., addressed the fact that this has in the past fluctuated. We can take a look at putting it into more aircraft-related program activities; yes, sir.

Mr. HANSEN. There is some space work in this, but it is predominantly aeronautical.

Mr. LIPSCOMB. The Air Force has a massive space effort going on also which increases the possibilities for duplication.

General PITTS. Mr. Fine is with the R. & D. Division. I would like to ask him to address this subject.

Mr. FINE. The point of the question is really somewhat applicable throughout the whole structure of the program, the philosophy which underlies the structure of the laboratories that we have. Certain laboratories have projects that are assigned to them. Because a laboratory has certain unique capabilities, their efforts may spread among technologies that relate to space or missiles or aircraft.

From the standpoint of single control of a laboratory function, all of the efforts and dollars are identified under that single program element. It is under the budget activity that is most closely related to the preponderance of its effort. It is really structured from a management control standpoint.

Mr. LIPSCOMB. I should think it better to place it where it is really more meaningful in the budget process. This has to do with aircraft, and is not attributable so much to space.

General MCNICKLE. Some of these assignments are rather arbitrary but we are working on getting them in the right places.

General PITTS. We will take a look at this area, sir.

EXPLANATION OF AEROSPACE AVIONICS PROJECTS

Mr. MINSHALL. On pages 15 and 16 of the project listing, you have a total of close to 30 projects.

On page 16 there are some items that I would like to have a little further explanation about. What is the total cost of all these projects?

General MCNICKLE. $50,108,000. $10 million for the operation of the lab and then $40 million for the projects.

Mr. MINSHALL. Let us start at the bottom on page 16. You have aerospace-borne antenna techniques for a total of $605,000. What do you intend to do with that $605,000?

Mr. HANSEN. I will have to supply that for the record. I do not know.

Mr. MINSHALL. Then the next one up, reconnaissance recording materials, processing and reproduction technology. That is just short of $1 million—$920,000.

General MCNICKLE. These are all applied research projects which we call exploratory developments. As you can see there are quite a few of them—each seeking to prove or demonstrate a new technique or concept. These are the types of things that will provide the technology for the next decade. We would like to provide answers for the record on all of them because I am not personally familiar with the particular technique or concept being pursued in each case.

Mr. MINSHALL. We think you should show it so we can ask questions. If you do not know, how are we supposed to know? These questions might be asked of us on the floor.

Mr. HANSEN. I would suggest we prepare a descriptive paragraph on each one of these and submit it for the record.

Mr. MINSHALL. For example, at 5227, about seventh or eighth from the bottom, vehicle defense and fire control, $400,000. What does that entail and what do you hope to prove by that program?

Mr. HANSEN. I cannot answer that.

Mr. MINSHALL. Then you have something that I thought the Air Force would be reasonably knowledgeable about. You have intercept or guidance techniques. That is a blank. You do not ask for anything for that. Then you have all these things: low-altitude radar techniques, evaluation and test of guidance systems, coherent optical device systems. What is that all about, for $400,000?

Mr. ANDREWS. Can you answer those questions?

Mr. HANSEN. No one that we have here can answer. We would like to provide a descriptive paragraph on each of these items and submit them for the record.

Mr. ANDREWS. Who thinks up all these programs? Where did they come from, if you do not know about it, Doctor?

Mr. HANSEN. They are primarily originated in our development laboratories and are reviewed.

Mr. MINSHALL. Another one, radar and infrared camouflage, $880,000.

Supply this information for the record, will you, please?

Mr. HANSEN. Yes, sir.

Mr. MINSHALL. If we have any further questions after you supply the information, we will have to ask you to come back.

(The information follows:)

LIST OF AEROSPACE AVIONICS PROJECTS

[Element code 62403F]

Project No.	Projects	Fiscal year 1968 actual	Fiscal year 1969 estimate	Fiscal year 1970 estimate
	Total	49,840	45,750	50,108
06C0	Air Force avionics laboratory operation	7,645	9,900	10,388
3178	Advanced ballistic missile guidance techniques	1,299	700	900
3181	Guidance for military aerospace systems	297	.....	.....
3833	Improved radiofrequency generation and amplification devices for electomagnetic warfare	.....	800	600
4025	Radar reflectors and dispensing techniques	476	400	500
4028	Aerospaceborne electromagnetic countermeasures	925	850	850
4030	Infrared electromagnetic countermeasures	641	890	800
4036	Electronic warfare techniques research	1,500	1,400	1,500
4038	Electronic deception and repeater development	435	500	600
4040	Electronic jamming techniques	1,137	600	750
4043	Communication jamming and deception techniques	364	400	500
4056	Infrared reconnaissance technology	1,154	1,700	1,500
4070	Electronic countermeasures performance criteria	448	.....	.....
4075	Ultraviolet and Unique techniques for reconnaissance and surveillance	478	300	300
4076	Infrared techniques for surveillance and fire control	554	500	550
4108	Radar terrain reconnaissance	249	300	275
4144	Tactical target weapon delivery technology	2,405	2,065	1,400
4156	Advanced solid state plasma devices	303	300	330
4159	Molecular electronics	2,033	1,100	1,300
4160	Bionics-cybernetics techniques	451	300	300
4161	Electromagnetic window techniques for aerospace vehicles	190	200	250
4163	Aerospaceborne detection/tracking technology	1,684	750	900
4164	Communications technology for satellite relay	904	850	950
4166	Bionics-cybernetics applications	446	250	350
4167	Integrated avionics	.....	300	400
4200	Celestial guidance techniques	159	400	100
4335	Applied communication research for Air Force vehicles	2,169	1,100	1,200
4357	Electromagnetic compatibility techniques	264	250	330
4367	Air-to-air identification—friend and foe	.....	.....	435
4421	Aerospaceborne guidance computers	654	400	300
4431	Unconventional inertial sensors for guidance	261	400	600
4460	Solid state microwave electronics	1,684	1,300	1,250
4608	Physics of radiation—resistant solid state materials and devices	699	300	400
4645	Coherent optical device physics	452	200	400
5042	High resolution radar technology	1,979	2,100	2,000

LIST OF AEROSPACE AVIONICS PROJECTS—Continued

[Element code 62403F]

Project No.	Projects	Fiscal year 1968 actual	Fiscal year 1969 estimate	Fiscal year 1970 estimate
5102	Inertial guidance subsystems	1,141	1,550	1,700
5177	Evaluation and test of guidance systems	999	500	1,000
5199	Low-altitude radar techniques	625	600	750
5201	Inertial guidance computation and integration techniques	664	500	750
5218	Interceptor guidance techniques	10	----------	----------
5227	Vehicle defense and fire control	264	400	400
5237	Laser technology	2,526	2,350	2,650
5244	Laser techniques for aerospaceborne applications	1,076	1,300	1,375
5546	Radar and infrared camouflage	850	800	880
6220	Photographic technology for reconnaissance and air surveillance	1,583	1,320	1,680
6239	Advanced reconnaissance sensor concepts and applications	1,510	1,300	1,540
6263	Electro-optical techniques for reconnaissance and surveillance	1,325	1,100	1,300
6272	Reconnaissance recording materials processing and reproduction technology	1,084	800	920
6278	Aerospaceborne antenna techniques	529	500	605
7062	Guidance computer interface electronics	300	400	450
7844	Damage assessment	250	125	250
7848	Scoring techniques	503	250	400
7849	Threat signature simulation	262	150	250

Explanation of Aerospace Avionics Projects

PROJECT 06CQ—AIR FORCE AVIONICS LABORATORY OPERATION

This project provides for the support activities required to operate the Air Force Avionics Laboratory (AFAL). It is one of 50 projects which make up exploratory development program element No. 62403F, aerospace avionics. AFAL is responsible for exploratory and advanced development programs concerned with navigation and guidance, weapon delivery and fire control, reconnaissance and aerospace surveillance, aerospaceborne communications, electronic countermeasures, avionic devices and techniques, and damage assessment and scoring techniques. The laboratory provides technical support to current and future systems programs and undertakes operational support projects in several of its mission areas. This project provides for the pay and related costs of civilian scientists and engineers, and supporting personnel, travel, transportation, rents, communications and utilities costs, procurement of supplies and equipment, and contractor support services.

PROJECT 3178—ADVANCED BALLISTIC MISSILE GUIDANCE TECHNIQUES

The objective of this project is to develop guidance techniques and to perform studies to improve the performance of current and future ballistic missile guidance systems with particular concern for ever increasing demands for better system accuracy while operating under more severe environmental conditions and mission profiles. ———.

PROJECT 3833—IMPROVED RF GENERATION AND AMPLIFICATION DEVICES FOR EW

The project objective is to develop advanced types of RF generation and amplification devices whose power levels and modulation capabilities are sufficient to counter advanced enemy radar systems. The near term objective is to explore tube development and employment concepts, existing development programs, solid state technology, systems requirements, and interservice development programs so as to evolve and pursue exploratory development programs supportive of future electronic warfare needs.

Fiscal year 1970 programs will emphasize the development of improved RF source designs ———.

PROJECT 4025—RADAR REFLECTORS AND DISPENSION TECHNIQUE

The objective of this project is to provide, through exploratory development in radar reflectors, radar absorbers, and selected passive type (nonemitting) electromagnetic countermeasures with associated means for deployment, a foundatiton for advanced penetration aids for aerospace vehicles. Feasibility of con-

cepts for degrading the performance of existing and postulated electromagnetic threats to offensive weapons systems will be demonstrated. ———.

PROJECT 4028—PASSIVE AEROSPACEBORNE ELECTROMAGNETIC WARFARE

The objective of this project is to investigate the generation and exploitation of signal detection, direction of arrival, processing, analysis, recording and display techniques in consonance with the passive determination of location, identity and characteristics of electromagnetic threats and targets for effective homing and warning, tactical/strategic mission planning and control of countermeasures.

PROJECT 4030—INFRARED COUNTERMEASURES

The mission objective is to provide for the passive defense of airbreathing and spaceborne vehicles against attack by surface, air or space launched missiles ———.

PROJECT 4036—ELECTRONIC WARFARE TECHNIQUES DEVELOPMENT

The objective is to provide the Air Force with a broad base in electronic warfare technology and devices that have direct application to and will provide efficacious solutions to penetration problems posed by advanced threat systems that will exist in the 1970–80 time period.

In fiscal year 1970 emphasis will be on countermeasures to ———.

PROJECT 4038—ELECTRONIC DECEPTION TECHNIQUES

It is the objective of this project to derive new or improved deception countermeasures techniques which will be effective against general classes of radars as well as specific threats, and to determine technical feasibility of these deception techniques through suitable evaluation procedures. This area of investigation is required to prevent a potential enemy from utilizing electromagnetically controlled defense against USAF aerospace vehicles. To insure effectiveness against sophisticated countermeasures techniques, the use of intelligent and efficient countermeasures signals is becoming increasingly necessary.

PROJECT 4040—ELECTRONIC JAMMING TECHNIQUES

The objective of this program is to provide USAF aerospace vehicles with an electronic defense capability which will insure their safe penetration of enemy electromagnetically controlled defense. The goal is an automatic defense that will rapidly analyze the threat environment and select a jamming response signal optimized by continuous monitoring of the environment. ———.

PROJECT 4048—COMMUNICATIONS JAMMING AND DECEPTION TECHNIQUES

The objective of this project is the development, through study and experimentation, of countermeasures techniques to sever the communication, guidance and identification links that may be employed by a potential enemy in directing its manned and unmanned interceptors, missiles, and aerospace weapon systems. ———.

PROJECT 4056—IR RECONNAISSANCE TECHNOLOGY

The project objective is to advance military infrared reconnaissance technology through fulfilling current and projected operational requirements. More specifically, to provide the technological advances required to achieve the performance levels needed for effective application of IR reconnaissance and surveillance systems. The areas of IR reconnaissance technology included are downward and forward looking reconnaissance, as well as detectors and optical materials for both reconnaissance and surveillance applications. ———.

PROJECT 4075—UV AND SPECIAL TECHNIQUES FOR RECONNAISSANCE AND AIR SURVEILLANCE

The objective is to provide techniques for the design of aerospaceborne sensors capable of detecting, locating, and continuously tracking enemy spaceborne weapons and to provide new sensors or techniques and concepts which will significantly extend the capabilities of aerospaceborne reconnaissance and surveillance subsystems.

Emphasis for fiscal year 1970 is directed toward the fabrication and testing of a design verification unit of the SIRIUS (spaceborne intensified radiometer for imaging ultraviolet spectroscopy) system ———. Additional in-house effort will involve investigation of spectral filtering techniques, high resolutions spectroscopy, and detector calibration techniques.

PROJECT 4076—INFRARED TECHNIQUES FOR AIR SURVEILLANCE AND INTERCEPT

The objective of this project is to develop techniques for detecting, identifying, and tracking military targets above the suface of the ground, during all phases of their flight, by the infrared radiation from the target. ———.

For fiscal year 1970 the major effort is on the development and testing of airborne measurement instruments. ———. Imaging systems will be used to measure the spatial patterns of powered airborne vehicles such as aircraft and tactical missiles. Information processing techniques will be investigated for automatic pattern recognition systems and tracking of nonsymmetrical area type targets.

PROJECT 4108—RADAR TERRAIN RECONNAISSANCE

The objective of this project is to develop techniques and technology needed to further the development of radar reconnaissance to fulfill specific requirements for obtaining reconnaissance information under all weather conditions day or night. This includes detection, location, and identification of specific objects of military interest, as well as any changes in or movement of such targets.

In fiscal year 1970 this program will establish the capabilities and limitations of advanced (airborne moving target information) techniques as applied to synthetic aperture side looking type radars; establish through theoretical investigations computer simulation and experimental measurements, a basis for understanding the effects of radar system nonlinearities on AMTI performance and to determine the predictability of AMTI.

PROJECT 4144—TACTICAL TARGET WEAPON DELIVERY TECHNOLOGY

The project objective is to develop technology for increasing the effectiveness of USAF tactical missions by evolving precise air-to-ground weapon delivery techniques.

The effort in fiscal year 1970 will include, advancement in the areas of infrared, passive microwave, radar, and magnetic detection techniques for weapon delivery will be pursued. Supporting technology is being pursued in the areas of optical and microwave target signature measurements.

PROJECT 4156—ADVANCED SOLID STATE AND PLASMA DEVICES

The objective of this project is to serve as the transition vehicle between basic research and exploratory development projects. New microelectronic devices will be sought by utilizing the results of basic research on solid state and plasma phenomena, coupled with an advanced technology in materials with improved techniques of devise design.

In fiscal year 1970 work on ferroelectric memory arrays will be examined with a detailed characterization and comparison to other microelectronic memory techniques. Work on plasma devices will be expanded to include exploratory development on MM wave plasma receiver protect tubes in the 60–90GHz range. Work on the nickel cathodes will continue. Further detailed characterizations will be made on thin film Schottky barrier devices. Ion implantation studies will be continued.

PROJECT 4159—MOLECULAR ELECTRONICS

The objective of this project is to advance solid-state device and integrated circuit technology to meet rapidly advancing systems needs for improved device and circuit capability. Each new equipment or system development imposes requirements which in many cases necessitates a device capability beyond that which is available. It is the intent of this project to provde a continuously expanding capability in solid-state devices and integrated circuits which will meet the needs of future space and airborne electronic systems. It is the further objective of this project to develop those material and process technologies required to support advanced device and integrated circuit developments.

The fiscal year 1970 areas of effort include the development of new solid-state devices both in silicon and gallium arsenide. Included are silicon UHF power transistors with power handling capability to 1 kilowatt. New device struc-

tures such as gallium arsenide Schottky gate FET are also being investigated as low noise, high gain linear amplifiers.

Investigations are being carried out to improve the speed of integrated circuits through development of improved integrated device capability, dielectric isolation and compatible passive components. Effort is also underway to reduce total power dissipation. Approaches to filtering, for implementation in integrated circuit technology, are being investigated. Semiconductor memory in both complementary MOS and metalnitrideoxide device technology are being explored to develop a low-cost semiconductor memory compatible with silicon device technology.

Integrated circuit techniques are being applied to sensors in both the visible and the infrared spectrum with the goal being an all solid-state electronically scanned sensor capability.

PROJECT 4160—BIONICS-CYBERNETICS TECHNIQUES

The decision to terminate this bionics-cybernetics project was made at about the same time as the President's budget was completed. The descriptive summary sheets reflect the change but the budget does not. This was an unavoidable error.

PROJECT 4161—ELECTROMAGNETIC WINDOW TECHNIQUES

The objective of this project is to provide techniques for use in producing improved electromagnetic windows, such as radomes, from an electrical standpoint. This exploratory development program does not include development of new materials but does determine the suitability of new materials from an electromagnetic transmission point of view. Most of the effort is directed toward use on high-speed aircraft and some toward use on reentry vehicles.

In fiscal year 1970, efforts will be devoted to reduction in side lobes caused by radomes; increase transmission efficiency of circular polarized waves through the radome; development of more efficient design for millimeter transmission; design for high incidence angle; employment of "A" type sandwich structure for nose cones; RF broadbanding; and reentry nose cone development.

PROJECT 4163—AEROSPACEBORNE DETECTION/TRACKING TECHNOLOGY

The objective of this project is to evolve and perfect electromagnetic sensors for the detection and tracking of aerospace and ground target vehicles. ———

PROJECT 4164—COMMUNICATIONS TECHNOLOGY FOR SATELLITE RELAY

The objective of this project is to augment and sustain the technological base for future military communication satellites applicable to triservice requirements for tactical and strategic communications links between air, space, land, and sea terminals. Included is communications technology for USAF aircraft and spacecraft unique to satellite relay. Problems requiring emphasis for solution include antennas, antenna pointing, user access, networking, jam resistance, and communications coverage.

There will be four major areas of effort to be pursued in fiscal year 1970. Three previously initiated efforts, namely, the airborne SHF distributed phased array antenna, the satellite unfurlable antenna array and the satellite self-managing channelized repeater will be continued. The only new effort to be initiated in fiscal year 1970 will consist of developing a single aperture, near flush mounted UHF transmit-receive, SHF receive only antenna suitable for use on large high performance aircraft of the KC-135/B-52/C-141 class.

PROJECT 4166—BIONICS-CYBERNETICS APPLICATIONS

The decision to terminate this bionics-cybernetics project was made at about the same time as the President's budget was completed. The descriptive summary sheets reflect the change but the budget does not. This was an unavoidable error.

PROJECT 4167—INTEGRATED AVIONICS

The objective of this project is to accomplish exploratory development in the area of avionic systems which will eventually lead to new concepts and integrated functions. By viewing the system or function as a whole, rather than a sum of previously portioned parts of techniques in an environment of forecasted technology, many improvements appear possible. Selecting a proper research vehicle, analyzing the fundamental mission requirements, and resyn-

thesizing the system in optimumized fashions can result in smaller, lighter, more reliable, and lower cost avionic systems.

The fiscal year 1970 effort will include information management aspects of avionic systems, information presentation and control system, multifunction microwave aperture, avionic system model, multisensor programable feature extraction, multisensor TRACALS, and weapons delivery with ICNI.

PROJECT 4200—CELESTIAL GUIDANCE TECHNIQUES

The project objective is to advance celestial navigation and guidance technology through exploratory development, to navigate or guide, in the most effective manner, aerospace weapon systems essential to the offensive, reconnaissance, and support force capability of the Air Force.

The fiscal year 1970 effort will be an in-house evaluation of star tracker and autonomous navigation techniques and contractual investigation of nuclear radiation effects on star sensors.

PROJECT 4335—APPLIED COMMUNICATIONS RESEARCH FOR AIR FORCE VEHICLES

This project objective is to advance the state-of-the-art for intra-and intervehicle (space, satellite, or aerodynamic) and vehicle-to-surface communication links except those specifically unique to communications satellites. Major technology areas are airborne relay and other means of beyond horizon communications; data links, including reconnaissance; modulation and detection, including antijamming; data input/output; tactical and strategic communications; equipment effectiveness and personnel communications. (Project 4164, communications technology for satellite relay develops techniques unique to communications satellite relay.)

The areas of effort to be pursued in fiscal year 1970 can be placed in the following general categories—input/output technology, radio repeaters, data links, modems, and personnel communications. The input/output area will address problems associated with voice to digital interface. The radio repeater effort will consist of an expansion of same frequency repeater (SFR) technology to accommodate multiple channels. The data link effort will address an automatic aircraft status reporting system. The modem effort will develop an advanced FH/PN antijam radio modem. The personnel communications efforts will consist of continued in-house implementation of an acoustic measurement facility, testing components of an advanced intercom system and studies pertaining to microphones and downed ariman location systems.

PROJECT 4357—ELECTROMAGNETIC COMPATIBILITY TECHNIQUES

Electromagnetic vulnerability reduction and avionics systems electromagnetic compatibility are essential to the success of any eixsting and future military operations. This project attacks the problem form the point of view of reducing the susceptibility of avionics subsystems to the interfering environment and controlling the creation of such environment. The approach is based on prevention of EMI problems instead of costly retrofit. This also requires the development of instrumentation and techniques to measure and evaluate the interfering phenomena and their effects. This project supports the technical requirements under technical domain titled "Vehicle Environment," the DOD and U.S. Air Force EM compatibility and radiation hazards programs and provides advanced compatibility techniques for future vehicle electronic systems.

The fiscal year 1970 effort will include the: development of instrumentation for the measurement of corona static on the SAMSO Titan III C vehicle; measurement of precipitation static noise on high-speed aircraft; development of slotted metallic RF windows for the purpose of lightning hazards reduction; study signal path and propagation media noise phenomena; investigate intravehicle EM interference levels in order to establish vehicle intrasystem RF interference analysis techniques; development of EMI and electrical radiation hazards detector for protection of EED's, personnel and avionic equipment; exploration of EHF field measurement techniques; development of magnetic sensors for use in measurement of EMI; investigate antistatic coatings for radomes, windshields, and canopies; study secondary power harmonic interference to VLF systems; investigate interference control techniques applicable to ultrasensitive receivers; and investigate integrated circuit solid state devices EMI susceptibility in an impulsive EM environment.

PROJECT 4367—AIR-BY-AIR IDENTIFICATION FRIEND AND FOE

The project object is to develop and optimize noncooperative air-by-air identification friend and foe techniques. These techniques will provide unambiguous identification of airborne radar targets (aircraft) at sufficient range to permit the timely release of air-to-air missiles against hostile targets. The techniques considered will be aimed at providing an all-weather, day/night capability.

In fiscal year 1970 potential techniques will be investigated to determine their feasibility for solving the AAIFF problems ———. Subsystem integration concepts and pattern recognition techniques for multisensor systems will also be evaluated.

PROJECT 4421—AEROSPACE GUIDANCE COMPUTERS

The project objective is to develop computers and computer technology which will economically satisfy the computational, evironmental, and reliability requirements of future navigation and guidance systems for all types of Air Force mission. Two general areas of endeavor will be carried out in-house and contractually, that is, (1) analysis of future missions to establish computer requirements and anticipated problems areas, and (2) development of the technology necessary to satisfy the projected requirements.

Specific areas which will receive emphasis during fiscal year 1970 are (1) design and development of a large scale integrated circuit (LSIC) multiprocessor for central avionics computer applications: (2) low cost computer design technology for all types of aerospace computers ;and (3) nuclear radiation-survivable computing subsystems.

PROJECT 4431—UNCONVENTIONAL INERTIAL SENSORS

The objective of the project is to investigate and develop new techniques for improved inertial sensing (angular and acceleration). These sensors are for use in future advanced inertial navigation guidance systems.

In fiscal year 1970 emphasis will be placed on completing the multiple rotation gyro development. Efforts to solve the problems associated with the ring laser gyro will be continued. The low cost accelerometer development for ASM's will be continued. In addition, the nutatron gyro development will be continued.

PROJECT 4460—SOLID STATE MICROWAVE ELECTRONICS

The objective of this project is to develop new and improved solid state microwave devices and circuits for the generation, transmission, reception, and control of microwave energy. This includes the support of particular materials, processes, and fabrication techniques which are pacting items in the development of new device technology. Major improvements in the cost, performance, and reliability of future avionics systems are the motivation for these efforts. Specific objectives are improvements in the efficiency and reliability of power generation, the integration of microwave circuits, the development of microwave processing devices and circuits, and the extension of the technology into the region between 3 millimeters and 10 microns.

The major areas of effort in fiscal year 1970 are power generation and integration. Gunn effect devices and avalanche diodes for pulsed and CW operation are being developed. High power transistor and transistor-multiplier sources are also being developed. Techniques for integrating these sources in microstrip are being developed. The LSA mode of the Gunn effect and the high efficiency mode in avalanche diodes are under investigation. Device development includes efforts at 60 GHz for modulators and receivers. Phase shifters in monolithic and hybrid form are being developed. Other areas of activity include switches, mixers, filters, and surface wave devices.

PROJECT 4608—PHYSICS OF RADIATION RESISTANT SOLID STATE DEVICES

The project objective is to determine and understand the radiation damage mechanisms in solid state electronics materials, to predict the effects of radiation environment on the behavior of solid state electronic devices, and to maximize the resistance of existing devices, and design new classes of hardened devices and integrated circuits.

The Air Force Cambridge Research Lab in fiscal year 1970 will continue studies to identify and control point lattice defects in Si and GaSa using high-energy

electrons as the radiation damage source. Radiation hardened device emphasis will be on silicon junction field effect devices which theory and experiment have shown to be inherently more radiation tolerant. This inherent hardness will be augmented by new device geometrics and the optimization of channel doping. Power transistors of the JFET type will be investigated.

PROJECT 4645—COHERENT OPTICAL DEVICE PHYSICS

The objective of this project is to study the light-matter interactions so as to develop more predictable, reliable, damage free, tunable lasers in the visible and near IR. The objectives include decreasing the cost and increasing the useful wavelength range of lasers.

Studies will be conducted in damage in laser rods with Q-switched pulses and will extend the present theories of damage to the picosecond range. Work will be done on the development of efficient laser sources in the 2 to 4 micron range and study will be directed at the detection mechanism responsible for the 300° K., 1,000 GHz bandwidth, 10.6 micron point-contact detector.

PROJECT 5042—AIRBORNE RADAR TECHNIQUES FOR GUIDANCE OF AEROSPACE VEHICLES

The objective of this project is to assure the timely availability of high-resolution radar sensor technology for navigation, guidance, weapon delivery, and reconnaissance in manned and unmanned aerospace vehicles.

In fiscal year 1970 efforts will be accomplished to improve radar resolution, overall image quality and stability, and to develop advanced methods of processing radar information for the extraction of difficult targets submerged in heavy background clutter.

PROJECT 5102—ADVANCED GUIDANCE TECHNOLOGY

The project objective is: To advance inertial guidance technology through inertial component development.

The fiscal year 1970 effort will continue sensor development of precise instruments for application to the tactical/limited war applications. A task will continue the development of special inertial instruments for a zero g. satellite; plan tests for limited orbital testing of existing instruments; development of an He^3 nuclear gyro; development of ring lasers for precise inertial sensors.

PROJECT 5177—EVALUATION AND TEST GUIDANCE SYSTEMS

The object of this project is to develop test methods and test equipment having the necessary accuracy to properly evaluate the performance of future guidance components and systems.

Areas of efforts in fiscal year 1970 will be: University studies on advanced test methods, test techniques and equipment, continued improvement of the 260-inch centrifuge, development of an aircraft position, velocity and attitude reference system, upgrading of track test capability, and the initiation of design studies for a terminal guidance test capability.

PROJECT 5199—LOW ALTITUDE RADAR TECHNIQUES

The objective of the project is to develop and evaluate low altitude penetration radar techniques that will permit aircraft and missiles to penetrate enemy defenses and complete military missions under all weather conditions and with the highest probability of survival and mission success.

Areas of effort in fiscal year 1970 will investigate forward look air-to-ground radar, and automatic terrain following and avoidance.

PROJECT 5201—NAVIGATION AND GUIDANCE SUBSYSTEMS

The objective is to investigate the area of navigation and guidance subsystems techniques with particular emphasis in the inertial and Loran areas. State-of-the-art advances in such areas as size, weight, power consumption, performance, reliability, reaction time, and cost are sought.

Fiscal year 1970 funds will be expended in the areas of ASM inertial midcourse guidance, flight testing of the Bi-modal Loran technique and preliminary systems studies utilizing the multiple rotation gyro (MRG).

PROJECT 5227—VEHICLE DEFENSE AND FIRE CONTROL

The objective of this project is to advance the technology of aerospace vehicle self-defense and to develop system concepts and techniques for advanced fire control systems for tactical aircraft.

The work under this project includes investigation of means of vehicle defense by disabling sensor and guidance systems of attacking threats. The fiscal year 1970 primary area of effort is gun fire control systems. This includes an effort at the University of Texas for basic analysis and evaluation of problems in fire control for both air-to-air and air-to-ground systems; in addition studies by commercial contractors are planned which will establish the optimized trainable gun system for close support tactical aircraft. This project also has an in-house laboratory effort engaged in work on sensing systems for attack and weapon delivery.

PROJECT 5287—LASER TECHNOLOGY

The objective is to develop and sustain the fundamental technology base in lasers and laser accessory devices for application to all mission oriented domains involving electronics, such as electromagnetic warfare, avionics communications, navigation and guidance, weapon delivery, fire control, reconnaissance, surveillance and advanced weaponry. To conduct in-house and sponsor contract work in fundamental supporting technologies and devices in the areas of solid state, semiconductor, liquid, chemical, and gas lasers; passive point and imaging detectors optimized for the respective laser spectrum lines; laser materials, pumping and Q-switching.

———.

PROJECT 5244—LASER TECHNIQUES FOR AEROSPACE APPLICATIONS

The objective of this program is to develop laser techniques which show promise for use in Air Force weapon systems. Techniques applicable to limited war problems will be emphasized. Work to be accomplished includes the design, fabrication, test and evaluation of feasibility laser subsystems.

Areas of effort to be investigated in fiscal year 1970 are: laser techniques for satellite to ground and satellite relay communications links; analysis of laser doppler velocimeter for navigation and weapon deliver; carbon dioxide laser imaging; aircraft weapon system harmonization; compass trail investigations; target designation techniques; and flight testing and evaluating techniques developed previously.

PROJECT 5546—RADAR AND IR CAMOUFLAGE

The objective of this project is to develop materials and techniques for reducing radar echo and infrared radiation from all types of aircraft, missiles, and space vehicles. Radar and IR camouflage decrease the inherent vulnerability of such vehicles by reducing detection range and simultaneously increase the effectiveness of ECM devices such as chaff and jammers by raising the jamming to signal ratio.

The fiscal year 1970 program will involve the following:

(*a*) Evolve analytical and experimental techniques to reduce radar cross section. ———.

(*b*) Develop basic new dielectric and binding materials ———.

(*c*) ———.

(*d*) Develop coatings to reduce the IR radiation in the ——— wavelength region.

(*e*) Conduct ground to aircraft to satellite studies o fthe effects of a turbulent propagation medium on attenuation, multipath amplitude phase scintillation, and band-width capabilities. Studies are made throughout the RF spectrum and at selected laser frequencies.

PROJECT 6220—PHOTOGRAPHIC TECHNOLOGY FOR RECONNAISSANCE AND AIR SURVEILLANCE

The objective is to provide technology for both day and night photographic reconnaissance application. Included are optical sensors, sensor components and analysis of operational modes that must be employed to insure both the collection of intelligence and/or strike data. Included also are the development of analysis and evaluation techniques including facilities and flight experiments as required for feasibility demonstration. Camera component work objectives include

lenses, optical glass, camera controls, image amplifiers, light sources, image motion sensing and compensation, exposure control, and associated environmental analysis.

It is planned to, in fiscal year 1970, continue work on all aspects of the photo reconnaissance area with continued major emphasis on the night problem as represented by the "Ancovs" program, evaluation of covert light sources, development of a night lens, and completion of work on the fiber optics coupled image amplifier camera which is being procured for in-house experiments. The project will, however, continue to supply technology to advanced and engineering developments mainly through expert assistance to systems and operational organizations made possible by use of research facilities such as the science optics laboratory; terrain illuminants range; and the photographic data analysis facility. Contracted research for day recon will be limited to image evaluation methods and camera control techniques represented by a new film drive technique and completion of the FREM Sensor.

PROJECT 6239—ADVANCE RECONNAISSANCE SENSOR CONCEPTS AND APPLICATIONS

The objective is to provide effective reconnaissance subsystem analysis and synthesis by fully exploiting established tasks and by detailed analysis of operational problems and requirements, data handling, automation, reconnaissance technology and mission simulation in a search for new concepts which apply, extend and integrate basic techniques to mission orientated capabilities. All project efforts are directed toward the ability to quickly and realistically predict, simulate, test, analyze and report the characteristics of new reconnaissance equipment, concepts and applications.

The fiscal year 1970 project will emphasize reconnaissance technical data handling; mathematical modeling for reconnaissance sensor analysis; collection, analysis and storage of target and background electromagnetic properties; and the scientific laboratory and flight evaluation of operational performance and design integrity of advanced airborne reconnaissance subsystems and systems.

PROJECT 6263—ELECTRO-OPTICAL TECHNIQUE FOR RECONNAISSANCE AND AIR SURVEILLANCE

The objective is to develop advanced electro-optical (E–O) sensing, image data processing and image display technology applicable to reconnaissance, surveillance and weapon delivery missions.

The fiscal year 1970 effort will include: high resolution electro-optical camera tubes. Multi-spectral laser line scan sensors for night reconnaissance. Image data processing for target enhancement and information recovery. Airborne near-real-time displays for reconnaissance imagery. Long range detection and imaging techniques for aerospace surveillance. Matrix detectors and displays, and low light level sensing techniques for tactical reconnaissance strike and weapon delivery concepts.

PROJECT 6272—RECONNAISSANCE RECORDING MATERIALS, PROCESSING AND REPRODUCTION TECHNOLOGY

The objective of this project is to maximize scientific and technological advancement for photographic and electronic signal recording media, chemical processing, and reproduction of reconnaissance data. Work under this project includes the complete photographic process from picture taking materials to the reproduction of final prints for the photo interpreter.

Areas being emphasized in fiscal year 1970 include: (1) printing techniques, materials and a new light source for Diazo reproduction; (2) research on recording materials (free radical, dry silver, and transparent photoconductor) and recording materials evaluation techniques; and (3) color receptor material and high-speed color processing equipment and chemistry. In-house sensitometric research and evaluation of receptor materials will continue along with consultation with advanced and engineering development and system personnel.

PROJECT 6278—AEROSPACEBORNE ANTENNA TECHNIQUES

The objective is to provide new antenna design techniques applicable to advanced aerospaceborne avionics equipment. This effort includes: Integration of active solid-state circuitry with antennas of 0.25 wavelength or larger; size reduction techniques for VHF and UHF antennas using ferrite, dielectric, and/or

active circuitry as loading devices; research in the areas of broadband traveling wave antennas; and reduced size antennas (0.25 wavelength or less) combined with active solid-state circuitry. In-house antenna feasibility studies will also be conducted.

PROJECT 7062—AEROSPACE COMPUTER SUBSYSTEMS

The project objective is to provide improved performance and operational capabilities in memory devices and subsystems, logic devices and subsystems, and input-output devices and subsystems for application to and use of future Air Force navigation and guidance systems.

In fiscal year 1970 emphasis will be placed on furthering both the memory and input-output areas. Memory efforts will include development of an all-film avonic memory, a complementary-metal-oxide-silicon (low power) memory, and a metal-nitride-oxide-silicon aerospace mass memory. Input-output efforts will deal with A/D and D/A converters using the complementary-metal-oxide-silicon technology.

PROJECT 7844—DAMAGE DETECTION AND ASSESSMENT

The project objective is to develop advanced techniques for real time internal damage assessment ———.

PROJECT 7848—SCORING TECHNIQUES

The objective is to investigate electromagnetic wave phenomena and measurement techniques and develop methods for application to the accurate measurement of the relative trajectory of missiles with respect to aerospace targets. Emphasis is placed on instruments which yield data on distance and direction, as well as the motion characteristics of the missile approaching the target.

The fiscal year 1970 program will accomplish the following: Conduct experimental test on a brassboard radar interprometer missile trajectory scorer, evaluate aconstic scoring technique for air-to-air gunnery requirements, derive scorer subsystem design criteria compatible with high-performance maneuvering targets, and complete development of the relative motion simulator.

PROJECT 7849—THREAT SIGNATURE SIMULATION

The objective is to develop concepts and techniques for the realistic simulation of the parameters of a threat aircraft which affect the guidance/fuzing performance of air-to-air missiles for the valid inflight evaluation of such systems against aerial targets and drones.

During fiscal year 1970, study and development efforts will be conducted on the use of hybrid flares in supersonic drones, on the production of forward IR simulation, on shaping output level versus aspect angle of RF simulators, and on two IR wavelength band simulation.

Mr. ANDREWS. Mr. Rhodes?

Mr. RHODES. No questions.

SPACE STUDIES

Mr. ANDREWS. What is your justification for the large increase in space studies? You are requesting $1.8 million for this project in fiscal year 1970, as compared to the $1 million provided in each of the two previous fiscal years.

Provide that for the record.

(The information follows:)

SPACE STUDIES

The prime purpose of analyses conducted under this activity is to evaluate technical and economic feasibility and estimate operational effectiveness of new military space systems. In both fiscal year 1968 and fiscal year 1969 we funded space studies at an annual rate of $1 million. In fiscal year 1970 we propose an increase of $800,000.

As evidenced by significant achievements in our space efforts, the quantity and quality of space technology available for exploitation is rapidly increasing.

Today, we can confidently describe several fields to which satellite technology is applicable. In the fields of meteorology and communications satellites, we have already entered solidly into the area of operational usefulness. New technology developments allow us to seriously consider applications in other areas such as surveillance and defense, and even in fields ——— significant possibilities of using the space environment for defensive purposes are developing. We believe it is prudent to expand the funding by $800,000 to permit a more exacting evaluation of possible advanced space concepts and identification of areas for greater exploitation of capabilities of earth satellites utilizing the newly evident technological advances.

In the long term, study results guide current and proposed technology programs and influence the future Air Force operational capabilities.

Mr. HANSEN. In a general way our knowledge of space technology has reached the point that it is feasible to have a greater application to the carrying out of military missions.

We have with us here from my staff, Dr. Michael Yarymovych. I would like to ask him to elaborate a little more on the specifics of these studies.

Mr. ANDREWS. Doctor, please elaborate.

EXPLANATION OF STUDIES

Dr. YARYMOVYCH. In the past few years, we have made quite a bit of progress in technology. In order to use this technology and see how it may affect our future defense posture, we have to conduct systems studies of various possible applications of space.

Mr. ANDREWS. Just what do you have in mind? Are you thinking about another MOL program?

Dr. YARYMOVYCH. Not quite. ———.

Mr. ANDREWS. Who is doing this work?

Dr. YARYMOVYCH. Those studies would be contracted to various industrial concerns. The fiscal 1970 studies have not yet been let out for contract.

Mr. ANDREWS. What part of this program is MOL-oriented or oriented toward manned systems?

Dr. YARYMOVYCH. In some studies, one does look at ways of utilizing man in the system, but that is only a general investigation.

ADVANCED SPACE SYSTEM CONCEPTS

Mr. ANDREWS. What are some of the advanced space system concepts which are being studied in this project?

Dr. YARYMOVYCH. I just mentioned ———.

Mr. ANDREWS. I wish you would elaborate for the record.

Dr. YARYMOVYCH. Yes, sir.

(The information follows:)

SPACE STUDIES

We intend to conduct a mission analysis and definition of systems concepts activity in the area of ———. One specific question is the role in this area of a national space transportation system as a mission dedicated space vehicle. A mission analysis of data relay satellites and their operational interface needs with other space systems is planned. We will continue our current fiscal year 1969 activity in ——— systems and intend to look at the mission applications of the space transportation system to other national defense needs.

CONTRACTOR VERSUS IN-HOUSE EFFORT

Mr. ANDREWS. Who are some of the major contractors in this area?

Dr. YARYMOVYCH. The fiscal 1970 contractors have not been chosen. In fiscal 1969, we have had typical aerospace contractors. We are negotiating contracts with various contractors.

Mr. ANDREWS. What in-house facilities are involved?

Dr. YARYMOVYCH. These are systems studies which do not involve in-house facilities.

Mr. ANDREWS. Questions on space studies?

Mr. HANSEN. May we correct the record on that. I think Dr. Yarymovych misunderstood the question. I think you meant which in-house laboratories of the Air Force are involved in these studies, rather than our facilities required. They are studies, not hardware items. The Space and Missile Systems Organization manages the various space studies. They are provided technical assistance from such in-house laboratories as the Aero Propulsion Laboratory, and the Air Force Flight Dynamics Laboratory. The Aerospace Corporation also provides technical assistance.

Mr. ANDREWS. Mr. Lipscomb?

MILITARY APPLICATION OF SPACE EFFORT

Mr. LIPSCOMB. From our hearings, particularly these today, I think the reader of the record may get the impression that we feel the Soviet Union is not actively engaged in military space efforts. However, is it not a fact that the Soviet Union does view its space efforts as having military application?

General PITTS. The great bulk of it; yes, sir.

Dr. YARYMOVYCH. They do not appear to make any distinction between military and civilian effort.

Mr. LIPSCOMB. Do the space studies we were talking about, and on which you said you were putting more emphasis, have an application for ———.

Dr. YARYMOVYCH. ——— is in this category.

Mr. LIPSCOMB. Even though the Air Force has been taken out of the MOL program, and even though your space efforts have been substantially decreased, it is still necessary, I assume, to keep abreast of space efforts as those efforts pertain to the military applications.

Dr. YARYMOVYCH. Certainly.

Mr. LIPSCOMB. This is not being done any place else in Government?

Dr. YARYMOVYCH. No.

General BOYLAN. In the same vein, Mr. Lipscomb, the studies that Mr. Minshall was asking for more details on relate to ongoing efforts. The descriptions are difficult to come by. They relate to ongoing efforts required to maintain a technical posture in aerospace as the Air Force uses it, both aircraft related and space related.

I regret I did not make that comment when the question came up. It is extremely difficult to explain in project terms exactly the task and how those tasks relate to equipment in the inventory and improvements thereto, or new techniques required for future capability.

Mr. LIPSCOMB. I can justify the space studies, but what Mr. Minshall was looking for—at least, what I assume he was looking for—was projects which really were not producing or which appear on the record as make-work projects. I know you would say there is none here. But that does occur now and then.

General MCNICKLE. There is one space study that has been very frustrating, and that is space rescue. We are quite uneasy about sending people out on missions and having to recognize that there is nothing we can do to help them once they go. We have studied this and NASA has asked for help. We have worked together on it. Sooner or later we will have to have some kind of space rescue system. We have not made any progress so far to come up with one.

ANTENNA STUDIES

Mr. LIPSCOMB. In the fiscal year 1969 program for space studies it says "A study of spacecraft antenna design trade offs has been initiated."

I notice on page 16 of the project listing that there also has been a program entitled, "Aerospace-borne Antenna Techniques."

Are the two related?

Dr. YARYMOVYCH. I believe they are. The development of aerospace avionics is directed toward specific design techniques and specialized antenna for satellite relays and navigation, whereas the study takes this work and attempts to synthesize these various antenna systems into a total package.

Mr. LIPSCOMB. What came first, the space study——

Dr. YARYMOVYCH. No, the technology.

Mr. LIPSCOMB (continuing). Or the exploratory development?

Dr. YARYMOVYCH. The exploratory development. The exploratory development drives various technologies toward improvements, and then the study picks up the various items of the technology and tries to synthesize them into a useful system and, furthermore, suggests what other areas of technology need to be improved.

Mr. LIPSCOMB. The Aerospace-borne antenna techniques study is quite an extensive program. You have spent over $1 million for it already, and you are programing $605,000 plus your program.

Dr. YARYMOVYCH. We simply provide the equipment for that.

Mr. ANDREWS. Mr. Rhodes?

Mr. RHODES. No questions.

ADVANCED DEVELOPMENT

ADVANCED SPACE POWER SUPPLY TECHNOLOGY

Mr. ANDREWS. Advanced space power supply technology. In the current fiscal year, $500,000 was programed for advanced space power supply technology. You are requesting $2 million in fiscal year 1970, a fourfold increase.

What is the basis for this increased request?

EXPLANATION OF INCREASE

Dr. YARYMOVYCH. This is symptomatic of this particular project. It started out as a project concentrating on a large retractable solar cell array, and this year this project requires increased funding to develop a prototype item.

Also, we have added another item to this project, namely, the design and test of a rechargeable, long-life battery. These new batteries become quite essential in syncronous orbit.

Mr. ANDREWS. Are other agencies working on that battery?

Dr. YARYMOVYCH. Yes. NASA is working on a complementary project. We are completely coordinated so we do not duplicate the effort.

Mr. ANDREWS. The Navy has been working on it for years; has it not?

Dr. YARYMOVYCH. Not that I am aware of in terms of space batteries.

Mr. ANDREWS. Would it take a special type of rechargeable battery for space?

Dr. YARYMOVYCH. Very much so. Batteries normally have very short life, as you are aware.

Mr. ANDREWS. The Navy battery would not be applicable to your need?

Dr. YARYMOVYCH. No.

Mr. ANDREWS. Who is doing this work? How will you spend the $2 million?

Dr. YARYMOVYCH. Hughes Aircraft Co. is working on the solar cell array, and the battery project has not yet been contracted.

Mr. ANDREWS. Once again, this is an area in which there has been considerable expenditure by NASA. Why can you not depend on NASA for much of your requirement in this area?

Dr. YARYMOVYCH. We do coordinate with NASA completely.

Mr. ANDREWS. That is not the question.

DIFFERENCE BETWEEN NASA AND MILITARY REQUIREMENTS

Dr. YARYMOVYCH. There are very specific requirements that the military satellites have which NASA does not.

Mr. ANDREWS. What, for instance?

Dr. YARYMOVYCH. For instance, survivability in a nuclear environment. Also, we have a greater interest in operating in synchronous orbit than NASA does.

Mr. ANDREWS. Can you point to any instance in which a NASA-developed space power supply element has been incorporated in the Air Force space program?

Dr. YARYMOVYCH. Yes. The fuel cell. The Apollo program developed a fuel cell originally, which was improved and incorporated in the MOL program.

Mr. ANDREWS. Is any part of this effort in support of the MOL program.

Dr. YARYMOVYCH. No.

Mr. ANDREWS. In what approved Air Force space programs will you use the power supply systems under development?

Dr. YARYMOVYCH. The current power supply under development will not come in time for the currently approved program. They are for the next generation. In this particular case, I would expect that the advanced power supply would be available to the TACSATCOM, to the early warning satellites, and similar systems.

Mr. ANDREWS. Questions on advanced space power supply technology?

Mr. LIPSCOMB. No questions.

Mr. MINSHALL. No questions.

COORDINATION WITH AEC

Mr. RHODES. You mentioned coordination with NASA. Do you also coordinate with the Atomic Energy Commission?

Dr. YARYMOVYCH. Yes; very much so. We have rather free exchange of ideas and correspondence with the AEC. We respond to questions in which direction their nuclear power supply should be going. We plan our activities accordingly.

Mr. RHODES. Is this activity mainly research, or do you actually plan to manufacture vehicles?

Dr. YARYMOVYCH. It is more than research. It is advanced development. We do plan to build prototypes, but not vehicles. They would be prototype systems which would then be put on some other satellite on a piggyback basis or special test basis for flight test.

Mr. RHODES. Are you developing anything which is comparable to the NERVA system?

Dr. YARYMOVYCH. No.

Mr. RHODES. Do you contemplate doing that?

Dr. YARYMOVICH. No.

Mr. RHODES. Thank you. That is all.

SPACE EXPERIMENTS SUPPORT (SESP)

Mr. ANDREWS. Space experiments support (SESP).

What is the reason for the increase from $16.8 million to $19.3 million for space experiments support?

EXPLANATION OF INCREASE

Mr. HANSEN. This program fluctuates from year to year. The nature of this program is that it is a gathering program to support the space experiments that have to be flown on launch vehicles. This program has to buy boosters. It has to select from among the desired experiments those which will be performed. This program cannot reflect an annual level amount because, for example, of the way we have to procure boosters. At the time a booster buy is being made, the SESP people will buy a booster. That gives them a big bill at one time.

Mr. ANDREWS. How many boosters will you buy under this program?

Dr. YARYMOVYCH. Actually, in fiscal 1970, we really won't buy a single whole booster, but we will buy pieces of five boosters over a spread of 2 or 3 years. We are incrementally funding them.

Mr. ANDREWS. I thought the Secretary said the program was up dollarwise because of the need to buy boosters.

Dr. YARYMOVYCH. We are buying pieces of five boosters.

Mr. HANSEN. The hardware for the program is bought incrementally, and, therefore, the costs of this hardware are not uniform from year to year.

Mr. ANDREWS. How much of this $19.3 million will you spend for boosters or parts of boosters?

Dr. YARYMOVYCH. About $12 million.

Mr. ANDREWS. Have you a breakdown of the $19.3 million?

Dr. YARYMOVYCH. Right.

Mr. ANDREWS. Put it in the record at this point.

Dr. YARYMOVYCH. All right.

(The information follows:)

BREAKOUT OF SESP FUND REQUEST

	Millions
Final payment for Titan IIIC booster	$7.137
Payload study and integration flight 71-2	2.923
Launch services for Titan IIIC launched on September 26, 1968	2.700
Thor booster procurement for Thor-Burner II flight 70-1	.800
Atlas F booster procurement for Atlas F-Burner II flight 70-2	2.250
Long Tank Thor booster procurement and begin procurement of Agena upper stage for Long Tank Thor-Agena flight 71-2	1.900
Second payment on Agena upper stage for Long Tank Thor-Agena flight 72-5	.310
Integration of secondary payload on NASA Nimbus D launch	.100
Payload compatibility study for Titan IIIC launch	.300
Support by Aerospace Corporation	.880
Total	19.300

MOL TERMINATION

Mr. ANDREWS. What impact will the termination of MOL have on this program?

Mr. HANSEN. None. This is a separate program.

Mr. ANDREWS. Would MOL flights have been used to carry some of the experiments involved here?

Mr. HANSEN. None had been planned so far. That might have been a future possibility. The availability of booster space and experiments is reevaluated annually. So far, there have been none of the SESP experiments programed to go into MOL.

SUPPORT FOR 1970 MULTIPAYLOAD FLIGHT

Mr. ANDREWS. How much of the $19.3 million will be directly in support of the one primary multipayload flight which is scheduled for fiscal year 1970?

Mr. HANSEN. $2.25 million of fiscal year 1970 funds directly support the multipayload launch that you mention in fiscal 1970. This launch is now scheduled to take place in October 1970.

Mr. ANDREWS. Describe that multipayload launch.

Mr. HANSEN. That particular launch is on an Atlas F with a Burner II, to be launched over the Western Test Range from Vandenberg. The Atlas F is one of the surplus vehicles from the deactivated weapons systems program.

Mr. ANDREWS. What is the purpose of the flight?

Mr. HANSEN. The Atlas F-Burner II is in effect a bus to put a group of experiments into orbit which have been selected from among the candidates submitted to make various measurements and to perform various experiments having military application in the space environment.

COST OF MULTIPAYLOAD FLIGHT

Mr. ANDREWS. What do you estimate the flight will cost, including hardware and all?

Mr. HANSEN. About $4 million.

Mr. ANDREWS. For one flight?

Mr. HANSEN. For one flight.

Mr. ANDREWS. That includes everything? Put a breakdown in the record of that $4 million that will be used to make this experimental flight.

Mr. HANSEN. All right, sir.

(The information follows:)

COST OF SESP FLIGHT

	Millions
Atlas F booster	$2.250
Burner II upper stage	.585
Integration of launch vehicle system and payload	1.240
Payload compatibility study	.100
Aerospace ground equipment and launch facility modification	.450
Payload heat shield and spacers	.200
Total	4.825

CANCELLATION OF DODGE II

Mr. ANDREWS. It is noted that the request presented to Congress last year in this area was for $18.8 million, and that a $2 million reduction was made in this item. What was the effect of this $2 million reduction?

Mr. HANSEN. The $2 million reduction was because of deletion of the program called Dodge II, which is an acronym for DOD gravity experiment.

Mr. ANDREWS. That was deleted?

Mr. HANSEN. That was deleted.

Mr. ANDREWS. Have you dropped plans for this flight?

Mr. HANSEN. Do we have plans now?

Mr. ANDREWS. Have you dropped them? You do not have any plans now?

Mr. HANSEN. That experiment was dropped, and there are no plans for it at this time.

FIRMNESS OF BUDGET ESTIMATES

Mr. ANDREWS. To what extent is the $19.3 million request based on firm estimates of experiments to be done?

Mr. HANSEN. There is an annual program review of the space experiment support program which took place on June 5. This is where all of the experiments' sponsors meet with the program office, and then an evaluation is made of which of these experiments can be accom-

modated in the planned flights. The money that is in there corresponds to the currently planned space flight program.

FLIGHTS PLANNED FOR 1970

Mr. ANDREWS. How many flights do you plan for 1970? You told us about one that would cost $4 million. Is that the only one?

Mr. HANSEN. Fiscal 1970 you are talking about?

Mr. ANDREWS. Right.

Mr. HANSEN. Yes, sir. We need to distinguish here between primary and piggyback flights. A primary flight is a flight that is made for the space experiment support program only. In addition to that, some effort is made to get experiments on a space-available basis. There may be some of those. I would have to check.

Mr. ANDREWS. The piggybacks would be part of a flight, is that right?

General PITTS. Possibly another flight, yes, sir.

Mr. HANSEN. It would be a different flight.

Mr. ANDREWS. Put something in the record. You have told us about one flight that you plan for 1970.

Mr. HANSEN. One primary flight.

Mr. ANDREWS. At a cost of $4 million. Put something in the record about other flights that might be undertaken in 1970.

Mr. HANSEN. Yes, sir.

(The information follows:)

ADDITIONAL SESP FLIGHTS

The primary multi-payload launch discussed here was originally planned to be on a Thor-Burner II vehicle. Later it was necessary to change to a more powerful Atlas F booster combined with the Burner II upper stage because of changes in the experiment comprising the payload. A change in schedule was necessary and the flight is now planned in early fiscal year 1971. This flight is being funded over the 3-year period fiscal year 1969 to fiscal year 1971.

The previously scheduled launch will have another Burner II fitted to the Thor booster to provide a launch in the second quarter of fiscal year 1971 to test two subsystems technological developments. This flight is being funded over the 3-year period fiscal year 1969 to fiscal year 1971.

The three other primary flights being funded with fiscal year 1970 funds are:

(*a*) A Thorad-Agena, scheduled for the fourth quarter fiscal year 1971 carrying a multipayload. This flight is being funded over the 3-year period fiscal year 1969 to fiscal year 1971.

(*b*) A Titan IIIC scheduled for the third quarter of fiscal year 1972, carrying a multipayload to synchronous orbit. This flight is being funded over the 4-year period of fiscal year 1969 to fiscal year 1972.

(*c*) A Thorad-Agena scheduled for the fourth quarter of fiscal year 1972, carrying a multipayload. This flight is being funded over the 3-year period fiscal year 1970 to fiscal year 1972.

Arrangements are being completed for the flight of one experiment aboard a NASA Nimbus D launch scheduled for the third quarter of fiscal year 1970. With the Atlas flight delay, this will be the only flight opportunity in fiscal year 1970.

Other piggyback secondary flights of opportunity are being studied.

Mr. ANDREWS. How much of a contingency factor is in this estimate of $19.3 million?

Mr. HANSEN. We have no contingency factor in that estimate.

Mr. ANDREWS. Questions on space experiment support? Mr. Lipscomb?

Mr. LIPSCOMB. No questions.
Mr. MINSHALL. No, thank you.
Mr. RHODES. No, Mr. Chairman.

SATELLITES, BALLOONS, AND ROCKETS

Mr. ANDREWS. Is the project titled "Satellites, balloons, and rockets" the same as the project entitled "Aerospace research support program" last year?

CHANGE IN PROGRAM NAME

Mr. HANSEN. The program entitled "Satellites, balloons, and rockets" combines the previous "Aerospace research support program" and the "Plastic balloon components and techniques program" into a single line.

Mr. ANDREWS. Does this change represent any organizational change, or is it merely a name change?

Mr. HANSEN. It is not an organizational change. It is a name change. It is merely a matter of combining two programs on one line.

Mr. ANDREWS. This is one of the few areas in which we find a decreased request for fiscal year 1970. Is this a real decrease or, under your change in terminology, is a part of the function included here last year now found in another program element?

Mr. HANSEN. No, this is a real decrease, Mr. Andrews.

EXPLANATION OF PROGRAM

Mr. ANDREWS. What is the general purpose of this program?

Mr. HANSEN. It is a support program that provides satellites and sounding rockets for the Air Force research and exploratory development program. It also does development work in the balloons themselves and their components.

Mr. ANDREWS. Questions?

BALLOONS

Mr. MINSHALL. I would like to hear something right now about balloons. Do you have a balloon expert with you, Mr. Secretary?

Mr. HANSEN. Have we any balloon experts?

Mr. MINSHALL. General, are you going to volunteer?

General PITTS. I know the applications we have used balloons for in the past, such as to measure various atmospheric parameters, test prototype satellite equipment, and to make solar measurements, which cannot be otbained on the ground because of atmospheric effects.

Mr. MINSHALL. This is $4 million worth, or part of it is.

General PITTS. ———.

Colonel HOERMANN. I have about half a million dollars for balloons, and it is generally for the development of new materials, sensors, and equipment. Also, it might develop some new cables and ground handling equipment which will allow us to tether a balloon over one spot. The Air Force program is the major balloon development effort in the United States.

You will remember several years one of the doctors of the Air Force jumped out at a very high altitude to show that he could survive.

Mr. MINSHALL. It did not work, though, for one guy I know of. Something went wrong.

Colonel HOERMANN. The Air Force officer did survive.

Mr. MINSHALL. I remember about 2 years ago a civilian jumped out and something went wrong.

Colonel HOERMANN. This work also supports other agencies. For example, some of the work that NASA has done where they took some of their MARS landing craft up to high altitudes and dropped them to see how they were going to land—we furnished the balloon technology that enabled them to lift these loads. We do balloon launching for NASA and for other people.

OTHER ACTIVITIES USING BALLOONS

Mr. MINSHALL. Is NASA in this balloon experiment, or are you the only one?

Colonel HOERMANN. We do the work for them. If they have a requirement to use a balloon, we will design and launch the balloon system.

Mr. MINSHALL. Is the Navy or the FAA or the Army in the balloon business?

Colonel HOERMANN. Not to my knowledge.

(Subsequent to the hearing the committee was advised by the Air Force that the Navy has a contract program for launching balloons from Fort Churchill, Canada.)

General MCNICKLE. ARPA has provided funds to the Air Force for balloon development.

Mr. MINSHALL. What is ARPA doing with balloons?

General MCNICKLE. They are interested in tethered balloons at extremely high altitudes.

Mr. MINSHALL. Yours are untethered low-altitude balloons?

General MCNICKLE. No.

Mr. MINSHALL. What are yours? Tethered high-altitude balloons also?

General MCNICKLE. Yes, sir.

USE OF LARGE BALLOONS

Mr. ANDREWS. On page 174, you say: "Development of extremely large balloons, 30 million cubic feet or greater, will be continued in order to provide greater altitudes and payload weight capabilities."

What do you use those big balloons for, colonel?

Colonel HOERMANN. I am sorry, sir. I am not familiar with the loads they carry. I was trying to answer Mr. Minshall's question.

Mr. ANDREWS. Can anybody tell us what you use those big balloons for?

Mr. MINSHALL. Maybe they are just going to see how big they can make them.

Mr. HANSEN. I am sure there is a better reason than that. We will have to talk to the people who are doing this and supply something for the record.

Mr. ANDREWS. What do they cost, who makes them, where do you get them? Can anybody answer and tell us about the balloons?

Mr. HANSEN. I think the two leading balloon manufacturers are Wingen and Schedjahl Corp.

General MCNICKLE. And Raven Industries.

Mr. ANDREWS. I think, Mr. Secretary, you had better put something in the record about balloons, because we might be asked questions, and we can tell the Members nothing based on what you and your supporting witnesses have told us.

Mr. MINSHALL. We can just say it is up in the air and we do not know.

Mr. ANDREWS. And we would be correct.

Do you know anything about balloons, general?

General MCNICKLE. Not a great deal, Mr. Andrews. I know we have been down to places like South America to launch a balloon to 100,000 feet and take up a large payload of sounding instruments and thereby get a longer period on station, rather than just firing a rocket at different times of the year.

Mr. ANDREWS. Is the purpose of it to study atmospheric conditions?

General MCNICKLE. Yes, sir; to take up instruments that give the scientists conditions at 100,000 and 150,000 feet.

Mr. ANDREWS. Are these balloons recoverable?

General MCNICKLE. We have developed a recovery system, however it is not economical for very high altitude balloons. Tethered balloons which can reach altitudes of 10,000 feet are recovered, of course.

(The information follows:)

BALLOON INFORMATION

The Air Force is one of the world's major developers and the largest user of plastic balloons. These balloons provide a stable high-altitude platform for a variety of uses such as the collection of atmospheric data, the observation of stellar and planetary characteristics beyond the interfering effects of about 90 percent of the atmosphere, antenna tests, radio propagation measurements, high energy particle investigations, measurement of blast effects, measurements in the spectrum from radio through cosmic radiations, and tests of space-mission components in a near-space environment. In tactical applications, balloons have shown a significant operational capability to augment more conventional weapons systems. Additionally, balloon platforms show promise of radically improving the efficiency and capability of future tactical weapons systems. It is significant that all three classes of balloons (free, tethered, and powered) use the same basic technologies.

The balloon platform provides long flight duration in an undisturbed environment up to 160,000 feet, large payload capability with virtually no restrictions on payload configuration, high reliability, precision trajectory control, and low cost. The USAF develops and launches over 150 completely instrumented research balloon systems each year. The techniques, balloons and balloon components developed each year by the Air Force are extensively used by other Government agencies and their contractors including the U.S. Navy, U.S. Army, Defense Atomic Support Agency, Atomic Energy Commission, Advanced Research Projects Agency, National Science Foundation, and others.

Free balloon capabilities are measured in terms of flight altitude, flight duration, payload capacity, range of trajectory for flight control and data retrieval purposes, and reliability. The following table shows progress that has been made over the past 5 years:

	1963	1968
Altitude (feet)	130,000	160,000
Payload (pounds)	5,000	10,000
Duration (day)	30	[1]
Reliability (percent)	90	[2]

[1] Months.
[2] Percent, 90 to 100.

Today's reliability for polyethylene balloons is greater than 90 percent, and 100 percent is approached for the more expensive balloons fabricated from reinforced materials called "scrim," usually Mylar supported by dacron thread. Control and telemetry during free balloon flight are now achieved over ranges up to 5,000 miles from control centers. The altitude and payload limits are obviously not all attainable in the same flight. Marked advances have been demonstrated, however, in the successful research flights of a 26 million cubic foot volume free balloon carrying 2,300 pounds to an altitude of 131,000 feet, a 9 million cubic foot balloon carrying 10,000 pounds to 90,000 feet, and in 1968 a 29 million cubic foot balloon (the world's largest to date) with a 400-pound payload to 100,000 feet.

Flight durations of months are now possible using superpressure free balloons (overpressure balloons that float at a constant-density altitude without the use of ballast). Conventional zero-pressure balloons can only fly for periods in excess of four weeks at the expense of carrying a substantial amount of ballast as part of the payload.

Free balloons containing a powered, directed flight capability have a potential which is under investigation as a quiet, stable platform for a number of specialized missions.

Tethered balloons are capable of carrying a 600-2,000 payload to 15,000 feet for periods varying from hours to weeks. Techniques have been developed to permit stable tethered operation in varied meteorological conditions including winds up to 50 knots. Such balloons can be rapidly retrieved and reflown. Tactical applications are varied and important. For example, 18 tethered balloons have been used 24 hours a day in Vietnam as radio relay stations operating between field units and combat control centers, and seven more have been requested by the Army. Previously helicopters, orbiting for ten hours a day, were used for this function. It has been estimated that the balloon system is saving $1,000 per day for each balloon, and the radio relay capabilities which have been increased by 14 hours a day can be valued only in terms of American and South Vietnamese lives. ———.

Another development uses a tethered balloon platform for a wideband data transmission system for remote command, control, and TV relay from various tactical weapons. Other future system possibilities include battlefield command and control, tactical aircraft strike control, and others, all performed on a real time basis.

The history of ballooning over the past 15 years has shown that requirements have consistently exceeded the state of the art. For the future, altitudes to 200,000 feet have been requested by ultraviolet and ozone investigators; the optical, cosmic ray and high energy particle scientists are in need of flights above 120,000 feet carrying payloads of tons; and extended heavy load capabilities, unique air launched balloon systems and tethered balloon advances would serve important tactical operational purposes.

The major balloon manufacturers are Raven Industries, Sioux Falls, S. Dak.; G. T. Schjeldahl Co., Northfield, Minn.; Winzen Research, Minneapolis, Minn., and the Goodyear Aerospace Corp., Akron, Ohio. Balloons range in cost from approximately $2,000 for a 840 cubic foot balloon to $22,000 for a 29 million cubic foot polyethylene balloon.

Mr. ANDREWS. Any further questions?

TETHERED BALLOON SITE

Mr. LIPSCOMB. Could you tell us where this new tethered balloon site under the fiscal year 1969 program was established?

General MCNICKLE. No.

Mr. LIPSCOMB. Was it paid for out of research and development funds? Was the initial work on the cable for high-altitude tethered balloons completed? Was this a one-time cost?

Mr. MINSHALL. How high up do these tethered balloons go?

General MCNICKLE. 15,000 feet, or so.

Mr. MINSHALL. Tethered to the ground? Aren't they a danger to air navigation?

General MCNICKLE. Yes, sir. That is the reason we go to the more remote places.

(Off the record.)

Mr. LIPSCOMB. Will you put in the record the cost and how the new tethered balloon site was financed? Maybe that is why there is a reduction in the program this year.

General PITTS. We will provide something for the record on that, sir.

(The information follows:)

COST OF TETHERED BALLOON SITE

Air Force Cambridge Research Laboratories (AFCRL) have established a tethered balloon site at the White Sands Missile Range, N. Mex. This site is approximately 95 highway miles north northwest of the permanent balloon detachment at Holloman Air Force Base. This location was picked because of its proximity to the balloon detachment, the ability to use the White Sands Range ground instrumentation, and the lack of flight altitude restrictions. Improvements to the site were financed by R.D.T. & E. funds provided by AFCRL. These improvements included asphalt pavement of the launch area and the fabrication of concrete ducts to contain the tethered cable from the winch to the launch point. Through fiscal year 1969, approximately $6,000 has been spent for these improvements.

Mr. LIPSCOMB. We do not get into this to put you on the spot, but it is our understanding you understood we were going to discuss some of these things before the committee.

General MCNICKLE. We will bring a balloon expert tomorrow, if you wish.

(Off the record.)

Mr. ANDREWS. Any further questions?

(No response.)

ADVANCED SPACE GUIDANCE

Mr. ANDREWS. Now we shall talk about advanced space guidance. You are requesting $7 million for advanced space guidance as compared to $1.9 million in fiscal year 1969, and $2 million in fiscal year 1968. Tell us the justification for such a large percentage increase in this area.

EXPLANATION OF INCREASE

Dr. YARYMOVYCH. The advanced space guidance effort is right now primarily concentrating on a program called SPARS, space precision attitude reference. This system will give us capability of pointing the sensors on satellites to an accuracy which is an order of magnitude better than we have been able to heretofore. In past years, we have been having conceptual studies done by two contractors. Now we have selected one of them to proceed to build a breadboard item and prototype of this unit.

Mr. ANDREWS. What is the relationship between this program and the aerospace avionics program we discussed a bit ago?

Mr. HANSEN. These are completely separate programs. They have no relationship to each other.

Mr. ANDREWS. Is this program related to the MOL in any way?
Mr. HANSEN. No; it is not.

LOW PRIORITY ITEMS

Mr. ANDREWS. The program presented to the committee last year included $3 million for this function. The justification in support of the fiscal year 1970 budget show that only $1.9 million was programed. Is this an indication that there are items of relatively low priority here which would probably be further deferred if across-the-board reductions are required in fiscal year 1970?

Dr. YARYMOVYCH. The items I spoke about were originally intended to be carried through the phase of fabricating and testing an engineering model to keep a better competitive advantage between the two, but as we proceeded further we found, first of all, it might be too expensive to keep the two contractors going all the way, so we cut one of them out; and, besides, one of them showed quite superior performance.

PURPOSE OF PROGRAM

Mr. ANDREWS. Tell us briefly what the purpose of this advanced space guidance program is.

Dr. YARYMOVYCH. The purpose of this program is to develop better techniques for providing attitude reference and guidance to space vehicles. Within that we have various projects.

Mr. ANDREWS. Is NASA engaged in this work?

Dr. YARYMOVYCH. Not in this particular part that we are doing. They of course are doing other work in this field.

Mr. ANDREWS. What differentiates your work from their work in this field?

Dr. YARYMOVYCH. The precision pointing requirements are a particular military requirement. There are others.

Mr. ANDREWS. Explain that.

Dr. YARYMOVYCH. ———.

SPACE PRECISION ATTITUDE REFERENCE SYSTEM (SPARS)

Mr. ANDREWS. Discuss the space precision attitude reference system (SPARS), which is part of your advanced space guidance program. Tell the committee what you are trying to achieve with this system that cannot be achieved with presently available systems.

Dr. YARYMOVYCH. The space precision attitude reference system, which I have alluded to several times now, is a combination of the star tracker, gyro package, a computer, and optical alinement. All these four elements are combined into a total system to provide a very precise attitude reference between a sensor and the vehicle platform.

Mr. ANDREWS. How much of the $7 million programed in this area is for SPARS?

Dr. YARYMOVYCH. $6.6 million.

Mr. ANDREWS. It takes up most of the money, then.

Dr. YARYMOVYCH. Yes.

Mr. ANDREWS. Do you give this program very high priority, Mr. Secretary?

Mr. HANSEN. Yes, I think this is an extremely important program for the reasons that Dr. Yarymovych outlined. ———.

Mr. ANDREWS. What is the total estimated amount you will spend on the SPARS effort?

Dr. YARYMOVYCH. ——— million is estimated.

Mr. ANDREWS. When do you expect to have it completed?

Dr. YARYMOVYCH. This estimate is through ———.

Mr. ANDREWS. On what Air Force space vehicle will the SPARS guidance be used?

Mr. HANSEN. We plan to put it on the Agena.

Dr. YARYMOVYCH. The SPARS system will be originally test-flown on one of the SESP flights which we were discussing before. It still has not been determined which one it will be.

Mr. HANSEN. Space experiment support program flights.

FUNDS FOR ADVANCED SPACE GUIDANCE PROGRAM

Mr. ANDREWS. Furnish a breakdown for the record so the committee may see what specific items are identified with this request of $7 million.

Mr. HANSEN. Yes.

(The information follows:)

1. Space precision attitude reference system (SPARS):	
(a) Complete $6 engineering model fabrication phase	$4.2
(b) Backup component development in star tracker baffling, detectors, and gimbals	1.0
(c) Long leadtime release for flight model and synchronous altitude applications study	1.2
Subtotal (SPARS)	6.4
2. Flexible guidance software system:	
(a) Begin prototype of software generation and validation system	.4
Subtotal (software system)	.4
3. Field testing support:	
(a) Arnold Engineering Development Center	.15
(b) Holloman, Central Inertial Guidance Test Facility	.05
Subtotal (field test support)	.20
Grand Total	7.0

Mr. ANDREWS. Mr. Lipscomb?

Mr. LIPSCOMB. No questions.

Mr. ANDREWS. Mr. Minshall?

Mr. MINSHALL. No, thank you.

Mr. ANDREWS. Mr. Rhodes?

Mr. RHODES. No questions.

Mr. ANDREWS. We will adjourn until 10 o'clock tomorrow.

FRIDAY, JUNE 27, 1969.

LIQUID ROCKET TECHNOLOGY

NEED FOR CONTINUED DEVELOPMENT

Mr. ANDREWS. The committee will come to order.

We will take up this morning liquid rocket technology.

You are requesting $11 million for advanced liquid rocket technology. This is an increase above the $8 million programed in fiscal year 1969 and the $3.4 million in fiscal year 1968. Why must the Air Force support such an expensive program in liquid rocket technology?

Mr. HANSEN. This is advanced development work, Mr. Chairman, that is aimed at anticipated military needs for very high performance, lightweight, small volume, throttleable engine systems. There are two principal rocket systems involved in the program. One is a high-pressure engine system which is aimed at a reusable launch vehicle. The other is a hydrogen-fluorine engine system that is intended for very high-energy maneuverable orbital stages.

Mr. ANDREWS. You are no longer developing liquid rocket ICBM's. You are using solid propellant engines. NASA has extensive development efforts in the area of liquid rocket propulsion. Why can't you depend on NASA developments for liquid rocket technology?

Mr. HANSEN. NASA has no corresponding developments. The rocket development effort of the Air Force and NASA are quite highly coordinated through the DOD/NASA/Aeronautics and Astronautics Coordinating Board, and in fact the development for the high-pressure engine is being partially funded by NASA. They have transferred funds to the Air Force that supplement the Air Force funds that are going into the Pratt & Whitney high-pressure engine contract. I am very confident that there is no duplication between our effort and the effort being done by NASA.

Mr. ANDREWS. Just what rockets do you have in mind with respect to rocket technology? Anything new? Anything expected to be developed today, or is it out in the future?

Mr. HANSEN. The application is directed to the future. The advanced engine development is always a longer leadtime item than the vehicle system to which it is to be applied that it goes on. The high-pressure engine is specifically aimed at powering a recoverable, reusable space vehicle. The hydrogen-fluorine engine is specifically aimed at a multiple restart capability, very high performanve, very low weight and volume engine that would be used in an upper stage vehicle which might be carried to orbit in a recoverable orbital vehicle. It would have the capability to have very high maneuverability in orbit.

Mr. ANDREWS. With what specific program or programs is the $3 million increase associated?

Mr. HANSEN. The $3 million increase is entirely in the high-pressure engine. It is about $5.4 million in fiscal year 1969 and goes to about $8.4 million in fiscal 1970 as that engine moves more into the hardware portion of the contract.

BREAKDOWN OF FISCAL YEAR 1970 FUNDS

Mr. ANDREWS. How much of the $11 million will be for hardware roughly?

Mr. HANSEN. I don't have——

Mr. ANDREWS. Supply that for the record?

Mr. HANSEN. I can supply it for the record.

Mr. ANDREWS. Give us a breakdown of the $11 million for the record.

Mr. HANSEN. Yes, sir.

(The information follows:)

LIQUID ROCKET TECHNOLOGY BREAKDOWN

The $11 million for liquid rocket technology is required to fund development contracts and purchase propellants as follows:

The high performance liquid rocket technology project requires $8.4 million of which $7.9 million is committed to the engine contract with Pratt & Whitney, West Palm Beach, Fla. and $500,000 is required for purchase of propellants. Of the $7.9 million, approximately $5.25 million is for experimental and demonstrator engine hardware and the remaining $2.65 million is for test of the hardware.

The advanced maneuvering propulsion technology project requires $2.6 million of which $2.39 million is committed to the engine contract with Rocketdyne, Canoga Park, Calif. and $210,000 is required for purchase of propellants. Of the $2.39 million, approximately $1.47 million is for experimental hardware and the remaining $920,000 is for test.

In summary, then, of the $11 million, a total of $6.72 million is required for experimental hardware, $3.57 million for test and $710,000 is for propellants.

ADVANCED LIQUID ENGINE FOR SPACE SHUTTLE VEHICLE

Mr. ANDREWS. What is the Air Force requirement for a modular 100,000-pound thrust advanced storable liquid rocket engine?

Mr. HANSEN. The advanced orbital storable liquid rocket engine program was completed in December of 1967, and is no longer an active project. The intent of that program was to bring along technology based on the potential need for an improved engine in the transtage on the Titan III–c or the Agena vehicles. To date this technology has not been applied to any specific vehicle.

Mr. ANDREWS. With what Air Force space programs is an advanced cryogenic rocket engine associated?

Mr. HANSEN. This is the high-pressure hydrogen oxygen demonstration engine, XLR–129 engine being developed by Pratt & Whitney. It would be used in a reusable launch vehicle, space transportation system, and possibly in the NASA space shuttle program. This is the effort that NASA is providing complementary funding——

Mr. ANDREWS. What space transportation system are you talking about?

Mr. HANSEN. I am talking about——

Mr. ANDREWS. We don't have any such system?

Mr. HANSEN, No, sir. This is just what NASA calls a space shuttle. They have been doing some study work under four study contractors. The Air Force has one or two study contracts from SAMSO who are assessing DOD requirements for a space transportation system. Both of these efforts are in response to the President's request for a proposed National space program plan to be submitted to him late this summer by a space task group chaired by the Vice President.

Mr. ANDREWS. You say NASA has four contracts?

Mr. HANSEN. These are study contracts.

Mr. ANDREWS. Isn't that enough study for all purposes? Why would the Air Force have to get into that act if NASA has four contracts?

Mr. HANSEN. There are various concepts for a space transportation system.

Mr. ANDREWS. Does the Air Force have a need for a space transportation system?

Mr. HANSEN. We think eventually we will. We think that we will be able to show that by having a recoverable launch vehicle system, we can save the country money over continuing to use our present expendable launch vehicles where every time the vehicle is used it is thrown away.

Mr. ANDREWS. NASA has recently demonstrated considerable ability to maneuver in space and dock and rendezvous in the Apollo program. Are you, to some extent, duplicating NASA efforts with an advanced maneuvering propulsion technology program, designed to demonstrate an advanced maneuvering engine?

Mr. HANSEN. No, sir; we are not.

NASA's maneuvering and space capability with the Apollo has a maximum capability of about 8,000 feet per second of velocity. This is a measure of the maneuverability, and the projected Air Force requirement to carry out its military missions is of the order of ———. It will take a more highly maneuverable vehicle to be able to accomplish those missions ———.

Mr. ANDREWS. If this program continues to completion and the $92.6 million total cost estimate is accurate, what will we get for the $92.6 million?

Mr. HANSEN. We will get the technology work that has been completed on the storable engine program, which is program 1. Programs 2 and 3 are the two engines that I have described before, the high-pressure hydrogen-oxygen engine and the advanced maneuverable propulsion engine which is fluorine and hydrogen-fluorine. What we will have is a demonstration of those engines brought up to the point where they are ready to be designed to flight configuration.

Mr. ANDREWS. What use will be made of those engines?

Mr. HANSEN. The engines, which are developmental or demonstration engines, will be used to run an extensive series of evaluation tests at the Rocket Propulsion Laboratory at Edwards AFB. The purpose of these tests is to demonstrate that the engines are adequately designed and developed for production design and utilization in vehicles, as I previously mentioned.

Mr. ANDREWS. I know that, but when produced and put into use what will they do? How will they be used?

Mr. HANSEN. The high-pressure engine would be used to propel the stage or stages of a recoverable launch vehicle system. The hydrogen-fluorine engine would be used to propel a very high energy upper stage which would be used as an orbital vehicle.

STATUS OF ENGINE AND SHUTTLE VEHICLE DEVELOPMENT

Mr. ANDREWS. Any questions on this item?

Mr. LIPSCOMB. At just what stage of development are the vehicles now? Bring us up to date on this recoverable vehicle. Where do we stand?

Mr. HANSEN. The recoverable?

Mr. LIPSCOMB. Is that an Air Force program, too?

Mr. HANSEN. There is an Air Force vehicle study under the space transportation system study program. This is a joint effort of DOD and NASA to determine whether it is feasible to develop for the country a single recoverable launch vehicle. Such a vehicle could replace the variety of current expendable launch vehicles and provide the country with a capability at lower cost than the present cost of launching and throwing them away each time.

Mr. LIPSCOMB. Does this engine with its recoverable vehicle and also the other satellites or vehicles you are talking about have a military mission?

Mr. HANSEN. Yes, sir.

Mr. ANDREWS. Tell us about it.

Mr. HANSEN. Yes, sir. This would have the capability to launch all of the military mission if this system were developed.

Mr. ANDREWS. What kind of mission? That is what we would like to know.

Mr. LIPSCOMB. You are talking way out in space.

Mr. HANSEN. All missions to include all satellites for communications, navigation, meterology, ———, and any military purpose whatsoever.

Mr. ANDREWS. Not launching missiles, weapons? That was the MOL program, was it not?

Mr. HANSEN. No, sir. The MOL program did not have a mission to launch weapons.

I want to emphasize that the space transportation system is in just a very early stage of concept formulation. However, these engines are very long lead items and were started on the basis that sooner or later the country has to come to these kinds of concepts. It does not make any more sense to throw away the launch vehicle every time than it would to have a trans-Atlantic transportation system where every time you flew across the Atlantic and landed the plane you burned it and took the next trip with a new plane. In order to really have economics in space operations we have to eventually get to a fully recoverable system where you just gas it up and take a payload to orbit and return to earth, land, refurbish the vehicle and reuse it.

This opens up a great new horizon for use of space because if a satellite in orbit failed, you would have the capability to fly up to it, inspect and repair it or bring it back to earth.

General BOYLAN. Or rescue.

Mr. LIPSCOMB. What techniques are you looking into for recovery of the recoverable vehicle?

Mr. HANSEN. There are two principal concepts that are being studied. One is called the stage and a half, in which there are expendable drop tanks. The vehicle takes off, drops some expendable fuel tanks, flys its mission, returns and lands. The concept that is currently generally favored is one that is completely recoverable. In this system there are two or three vehicles that are connected together and take off together. One goes on to orbit and the remaining booster vehicles go up to about 8,000 feet per second and then separate and return to the launch base and land.

Mr. LIPSCOMB. Do you think that you could get by with a program like this at the same funding level as you had for fiscal year 1969?

Mr. HANSEN. No, sir. We would not be able to continue the program as planned. It would have to be delayed because there is a hardware cost buildup as we go into the actual construction and testing of the engines.

I would remind you that all we are talking about in this advanced development line is doing advanced work on the engine. The high-pressure engine being developed in this program is at a 250,000-pound level. The studies indicate that that engine for a space transportation system would have to be scaled up to about 1-million-pound thrust for production. This engine program is being conducted as a feasibility demonstration engine.

Mr. LIPSCOMB. Is it a military program?

Mr. HANSEN. Yes, sir. It is a military program and it is——

Mr. LIPSCOMB. Could we not cut $2 million or $3 million at this point? I am getting, as all Members are, hundreds of thousands of letters that we are not able to finance our educational program adequately this year because of limitations on funds. It occurs to me that here is a program that is out in space and a program for which perhaps you really don't have a mission lined up. You don't have a vehicle and——

Mr. ANDREWS. If the gentleman would yield, NASA has four contracts on the same thing?

Mr. HANSEN. No, sir. I would like to correct your statement, Mr. Andrews. NASA has no contracts on these engines. They are very interested in these engines.

Mr. LIPSCOMB. Let NASA pay for them then. The military has enough problems running wars, and military things like that, and they have been put in business they don't belong in. I am getting a little concerned about some of this now.

Mr. HANSEN. These engines and the vehicles they would be intended for are aimed at carrying out military missions at a lower cost to the country by putting up satellites with recoverable launch vehicles instead of doing it with the present very costly technique of throwing away the launch vehicle every flight. We also have no way to go up and recover the hardware or inspect the hardware that is in orbit consistent with, military requirements to perform these functions. I think this is a very good program and I think that to not put the funds in to go ahead with it simply——

Mr. LIPSCOMB. How much would it delay it if we took $2 million out of a program like this and used the $2 million for the national education program?

Mr. HANSEN. I think we would have to analyze the program to see what we could do at a lower funding level and see how much it would delay it. It would incur a delay and make the program cost more in the long run. Once you have planned a program in an orderly fashion, if you stretch out some part of it you save money this year but make the total program cost more.

Mr. LIPSCOMB. We will find a couple million dollars in here someplace.

You say that every program that we are talking about today and tomorrow and the next day is in the same position—that we just can't possibly reduce them or delete them?

Mr. HANSEN. No, sir. I think it would be presumptive of me to say that about the total package, but I do think that these developments are specifically aimed at a very good program.

Mr. LIPSCOMB. I am getting a little discouraged. In the next 48 hours why don't all of you sit down and determine where you can give us a clue as to where we could reduce some of these programs? That would save another 48 hours of inquiring into the programs. Why don't we do something like that? I am not being facetious. You are really not justifying the military necessity of the programs. You have not demonstrated one iota to me that there is a military mission for this program now which requires us to rush ahead with. Admittedly we should go into basic research and study, but to go ahead and develop an engine in these times I don't know. So far you don't impress me one bit that the Congress shouldn't reduce this program by $3 or $4 million. Someplace in this massive budget there must be some funds we can cut. There must be.

Every time we ask you, "Could you get along for less?" you say, My gosh, no; either the contract will blow up or the program will be lengthened out and it will cost you more, or something.

It is just getting ridiculous. We ask about each of these items. I get frustrated listening and every day I have been making speeches. We have got to find someplace where we can come up with a reasonable program, and you just haven't got it this year.

Mr. HANSEN. You mentioned the military mission. If——

Mr. LIPSCOMB. What is the military mission in space? You don't even have one. You have satellites for——

Mr. HANSEN. Communications and early warning.

Mr. LIPSCOMB. Are you having trouble with those programs?

Mr. HANSEN. The military mission is to be able to continue those programs at a lower cost to the country.

Mr. LIPSCOMB. You are not doing it this way.

Mr. HANSEN. Yes, sir. I challenge you on that point.

Mr. LIPSCOMB. Go ahead. Good.

Mr. HANSEN. I say if you take the projected traffic of the military for satellites——

Mr. LIPSCOMB. Are you doing all the military traffic for Army, Navy, and Air Force?

Mr. HANSEN. The Air Force is the principal space agent. There are a couple of exceptions, but we do all of the launches; yes, sir. If you take the total cost of expendable launch vehicles for some reasonable period of time such as 10 or 20 years, it is a very large bill of money. We believe that we can design a recoverable launch vehicle which will do that job at significantly less cost for the country, and the longest lead item for it is the development of the engines. This is an advanced development program for a high-performance engine system.

Mr. LIPSCOMB. I would again ask you frankly, Why couldn't you reduce this program by $3 or $2 million, or just tell the committee "Maybe we could get by with a million dollars less"?

I want to hear something positive for a change. Everything we touch is sacrosanct—except that one you tried to explain yesterday and we finally found out it was canceled.

Mr. HANSEN. When a program is aimed at reducing the cost of a task that we are already obligated to do, the sooner we get on with it, the sooner the cost reductions come to bear.

Mr. LIPSCOMB. So there is no misunderstanding how I feel——

Mr. HANSEN. I understand how you feel.

Mr. LIPSCOMB (continuing). Is it a bad suggestion that you go through this big budget book and see what you can determine is unnecessary?

General PITTS. Mr. Lipscomb, we will take a look and come back and advise you as to requirements for absolute funding in this area.

For that second engine, there is a very definite military mission, that is, the advanced maneuver propulsion technology. ———.

Mr. LIPSCOMB. We must get that done?

General PITTS. Yes, sir. ———. I am trying to point out that there is military need for an engine which has the characteristics to do that job. That is the second engine.

Mr. LIPSCOMB. That is all right.

I just want you to know right now that I am going to make an effort to reduce your research and development budget.

General PITTS. Yes, sir.

(The information requested follows:)

POSSIBLE REDUCTIONS IN ADVANCED LIQUID TECHNOLOGY PROGRAM

The funds requested in this area are the absolute minimum practical amount required to continue these projects in fiscal year 1970. This year's contractual commitment for high performance liquid rocket technology is $8.4 million of which $500,000 is required to purchase propellants necessary for component test firings. We have limited this year's activities to:

(a) Continue engine component developments started in fiscal year 1969 (e.g., test of the main fuel turbopump, the preburner injector, and the oxidizer valve).

(b) Begin fabrication of the main chamber, the oxidizer turbopump and the nozzle. Unless these two activities are carried on, we will not be able to demonstrate XLR-129 engine performance in August 1971, which is necessary for an orderly program on the reuseable space transportation system.

The advanced maneuvering propulsion contractual commitment is $2.6 million of which $210,000 is required to purchase propellants necessary for engine component test firings. The planned task for fiscal year 1970 is to finish building one segmented injector and thust chamber and fire it. There is no way to reduce the quantity of component test hardware and still maintain progress toward demonstrating this engine for ——— mission application.

FUNDING FOR THE FUTURE

Mr. LIPSCOMB. You have not yet justified all of the substantial amounts that you have in here. Next year if you find that you could not get by in fiscal year 1970 you will come back with a better presentation and better justification for the programs that you need in fiscal year 1971.

Mr. HANSEN. I assure you that we are going to attempt to make——

Mr. LIPSCOMB. You didn't make up this budget, Mr. Secretary.

You keep trying to justify it but you have not had time to go through here item-by-item.

Mr. HANSEN. This particular item, Mr. Lipscomb, the advanced——

Mr. LIPSCOMB. This is not your budget that you are justifying. As far as I know, you inherited this budget, isn't that right?

Mr. HANSEN. I inherited it.

Mr. LIPSCOMB. You don't have to defend every program in this book.

Mr. HANSEN. This particular program is one—let me say a little more about it.

Mr. LIPSCOMB. This is not the only program that you have been justifying. You have been attempting to justify every one of them. You don't have to do that.

Mr. ANDREWS. This is your revised budget.

Mr. LIPSCOMB. They revised it to a degree.

Mr. HANSEN. This was——

Mr. ANDREWS. You stand by this budget here, do you not, Mr. Secretary?

Mr. HANSEN. Yes, sir. I have had the opportunity to review it. It was revised by the present administration before I came on the job but one of the first things that I did was to spend time with my predecessor going over it. The reason that I have defended this particular program so strongly is that I was well aware of it for several years before I came into this job. Dr. Seamans and Dr. Paine of NASA have directed a joint DOD-NASA study of the Space Transportation System, and the cochairmen of that study are Dr. George Mueller of NASA and Grant Hansen of the Air Force. So I am very familiar with this area.

Mr. LIPSCOMB. I am glad that you are in on this project and feel so deeply about it. In some respects maybe I am sorry I picked on this particular one, so I will find another.

Mr. HANSEN. The depth of my feeling reflects my honest belief that there is the potential in this program to save the country a very large amount of money. I will say that I intend to do as much work as I am personally capable of to try to apply my thinking to the next budget cycle where I will have the opportunity to get into it earlier. I do know that——

Mr. LIPSCOMB. You will get an opportunity. You are going to start the cycle next month?

Mr. HANSEN. We have started the cycle already. We are in a position on many of these programs where the Air Force's original desires are sent forward to D.D.R. & E. and are revised upward or downward there. When we finally arrive at an administration recommendation as to what the program is, I feel that it is our job to come here and try to explain that program to the best of our understanding of it.

ORIGINAL FUNDING FOR 1969

Mr. LIPSCOMB. Just one more question before we leave this program. Does anyone in the room know what the program was programed for in fiscal year 1969 originally?

Mr. HANSEN. Are you talking about the liquid rocket technology program?

Mr. LIPSCOMB. The advanced liquid rocket technology program.

General PITTS. It held at $8 million all the way through.

Mr. LIPSCOMB. It was not attacked in any way?

General PITTS. No, sir. Our record shows $8 million submitted and $8 million approved.

Mr. LIPSCOMB. Last year's justification shows $8.4 million. Evidently you were reduced in some way $400,000.

Mr. FINE. That was part of the overall congressional reduction within the amount appropriated. The $8 million is what the original approved program was for.

General PITTS. I was talking to appropriated money.

Mr. LIPSCOMB. That is a $400,000 reduction?

Mr. FINE. $400,000 was the reduction.

Mr. LIPSCOMB. How much difficulty did that $400,000 reduction cause in the program?

Mr. FINE. Coming early enough in the year, I am sure it could have been accommodated without any significant effect upon the program or schedules.

Mr. LIPSCOMB. Thank you, Mr. Chairman.

DEFENSE SUBSYSTEM DEVELOPMENT AND DEMONSTRATION

CAPABILITY OF MISSILE SYSTEM

Mr. ANDREWS. Now we will take up Defense Subsystem Development and Demonstration.

You are requesting $12.9 million for a project called Defense Subsystem Development and Demonstration. Under this project, you are attempting to demonstrate the feasibility of ——— nonnuclear kill of ballistic missile reentry vehicles. This is, of course, an antiballistic missile effort. Tell the committee what the status of this program is and how feasible you believe such an approach to ballistic missile defense appears to be.

General MCNICKLE. Mr. Chairman, with your permission, I have Colonel Foster here, an expert on the program.

Mr. ANDREWS. Colonel?

Colonel FOSTER. The status of the program is this:

We have a flight scheduled ——— where the original program was intended to ——— due to fund restrictions it will now only test ———. At the end of those ——— flights there is no further funded effort.

Mr. ANDREWS. Is this truly an antiballistic missile program?

Colonel FOSTER. It is an advanced development program. It could evolve into a weapon that could be applied to ballistic missile defense, we believe.

Mr. ANDREWS. How long have you been working on this program?

Colonel FOSTER. It got started in the initial stages about 1965.

Mr. ANDREWS. Working on it 4 years?

Colonel FOSTER. Yes, sir. However, there has been a fund reduction every year.

Mr. ANDREWS. If we get the Sentinel system will you still need this system?

Colonel FOSTER. This program could apply to ballistic missile defense, regardless of what booster you are talking about or what system.

It is not a system in itself. It is essentially a front end to fit on a booster; to be compatible with Spartan, Minuteman, or Polaris.

Mr. ANDREWS. You are talking here about a warhead?

Colonel FOSTER. I am talking about an upper stage———

Mr. ANDREWS. It would be an antiballistic missile system?

Colonel FOSTER. Yes, sir. It is like a Sidewinder out in space.

Mr. ANDREWS. If you get the Sentinel system, would you still need this system?

Colonel FOSTER. You could still make good use of this upper stage, yes sir,———.

TERMINATION OF PROGRAM

Mr. ANDREWS. When do you see the end of this program?

Colonel FOSTER. This program will end by the end of fiscal year 1970. There are no further funds.———.

Mr. ANDREWS. That is what you hope to do?

Colonel FOSTER. That is what we have hoped to do; but we did not get the money, to do it.

Mr. ANDREWS. What are you going to do with the $12.9 million if you get it?

Colonel FOSTER. We will demonstrate———.

SUPPLEMENT TO SENTINEL SYSTEM

General MCNICKEL. The Army is very interested in this, Mr. Chairman. Actually also putting money into it.

Mr. ANDREWS. If you had the system you would supplement the Sentinel?

General MCNICKLE. Yes, sir; with a nonnuclear or small nuclear capability.

Mr. ANDREWS. You could place these missiles, rockets, whatever you attach to it, at places other than the sites of the Sentinel system; right?

General MCNICKLE. Yes, sir; if desired; but there is no need to do this.

Mr. ANDREWS. This program was substantially increased from the $5 million programed in the January budget to $12.9 million and the estimate of the total cost of the program was increased from $17.8 million to——— million. Is this indicative of cost increases in this effort or does this reflect a technological breakthrough which you wish to exploit?

Colonel FOSTER. I would like to answer both of those. It is a technological breakthrough we hope to exploit. We do not feel it is a cost increase. Rather, it is a better estimate of the cost of the program which was in a great state of flux at the time the budget was first submitted. At that time, they were deciding to cut the program back to the minimum program that one could get and still make use of the money that had already been spent. This program turned out to be the———. At the time it was estimated that we ought to be able to do this for $5 million. The Air Force was studying the request to provide the minimum program and the actual cost was $12,9 million.

Mr. ANDREWS. Is it expected that the $12.9 million requested for fiscal year 1970 will complete this program? When do you——

Colonel FOSTER. It will complete the phase that is approved. It will not complete the program as we had originated it.

Mr. ANDREWS. When do you expect to make a decision to continue, redirect, or reorient this program?

Colonel FOSTER. Well, D.D.R. & E. has already decided to reorient it by deleting ———. We have already requested they be reinstated. I would hope that the Air Force would ask to reconstitute it if and when the first shot in ——— proves that ———. I would hope that we would go back in then and ask to be able to add the ———.

FUTURE POSSIBILITIES OF SYSTEM

Mr. ANDREWS. Do you think that you can take this system, if available, and knock down an incoming ICBM?

Colonel FOSTER. Sir, I would like to qualify and not call it a system. I believe this piece of hardware can knock down an incoming RV; yes, sir.

Mr. ANDREWS. You are talking in this program just about the ——— capability?

Colonel FOSTER. Yes, sir. I am talking about the upper stage ———.

Mr. ANDREWS. You are not thinking about using this on a Minuteman; are you?

Colonel FOSTER. The original design guidelines were to be compatible with Minuteman in terms of diameter, length, and weight; yes, sir.

Mr. ANDREWS. I thought the Minuteman had all the capability you wanted?

Colonel FOSTER. It has no capability at the present time for defense.

Mr. ANDREWS. Would you use a Minuteman to knock down an incoming missile?

Colonel FOSTER. We have proposed consideration of a system concept which would use a small number of Minutemen as a booster for defense against a light attack by the Chinese or inadvertent attack by the U.S.S.R.; yes, sir. We have proposed to do the R. & D. to determine just how well that can be done

Mr. ANDREWS. Would the ——— have an all-weather capability?

Colonel FOSTER. Yes, sir. It operates completely out of the atmosphere.

Mr. ANDREWS. How sold are you on this program?

Colonel FOSTER. I am sold enough that I am convinced in my own mind it will be done. It is a question of when.

Mr. ANDREWS. That it will work?

Colonel FOSTER. Yes, sir.

Mr. ANDREWS. Mr. Secretary, do you want to comment on this program?

Mr. HANSEN. Yes, Mr. Chairman, I would like to.

I think this program is very worthwhile pursuing as a potential major improvement to the Safeguard system or to be applied to Minuteman or Poseidon. I think the ability to get a nonnuclear kill ——— is a very desired program to pursue. I think it has a reasonably good chance of being successful. This program is very worth while pursuing to settle the question of whether or not it will work, at which time a decision could be made as to whether or not we wanted to

introduce it into the system. The system itself has to have the early warning radars, and launch facilities. This particular program covers a device which provides accurate ———. I think this is a very necessary technological adjunct to the Safeguard system.

Mr. ANDREWS. How did you launch these warheads? Attach them to something? How would you launch them? Does it take special equipment or do we have the equipment on hand now?

Mr. HANSEN. This would be——

Mr. ANDREWS. I know we have the silos for the Minuteman missiles, and you say these could be used on those missiles?

Mr. HANSEN. Or it could be used on the Poseidons, launched normally.

Mr. ANDREWS. What about the Nikes that we have?

Mr. HANSEN. It could be used on the Nikes or on the Spartan in the Safeguard system.

Mr. ANDREWS. It would add to the reliability of whatever missile is used?

Mr. HANSEN. No, sir. It is not a question of reliability. ———.

Mr. ANDREWS. Hoping for one?

Mr. HANSEN. ———.

Mr. ANDREWS. What contractor are you working with on this project?

Colonel FOSTER. Ling-Temco-Vought.

Mr. RHODES. Mr. Chairman?

Mr. ANDREWS. Yes.

OPERATION OF SYSTEM

Mr. RHODES. Is there any way to jam it?

Suppose they put on the reentry vehicle capability for jamming one of these things; then what happens?

Colonel FOSTER. ———.

Mr. RHODES. What altitude do you make your kill with this system?

Colonel FOSTER. It is always above ———.

Mr. RHODES. ———.

Colonel FOSTER. The defensive warhead?

Mr. RHODES. No; the RV, reentry vehicle that you are trying to kill.

Colonel FOSTER. ———.

Mr. RHODES. No. I say ———.

Colonel FOSTER. ———.

Mr. RHODES. If this were a MIRV would the kill occur at a point in the ballistic flight at a point before the vehicle separated?

(Off the record.)

Mr. RHODES. Actually, when do the MIRV warheads separate in the various independently targeted components?

Colonel FOSTER. I am not qualified to answer for the offensive point of view.

Mr. WALSH. ———.

Mr. RHODES. That is a real problem. The best way is to put a big net up there and catch them as they come in and let them bounce.

Mr. HANSEN. Mr. Rhodes, one of the things that we are thinking of in the concept formulation stage, under space studies, is the idea of ———. This is a very early concept formulation but we think this is very important. This is being looked at hard.

Mr. RHODES. That is very encouraging. That is exactly the place to do the job.

Hopefully with nonnuclear weapons.

Would you plan to do it with nonnuclear weapons ———.

Mr. HANSEN. We would hope to be able to do that. If I might say, this is in the Buck Rogers era. Anything you can think of, if you keep working on it, can eventually be made to work. ———.

Mr. RHODES. That is all in the Buck Rogers stage, as you say. I am glad that you are thinking along these lines.

Thank you, Mr. Chairman.

PROGRAM FUNDING

Mr. HANSEN. That is why I am interested in keeping funds on the engine program.

Mr. ANDREWS. You say that it is estimated to cost ——— million?

General MCNICKLE. Yes, sir; from all sources.

Mr. ANDREWS. How much of that has been funded to date, do you know?

Colonel FOSTER. $12.9 million, sir.

Mr. ANDREWS. You are asking for $12.9 million this year. You had?

General PITTS. $12.8 million funded to date.

Mr. ANDREWS. How much in 1969?

Colonel FOSTER. 1969, there was $10 million, of which $1 million was in the Air Force line and $9 million was provided from the Army budget.

Mr. ANDREWS. In the January budget you had $5 million and now it is $12.9 million. How much did you have prior, including this year, 1969?

Colonel FOSTER. Up through 1969, there would have been $12.9 million in the Air Force plus $9 million from the Army.

Mr. ANDREWS. Is that counting what you are requesting now?

Colonel FOSTER. No, sir. That is up through 1969.

General PITTS. 1969 and prior; $21.8 million.

Mr. ANDREWS. You estimate the total cost to be ——— million is that still your estimated cost?

Colonel FOSTER. That is Air Force, yes, sir.

Mr. ANDREWS. You are within ——— million of completing the funding of this program if this $12.9 million is appropriated for this year?

Colonel FOSTER. No, sir. The ——— million does not include the $9 million that was funded by the Army. We have gotten $12.8 million, Air Force, and we need another $12.9 million in 1970.

General PITTS. Add another $9 million by the Army in 1969 and that is total funds. That completes the approved funding.

Mr. ANDREWS. How much is the program going to cost overall? That is, Army, Navy, Air Force, and all services?

General PITTS. ——— million.

Mr. ANDREWS. How much has been funded by Air Force and Army at this time?

General PITTS. Up through 1969, $12.825 million by the Air Force and $9 million by the Army which was made available to the Air Force.

Mr. ANDREWS. Total of $21,825,000?
General PITTS. Yes, sir.
Mr. ANDREWS. You are requesting this year $12.9 million?
General PITTS. Yes, sir. ———.
Mr. ANDREWS. This year's request, if granted, would fully fund the program?
General PITTS. Yes, sir. That completes the Air Force funding. As I think Colonel Foster pointed out, D.D.R. & E. made the decision to delete the ——— launches from the approved Air Force programs. I would think we would try to go forward and further refine the system.
Mr. ANDREWS. So far as the Air Force is concerned?
General PITTS. It would fund to completion.
Mr. ANDREWS. This request, if granted, would fund your part of the program?
General PITTS. Yes, sir; the approved part.
Mr. ANDREWS. Mr. Lipscomb?

ARMY'S PARTICIPATION IN PROGRAM

Mr. LIPSCOMB. Why isn't the Army participating in the fiscal year 1970 program?
Colonel FOSTER. They are participating to the extent that they have added some experimental equipment not included in these funds. They are ——— of their own to check it out and in addition to this program they are doing studies.
The reason they participated in 1969, is that at that time OSD decided whatever would be done in this line should be done in conjunction with the Nike-X ballistic missile defense activities, so they took $9 million that was in the Air Force line to do this and transferred it into the Army line and then gave it back to us to do it.
Mr. LIPSCOMB. And as I understand it, the appropriation of $12.9 for fiscal year 1970, will finance the program to completion as far as the Air Force is concerned?
General PITTS. That has been D.D.R. & E.'s decision.
Mr. LIPSCOMB. And the program to completion means the second phase or launch of the ——— flights to demonstrate the nonnuclear kill capability of this system. This is dependent on the result of the ——— launches. The decision to do one thing or the other will be made at that time.
That is still the present mission and this $12.9 million will bring us up to that point?
General PITTS. That is right.
Mr. LIPSCOMB. No more funds will be asked by the Air Force?
General PITTS. I think Colonel Foster testified that the Air Force hoped to reopen the decision after the first successful launch. As of right now the decision is that this will go under the Safeguard system and it will be the technology used by the Army in furthering its system.
Mr. LIPSCOMB. As of this moment this will not appear in the 1971 budget.
General PITTS. You are entirely right.

Mr. LIPSCOMB. In the discussion with Mr. Rhodes you were talking about ———. Was that the content of the discussion?

Mr. HANSEN. The principal thrust was that we wanted to be able to ———.

Mr. LIPSCOMB. Even if we develop this capability, and hopefully it will be possible, we would still have to have the Safeguard ground system ——— would we not?

Mr. HANSEN. I think so. For one thing, I don't know how many years off the kind of imaginative scheme that I described might be. In the meantime we have to be concerned for the safety of our country.

Mr. RHODES. Mr. Secretary, you have to be stronger than that. You are never going to rely on on system to stop missiles coming in. You will deploy your defense in depth.

Mr. HANSEN. You are absolutely right. That is what I was going to go on to say. I do not think that a system like this, even if developed, could ever be made so perfectly and foolproof that you could believe that it was going to catch them all. So, I think you have to have a multiple capability. ———.

I consider it would be no conflict whatsoever between this type of thinking and the requirement for a Safeguard system now.

Mr. LIPSCOMB. In other words, the answer is yes, we will have to have a Safeguard type ground system in our own country?

Mr. HANSEN. Yes, sir; that answer is yes.

Mr. ANDREWS. This would be part of the Safeguard system?

Mr. HANSEN. I think it would be better described as a supplement to the Safeguard system.

Mr. ANDREWS. What I meant is that it would be part of our capability to knock down an incoming missile.

Now at the present time do we have any method of detecting launches from either China or Russia?

Mr. HANSEN. ———.

Mr. ANDREWS. ———.

Mr. HANSEN. You mean in existence today or in planning?

Mr. ANDREWS. Suppose they are launching a missile at 11:30.

General PITTS. ———.

Mr. ANDREWS. How soon after that launch will we know about it?

Mr. WALSH. ———.

Mr. ANDREWS. So the earliest you can hope to know about a launch would be ———?

Mr. WALSH. ———.

Mr. ANDREWS. How long would it take a missile launched from Russia to strike the United States?

Mr. WALSH. Approximately 30 minutes.

Mr. ANDREWS. You have ——— minutes to get busy and try to knock down that missile?

Mr. WALSH. Yes. Right now the principal step we can take is to launch our bomber fleet because we have no active defense against missiles. By launching the bomber fleet under positive control we can be assured they do not damage the bombers.

Mr. ANDREWS. And the bomber would go up hoping to knock down the missiles?

Mr. WALSH. No, the bomber then would fly toward Russia in case there is a necessity of retaliation.

Mr. ANDREWS. That is retaliation?

Mr. WALSH. Yes.

Mr. ANDREWS. But at the present time we have nothing to knock down that missile?

Mr. WALSH. That is correct.

Mr. ANDREWS. And it will be 1971 before w will have the capability of intercepting hopefully an incoming missile?

Mr. WALSH. I believe it is 1973. That is the operational date for the Safeguard system.

Mr. ANDREWS. Off the record.

(Discussion held off the record.)

General BOYLAN. ———.

Mr. ANDREWS. ———.

General BOYLAN. That is right.

Mr. ANDREWS. To what?

General BOYLAN. On the order of about ———.

ABILITY TO INTERCEPT RUSSIAN SLBM'S

Mr. HANSEN. I think there is another point which needs to be brought out in connection with what you are saying. As the general said, we have ——— but the times that you ask about are not the most dangerous from the point of view of warning. The most dangerous is the Russian submarine launched intermediate range ballistic missile where we have considerably less than a 30-minute time of flight and a late warning. The toughest job for the Safeguard system and the early warning capability of the country is to warn against and intercept a warhead which is launched from a Russian submarine.

Mr. ANDREWS. They have had that capability of launching missiles for years; that is, launching 400 to 500 miles from the coast. We have been hearing about these submarines for years. They still have that capability and we at this time have nothing to knock out those missiles.

Mr. HANSEN. That is correct.

Mr. ANDREWS. There we are dependent on our ASW capability and the detection capability of our submarines. We have been told here that they have gone all out in a submarine building program. ———.

Mr. WALSH. By ——— we expect to have completed our anti-SLBM radar net around the coast of the country which will warn of a submarine launched ballistic missile coming from a submarine. Still the warning time is short.

Mr. ANDREWS. You will not get that until the missile is launched?

Mr. WALSH. That is right.

Mr. ANDREWS. We are still back to where we are impotent insofar as knocking down incoming missiles?

Mr. WALSH. You are quite correct.

Mr. ANDREWS. This program is designed to give us the capability, or additional capability, to destroy incoming ICBM's.

General PITTS. Complementary; yes, sir.

Mr. ANDREWS. Mr. Lipscomb?

Mr. LIPSCOMB. I have nothing further.
Mr. RHODES. I have nothing further.

TACTICAL SATELLITE COMMUNICATIONS

STATUS OF DEVELOPMENT

Mr. ANDREWS. Now we will discuss "Tactical satellite communications." You are requesting $8 million for tactical satellite communications. What is the status of the tactical satellite communications program? How successful was the planned satellite launch scheduled for February of this year?

Mr. HANSEN. I will ask Mr. Walsh to answer the questions on the tactical satellite communications system, Mr. Chairman.

Mr. ANDREWS. Mr. Walsh?

Mr. WALSH. This program is now in the feasibility demonstration stage of development. Using the experimental satellite which we have designated TACSAT I, the four services—Army, Navy, Air Force and Marines—are conducting tests both joint and individual with the objectives of hardware verification and design and the development of operational concepts. The operational concept development is necessary because this is an entirely new mode of communications and one which is unfamiliar, naturally.

The data obtained from these tests will be analyzed and used to define in detail the follow-on operational system.

As regards the launch, following a near perfect orbit injection by the Titan III–C booster on February 9, 1969, TACSAT I has performed as anticipated. The satellite is now stationed over the Equator at 108 degrees west longitude and can be described as an unqualified success. It meets or exceeds all its design specifications.

It has been used for communications which span one-third of the globe.

Recently terminals which can be carried by three men and set up within minutes, communicated from the Washington area to remote Pacific islands in the vicinity of American Samoa.

As a matter of fact, it has been successful beyond our expectations in this regard because communications were carried forth from islands which were below the horizon so that although the satellite was not within sight of the terminals, its sensitivity was great enough on the receiving end and its power was great enough on the transmitting end so that it could send signals slightly beyond the horizon.

Also the Apollo range instrumentation aircraft and the primary receiving ship, the carrier, used in the Apollo program, are equipped with terminals and TACSAT I was used in a backup role to support the Apollo 10 program.

As a matter of fact, it was so successful in its backup role, where it provided communications in the recovery area, that when high frequency communications—which are known for their erratic quality—were down, for about 20 hours there were high frequency outages covered by the TACSAT satellite communication.

As a result of this, NASA has decided to drop high frequency, the standard long range communication, as their primary communications

in the Apollo 11 test and rather rely on TACSAT for the communications as their primary long range recovery area communications. They have dispensed with the separate communications ship which they have used in conjunction with the carrier.

I think this represents really a true technological breakthrough. I don't like to use the word breakthrough, but the proponents of satellite communication have said that satellite communications will ultimately replace high frequency communications which, as I have noted before, are erratic, and I think this is the beginning of the replacement. It is a technical milestone.

Mr. ANDREWS. Who is using that satellite?

Mr. WALSH. It is being used now by the Army, the Navy, Marines, and the Air Force in tests, and also it is used by NASA during the Apollo tests and also with preliminary circuit checkouts so we can add NASA to the list of people using it.

Mr. ANDREWS. And the performance has exceeded your expectations?

Mr. WALSH. The performance has equaled or exceeded all the design specifications, and I think that that is an outstanding enough event to say it exceeded all our anticipations.

Mr. ANDREWS. What is the primary mission of that satellite?

MISSION OF SATELLITE

Mr. WALSH. The primary mission of this particular satellite, as apart from the mission of the program, is to enable us to develop operational capability in the use of satellite communications.

Mr. ANDREWS. Is this satellite being used for tactical purposes?

Mr. WALSH. Not now because we are trying to develop the communication concepts and moreover we are limited in the number of terminals. We will have by the end of the year 65 terminals or 65 standard terminals plus several jury rigged terminals. It turns out the satellite is so sensitive you do not have to use standardized terminals.

Mr. ANDREWS. What do you mean by a terminal? You mean a ground station?

Mr. WALSH. A terminal is a ground station, a station on a ship or a station on an aircraft.

Mr. ANDREWS. Has the Army had one of these communication satellites in the atmosphere?

Mr. WALSH. Some years ago the Army attempted a communications satellite program.

Mr. ANDREWS. What was the name of the one they put up there?

Mr. WALSH. The defense communications satellite program, the DCSP? Was it a program called Relay?

Mr. ANDREWS. Off the record.

(Discussion held off the record.)

Mr. ANDREWS. Continue, Mr. Walsh.

Mr. WALSH. TACSAT differs from the other communications satellites in that it has high sensitivity. It has directional beams which thereby enhance its sensitivity and make it capable of receiving very weak signals. At the same time it has high power, again coupled with this directive antenna, which enables it to put high power on the earth and thereby work with a fairly insensitive receiver, so as contrasted with the 60-foot dishes which have to be used in order to communicate

with the present crop of communications satellites, it takes a 3-foot dish and low power.

Mr. ANDREWS. What do you call this?

Mr. WALSH. TACSAT-I.

Mr. ANDREWS. What is the difference between that and SYNCOM?

Mr. WALSH. Two principal differences. The Tacsat operates at two frequencies, UHF and SHF. UHF roughly is 200 to 400 megacycles. SHF is 7,000 to 8,000 megacycles.

Mr. ANDREWS. Explain that language in layman's terms. What is the difference between the two?

Mr. WALSH. Basically it is much more sensitive, much more powerful, and operates at a different wavelength.

Mr. ANDREWS. Will you have terminals in Vietnam?

Mr. WALSH. Not yet because we are still testing them. We have a limited number of terminals.

Mr. ANDREWS. Could you have terminals in Vietnam?

Mr. WALSH. Yes, that is the kind of application we have in mind.

DIFFERENCE BETWEEN TACTICAL AND STRATEGIC COMMUNICATIONS

Mr. ANDREWS. It was reported yesterday that communications equipment will be installed in Air Force 1 and in the SAC command post in order to utilize Tacsat communications satellite now in orbit. This appears to be a "strategic" use of a tactical communications program. Why do we have both strategic and tactical communications programs?

Mr. WALSH. Unfortunately we use "tactical" and "strategic" in satellite communications in somewhat unusual ways. By strategic communications we refer to point to point long haul communication, such as provided by the telephone company between those points. On the other hand the tactical communications refer to communications between small terminals and mobile terminals. So even though the Strategic Air Command command posts are involved in a strategic context, the problem here is that the terminals are very small and are in motion as contrasted with the very large and immobile terminals used with the defense communications satellite program, for example.

Mr. RHODES. What do you use for power on the Tacsat?

Mr. WALSH. Solar cells.

Mr. RHODES. Are you working on the possibility of using nuclear sources?

Mr. WALSH. We have examined other alternatives but right now and even for the next few generations of these satellites it appears that the technology supports the use of solar cells rather than nuclear sources. We are investigating the use of regenerative fuel cells for carrying us through eclipse periods.

TOTAL PROGRAM COST

Mr. LIPSCOMB. Last year the descriptive summary indicated that the total estimated development cost of a tactical communications satellite program was $107 million. This year the descriptive summary indicates that the total estimated cost of the development program is "undetermined." What happened to cause you to become unable to estimate the cost of this program?

Mr. WALSH. In 1968 we proposed to OSD a two-phase operational system. The first phase was an interim phase and based on using a satellite essentially identical to that just launched.

The development costs of the space segment of the program, including paying off the remaining costs of the satellite just launched, were estimated at $107 million.

However, the total proposal was deferred by OSD pending the outcome of the present satellite launch and test program.

At the time the budget was prepared we were in the process of trying to restructure a new program geared to the new timing and the new guidelines laid down by OSD. However, since then we do have a determined cost for the program and they are as follows:

We still propose a two-phase program. Costs for the first phase are estimated at $139 million for four spacecraft. That covers R.D.T & E. and investment costs.

The second phase is somewhat more nebulous and won't be defined in detail until the first one is well along. However, if the design remains as we now postulate it, the cost will be $279 million for five spacecraft. This includes R.D.T. & E. and investment costs for one R. & D. spacecraft and four operational spacecraft.

(Clerk's Note: Subsequent to the hearings the last two paragraphs of Mr. Walsh's answers were changed to read as follows.)

We still propose a two-phase program. Costs for the first phase are estimated at $139 million for four operational spacecraft. That covers minimal R.D.T. & E. and is primarily investment costs.

The second phase is somewhat more nebulous and won't be defined in detail until the first one is well along. However, if the design remains as we now postulate it, the cost will be $279 million for five spacecraft. This second phase includes substantial R.D.T. & E. as well as investment costs for one R. & D. spacecraft and four operational spacecraft. The total phase I and II programs consist of one R. & D. spacecraft and eight operational spacecraft.

Mr. LIPSCOMB. Did I understand the first phase was $137 million?

Mr. WALSH. $139 million.

Mr. LIPSCOMB. The second phase?

Mr. WALSH. $279 million.

Mr. LIPSCOMB. This is a $418 million program in total?

GROUND TERMINALS PROPOSED

Mr. WALSH. Roughly $418 million for the spacecraft. That is not the whole program by any means. As a matter of fact, the principal cost in the program is not in the spacecraft but it is rather in the terminals. There is approximately $2 billion estimated for the terminal procurement costs.

This is one of the problems which has caused us great concern because that is a lot of money even though we are talking about 14,000 terminals. These are those which meet the priority requirements of the Army, Navy, Air Force, and Marines.

We are taking steps to try to reduce this number by a major factor. For example, there is a separate program underway known as an ultra-reliable radio transceiver for aircraft, and we are trying to influence—and I believe we have succeeded in influencing—this program in such a way that with but minor modifications we will be able to use the new standard airborne transceiver almost directly for satellite use.

This will mean that of the some 7,000 Air Force terminals maybe half of those, or perhaps hopefully more, will become not specialized tactical satellite terminals but rather will be just a standard radio, and this would reduce the cost by several hundred million dollars. That is the kind of thing we are trying to do.

PHASEOUT OF CURRENT COMMUNICATIONS SYSTEMS

Mr. RHODES. If this is fully funded and becomes operational what systems do we have in being now which could be phased out? Will this just be added on to a myriad of communications systems which the Defense Department already operates?

Mr. WALSH. We certainly hope not to do that. Our criteria in determining applications for the tactical satellite were either those which can be done more cheaply by tactical satellites, or those which cannot be performed by other means. By "more cheaply," if we are talking about existing communications, we mean to compare the operating cost of existing communications with the acquisition and operating cost of satellite communication. There is no use saying satellites would have been cheaper if we had started out from scratch that way. If the cost of satellite communications is less than that of contractual communications, we will discard the present systems.

On the other hand, in terms of new communications requirements, of course, it is a direct cost tradeoff. You buy either a tactical satellite terminal or some other kind of terminal.

There are some things which we are not doing to our satisfaction by present means of communications, and in that case satellite communications might be an add-on.

The specific one that comes most strongly to mind is the control of the Polaris submarines. ———.

On the other hand with tactical satellites they will be able to communicate in a way which greatly enhances their effectiveness.

Mr. RHODES. Then you get into the strategic field when you talk about Polaris.

Mr. WALSH. That is right.

Mr. RHODES. Don't you have an unfortunate name there?

Mr. WALSH. Yes.

Mr. RHODES. This system will not be used for the commanding officer of a company to call the CO 1st Battalion by satellite or anything like that, will it?

Mr. WALSH. There were hopes that could be done. In certain instances it will be done, but not everybody now who has a walkie-talkie will have one of these terminals. The lowest cost we can possibly forecast for these terminals are on the order of $100,000 and you will not give every squad leader a $100,000 terminal. That is one of the big problems. The terminal is a fairly significant unit. Those which have elaborate equipment are the ones who will use the satellites.

Mr. LIPSCOMB. In answering Mr. Rhodes when he asked if you were going to just do away with all the present systems you said "We hope not." Don't you have any plan?

Mr. WALSH. One of the principal purposes of the ongoing tests now is to determine what we can get rid of and to develop the use of tactical

satellites to replace present communications. I say "hope" because we have not concluded our test program.

We recognize we cannot advocate spending $2 billion on something else on top of what we already have.

Mr. LIPSCOMB. What is the best estimate of the total development cost of the tactical communications satellite program, including satellites, ground equipment and all other aspects of the system?

What is your best estimate of the total procurement cost of this system?

Mr. WALSH. I suppose some of that was included in my previous remarks. The studies to date have shown that the total development cost of an operational system may be as high as $250 million.

Total system cost, including 5 years operating and maintenance costs, may approach $3 billion.

I must emphasize that these costs are preliminary at this time and are very sensitive to system design which is not firm and we hope to modify it in a way that the costs will be reduced.

SYSTEM DEFINITION AND DEVELOPMENT

Mr. LIPSCOMB. Do you plan to initiate the contract definition phased engineering and design for the operational tactical communications satellite system in fiscal year 1970?

Mr. WALSH. Yes. During fiscal year 1970 we plan to initiate a planned definition and we have included sufficient funds in the 1970 program for this effort. We do not at this time plan a contract definition effort for the terminals.

Mr. LIPSCOMB. What is the Air Force requirement for tactical communications satellite system? How would you relate it to the tactical communications systems now in being or under development?

Mr. WALSH. System requirements for tactical satellite communications system have been submitted by all four services. As now envisioned the system would be used in those instances where critical tactical communications are unsatisfactory or where it is more cost effective to use satellites rather than conventional communications.

Mr. LIPSCOMB. Does the Army have a stated requirement for the system you are developing? Do the Marines? Will the Navy have use of this system?

Mr. WALSH. All four services are participating in the current Tacsat program. All services have stated requirements for an operational system. The system design now being considered will serve all services.

As I indicated, there are approximately 14,000 terminals.

Mr. LIPSCOMB. How are the other services participating in the program?

Mr. WALSH. The organization of the tactical satellite program is rather unusual. It is managed by a tactical satellite executive steering group. This group consists of a member from each of the offices of the Assistant Secretaries of the Services, Army, Navy, and Air Force, plus our backup military members.

I am the Air Force member at this time.

We essentially take advantage of our positions in our service structures to enforce the decisions which are made by the group jointly, and each service then takes its piece of the program and works it out. This has worked out rather well.

Originally the Air Force was assigned responsibility for the spacecraft and for the airborne terminals. The Army was responsible for the ground terminals and the Navy the shipborne terminals, which seemed a logical division of responsibility.

It turned out, however, that we recognize that it would be extremely wasteful and duplicative to try to each design a SHF or UHF terminal, so we cut up the pie in a somewhat different way. The Air Force retained the responsibility for the spacecraft, and the Air Force also was assigned responsibility for the development of all UHF terminals, land, air, and sea.

The Army was assigned the responsibility for the development of all SHF terminals.

The Navy was the lead service in developing the test plan, so they did not actually develop any equipment under this.

Mr. LIPSCOMB. Are they financing any part of the program?

Mr. WALSH. Each finances that portion of equipment which he will use through military interdepartmental purchase requests so that the Air Force buys all the UHF terminals for the Army, Navy, and Air Force. The Army buys all the SHF terminals, and each pays its share.

Mr. LIPSCOMB. Are the figures that you have given us just the Air Force?

Mr. WALSH. The figures I have given, except for the spacecraft which is Air Force only, have been for the three services.

Mr. LIPSCOMB. What level of command would be included in a proposed tactical satellite communications system?

Mr. WALSH. The operational tactical satellite communications system is expected to serve primarily lower levels or operating elements within our forces. Within the Air Force the system will serve airborne aircraft as well as our mobile ground elements. The smallest terminal now being considered is one which can be used by forward air controllers are long-range patrols.

Mr. LIPSCOMB. With an operational tactical satellite system would there be a tendency for field officers to depend upon higher authority for orders and advice to a greater extent than is done now?

Mr. WALSH. The operational concepts concerning how to use satellites are now being developed. The technical capability exists for the field forces to contact directly higher command levels. However, the actual employment is now being investigated.

Mr. LIPSCOMB. You have some time to develop plans.

Mr. WALSH. Yes.

Off the record.

(Discussion held off the record.)

EXPANDABLE STRUCTURES

PURPOSE OF PROJECT

Mr. ANDREWS. Discuss the new program entitled "Expandable Structures" for which you are requesting initial funding of $500,000. What do you mean by expandable structures?

Mr. HANSEN. Expandable structures are schemes for folding up into a very small package, or a packing with high volumetric efficiency, a structure which can be carried in this compact fashion into space. It is then expanded by some mechanism to form some such structure as a large antenna, an antenna dish, ———.

This is just barely starting. In the program this year we have requested a half million dollars. The anticipation is that the program would amount to something on the order of $10 million to construct and demonstrate some expandable structural devices.

Mr. ANDREWS. Are you starting from scratch on this program?

Mr. HANSEN. There has been some previous exploratory development work on materials and techniques of folding. I have seen, for instance, a device which folds up in a cylinder about 12 to 15 inches in diameter and about a foot high, and when released with an explosive bolt arrangement it expands into an antenna dish, about 6 to 7 feet in diameter. It is quite rigid.

Mr. ANDREWS. You say this program will total $10 million?

Mr. HANSEN. We estimate this advanced development program would have a total cost of about $10 million.

Mr. ANDREWS. Who will do the work for you?

Mr. HANSEN. This is being done by the laboratory at Wright Field.

Mr. ANDREWS. Doing it in-house?

Are you doing it with your personnel?

Mr. HANSEN. I think this item covers contract work they want to do. There are several contractors who have been working on expandable structures.

Mr. ANDREWS. I understand, but who will work on your program, if you know?

Mr. HANSEN. We do not yet know.

Mr. ANDREWS. You have not selected contractors?

Mr. HANSEN. No, sir.

Mr. ANDREWS. Will you let a contract by competitive bid or negotiations?

Mr. HANSEN. I am sure anything in this field would have to be done on competitive bid because I know there are several——

Mr. ANDREWS. Here is another of those cases where you start out with $500,000 and you have not yet selected the contractor, and you have a $10 million program envisioned.

The original contractor probably will be locked into the job until it is completed. Is that right?

Mr. HANSEN. That would be a good possibility; yes. In this particular one I do not know whether we contemplate having more than one contractor. I would suspect we do. It would be my desire to see to it that we get the effort in here divided so we have two or more contractors working in this field.

OBJECT OF PROJECT

Mr. ANDREWS. Tell us what the objectives of this program are.

Mrs. HANSEN. The objective of the program is to develop the techniques for making large structural shapes in space which can be transported into space in a small, compact packaging arrangement.

Mr. ANDREWS. All this has to do with space, then?

Mr. HANSEN. Yes, sir. I cannot think of any aeronautical application for an expandable structure of this type.

Mr. ANDREWS. Is this to be a continuing program or do you anticipate program completion at an estimated date? You said it would cost $10 million.

Mr. HANSEN. As presently visualized, the program would not be a continuing program. It is to develop some specific demonstration hardware for expandable structures techniques, and then this would be picked up later on in a specific application such as I have mentioned. This would perhaps be an antenna dish for relay satellite ———.

AREA INVESTIGATED BY NASA

Mr. ANDREWS. With what Air Force requirement is this program identified?

Mr. HANSEN. It is identified with our requirement to try to develop a technique to put structure into space to support our space programs ———.

Mr. ANDREWS. Mr. Secretary, it seems to me that the Air Force is getting more and more interested in outer space. You are not trying to take over NASA objectives, are you?

Mr. HANSEN. No, sir. Our interests in space are in applying the work that NASA has done. We want to utilize the things that have been developed in space to do things for military purposes which we either could not do before ——— or to do things that we were doing before in a better way, like communicating from point to point at great distances.

Mr. ANDREWS. Do you know whether or not NASA has been interested in an expandable structures program?

Mr. HANSEN. Yes, sir; NASA has done a considerable amount of work in expandable structures.

Mr. ANDREWS. Why could you not use their knowledge in acquiring an expandable structure? Here you want $10 million to get into the same type of program which NASA has been engaged in—for how long, if you know?

Mr. HANSEN. If the Air Force laboratories are going to get into the utilization of this technology they have to start working with it. There is coordination on the expandable structures to make sure that what is done under this line is not a duplication of what NASA is doing. Again, in expandable structures there are many different ideas about how to do it. NASA is pursuing some of these ideas and the Air Force is pursuing some of these ideas.

Mr. ANDREWS. That is the point. Why should you both be pursuing the same idea?

Expandable structures means just what it says, as defined by you.

Mr. HANSEN. I think the only justification I could provide for both being in it is that both will be utilizing it.

Mr. ANDREWS. That does not justify both of you getting into the R. & D. phase of it. Let one organization come up with the answers and then both use what has been found.

Mr. HANSEN. I think we would be subject to criticism in having both of us doing it only if there is duplication. I think so long as we can avoid duplication to have both agencies who are going to be utilizing this technology work with it and get familiar with it is a proper thing to do.

Mr. ANDREWS. The fact you are both in the same type of R. & D. program would subject you to criticism for duplication.

This is a brandnew program and you have not gotten into it?

Mr. HANSEN. We have not gotten into it in advanced development.

Mr. ANDREWS. You have not had any money heretofore. This is your first request for appropration. The subject is "Expandable Structures."

You say that NASA has been in this field for some time. You do not know how long.

Would you find out and put something in the record about what NASA has done in this area of R. & D.?

Mr. HANSEN. Yes, sir.

(The information follows:)

NASA WORKS ON EXPANDABLE STRUCTURES

NASA has been conducting research and exploratory work in expandable structures since about 1961. They have conducted research in the area of fabrics and are developing design criteria through a material-testing program. Current efforts at the exploratory development level are directed toward establishing the technology for an expandable lunar shelter and an erectable and expandable parabolic antenna.

Mr. ANDREWS. Mr. Lipscomb, expandable structures.

Mr. LIPSCOMB. I have no questions, Mr. Chairman.

Mr. HANSEN. I would say this for the benefit of Mr. Lipscomb: If he wanted to talk to me about relative priorities between this and the engines we were talking about I would certainly put those engines much higher in priority.

Mr. LIPSCOMB. So would I.

Mr. ANDREWS. There should not be too much complication about studying expandable structures. Here we have an opportunity to save $10 million if NASA is doing the same work. That is what I wanted you to research and put in the record; what they are doing.

Also put in that statement what you would hope to do with this money which they are not doing.

Mr. HANSEN. That will be provided.

(The information follows:)

PROPOSED USE OF EXPANDABLE STRUCTURES FUNDS

The NASA work in expandable structures is concentrated mainly in research and exploratory work for an erectable and expandable antenna. A lower level of effort consisting of research effort is directed toward providing the technology for an expandable lunar shelter. The Air Force has worked on expandable structures technology in the last 4 years under the exploratory development category. The Air Force program does not duplicate any of the present NASA programs. It is directed to the development of flight test models of expandable reentry vehicles and airlocks, ———.

SATELLITE SYSTEM FOR PRECISE NAVIGATION

Mr. ANDREWS. You are requesting $1 million for the project entitled "Satellite System for Precise Navigation."

Has not the Navy had considerable experience with navigation satellites? Why must the Air Force enter this field of endeavor?

Mr. HANSEN. I think this navigation satellite program is a program with a very high payoff potential. It is a coordinated multiservice program, and is managed by the Navigation Satellite Executive Group with representatives from each of the three services under the overall direction of D.D.R. & E. The Navy, Army, and Air Force are all par-

ticipating. The Air Force has the position of overall assigned leadership in the space launch programs for DOD.

The Navy experience in this field is being applied through the Navy membership in the program.

USE OF 1969 FUNDS

Mr. ANDREWS. Last year you had $500,000 for this project. Put a statement in the record showing how the $500,000 was spent.

Mr. HANSEN. All right.

(The information follows:)

PREVIOUS EXPENDITURES ON SATELLITE SYSTEMS FOR PRECISE NAVIGATION

Fiscal year 1969 expenditures are for four tasks—

(1) Receiver initial development.
(2) User cost optimization study.
(3) Avionics integration study.
(4) Naval operations study.

The receiver development is a breadboard development to determine circuit properties, subassembly characteristics, sensitivity to radio frequency noise, necessary power levels and accuracy potential. The user cost optimization study will perform a second iteration in concept details to determine if lower cost could be attained especially for minimum equipment users. It will use the previous study as a base. The avionics integration study will define the value of a satellite system in allowing terminal operations with user equipment installed for mission operations. The naval operations study will examine the application of high accuracy, realtime, 3-D position fixing in a mobile base, moving user problem. All tasks were coordinated with the Army, Navy, and Marines prior to approval. Contractors involved are TRW Systems, Inc. (tasks 1 & 2), Boeing Aircraft (task 3), Grumman Aircraft (task 4) with Magnavox (who was the user equipment subcontractor to Hughes Aircraft in the original study) as a possible task 1 competitor. Hughes declined to contract for the proposed effort.

OBJECTIVES OF PROJECT

Mr. ANDREWS. You are requesting $1 million this year. What size program dollarwise do you have in mind?

Mr. HANSEN. We are not really that far along. The purpose of the $1 million this year is to continue the study program to define a system which meets the requirements for all the services. The overall objective is to permit a ship, an airplane, a truck, or any device properly equipped with ground equipment to receive information from this navigation satellite and be able to determine its position on the earth or in the space around the earth to an accuracy of ———.

Mr. ANDREWS. You mean a ship can touch base with a satellite and determine its exact location within ———.

Mr. HANSEN. Yes. The navigation satellite system has a constellation of four or five satellites, which transmit range information to a user. At the time of that transmission the system operates between the satellite and the user terminal in such a fashion as to pinpoint its position on an objective accuracy of ———.

Mr. ANDREWS. For years ship captains have been taking that kind of information from stars.

Mr. HANSEN. They don't get it this accurately.

Mr. ANDREWS. I was thinking one advantage of this over the old system of taking a reading from the stars would be that this probably would have an all-weather capability.

Mr. HANSEN. Yes, that is correct.

Mr. ANDREWS. You can take a reading from the stars only on a clear night.

Mr. HANSEN. These readings, of course, would be electromagnetic rather than optical. It would be an all-weather capability.

Mr. ANDREWS. Is that right?

Mr. WALSH. That is right.

Mr. ANDREWS. On a cloudy night the navigator on a ship could not see the stars to take a reading.

Mr. HANSEN. The Joint Chiefs of Staff have established navigation requirements which this system will fulfill. I think you should recognize that this is the seed of a system which, if we went into a full worldwide deployment and equippage, would be a very costly system.

Mr. ANDREWS. Have the Army and Navy agreed to use the satellite?

Mr. HANSEN. They have agreed to participate in the effort covered by this request which is to continue the studies and define what the system would be.

Mr. ANDREWS. The Air Force is doing the R. & D. on this system?

Mr. HANSEN. The Air Force is the principal R. & D. agent. Some of the terminal equipment is being looked at by the other services.

ART OF FULLY OPERATIONAL SYSTEM

Mr. ANDREWS. Are any of the other services furnishing any money in the R. & D. effort?

Mr. HANSEN. This year we have a request for only $1 million to continue the study. The Navy is also pursuing studies on alternative satellite concepts.

Mr. ANDREWS. What is your best estimate of the cost of development and deployment of a fully operational worldwide system?

Mr. HANSEN. With the caution that an estimate at this stage of the game has to be very, very preliminary because the system itself is in just the very earliest phases of concept formulation, we have estimated that to put together a test and demonstration system, which would be useful operationally for one region of the earth, would cost something on the order of a half billion dollars.

Mr. ANDREWS. A half billion dollars?

Mr. HANSEN. To have an entire worldwide system with several thousand service vehicles equipped with the proper equipment to deal with a worldwide system we would estimate as probably on the order of $3 billion.

USE OF NAVY NAVIGATION SATELLITE SYSTEM

Mr. ANDREWS. Has not the Navy already put up navigation satellites?

Mr. HANSEN. This is the Transit system. Each fix taken is much less accurate.

Mr. ANDREWS. How much less accurate? You hope this system will take you within ———.

Mr. HANSEN. Yes, sir.

Mr. ANDREWS. How do you know that goal will be achieved?

Mr. HANSEN. One of the principal things to do in this study——

Mr. ANDREWS. You hope to get a ——— accuracy?

Mr. HANSEN. That is the objective and it is believed to be technically feasible.

Mr. ANDREWS. What is the accuracy of the Navy navigational satellite system.

Mr. HANSEN. I think in satisfying this requirement the Navy's Transit system is entirely for navigation from ships where the object itself is moving very slowly.

The object of the navigation satellite system is to provide this capability even for a supersonic airplane.

Mr. ANDREWS. How long has the Navy had this navigational system?

Mr. HANSEN. I think the details of the Navy system, I would prefer to supply for the record.

Mr. ANDREWS. How many satellites do they have up in their system?

Mr. HANSEN. I think I should supply that information, also.

(The information follows:)

The Navy navigation satellite system (Transit) entered an operational test phase in 1964. It was declared fully operational October 11, 1968. Four satellites are in orbit.

POSSIBLE DUPLICATION IN SYSTEMS

Mr. ANDREWS. I suspect duplication here again, Mr. Secretary.

Mr. HANSEN. I can guarantee no duplication because the Navy is a participant in this program. The Navy has representation on the NAVSEG, which is the DOD executive committee for the direction of this program.

Mr. ANDREWS. I understand that.

Mr. LIPSCOMB. That doesn't guarantee no duplication.

Mr. ANDREWS. You have a satellite up for navigational purposes and you are trying to do the same thing.

Mr. HANSEN. No, sir.

Mr. ANDREWS. If I remember correctly you said the difference between your system and theirs would be to give you more accuracy.

Mr. HANSEN. We are not trying to do the same thing. If we wanted to do the same thing we would just use the Navy system.

Mr. ANDREWS. That is the next question. Why do you not use the Navy system which is already in existence? You are talking here about a half billion dollars program. This is to do something which might not be identical but the purpose of the program is the same. It is to do something which the Navy already has in existence.

Mr. HANSEN. The navigation satellite has two advantages that I know of just offhand; it has an objective of considerably greater accuracy and such accuracy puts us into the threshold of potentially new military uses.

The second advantage is, and I will correct the record if I am not right on this, the Navy system is only a two-dimensional system. It gives you a position on the surface of the earth whereas this system is a three-dimensional system so that you can use it for aircraft as well as something which is on the surface of the earth.

Mr. ANDREWS. Can your aircraft today use the Navy navigational satellite system?

Mr. HANSEN. To my knowledge, no.

Mr. ANDREWS. The answer is that you want something the Navy does not have which can be used by the Air Force?

Mr. HANSEN. Yes, sir.

Mr. ANDREWS. Mr. Lipscomb?

Mr. HANSEN. It took a long time to get us to say that but that is correct.

Mr. LIPSCOMB. Will the Air Force then have something the Navy wants to use?

Mr. HANSEN. Yes, sir.

Mr. LIPSCOMB. Why does it not work both ways? You cannot use the Navy's but the Navy can use yours.

Mr. HANSEN. The Navy system was designed almost 10 years ago as a surface only system. When we get a three-dimensional system it will satisfy both requirements. The purpose of the Joint Chiefs of Staff instructions and the DOD–NAVSEG joint service organization is to make sure that, if we come up with a recommendation for a program, it will supersede anything else that any service had in the way of navigation satellites and will satisfy all requirements.

Mr. ANDREWS. Could the Navy system be modified to such an extent that your aircraft can use it in a three-dimensional situation?

Mr. HANSEN. Anything which was usable from the work which had already been done on Transit would be used. The existing satellites could not be.

There are several limitations to the Transit system for high-speed aircraft. We talked about accuracy and the three-dimensional characteristics. Also we need to take readings more frequently than the Transit system would permit. The Transit system is subject to the introduction of errors if the terminal station is moving very rapidly, as it would be in the case of an airplane.

Mr. ANDREWS. It is important for a pilot to correct navigational information. If you tell us categorically that the pilots cannot use existing Navy systems in my opinion you make a stronger case in your request.

Mr. HANSEN. That is true, our pilots cannot use the Transit system.

Mr. ANDREWS. Further questions?

(No response.)

Mr. ANDREWS. We shall adjourn subject to call of the Chair, gentlemen.

MONDAY, JUNE 30, 1969.

Mr. SIKES. The committee will resume its discussions of fiscal requirements for "Research, development, test, and evaluation, Air Force," for fiscal year 1970.

In resuming the study of astronautic requirements, we are now ready to take up "Space relay and data management."

SPACE RELAY AND DATA MANAGEMENT

OBJECTIVES AND COST OF PROGRAM

You are requesting $1 billion for a new program entitled "Space relay and data management." What are the objectives of this program?

Mr. HANSEN. Mr. Chairman, the objective of this program is to develop a secure communcations system which would enable the development of a space data relay satellite system. The communications sys-

tem itself is the only thing covered by this request. This is a ——— system which is aimed at providing very secure communication in space ———.

The estimated total cost of this subsystem development is ——— million.

Mr. SIKES. The total cost would be ——— million?

Mr. HANSEN. For the communications subsystem, which would be the principal element of this space data delay satellite.

Mr. SIKES. Is this the first effort of its kind in space?

Mr. HANSEN. Yes; it would be.

The military requirement for this satellite would be to provide a data processing and relay capability so that from a worldwide network of satellites the information could be relayed directly back to the United States without having to go through overseas ground stations. We think that the direct payoff for having such a system could be tremendous.

Mr. SIKES. Does that mean anyone can now read the data that is relayed back to us from space?

Mr. HANSEN. No. The data is relayed from the satellites that are out of line of sight with the continental United States to ground stations around the world, and from those ground stations the information is then relayed back through submarine cables or communication satellites, but it does involve ground stations.

With a space relay satellite, a satellite would communicate via a secure system with another satellite which would communicate directly with the United States and eliminate the requirements for these overseas ground stations, or at least provide an alternate communication network routing.

Mr. SIKES. Did I misunderstand you initially? Do you seek security in the information that you are returning as well as the more direct routing?

Mr. HANSEN. Yes, sir; both of those.

The use of this ——— provides a system which ——— would be very secure.

Mr. SIKES. Do we have security now in the information which is relayed back to us?

Mr. HANSEN. Yes; we do. However, it is much more susceptible to the possibilities of jamming or natural interference because of its lower frequency and because it has to go down to the earth at some ground station and then be relayed through conventional ground communication or through a satellite link.

Mr. SIKES. Questions, Mr. Rhodes?

Mr. RHODES. Actually, you are talking about messages that emanate from the other side of the planet?

Mr. HANSEN. Yes, sir.

Mr. RHODES. This would have no application to a message which originates in Western Europe, for instance, because of the fact that you probably would be able to send the message to the satellite and then immediately to a ground station in the United States, would you not?

Mr. HANSEN. Yes; that is right. The application of the data relay satellite would be primarily to communicate with satellites that are stationed over in some other part of the earth and not in line of sight from the continental United States.

Mr. RHODES. How many satellites are you talking about, three?

Mr. HANSEN. The concept of the relay satellite itself is still embryonic. The purpose here is to develop the communication subsystem that would be used in such a satellite. I would think it would not take a very large number, a fairly small number of satellites should do it. I think three might be a reasonable number.

Mr. RHODES. In stationary orbit?

Mr. HANSEN. Yes; they would be in stationary orbit.

Mr. RHODES. That is all.

GRAPHITIC REENTRY MATERIALS

OBJECTIVE AND COST OF PROJECT

Mr. SIKES. Graphitic reentry materials. What is that?

Mr. HANSEN. Dr. Lehmann is here with me and he will discuss graphitic materials.

Mr. SIKES. What is it?

Dr. LEHMANN. The graphitic materials we are discussing here constitute a solid block of graphite with very high mechanical and thermal strength which you can then use on a reentering vehicle at the very tip of the nose.

Mr. SIKES. What are the objectives of the program?

Dr. LEHMANN. The objectives of the program, sir, are to improve our ability to bring reentry vehicles down through the atmosphere in ways differently than we do now. At the present time they come in rather steeply and comparatively slowly. We want to get them so they can reenter at very high speeds or at a very low angle where they will remain in the dense lower atmosphere for a long time. The heat buildup is very high and our present materials would not stand it. The graphite offers one way of solving that problem.

Mr. SIKES. This is a $2 million request to initiate the program and the total program is to cost ——— million?

Dr. LEHMANN. That is right, sir; that is the cost estimate.

Mr. SIKES. What is the basis of your estimate for the total cost?

Dr. LEHMANN. The estimate, sir, for the total cost is based on the experience of our managers in the Air Force Materials Laboratory and in our space and missiles system organization and of our Air Force Weapons Laboratory. They will have to go through the development of the material, the development of design criteria, of means of testing, and the evaluation of this material in the construction of a prototype samples.

Mr. SIKES. Are there Air Force objectives which are peculiarly required by this program?

Dr. LEHMANN. Yes.

Mr. SIKES. In other words, does NASA have a similar requirement or anyone else have a similar requirement?

Dr. LEHMANN. No, sir. This would not come in other than in the reentry vehicles of warheads, sir. The Navy has similar problems but

the advanced ballistic reentry systems program, which is managed by the Air Force as a joint service operation and the deputy, who is a naval officer, is fully in accord with this development program.

Mr. SIKES. Is this to be contract or in-house work?

Dr. LEHMANN. This will be contract work, sir.

Mr. SIKES. Who will be the contractor, or has that been determined?

Dr. LEHMANN. That has not been determined. There will be several.

Mr. SIKES. Why was it decided to break this program out separately?

Dr. LEHMANN. Sir, it was broken out as a separate program because it is a concentrated effort to develop one particular material for a set of very specific applications and it builds upon the results of our earlier exploratory development work. This is now focusing efforts toward the specific application and carrying it farther than we have gone.

Mr. SIKES. Over what time period will the ——— million be spent?

Dr. LEHMANN. It will go through fiscal year ——— sir.

Mr. SIKES. When will the program be completed?

Dr. LEHMANN. It should be completed, sir, in fiscal year ———.

Mr. SIKES. Questions?

TYPES OF HEAT SHIELDS

Mr. RHODES. What materials do we use now for reentry vehicle heat shields?

Dr. LEHMANN. It varies with the kind of material. The NASA reentry vehicle is a very big, very blunt object because they are reentering a man. Our Minuteman II has a Mark II warhead, which still is relatively a blunt warhead.

———.

Mr. RHODES. Do you have to have this in order to perfect a fractional orbit system?

Dr. LEHMANN. Do you mean "Would the Soviets have it for their fractional orbit system?"

Mr. RHODES. Either that or would we have to have it if we went to fractional orbit?

Dr. LEHMANN. It depends. If we want to get down into the atmosphere and maneuver, we would have to have something like this. If we simply have a fractional orbital bombardment system without maneuvering, I think the answer is no.

Mr. RHODES. This actually would be adaptable to a manned spacecraft too.

Dr. LEHMANN. No, sir. This is for an unmanned reentry vehicle carrying warheads.

Mr. RHODES. ———.

Dr. LEHMANN. ———.

(Off the record.)

Mr. SIKES. Back on the record.

AEROSPACE CORP.

FUNDING LEVEL

Under Aerospace Corp. you are requesting a 3-percent cost-of-living increase for the Aerospace contract, which would increase the line item for aerospace from $24 million to $24.7 million. This reflects only the above-the-line amount for Aerospace.

What additional amounts are included in the fiscal year 1970 budget in what weapons programs for additional funds for Aerospace Corp., and that can be provided for the record.

(The information follows:)

ADDITIONAL FUNDS, AEROSPACE CORP.

	Thousands
R.D.T. & E.:	
Tactical satellite communications	$1,320
Titan III space booster	7,200
Manned orbiting laboratory	[1] 15,560
Special activities	6,870
Program 949	4,160
Space experiments support program	240
Advanced ballistic reentry system	7,600
R.D.T. & E.	[1] 42,950
Missile procurement: Special activities	7,194

[1] Subject to further review.

The estimate for fiscal year 1970 is being reviewed in the light of the decision to cancel MOL. It is too early to identify what impact/adjustments will be made to the total aerospace program as a result of this decision. The committee will be advised when the fiscal year 1970 aerospace program is finalized.

Mr. HANSEN. I want to point out, as I did the other day, that the amount requested for the budget of Aerospace is under review as a result of the MOL cancellation. We will provide the breakout of this for the record, but if we do not have the final determination on MOL by the time we provide it, we will have to asterisk and say subject to revision.

Mr. SIKES. Very well.

At the time you have final figures, give us the total increase in fiscal 1970 or the total amount in fiscal 1970 compared to fiscal 1969.

Mr. HANSEN. Yes, sir.

AEROSPACE CONTRIBUTIONS TO AIR FORCE PROGRAMS

Mr. SIKES. What have been some of the contributions of Aerospace Corp. to the Air Force during the current fiscal year?

Mr. HANSEN. I would like to read the titles of a few items and then provide a little descriptive paragraph on each one for the record.

Mr. SIKES. Very well.

Mr. HANSEN. Some of the titles are: Satellite Experiments To Measure Earth Infrared Background; Range Safety System for the Titan III-C; Dual-Spin Altitude Control System, the Correction of a Recovery Parachute Difficulty; A New Development on High Strength Bolts To Resist Hydrogen Cracking; A Simplified Propellant Tank Drain System; A $2 Million Saving in the Navy Flight Test

Program; Some Production Savings in the Minuteman Booster Program; A $36 Million Saving on the Overhaul of Atlas Engines; Some Savings on a Shock Isolation Systems Test; and Development of an Improved Command Destruct System.

(The information follows:)

AEROSPACE CORP.—ACCOMPLISHMENTS

SATELLITE EXPERIMENTS TO MEASURE EARTH INFRARED BACKGROUND

In order to design infrared sensor systems to detect high temperature sources against a sunlit background, it is necessary to measure the infrared light from earth. Aerospace personnel have designed two satellite experiments which have been flown, and successfully provided these necessary earth infrared radiance data.

The results of the experiments, after evaluation by Aerospace, have provided the data to reevaluate and make improvements to an infrared detector system now in design. In addition, these results are expected to make significant contributions to future sensor system designs.

DUAL-SPIN ATTITUDE CONTROL

During the year, Aerospace engineers contributed to the growing technology of control systems for dual-spin satellites. A dual-spin satellite is one in which major portions of the satellite rotate at different speeds in order to provide stabilization and at the same time allow an antenna to point continually in one direction or perhaps permit spinning sensors to scan at different rates. The concept has been applied to communication and meteorological satellites and has great potential for a wide variety of future missions.

Aerospace engineers have made major contributions to the basic theory governing the control of dual-spin satellites. This work included developing mathematical models to describe the dynamic intercoupling of the vehicle and control systems; defining basic criteria for properly selecting nutation damper parameters; and contributing the concepts for attaining attitude maneuverability through momentum exchange rather than fuel expenditure.

RANGE SAFETY FOR THE TITAN IIIC

During the past year the safety office at ETR (Eastern Test Range) became concerned that under certain failure conditions the second stage of the Titan IIIC ——— when flying flight plan 7. ETR requested that the Titan IIIC be provided with the command capability for auomatic sustainer cutoff (ASCO)

———.

As a result of the Aerospace analyses, plans to install ASCO were terminated and the probability of successful Titan III missions has not been degraded. ——— costs estimated at $100,000 associated with booster redesign were avoided.

CORRECTION OF RECOVERY PARACHUTE DIFFICULTIES

Aerospace engineers were requested to investigate the high failure rate experienced during proficiency tests of the MK VC satellite recovery parachute. The failures were occurring because the parachute did not inflate properly and it would frequently become entangled in the retrieval rig trailing the recovery aircraft.

In order to correct these difficulties, Aerospace recommended revisions to the manufacturing drawings which contained the finished parachute dimensions required to insure proper inflation at all anticipated descent velocities. New packing procedures were also devised. Tests of parachutes fabricated and packed according to the Aerospace recommendations have been completely successful. As a consequence, the Air Force adopted these recommendations for all future procurement and utilization of the MK VC parachute. It is expected that the improved reliability of this parachute should lead to annual cost savings of approximately $130,000.

RADAR BACKSCATTER STUDIES

A significant advance in the theory of radar backscatter has been achieved at Aerospace. A theory was developed to describe the scatter of radar waves from the turbulent fluctuations or disturbances in the ionized wake or column of air that trails behind any missile or space vehicle when it reenters the earth's atmosphere.

HYDROGEN CRACKING OF HIGH-STRENGTH BOLTS

In the fall of 1966, high-strength stainless steel bolts used in the oxidizer valve of the Tital IIIC were found to be broken.

The solution to the problem as determined by Aerospace scientists was to modify the heat-treat schedule for the bolt. The modification eliminated the susceptibility of the bolt to hydrogen cracking without affecting its mechanical properties. This has resulted in a new set of specifications for this component.

SIMPLIFIED PROPELLANT TANK DRAIN FOR MOL

The tanks supplying propellant for the attitude control system on the now canceled MOL must be drained in the event there is a launch abort on the pad.

By making the special drain system unnecessary, the Aerospace modification eliminated numerous lines, parts, and fittings, and made possible estimated cost savings of between $50,000 and $100,000 on each of the six to eight vehicles. In addition, the resulting simplified procedures for propellant loading and unloading will lead to further cost reductions associated with ground-handling equipment and personnel.

$2 MILLION SAVING ON NAVY FLIGHT TEST PROGRAM

At the request of D.D.R. & E., Aerospace reviewed the Navy heavy advanced target simulator (HATS) and miniaturized augmentation study (MAS) flight test programs to assess their value to the solution of penetration aids development problems. Flight test objectives and vehicle configurations were studied in relation to state-of-the-art and currently programed ABRES activities. This study revealed that objectives of the MAS program were substantially met by existing ABRES program activities, and that minor test plan adjustments would permit achievement of HATS objectives by two rather than three flight tests.

The Aerospace recommendations, now under active consideration by D.D.R. & E. will result in a savings of three Athena boosters and their associated flight test support costs (approximately $2,150,000) if adopted.

MINUTEMAN BOOSTER PRODUCTION SAVINGS

Aerospace introduced ideas for substantial modification of motor testing which will result in an aggregate saving of approximately $850,000 to the Minuteman program.

SAVINGS OF $36 MILLION FOR ATLAS OVERHAULS

An analysis of the condition of engines on Atlas missiles to be used in the advanced ballistic reentry system (Abres) program resulted in a recommendation that the time between overhaul of the engines be extended, which could eventually result in a total saving of $36 million.

SAVINGS ON SHOCK ISOLATION TESTS

Aerospace engineers' extensive knowledge of facilities and testing practices and careful attention to specification detail resulted in identification of an incompatibility between the contract requirements and a contractor proposed new test machine. An alternative and suitable machine was identified leading to a saving of the purchase cost of the new machine (approximately $30,000) and a subsequent slippage of the test program which probably would have occurred when the need to purchase a second machine became apparent.

IMPROVED COMMAND DESTRUCT SYSTEM

All launch vehicles currently operating from the Western Test Range carry command destruct systems to abort the flight in the event of malfunction. When it was determined that the command-destruct receivers on the vehicles were quite

vulnerable to spurious signals, a solution to this problem was proposed which required replacing the current destruct system with a new digital command system.

As a result of the investigation the Air Force decided to modify the current onboard receivers in accordance with the Aerospace proposal. The acceptance of this recommendation resulted in a nonrecurring cost avoidance of approximately $2,000 per vehicle.

NUMBER OF EMPLOYEES

Mr. SIKES. How much of the total work of the Aerospace Corp, is done with the Air Force? What part is done for organizations other than the Air Force?

Mr. HANSEN. Based on pre-MOL cancellation plans for fiscal year 1970 it was approximately 93 percent Air Force, 4 percent other DOD, and 3 percent other Government agencies non-DOD.

Mr. SIKES. What is the total number of employees projected for Aerospace Corp. for fiscal year 1970 and how does this compare with fiscal year 1969? I would like to have you include both technical and support personnel and that can be for the record.

(The information follows:)

	Fiscal year—	
	1969	1970
Engineer/scientists (MTS)	1,793	1,796
Technicians	538	518
Mission support	1,430	1,398
Executives	13	13
Corporate total	3,774	[1] 3,725

[1] Subject to change due to cancellation of MOL. Total impact is not known at this time.

EFFECT OF CANCELLATION OF MOL PROGRAM

Mr. SIKES. It is noted from the justification that the amount spent with the Aerospace Corp. for the MOL program is estimated to increase from $13.4 in 1969 to $15.6 million in fiscal 1970. Will all of this be deleted?

Mr. HANSEN. No, all of it cannot be deleted. But there will be a reduction.

Mr. SIKES. You will provide the facts?

Mr. HANSEN. Yes, sir.

Mr. SIKES. And that, of course, will modify the overall cost of the Aerospace program?

Mr. HANSEN. Yes, sir, it will.

Mr. SIKES. Other items will not be cranked in to replace the MOL?

Mr. HANSEN. Because Aerospace has been operating under a manpower ceiling and some tasks have had to be deferred, that is being looked at.

Mr. SIKES. The committee would like to be fully advised on any decisions that are made and the reasons for them, in this connection.

Mr. HANSEN. Yes, sir.

(The information follows:)

DISPOSITION OF MOL FUNDS

When the fiscal year 1970 Aerospace program has been finalized, the results will be furnished to the committee under separate correspondence.

SALARY INCREASES

Mr. SIKES. Have there been increases in the salaries of the top officials of the Aerospace Corp. in the last year?

Mr. HANSEN. Yes. The Aerospace board of trustees approved salary increases for 11 of the top officials.

Mr. SIKES. Do you have the details on those increases?

Mr. HANSEN. Yes, I do.

Mr. SIKES. Can you give them to us at this time?

Mr. HANSEN. Yes, I can give that to you at this time.

These increases have been forwarded to the Air Force Systems Command Salary Review Committee, where these are pending review. The present indication is that the Air Force will disallow these increases. However, it is still under study.

Mr. SIKES. Will you give us the proposals for the record.

The Air Force would have the right to reject it if it feels its increases are not justified?

Mr. HANSEN. Yes, sir.

Mr. SIKES. You are examining that fact?

Mr. HANSEN. Yes, sir.

Mr. RHODES. When you put in the record the information requested by the chairman about salaries and salary increases will you also include the total former salary and the present salary so we may have a basis of comparison, and also that should either include bonuses or show the bonuses as an addition.

Mr. HANSEN. There are no bonuses in the Aerospace structure, the straight salary is the total compensation.

(The information follows:)

	Total new salary	Total old salary	Increase
President	$97,500	$90,000	$7,500
Senior vice president	70,000	66,000	4,000
Vice president and operations general manager, San Bernardino	65,000	60,000	5,000
Vice president and operations general manager, MOL	58,000	53,000	5,000
Vice president and associate general manager, San Bernardino	55,000	53,000	2,000
Vice president and operations general manager, El Segundo	50,000	44,500	5,500
Vice president and general manager for manned systems, El Segundo	50,000	48,000	2,000
Vice president and general manager for systems planning, El Segundo	50,000	45,000	5,000
Vice president, administration, and treasurer	45,500	39,600	5,900
Vice president and general manager, laboratory, El Segundo	45,500	38,500	7,000
Vice president for corporate planning	44,000	40,000	4,000

Note: To date none of the above increases have been approved. Any amount in excess of the Air Force approved figure will not be allowed as reimbursable costs on cost-type Government contracts.

ACQUISITION OF PROPERTY

Mr. SIKES. Has Aerospace Corp. acquired any additional properties in the last year?

Mr. HANSEN. Only severable facilities such as test equipment, furniture and the like, which comes under the Government facilities contract. There has been no new property, such as buildings.

Mr. SIKES. Is this at cost to Aerospace at present or ultimate cost to the Government?

Mr. HANSEN. I am sorry, I did not understand.

Mr. SIKES. Is the Government paying for it now or eventually or Aerospace paying for it?

Mr. HANSEN. This will be paid for by the Government under a facilities contract, no-fee-type contract.

Mr. SIKES. Provide the amount.

(The information follows:)

PROPERTIES ACQUIRED BY AEROSPACE CORP., FISCAL YEAR 1969

[Dollars in thousands]

Facilities:
Fiscal year 1969, $500.
Fiscal year 1970, $600.

OTHER EQUIPMENT, AIR FORCE

AIRBORNE WARNING AND CONTROL SYSTEM (AWACS)

LARGE FUNDING INCREASES FOR AWACS EQUIPMENT

Mr. SIKES. Under "Other equipment" there is a request for $385.2 million, which compares with $383.7 million for fiscal 1969, $277.2 million in fiscal 1968.

I think the committee would like to know why there was a very significant jump between fiscal 1968 and fiscal 1969 to a new level a hundred million dollars higher and the same level is maintained in fiscal 1970.

What is happening in that area to require or justify this very large increase?

General MCNICKLE. The two programs that have the largest increase are the AWACS, which goes to $45 million in fiscal year 1969 and $60 million in fiscal year 1970 and TRACALS—traffic control and approach landing system.

AWACS is our airborne warning control system, which we desperately need both for air defense and for tactical control of fighters. It is moving along. We have two radar contractors competing and a third contractor in a backup position for the radar development. We expect to select an airframe prime contractor to incorporate the radar into an AWACS.

(Off the record.)

———.

Mr. MINSHALL. ———. What distance are we talking about?

General MCNICKLE. ———.

Mr. MINSHALL. What is this in miles?

AVAILABLE AIRCRAFT RADAR WARNING CONTROL SYSTEMS

General MCNICKLE. ———.

Mr. MINSHALL. I know, but ———.

What is it?

General MCNICKLE. We do not have an airborne warning and control airplane with a lookdown radar to serve areas like this. We have old obsolete EC–121's that have a limited capability.

Mr. MINSHALL. What are we able to do with our equipment ———?

General MCNICKLE. Colonel Ahern can give you some of the data.

Mr. SIKES. How far from the aircraft is this system effective ———?

I am sure that is what the gentleman wants.

General BOYLAN. The AWACS aircraft operating in an altitude of about 30,000 to 35,000 feet over land would have the capability of control ———.

Mr. MINSHALL. ———. Then we can get into the other question.

General BOYLAN. Then let me start with what we have now ———. Out there today we have some ——— aircraft in combination, one of them is the EC–121 which has about ——— nautical mile look-down capability until it hits the coast and then the ground clutter from the earth destroys this capability. ———.

Mr. SIKES. ———.

General BOYLAN. Actually, in Southeast Asia we have to use a family of airplanes to accomplish the total control mission.

Mr. SIKES. How many?

General BOYLAN. We have ——— separate airplanes.

(Off the record.)

WORTH OF NEW RADAR WARNING SYSTEM

Mr. SIKES. Is that worth what amount, $60 million?

General BOYLAN. Absolutely, sir, because the mission of this aircraft is not only for control of our tactical forces in areas such as Southeast Asia where we will not necessarily have ground radar installations, but the AWACS airplane is designed also for air defense of the continental United States.

Mr. SIKES. Let me preempt one of the critics on the floor who feels the Air Force is "wasting a lot of money and not accomplishing very much," and ask you why ———.

General BOYLAN. Mr. Chairman, the problem, ——— has been the development of a highly reliable efficient long-range look-down radar There has been considerable work done by this country in this field.

In the case of the YF–12A prototype, we have flown a look-down radar. In AWACS we have two competing developments which have demonstrated this capability. The Navy has developed a lookdown radar which has good efficiency over water, something less over land.

Mr. SIKES. You have not exactly answered my question.

From the standpoint of this committee, which is charged with defending the Air Force position and what it does, what is the answer to the charge that the Air Force should have developed this capability ———.

General BOYLAN. ———. Without a lookdown radar, there is very low efficiency below the radar horizon in control of forward fighters or air defense interceptors.

Mr. SIKES. For years we had radar, and then began to go to OTH radar and now lookdown radar. For the record, I think you had better differentiate between them.

(The information follows:)

DEFINITION OF TYPES OF RADAR

Our present ground radars are range and line-of-sight limited. These radars have detection ranges of some 250 miles and due to the line-of-sight limitation, practically no capability against low-flying targets.

Over-the-horizon (OTH) radars are being developed to overcome the range and line-of-sight deficiencies. By "bouncing" their signals off the ionosphere and the earth's surface, the line-of-sight limitaton is overcome and target detection at all altitudes between the earth's surface and the ionosphere is possible. The range of the proposed CONUS OTH system will be approximately ———.

Present airborne radars function much the same as ground radars and have the capability to detect only those targets operating above the radar horizon. Because of their altitude, their line-of-sight range is greater. However, reflections from the ground generally mask aircraft which are between the airborne radar and the ground, so such radars have little capability against low-flying targets. Lookdown radars, utilizing pulse-Doppler principles, are being developed to provide a detection-and-tracking capability of low-level targets against a ground clutter background. Such a radar will be used on the AWACS aircraft.

It should be realized that OTH radars provide long range detection, but no command and control capability for intercept. AWACS would receive timely warning from OTH detection, and then provide the necessary intercept command and control.

ADOPTION OF VARIOUS RADARS TO AWACS SYSTEM

Mr. RHODES. I want to ask you, if my memory serves me correctly, last year the AWACS system was supposed to have OTH radar.

General BOYLAN. That is a complementary system in the total air defense environment of the United States. It is not in the airplane. The over-the-horizon radar would be——

Mr. RHODES. It is not to be an airborne radar?

General BOYLAN. No, sir. It would be based ——— and give us the coverage against penetrating bombers out to about ——— miles. Then in conjunction with the AWACS, the OTH would give the position of the bomber plus or minus ——— miles at ranges of ——— miles.

The AWACS then on station would direct a radar intercept with a fighter interceptor because it could look down and direct a fighter to an incoming bomber for attack or identification.

Mr. RHODES. What type aircraft will you use for the downlooking radar?

General BOYLAN. The current program is considering a 707 or DC–8 type. It would be an "off-the-shelf" type of airplane.

(Off the record.)

Mr. MINSHALL. Let me get back to my original question of a few minutes ago. Are you sure of ——— ?

General BOYLAD. No, sir; I am not.

Mr. MINSHALL. ———

Mr. WALSH. ———

Mr. MINSHALL. General McNickle made a statement 5 minutes ago and said ———.

Mr. WALSH. (Off the record.)

HOPEFUL IMPROVEMENTS WITH FUNDS REQUESTED

Mr. MINSHALL. What extra range or what additional range are we buying with the money you have asked for in the budget, namely $60 million?

General MCNICKLE. We are buying an important year of radar development plus integration of the electronic software into an aircraft. We are buying the development of a prototype AWACS airplane.

Mr. MINSHALL. What range do you hope to get?

General MCNICKLE. ——— miles.

General BOYLAN. That is in a look-down mode from 30,000 feet, looking down over the surface to detect the bomber between the radar and the surface.

Mr. MINSHALL. In other words, we are going up from ——— miles to ———.

General BOYLAN. That is right, sir.

In the straightaway mode looking out the new radar will be on the order of ——— miles as opposed to about ——— miles from our current EC–121.

Mr. WALSH. I would like to emphasize the EC–121 really cannot see low-flying targets at all even at less than the ——— miles quoted because what they see is the reflection ———.

Mr. MINSHALL. How far along are you with the development of the new radar?

Mr. WALSH. We have demonstrated the basic performance of two different radar techniques which will give us this capability.

Mr. MINSHALL. When will you be operational with this capability if we give you the money?

Mr. WALSH. If you give us the money, we expect to have it operational in late ———.

Mr. RHODES. What type aircraft will you use for the intercept?

Mr. WALSH. This can work with a variety of interceptors, with any interceptor we have in the inventory. The original plan you alluded to earlier is one in which we would use a modified F–106. The planned AWACS program enhances the capability even of the existing F–106 because we will be able to detect low-flying aircraft which we cannot do at all now with the present network of radars. We have gaps through which the low-flying bombers can come.

Mr. RHODES. Are you still going to use the F–106 armed with the Phoenix?

Mr. WALSH. We plan to arm it with the AIM–47, an air-to-air missile made by Hughes Aircraft Co., related to but not quite the same as the Phoenix.

TOTAL ESTIMATED AWACS DEVELOPMENT AND PROCUREMENT COST

Mr. MINSHALL. What is the total estimated development cost on this whole program ——— up to the time it goes in operation?

General MCNICKLE. We estimate the R. & D. to be a little less than $700 million.

Mr. MINSHALL. Is that R. & D.?

General MCNICKLE. Yes, sir.

Mr. MINSHALL. What do you estimate the procurement will be?

Mr. WALSH. There are two procurements being talked about.

One is procurement for Air Defense Command and one a procurement for Tactical Air Command. Approximately ——— for Air Defense Command and ——— for Tactical Air Command, for a total with training and attrition aircraft of ———.

Mr. MINSHALL. What is this in dollars? You have nearly $700 million in R. & D. What is the procurement?

Mr. WALSH. The procurement of ——— is $1.9 billion.

Mr. MINSHALL. How many billion again?

General PITTS. $1.964 billion to be exact.

Mr. MINSHALL. It is going up every day.

Mr. WALSH. That is for ——— ADC and TAC. The ADC mission procurement total alone is estimated to be $1.468 billion for a ——— aircraft buy.

Mr. MINSHALL. I do not know how you fellows can come up with such billion dollar programs so fast, so soon, and of which many never work.

Mr. WALSH. This radar program I think we rightly can say is a radar which has been more thoroughly tested before we started than any other radar program on which we have embarked. We have already had a flight test program of the basic radar principle of two of the radar techniques which are in competition here.

Mr. MINSHALL. Your procurement then will be $1.9 billion. Is that the closest figure you can give us?

Mr. WALSH. Yes, for ———.

Mr. MINSHALL. You have nearly $3 billion, or $2.6 billion programed then?

Mr. WALSH. That is correct.

I would like to point out that in fact we anticipate a cost saving in Air Defense Command by the use of this radar or this aircraft system. There are two reasons for using AWACS. One has to do with improved performance which gives you the lookdown capability and will stop low-flying aircraft which we cannot do now. However, there are two other capabilities which we are achieving to some extent now with the existing radar; namely, survivability, which in the present system we achieve through redundancy, and also long range, which in the present system we achieve by having very many radars remote from the coastline or the borders.

In fact, when we install AWACS we will be able to eliminate very many existing radars, eliminate all of the redundancies because that will not be needed for survivability, the flying platform will give you survivability. So we anticipate on the Air Defense Command side that we will incur savings or cost avoidance of approximately $60 to $100 million each year it operates.

ASSESSMENT OF RUSSIAN THREAT IN DEVELOPMENT PLAN FOR AWACS

Mr. MINHALL. What do you estimate the Russian threat will be in ——— with manned bombers? This is the only thing that is good for?

Mr. WALSH. No. The Air Defense Command version is good for the Russian threat of manned bombers. However, the Tactical Air Command version is useful for fighting in wars such as Southeast Asia where you have to get command and control capability in a hurry.

Mr. MINSHALL. What do you estimate in ——— the Russians will have in manned bomber against the United States?

Mr. WALSH. They have of the order of 200 heavy bombers now, plus several hundred medium bombers, which could fly one-way missions. I do not know offhand what the national intelligence estimate is on the threat, but it is somewhat less than that, in that it discounts the capabilities of the medium bombers.

The Air Force is dissenting in the national estimate.

General BOYLAN. The intelligence community estimate for mid-1975 is ——— heavies; the Air Force view on that estimate is ———. For the mediums, the community estimate is ———; the Air Force is slightly higher at ———.

I think, without casting stones at the community, that the Air Force's estimate of the Soviet bomber force has been more nearly accurate over the last several years.

Mr. WALSH. For the last several years, the community estimate has always been that the number of bombers will decrease in subsequent years, and in each year it has remained about the same.

Mr. MINSHALL. Is the manned bomber threat increasing or decreasing?

Mr. WALSH. In the last couple of years it has remained about constant. It increased prior to that, but it has not decreased as has been the intelligence community estimate.

Mr. SIKES. Has it increased in capability while in numbers remaining constant?

Mr. WALSH. It has increased in capability in that it has been equipped with air-to-surface missiles, reasonably long range, the purpose of which is to stand outside our radar defenses and lob in missiles. This is one of the capabilities that AWACS will give us we do not have now, that we will be able to perform intercepts at ranges such as we can kill the bombers before they launch their air-to-surface missiles.

General BOYLAN. May I add one point, Mr. Minshall, to what Mr. Walsh has just said?

As to cost savings, some major fraction of these savings has already been applied against the air defense force of the United States.

For example, on major search radars, by the end of 1962 we had 179; by the end of this year we are down to 128; we are scheduled to go down further to 118.

On GAP filler radars, the picture is the same; from 135 down to 17. These will then all phase out, as the AWACS comes in. As the AWACS comes in our search radar posture will decrease to 84.

Mr. MINSHALL. How much have you put in this program so far in R. & D.?

Colonel AHERN. We have put in $13.7 million in fiscal 1968 and prior years. And the approved fiscal year 1969 program is $39.3 million.

Mr. MINSHALL. That is the total amount that you have put in AWACS?

Colonel AHERN. Yes, sir.

Mr. MINSHALL. Thank you, Mr. Chairman.

Mr. RHODES. General, do the Russians have a bomber, or will they have by ——— with low-level penetration capability?

General BOYLAN. They have that now, sir.

Mr. RHODES. And that is what this system is designed to overcome?

General BOYLAN. In conjunction with over-the-horizon radar, and AWACS, we can direct our interceptors into this Russian bomber before he can launch standoff weapons.

Mr. RHODES. How many tanker aircraft do the Russians have at the present time?

General BOYLAN. It is on the order of ——— I think.

Mr. WALSH. The Russian bombers are adaptable to be used either as tankers or bombers, so the question does not have a direct answer. The answer is it depends on just what——

Mr. RHODES. What day it is.

General MCNICKLE. Yes.

Mr. WALSH. On what they are trying to do.

General BOYLAN. I think the general feeling of the community is about ——— percent of the heavies so configured could be used as tankers.

The Air Force does not necessarily share that view.

Mr. RHODES. They would have the capability then to use fighter-bomber aircraft if they had enough refueling aircraft available, would they not?

Mr. WALSH. If they were flying an all up heavy bomber threat, they could only bring a handful of fighter-bombers. The tankers would not admit to support of very many fighter-bombers. But they could bring a fair number of medium bombers which have decent range capability of their own.

(Off the record.)

Mr. DAVIS. You spoke of the bomber force being about constant in numbers and also constant in threat. What is going on in their bomber force? Are they still using primarily the props or is there a conversion from props to jets going on, or what do we know about this?

Mr. WALSH. More than half of there heavy bombers I believe are turboprop and there is no conversion that I am aware of. They are still manufacturing about ——— a month, which keeps their plant open. ———. This is one of the things that causes the Air Force to be concerned about the threat growing.

Mr. HANSEN. They are also producing medium bombers, are they not?

Mr. WALSH. I just do not know.

Mr. HANSEN. My information is that they are producing medium bombers ———.

Mr. DAVIS. And these, too, are turboprops?

Mr. HANSEN. The mediums are jet bombers.

General PITTS. Parenthetically, another immediate concern of the intelligence community has been the ever-increasing probes of our defense perimeter by long-range Soviet bomber aircraft during this past year in the Alaskan area, the Labrador-Newfoundland area, and around the Iceland area ———.

ESTIMATE OF MIX OF RUSSIAN ATTACK THREAT

Mr. MINSHALL. In case of attack, what does the Air Force estimate the nature would be, a mix of missiles and aircraft, submarines?

You never quite agree with the intelligence community. What is your estimate of it?

Mr. WALSH. It is our belief that the rational attack, and, of course, one can postulate scenarios which blunder into irrational——

Mr. MINSHALL. What is your general area, how do you wargame the whole business?

Mr. WALSH. I wargame against surprise initial attack and this surprise initial attack would be coordinated attack involving bombers, missiles, and submarines.

The submarines would launch missiles in an attempt to get our bombers before they could get off the ground, then there would be a followup wave of missiles and heavy bombers.

Mr. MINSHALL. And how much of a role would the bombers play in this attack?

Mr. WALSH. The bombers play a surprisingly significant role because the total payload carried by bombers is quite high.

As to how the bombers would be used, there are really two alternatives.

One is, they might be used to attack our withheld forces. Presumably, when we got warning of the attack we would launch a retaliatory attack, but we would also hold back some of our forces in order to see what the developments were and use them to terminate hostilities as best we could. So one role of the bombers would be to attack our withheld forces.

The other, of course, would be to attack our civilian population either just to wantonly destroy or to hold it hostage.

Mr. MINSHALL. The reason I ask the question is, there are some members of the intelligence community that feel the bomber attack is on the wane and more emphasis being put on missiles, and by ——— the Russians, even though they are manufacturing ——— every month, it is still going to be, in effect, an obsolete bird.

Mr. WALSH. All I know is that the capability of the Russian bombers to deliver destruction is extremely great. ———.

So it is a very severe threat indeed.

Mr. MINSHALL. You must feel this or you would not have asked for this money for AWACS.

I merely said there are others in the intelligence community that feel the threat is going to be more from missiles and they are going to gradually phase out their bombers, other than to make us spend a lot of money preparing for a possible defense.

Mr. WALSH. There is one other capability the bombers have that missiles do not have. That is, they can be used as a blackmail threat. If we had no defense against bombers, they could launch bombers at us, fly around our borders and embarrass us, to say the least, by our inability to do anything about it.

Mr. SIKES. I am interested in your reaction to the reasons for the increased penetration of U.S. airspace around Alaska.

Do you think the Russians are trying to tell us something, that they do have this low-altitude attack capability, or what other explanation would you place upon the fact that the number of penetrations in that area has been increasing rather significantly?

Mr. WALSH. I do not believe they are trying to tell us anything because that would be giving us information which they are very reluctant to do.

Mr. SIKES. I mean a warning.

Mr. WALSH. I do not think it is a warning. That is, I do not think it is intended as a warning. What it does indicate is that they can read our newspapers as well as we can. They see stories that we are phasing down the air defenses. They are not sure whether or not to believe these stories so they are flying essentially ferret missions to see how soon they are detected by our radars and also how quickly our interceptors can get up to chase them, or whether our interceptors get up to chase them.

In the past we used to try and intercept every probe and now we only intercept some of them. It would indicate we are really cutting down on the number of sorties being flown. They are probing by these missions, I am quite certain.

Mr. SIKES. Further question?

Mr. RHODES. May I ask one off the record?

(Off the record.)

Mr. HANSEN. Mr. Chairman, I would like to go back if I might and offer a little different point of view on the answer to your question about why ———.

Mr. SIKES. We will be glad to have it.

Mr. HANSEN. I spent quite a bit of time on this program, have looked back over what has been done with this, and so on, and it is my personal view that ———.

Mr. SIKES. Especially in the Senate.

Mr. HANSEN. In our system, within the services, between the services and the OSD, and in the Congress. These debates raise questions and they lead to further studies.

The air defense problem is a very complicated one, starting with the complication we have just been discussing as to what the threat is and how we assess both the capability and the intention of the potential enemy, and then move from that to the air defense job itself and how it ought to be done.

Our current view is that we ought to be preparing ourselves to cope with the capability that we believe exists, and not worry quite so much about the intention to use that capability. It is my view that it is important that we have a capability against bombers which would counter a low-altitude-flying bomber simply because if our potential enemies detect, as they surely would, that this is an area of weakness on our part, I think we could pretty well count on the fact that they would concentrate their attack in that area of observed weakness.

I think it important that we move into hardware with AWACS so we can see just how well these systems do work.

Mr. SIKES. I think you have given us a very good answer. In essence, I think you are saying on the one hand it is the workings of a democracy, and on the other hand it is totalitarianism in action.

Mr. HANSEN. Yes, sir. I was not attempting to editorialize about which one was the best, although I have my personal view that ours is the best.

Mr. SIKES. This was the practical effect of it.

Mr. HANSEN. I was just saying that from all I understand, they tend to go ahead and implement something in hardware and try it out, whereas we tend to try to be more sure that we are doing the right

thing before we move ahead into the expenditures that are involved in hardware, because hardware is expensive, as we all know.

Mr. SIKES. Mr. Preston?

BASIS FOR INTELLIGENCE ESTIMATES

Mr. PRESTON. General Boylan, what was the basis for the estimate you gave the committee that the United States is ——— behind the Soviet Union? It would appear from the testimony that we do not really have much hard intelligence on the ——— which have been observed. If this is the case, as it seems to be from the testimony, what was the basis of your ———?

General BOYLAN. I am not sure I made that observation, but the basis for that observation would be that we have observed ——— on the part of the Soviets, ———.

———.

As was stated subsequently, the IOC on AWACS, as we see it, is late ———.

Mr. PRESTON. ———.

General BOYLAN. Very possible.

General MCNICKLE. We have been 8 years in incubation on this program right now. ———.

General BOYLAN. (Off the record.)

REDUCTION IN BUDGET ESTIMATE FOR AWACS

Mr. SIKES. Your request for the continued development of AWACS for fiscal 1970 is $60 million. Funding in 1969 was $45 million, and in fiscal 1968, $3.8 million. The January budget request was $75 million. Will you explain the reduction?

Colonel AHERN. This was directed by OSD on the assumption that the engineering development phase would not start until March 1970. Originally we anticipated beginning engineering development in December 1969. That accounts for a 3-month period of time. And the total amount was so reduced.

Mr. SIKES. The Air Force request for fiscal 1969 was $75 million, but only $45 million was programed. What changes were made in the 1969 program, and what are the present effects of those changes?

Colonel AHERN. We originally envisioned AWACS entering contract definition in fiscal year 1968 and proceeding to engineering development in fiscal year 1969. Under that schedule, the program would have required the full $75 million in fiscal year 1969.

However, the program was not approved to proceed to contract definition until November of 1968. The program was then reduced to $45 million to accommodate the slip.

An additional $5.2 million was withdrawn once the progarm entered contract definition and we could more accurately determine final cost.

Finally, an additional half million dollars was withdrawn from the MITRE support item, and the present funding is now $39.3 million.

TOTAL AWACS PROGRAM COST

Mr. SIKES. The descriptive summary material presented in support of the fiscal year 1969 budget indicated that the total estimated development cost of AWACS was $592.8 million (p. 228). The descriptive summary material presented in support of the fiscal year 1970 request indicates that the total estimated development cost of AWACS is undetermined. Why is this cost now termed undetermined? We should expect a better cost estimate 1 year later.

Colonel AHERN. When the fiscal year 1970 descriptive summary was prepared, we did not know what the scope of the development program would be, as it was in the process of revision.

Mr. SIKES. What is your present best estimate of the total development cost of AWACS?

Colonel AHERN. The Air Force presently estimates that the AWACS program will require $688.7 million for development. The present estimate corrects for cost of living increases and the addition of a brassboard radar flight test program in the schedule.

Mr. SIKES. What is your best estimate of the total procurement cost of AWACS if the system is adequately developed?

Colonel AHERN. The Air Force estimates that the proposed procurement of ——— AWACS will cost $1,964 million. The approved ——— AWACS for air defense will cost $1,468 million. Contract definition is scheduled to be completed during fiscal year 1970 and at that time we will have a much better estimate of the procurement cost of AWACS.

PRACTICALITY OF AWACS DEFENSE

Mr. SIKES. The degree of defense which must be provided to the continental United States against a possible manned bomber attack is the subject of some controversy. The manned bomber threat is limited. The Soviet Union is not actively developing any new manned strategic bombers that we know about, and seems to be only producing enough new bombers to maintain the small inventory they have had for several years. The Soviets seem to be concentrating heavily on building up their strategic missile forces. There has been no decision in the Department of Defense as to what, if any, new manned interceptor aircraft shall be developed and deployed. The F–12 and the F–106 have both been discussed, but neither has been accepted at this time. Why should we proceed with the AWACS program until decisions have been readied as to the bomber defense to be provided for the United States?

Mr. HANSEN. Our current Conus air defenses were designed in the 1950's to counter high altitude subsonic (or slightly supersonic) bombers. Today's Soviet threat to the United States is composed of ballistic missiles and bombers. While the preponderant threat is the missile threat, the bomber threat has not diminished as predicted and the Soviets have retained the production option to maintain the bomber force (current bomber production is ——— per month).

The United States has consistently maintained the concept of a mixed force of missiles and bombers as the most effective offensive force and plans to undertake development of a new advanced manned strategic aircraft. The Soviet Union probably finds the mixed force equally attractive as they have not reduced their bomber strength at the predicted rate.

The present Soviet bomber force is capable of low level penetration with gravity bombs and launch of standoff air-to-surface missiles against the Conus. Our present air defense has minimal capability against these tactics due to limited low altitude radar coverage and limited ground radar detection range ———. In particular, by penetrating at low altitudes with gravity bombs, the Soviets are able to take advantage of the economy of bombers in delivering large tonnages of gravity bombs. In addition, the present ground environment is vulnerable to missile attack.

To correct these deficiencies and, at the same time, to reduce our total expenditures for air defenses, the decision was made by the Secretary of Defense in 1967 to reduce the present interceptor force and air defense ground environment and to modernize our air defense forces with AWACS, OTH radar and an improved interceptor. The net results would be an improved survivable air defense system with long-range coverage at both high and low altitude and with capability to engage attacking bombers prior to ASM launch points. The development concept paper supporting this decision pointed out that this could be achieved at an estimated saving of $500 million annually over the present air defense system once modernization costs are amortized. The planned air defense phasedown has been underway for over a year and has been accelerated.

To correct deficiencies in our present system, to achieve a capability to counter the present threat and any improved Soviet bomber capability, and to realize cost savings in total expenditure for air defense, we should proceed with the air defense modernization program with AWACS as its key element. While the greatest advantage would be realized by employing an improved interceptor with AWACS, the delay in the interceptor decision should not be permitted to delay proceeding with AWACS. Regardless of the interceptor employed, AWACS will provide improved survivability, command and control, low altitude coverage which will effectively deny the use of gravity bombs to the Soviet and distant bomber engagement to counter the bomber threat of the mid-1970's.

Mr. SIKES. Describe your proposed AWACS force. How many aircraft would be in the force? What is the estimated unit cost of each AWACS aircraft with all of its necessary equipment?

Mr. WALSH. The Air Force expects to buy ——— AWAC systems. The air defense forces will use ——— UE and ——— attrition aircraft. The tactical forces will receive ——— UE aircraft. In addition there will be ——— aircraft for training purposes. The unit cost of the aircraft will be slightly in excess of $30 million.

Mr. SIKES. How important is the tactical warfare role of AWACS? If the air defense role were eliminated, how high a priority would the AWACS program have?

General BOYLAN. The Air Force considers the requirement for a tactical version of the AWACS to be mission essential. World event-

in recent years, and particularly those related to Vietnam and Korea, establish the critical need for a flexible airborne control capability through which commanders can quickly respond to the highest national authority and insure prompt, selective application of tactical air power anywhere it is required. The Air Force has sought such a capability since 1963.

In addition to having a tactical air defense role, tactical Air Forces are charged with conducting sustained air operations (counter-air, interdiction, close air support, airlift, and so forth) and may be employed at any level of military action ranging from a show of force through general war. ———. The Air Force considers the AWACS program to be one of the five most important new Air Force development efforts currently under consideration.

Present methods of tactical airborne command and control provide only a fraction of the capability offered by AWACS. Among the new airborne radar contenders, AWACS radar is by far the most capable of tracking enemy tactical aircraft against a land background.

As to the second part of the question, the tactical need for AWACS is as important as the strategic defense need, given an enemy strategy that may call for either type of U.S. response. Although removal of one of the two vital uses we plan for AWACS would reduce cost effectiveness of the program; within the tactical environment, the high priority of the AWACS system would not be affected.

Mr. SIKES. What systems and procedures does the Air Force now use to accomplish the task that the AWACS would accomplish in its tactical role?

Mr. WALSH. The Air Force does not possess a system having the capabilities envisioned for the tactical version of the AWACS which will serve as the primary airborne element of the Tactical Air Control System (TACS). The TACS provides the Air Force component commander with the organization and equipment necessary to plan, direct, and control tactical air operations and coordinate joint operations with components of other United States and allied services. Until recently, the TACS has depended almost entirely on ground-based elements to insure timely and effective control of tactical airpower. Experience in Southeast Asia emphasized the essential requirement for airborne elements to augment control, surveillance, and communications functions of the TACS. The extensive geographical employment and multiple uses of tactical air power in Southeast Asia were complicated by highly sensitive political/military restraints, complex rules of engagement, and sophisticated enemy air defenses. This situation underscored the urgent need to extend the range and capabilities of the TACS. As a result, a number of systems, highly specialized and limited by the state of technology, were diverted from other important missions and extensively modified to provide partial and temporizing solutions to some of the TACS needs in Southeast Asia.

EC-121 aircraft were diverted from CONUS air defense and modified to provide a limited surveillance capability beyond the range of ground-based elements of the TACS and in support of strike and reconnaissance operations over North Vietnam. This capability depends primarily on cooperative friendly and enemy targets using IFF trans-

ponders. C–130 aircraft were diverted from tactical airlift resources and modified to provide a communications and forward control capability in interdiction areas. ———. KC–135 radio relay aircraft were diverted from the SAC tanker fleet to provide the vital communications link between in-country control facilities and flights operating over enemy territory. ———. These systems serve a useful purpose but are inadequate, even when fully combined, to satisfy all current and future needs of the tactical air forces worldwide. None of these systems have the necessary growth potential to accept AWACS-type technology such as an overland radar. Most are approaching the end of their useful life in any capacity due to airframe age. The AWACS will not only integrate all of these airborne capabilities into one modern jet platform but will provide significant new capabilities.

DEVELOPMENT STATUS OF RADAR

Mr. SIKES. What is the development status of the AWACS radar?

Colonel AHERN. Sir, the Air Force has successfully completed its overland radar technology program, and a final report was submitted in October 1968. It examined the technology for developing an airborne radar capable of operating overland, and it established the fact that this technology was adequate and suitable for an AWACS.

It was this factor which led to approval for the Air Force to enter into contract definition for the AWACS system.

The Air Force also had continuing effort developing long lead items for the radar candidates, as mentioned in an earlier question.

We will also conduct a brassboard flight test of a radar in a high-performance jet prior to committing large amounts of production dollars.

Mr. SIKES. What is the estimated development cost of the radar?

Colonel AHERN. We estimate it will cost $45 million to develop an operational radar which will be capable of being placed in a high-speed jet and test flown.

Mr. SIKES. How much has been spent on it to date?

Colonel AHERN. On the radar alone, sir?

Mr. SIKES. Yes.

Colonel AHERN. I would have to provide that for the record.

Mr. SIKES. I would like also provided for the record a breakdown of the $60 million requested for the program, showing that part assigned to development of the various components of the AWACS system.

(The information follows:)

COMPONENT COST OF AWACS

The Air Force has spent approximately $11.3 million through the AWACS program on the radar techniques which are currently candidates for the AWACS radar. This figure includes the cost of efforts which will extend through August 1969.

The Air Force proposes to use the $60 million in the budget in the following manner:

a. ——— MITRE engineering support.

b. ——— support from various Air Force support units such as AFSWC and the Arnold Engineering Development Center.

c. ——— conclude Contract Definition.

d. ——— initiate development of the brassboard radar development program in the following areas:

(1) Conduct analysis of and prepare drawings for the radar interface, electrical and hydraulic modification to aircraft, cooling equipment, and test instrumentation.
(2) Finalize rotodome electrical and aerodynamic design.
(3) Prepare for wind tunnel testing.
(4) Finalize radar design approach.
(5) Prepare radar engineering drawings.
(6) Initiate design and fabrication of full scale brassboard radar.
(7) Maintain liaison between prime and radar contractors for design and interface control.

ANNUAL OPERATING COST

Mr. SIKES. What is the estimated annual operating cost of the deployed AWACS system?

Colonel AHERN. We estimate the annual operating costs of the ADC force as $147 million. This represents O. & M., Military Personnel recurring investment cost, and depot maintenance.

Mr. SIKES. A few minutes ago a savings was referred to. What is the saving?

Mr. WALSH. Since I referred to the saving, perhaps I should address that.

The $147 million just quoted was the amount associated with the Air Defense Command operation. The saving will result from our ability to phase down almost completely our network of heavy surveillance radars as well as our SAGE direction centers, the present airborne, long range, early warning aircraft—these are the C–121 aircraft referred to earlier by General McNickle—and other similar systems, as well as the associated base operating and supporting costs for these different systems.

Mr. ANDREWS. Last year the Air Force awarded $2.5 million contracts to both Boeing and McDonnell-Douglas for design, fabrication and testing of a surveillance simulation model in support of AWACS. Why were two contracts let for the same item?

Colonel AHERN. Sir, the simulation model efforts are part of the AWACS support program. One was let for each type radar under consideration. This was designed to strengthen the contract definition and evaluation phase; in other words, to give us a more accurate look at both radars.

The support program also permits us to progress to the fly-before-buy concept by initiating long leadtime items and engineering design and development efforts. The development of the simulation model for each of the radars will result in demonstration and comparative evaluation of the overall performance of the surveillance element of AWACS, the AWACS system, at the earliest possible date.

This simulation effort will allow evaluation of the AWACS surveillance capability in the clear and under specified threat environment for each of the candidate radars.

Mr. ANDREWS. What is the status of the AWACS program?

Colonel AHERN. At present, sir, we are in contract definition. Prime contractors are to submit their proposals for development and production of the system by August 22, 1969, and the Air Force is to select the acquisition contractor in December of 1969.

Mr. ANDREWS. I am getting a little confused, so will you please again briefly describe this system?

Colonel AHERN. Sir, the AWACS system consists of a basic Boeing 707 or a DC–8 airframe modified with lookdown radar and associated

software which is capable of "flushing" or becoming airborne, for survival. It will then proceed to a point some ——— miles distant from the coastline of the United States, and there set up a surveillance patrol which will permit them to detect incoming bombers and vector interceptors against them.

Mr. ANDREWS. How many planes are involved in this program?

Colonel AHERN. ———.

Mr. ANDREWS. Is this a 24-hour operation?

Colonel AHERN. Yes, sir; it would be under periods of distress.

Mr. ANDREWS. Ordinarily, what would be the operation?

Colonel AHERN. Ordinarily, sir, we would be relying on the OTH radar for our long-range surveillance. When periods of tension occurred, we would probably man under a higher defense condition with the AWACS. Ordinarily in normal defense conditions we probably would man with AWACS on a random basis. ———.

Mr. ANDREWS. Where would they be based?

Colonel AHERN. They would be based at the first site——

Mr. ANDREWS. I am talking about the ones that are operating now.

General BOYLAN. The EC–121 operates out of Cape Cod, Otis Air Force Base. We have some 67.

Mr. ANDREWS. Is there any other base of operation?

General BOYLAN. Sacramento for the west coast.

Mr. ANDREWS. Both west coast and east coast?

General BOYLAN. Yes, sir. ———.

(Off the record.)

Mr. SIKES. What kind of contracting procedure will be followed in the AWACS program?

Colonel AHERN. Sir, the Boeing Co. and McDonnell-Douglas will propose on both development and production of the AWACS system. Included within their proposals will be separate radar proposals so the Air Force will have the prerogative of choosing both the prime contractor and the radar subcontractor.

The actual contracting details have not been finalized as yet. However, the prime contractor will be responsible for the entire system development and production.

Mr. SIKES. Is it a single package?

Colonel AHERN. Yes, sir; in essence it is.

Mr. SIKES. Further questions on AWACS?

POST ATTACK COMMAND AND CONTROL SYSTEM (PACCS)

FUNDING FOR PROGRAM

Mr. SIKES. Under postattack command and control system, will the $500,000 requested for fiscal 1970 complete the development?

Colonel STEWART. No, sir; it will not. We need an additional ——— in fiscal year 1971 to complete the equipment procurement and to provide the support for the data link program.

Mr. SIKES. The justifications show no additional requirements as of fiscal 1970. Is this something that has been developed since the justifications came to the committee?

Colonel STEWART. It must have, sir.

Mr. SIKES. Check your facts and supply the correct answer for the committee.

(The information follows:)

ADDITIONAL FUNDING REQUIREMENTS FOR POST ATTACK COMMAND AND CONTROL SYSTEM (PACOS)

The additional requirement which involves the fiscal year 1970 and 1971 funding of ——— thousand is to provide a real time ground-to-air data link to update the airborne data automation system. In addition, it will be used for Mitre/equipment which will interface between the aircraft's communication system and the airborne data automation system. In addition, it will be used for Mitre/contractor support, spares, and ground testing.

EMERGENCY ROCKET COMMUNICATION SYSTEM

COST OF SYSTEM

Mr. SIKES. Under emergency rocket communication system, where $1.5 million is requested, will this amount complete the development of that system?

Colonel STEWART. No ———.

Mr. SIKES. Do you know how much?

Colonel STEWART. I can provide that later.

Mr. SIKES. Provide it for the record.

(The information follows:)

COST OF FLIGHT TESTING OF EMERGENCY ROCKET COMMAND SYSTEM

If the modifications to the payload are extensive enough that requalification is required, then fiscal year 1972–73 funding will be required to procure test payloads ——— boosters, telemetry, instrumentation, and silo refurbishment ——— and Mitre/contractor support, data collection and analysis, and light proof testing ——— for a total of approximately ———.

SPECIAL PURPOSE COMMUNICATIONS

NEED FOR SPECIAL COMMUNICATIONS SYSTEM

Mr. SIKES. Under "Special Purpose Communications," you are requesting $5 million for fiscal 1970 as compared with $1.4 million in fiscal year 1969 and $582,000 in fiscal 1968. This program is described in your statement on page 81.

What is the anticipated total development cost for the very-low-frequency radio equipment envisioned in this program?

General PITTS. ——— million to completion, Mr. Chairman.

Mr. SIKES. If the equipment is successfully developed, what will be the total procurement cost of equipping SAC's airborne command-post aircraft and the key control centers on the ground with this equipment?

General PITTS. ——— million in fiscal 1971, and another ——— million in 1972, for a total of about ——— million.

Mr. SIKES. To what extent were you able to utilize very-low-frequency radio equipment which has been developed in the Navy or elsewhere for this effort?

Colonel STEWART. We have not been able to use the Navy equipment.

They now are different. The main reason for the joint work to be done in the future is to make the two service equipments fit together.

Mr. SIKES. I am not sure I understand. What is the reason the Navy equipment cannot be used by you?

Colonel STEWART. They use it for different purposes. They are interested in controlling the subs.

Mr. SIKES. Underwater communications, primarily?

Colonel STEWART. Yes, sir.

Mr. WALSH. The principal reason we cannot use the Navy's is that they are communicating with relatively slow-moving vehicles, whereas we are communicating with fast-moving aircraft. There is a technical problem of synchronizing the antijam system, which is different for fast- and slow-moving vehicles.

Mr. SIKES. Questions?

Mr. PRESTON. Is that difference basic to the equipment, or is that something which could be modified in the Navy equipment?

Mr. WALSH. It is basic to the equipment. There are essentially two different tacks one could have taken to how he generates antijam signals. The Navy took an approach which is quite complicated, but it works well with essentially stationary vehicles, whereas the Air Force system is adaptable also to fast-moving targets: aircraft.

Mr. MINSHALL. What frequencies are you talking about?

Mr. WALSH. ———.

Mr. SIKES. One of the difficulties with very-low-frequency communications is the very low rate at which data can be transmitted. What is the rate of transmittal for the equipment you are developing for SAC communications?

Colonel STEWART. From seven words per minutes to 67 and 100 words per minute.

Mr. SIKES. Isn't that too slow to be of practical value?

Colonel STEWART. No, sir; in that we are passing only emergency, preplanned messages. There is not a need for a large volume. Understand, this is after other means of normal communication have been destroyed.

Mr. SIKES. What is your requirement for very-long-range communications for this purpose?

Colonel STEWART. The communications are from either the transmitter sites on the east and west coasts or the SAC command post. ———.

ROLE PLAYED BY AIRCRAFT IN COMMUNICATIONS SYSTEMS

Mr. PRESTON. There is some talk of a long, trailing antenna for the aircraft. What role does the aircraft play? You are indicating these transmissions will be made from the ground. Is that entirely correct?

Colonel STEWART. You can use the two ground stations on the east and west coasts or the airborne command post. This does have a very long, trailing wire or antenna. It is one area of development we are trying to improve on.

Mr. PRESTON. Wouldn't these aircraft be relatively slow?

Colonel STEWART. Yes, sir.

Mr. WALSH. It will be close to the Minuteman site, because it will be orbiting over the United States. As a matter of fact, this particular system is not to be used in giving launch orders to Minuteman. UHF relay will be adequate for that, because there will be orbiting relay aircraft to cover the continental United States. ———.

Mr. PRESTON. Can this capability be achieved by utilizing the tactical communications satellite?

Mr. WALSH. The tactical communications satellite is an alternative way of achieving this capability. We do not have it right now. As a matter of fact, one of the future plans for the tactical satellite would be to provide this capability. That is in the future.

Mr. SIKES. Are we not about to have a redundancy of communications?

Mr. WALSH. I think, in something as important as deciding that a nuclear world war is upon us, we certainly need a redundancy in communications.

TYPES OF TACTICAL COMMUNICATIONS SYSTEMS.

Mr. PRESTON. How many ways do we have now to do this, and how many will we have if all of the proposed communications systems under development are completed and deployed?

Mr. WALSH. I would have to tell you that for the record, because I can only cite right now three possible methods. One is normal HF communications, which are subject to interruption by nuclear effects and hence are likely to go down when you need them the most. Another is this particular one at issue. Finally, in the future, would be satellite communications.

Mr. MINSHALL. How long is the trailing antenna you mentioned?

Mr. WALSH. ——— feet is the length. Very long.

Mr. SIKES. You were about to identify one other communications system.

Colonel STEWART. The emergency rocket communications system we discussed before.

Mr. SIKES. Are you not going to have a weight and control problem with ——— feet of wire trailing?

Mr. WALSH. This only trails the command-post aircraft, we hope we can use shorter antennas with the tankers and bombers.

Mr. MINSHALL. What kind of wire is it? What is it made of? How much does it weigh?

Mr. WALSH. ———. I cannot give you the weight now, but I will for the record. It is quite a problem, not only in its weight, but also the drag produced by it. It is currently in use.

(The information provided the committee is classified.)

Mr. MINSHALL. You could not have very many spares with a rig like that.

Mr. WALSH. I do not know how many spares we carry, or if we do carry a spare.

Mr. MINSHALL. If it breaks, you have had it.

RELIABILITY OF OTHER COMMUNICATIONS SYSTEMS

Mr. SIKES. Does all of this mean, after the considerable sums spent in developing other systems, they are not reliable and effective?

Mr. WALSH. No; it does not mean they are all not reliable, but they have different vulnerabilities. For example, this ———.

Moreover, high-frequency communication is something we have had for a long time. The alternative communication, the emergency rocket communications, ———.

Mr. SIKES. Is it planned to include ———?

Mr. WALSH. No; it is not planned to do that, ———.

Mr. SIKES. According to your studies, under the most probable circumstances what percentage of increase in effectiveness will the SAC airborne command posts have if you add a very-low-frequency capability?

Colonel STEWART. We cannot give an exact percentage figure, but we know that VLF will provide us a higher percentage of survivability in a nuclear environment, and it might be the difference between success and failure in getting the message through.

Mr. SIKES. Are there questions on "Special Purpose Communications"?

(No response.)

OVER-THE-HORIZON RADAR

COST AND USE OF SYSTEM

Mr. SIKES. We turn now to "Over-the-Horizon Radar." There is a request for $3 million for the development of an over-the-horizon radar for the continental United States. $1.5 million has been provided for this effort previously, and the total cost of development of the radar is estimated to be ——— million.

If a decision is made to deploy an operational CONUS over-the-horizon radar, what will be the production and installation cost of such a system?

Colonel AHERN. Sir, the Air Staff has requested approval to proceed with contract definition for ——— sites for OTH. These would each provide approximately ——— degrees of coverage. The cost for R.D.T. & E., production, installation, and interim operation and maintenance, prior to becoming fully operational, is ——— million.

Mr. SIKES. Where will they be located?

Colonel AHERN. ———.

Mr. SIKES. How will costs differ with and without a capability to detect submarine-launched ballistic missiles?

Colonel AHERN. To add the sub-launched ballistic missile capability to the aforementioned system would cost an additional ——— million.

Mr. SIKES. Would that be justifiable?

Colonel AHERN. We have not considered it in our present plans.

Mr. SIKES. Why not?

Colonel AHERN. There are other efforts underway which we think will adequately fill the need for SLBM detection capability.

Mr. SIKES. Why are both the over-the-horizon radars and the AWACS, in addition to the BMEWS and the other radars which we

now have, all necessary for the detection of enemy aircraft threatening the continental United States?

General BOYLAN. Mr. Chairman, as we discussed earlier with the AWACS development program, the OTH radar will provide a capability to extend our bomber holdback line out to a range of ——— miles.

This system, with approximately ——— fixing capability, in conjunction with AWACS and available interceptors, will provide us the ability to counter Soviet bombers and their capability to launch air-to-surface missiles. It is a hand-in-glove capability with AWACS to upgrade significantly CONUS air defense capability.

Mr. WALSH. Might I add that the principal reason for the proposal of the CONUS OTH radar is essentially to save the money during peacetime which would be required, alternatively, to fly AWACS on an early warning rather than on a command and control mission.

This is much less expensive to operate than an equivalent number of AWACS used for early warning.

COSTS OF RADAR SYSTEM

Mr. SIKES. Provide a comparison of the cost for the record, if you will.

(The information follows:)

COMPARATIVE COSTS OF RADAR SYSTEMS

It has been estimated that to accomplished a peacetime early warning mission by AWACS alone would require ———. Estimated 10-year operating and maintenance (O. & M.) costs for this AWACS coverage are $1.43 billion. (Only AWACS O. & M. costs are considered here as AWACS has been approved for a wartime command-and-control mission and is assumed available for peacetime surveillance.)

As a comparison a ——— OTH system could be acquired and operated for a 10-year period for some $300 million. It would not, however, provide the reliability of coverage of the AWACS ———. A combination AWACS/OTH system, which would provide the same reliability as AWACS alone, would cost some $580 million over a 10-year period. Thus, a system which provides basic OTH peacetime coverage with augmentation by AWACS as required was recommended.

Mr. SIKES. Questions on over-the-horizon radar?

USE OF OTHER RADAR SYSTEMS

Mr. ANDREWS. Will this be in addition to or a supplement of the so-called early warning line we have up in Alaska?

Mr. WALSH. The coverage area of this will be different than the early warning line. ———.

Mr. ANDREWS. That is what I asked you. What about BMEWS?

Mr. WALSH. BMEWS is not designated to provide warning of aircraft attack but, rather, to provide warning of missile attack, ———.

Mr. ANDREWS. You had your early warning line across the northern part of the North American Continent.

Mr. WALSH. That is right.

Mr. ANDREWS. Then you want to have AWACS on each side.

Mr. WALSH. ———.

Mr. ANDREWS. You have been working on the early warning line for years.

Mr. WALSH. Yes.

Mr. ANDREWS How long has it been in operation? Four or 5 years?

Mr. WALSH. Longer than that.

Mr. SIKES. Originally, there were three of the early warning lines. There was the Pine Tree Line, the Mid-Canada Line, and then the DEW Line. What is the status of each of those now? The Pine Tree Line has been discontinued; has it?

Mr. WALSH. The Pine Tree Line has been, I believe, amalgamated into the general network of radars across Canada, and does not exist as a distinct line any more.

STATUS OF EARLY WARNING SYSTEM AND RELATED ACTIVITIES

Mr. SIKES. Why don't you, for the record, bring us up to date on each of the three, and tell us what position, if any, it occupies in the present warning system.

Mr. ANDREWS. The system you are talking about today is in addition to the lines you have in use now?

Mr. WALSH. It is in addition to or replacement of. Once we have this and AWACS, it will eliminate the Distant Early Warning Line.

Mr. SIKES. Bring us fully up to date, for continuity in the record, including the purpose of White Alice and all the other activities.

(The information follows:)

UPDATE OF EARLY WARNING LINE SYSTEMS AND RELATED ACTIVITIES

The Pine Tree Line was established by agreement with the Canadian Government on August 1, 1951. This line consisted of a series of radars established across Canada to provide manual surveillance and weapons control against an enemy bomber force approaching from the north. In 1963 these radars were tied to the Semiautomatic ground environment (Sage) system and the line ceased to exist as an entity. The radar sites became part of the contiguous Canada-United States radar surveillance and weapons control system and provide surveillance and weapons control in the Canadian area. Support of these radars involves a cost-sharing agreement with the Canadian Government.

The Mid Canada line, a radar fence that stretched generally across the 55th parallel, became operational on January 1, 1958. Its function was to confirm DEW Line penetrations and to permit better positioning of the defending interceptor force against a penetrating bomber formation. The Mid Canada line was phased out on March 31, 1965 as the contiguous radar system overlapped its capabilities.

The Distant Early Warning (DEW)' Line, initiated on August 1, 1951, consists of 33 surveillance radars extending from the Aleutians to Greenland to provide detection and distant early warning against the manned bomber threat. The communications between sites form an essential communications link across the Artic area. Six of the DEW Line radar sites are being phased out and a long range surveillance radar and height finder will be installed at Cold Bay.

The White Alice system serves DOD and other Government agencies in Alaska. It is linked to Canadian and CONUS long-distance telephone facilities. It provides communications circuits for the DEW Line system, the BMEWS system, the various A.C. & W. sites, other military operations, civilian government agencies, and the civilian population of Alaska.

Tactical Air Control System

COST AND STATUS OF SYSTEM

Mr. Sikes. Under "Tactical air control system," there is a request for $3.7 million for further development. It is indicated that the total estimated cost of this development effort is ——— million, and that after the fiscal year 1970 funding, ——— million will be required to complete the program.

Does this mean that as of now you have completed about 50 percent of the development effort?

Colonel Stewart. The TACS program is conceived as a continuing updating of the tactical air control system. We aim to get most of the new equipment off the shelf. We do have to go into new R. & D. on some equipment, however.

I think it would be fair to say that the development phase is about half over, as closely as we can look into the future.

Mr. Sikes. Since so much of the development effort on this program is not completed; why are you requesting a sum as large as $71.9 million in the "Other procurement" appropriation for procurement of this equipment? In other words, aren't you getting ahead of the picture by buying equipment at that level at this time? Could you not wait until the development of the system is more nearly completed?

Colonel Stewart. This would be true of any of the R. & D. portions. As I indicated, a very large percentage of the program, of the new equipment going in, is off the shelf and, as such, would be procured with procurement funds.

Development of New Air-Conditioning Units

Mr. Sikes. One of the objectives of the fiscal year 1970 program is indicated to be developing a multihigh frequency air-conditioning unit. Describe this unit and tell us how it functions, and tell us why there is a requirement for it.

Colonel Stewart. All the equipment to date in the TACS portable unit has been fixed to operate either 60 cycles at a permanent base or 400 cycles on a deployed status, all, that is, except the air conditioning. This is a very important part of the system, and at present we have to carry along two separate conditioners to cover both the frequency requirements. We would like to get it all in one package.

Mr. Sikes. To be sure the record is complete; what are you going to air condition?

Colonel Stewart. Most of the shelters require air conditioning for the equipment especially, and for the people in them. The temperatures get very high.

Mr. Sikes. Questions on tactical air control system?

(No response.)

Defense Communications Planning Group

Mr. Sikes. Under defense communications planning group, I would like for the record a listing of the items which you plan to develop under the heading of "Defense communications planning group" for which you are requesting $19 million, and indicate what the total estimated cost and time schedule is for each of the items listed.

(The information follows:)

U.S. Air Force Fiscal Year 1970 R.D.T. & E.

The following list of efforts were obtained from the defense communications planning group (DCPG) for the expenditure of $19 million in fiscal year 1970 Air Force R.D.T. & E. funds controlled by the DCPG.

[In millions of dollars]

	Costs		
	Fiscal year 1970	Fiscal year 1971	Total
Sensors..... Design changes and modification to aerial emplaced intrusion detection devices.	0.7	——	——
Navigation delivery..... Development of Radar, Radio and Visual devices for more accurate emplacement and location of sensors.	1.0	——	——
Data collection..... Design of automatic airborne relay equipment of sensor information and appropriate engineering changes to airborne relay vehicles.	1.5	——	——
Data processing..... Development and changes to the ground based terminal equipment which receive sensor information from the airborne relay vehicle. Development of an airborne assessment capability.	8.0	——	——
Testing at Eglin AFB..... Testing of sensors, data collection and data processing handling in a controlled environment to insure proper functioning of all equipments and for correction of service revealed deficiencies.	6.5	——	——
Follow-on developments..... Development of new equipments —— items include work in the electronic countermeasures area, delivery of sensors at higher airspeeds and improved delivery accuracy.	1.3	——	——
Total.....	19.0	——	——

Note: All efforts, with the exception of follow-on developments, are currently underway and will continue through fiscal year 1971. The follow-on development efforts will begin in fiscal year 1970 and continue through fiscal year 1971. R.D.T. & E. funds are not budgeted beyond fiscal year 1971.

Cryptologic Activities

Mr. Sikes. Under cryptologic activities, you are asking for a large increase. The fiscal 1970 request is for $6.8 million, as compared to $2.7 million in fiscal year 1969 and a total of $4 million in fiscal year 1968 and prior years.

For the record, tell us why this increase is necessary.

(The information follows:)

Increase for Cryptologic Activities

The cryptologic activities program element includes research and development for communication security (COMSEC) and electronic and communications intelligence (SIGINT) equipments. In fiscal year 1969, the program element was funded at $2.7 million and the research and development efforts were all in the exploratory development category. The increase in fiscal year 1970 funding re-

quirements primarily supports the evolution of these projects into the advanced and engineering categories of development. These projects include collection, recording, and processing equipment development for SIGINT.

TECHNICAL SENSOR COLLECTION

Mr. SIKES. Under technical sensor collection, you are requesting $7.4 million in fiscal year 1970. A part of this program is designated "Sentinel foam." What is that?

Colonel STEWART. Sentinel foam, sir, is to put a ———. The program has been proposed for several years, the last 2 years anyway, I think, and has not been given the go ahead.

The idea is to be able to ———.

Mr. SIKES. This, I believe, is to ———; is that correct?

Colonel STEWART. Yes, sir.

Mr. SIKES. What can we learn?

Colonel STEWART. ———.

Mr. SIKES. Why do you need this, in view of the other collection devices which we have or which we are developing?

Mr. WALSH. ———.

Mr. SIKES. Is this information not available in any other manner?

Mr. WALSH. There is an alternative collection program which involves ———.

Mr. PRESTON. If what you imply is in fact the case, ———.

Mr. WALSH. ———. There are other ways of acquiring information ———. This is quite valuable, and we have programs to do that. However, you cannot determine, necessarily, ———.

Mr. SIKES. Do you anticipate that this information can be collected and forwarded in time to be of any value?

Mr. WALSH. It will be valuable, among other things, for the design of ———.

Mr. PRESTON. Recently, the Secretary of Defense testified to the committee that ———. What was that capability, and how does that compare with Sentinel Foam capability?

Mr. WALSH. ———.

Mr. SIKES. Off the record.

(Discussion off the record.)

Mr. SIKES. What is the total estimated cost of the Sentinel Foam ——— and its equipment?

Colonel STEWART. The total cost, as a budgetary estimate only, is ——— million. This includes the facilities, the equipment, and the testing through category 2, assuming the program is approved.

Mr. SIKES. What does it cost this Nation, directly or indirectly ———.

Colonel STEWART. I think you are talking about the Sentinel shoe facility ———.

Mr. SIKES. To whom do we make payments, and in what amount, directly or indirectly? This country gets nothing free.

Colonel STEWART. That is right. The direct costs for provisioning, spare parts, and so forth, to the ——— operation are $200,000 annually.

Mr. SIKES. $200,000 or $800,000?

General PITTS. $200,000.
Mr. SIKES. Questions on technical sensor collection?
(No response.)

CLEAR SKY

COST AND NATURE OF PROJECT

Mr. SIKES. Under clear sky, why should we continue spending between $9 and $10 million a year on the ——— system known as "Clear sky"?
General MCNICKLE. This is a mission which has been assigned to ———.
Mr. ANDREWS. Could we have General McNickle explain this Project Clear Sky?
Mr. SIKES. Yes.
What is accomplished through its utilization?
General MCNICKLE. ———.
The clear sky R.D.T. & E. program, unlike the rest of the Air Force R.D.T. & E. program, is conducted solely ——— for the purpose of developing and improving equipment and techniques directly related to the system.
Mr. SIKES. Is this really R. & D.?
General MCNICKLE. The R. & D. is to keep updating the system to make it more responsive.
Mr. SIKES. What is the total cost?
General MCNICKLE. $9.6 million of R. & D. in fiscal year 1970. We do not have it broken down.
General PITTS. To date, we have spent about $33 million in R. & D.
Mr. ANDREWS. How are you spending it?
General PITTS. I would have to refer to the R. & D. community on that, sir.

USE OF FUNDS PROVIDED

Mr. ANDREWS. How do you spend that $9 million or $10 million a year?
General MCNICKLE. Parts of the funds are used to identify systems that need updating ———.
Mr. SIKES. Either I misunderstood you, or the total cost of updating the R. & D. effort is the same as the total cost of operating; is that correct?
General MCNICKLE. No; these are R. & D. costs.
Mr. MINSHALL. You are updating at $9 million a year. What are you doing when you update, aside from the general terms you use? That is a lot of updating. What do you actually do?
General MCNICKLE. We do not know many of the details because the work is carried out directly by ———.
Mr. MINSHALL. Who does know?
Colonel HOERMANN. I can give you some information on this, sir. ———. It is this type of work.
Mr. MINSHALL. What did you do last year in the way of updating, and how much did you spend on it?
Colonel HOERMANN. $8.9 million.
Mr. MINSHALL. How did you spend that money, and who got it?
Colonel HOERMANN. Some of these projects run over 1 year. ———.

Mr. MINSHALL. Is this in-house, or is it contracted out?

Colonel HOERMANN. It is contracted, sir. However, the Air Force Special Weapons Center, Aeronautical Systems Division, and the Air Force Flight Dynamics Lab participated in certain tasks during fiscal year 1969 and are expected to continue participation in fiscal year 1970.

Mr. MINSHALL. Who had the contract for $8.9 million last year?

Colonel HOERMANN. It is done with numerous people.

Mr. MINSHALL. Who are the major ones?

Colonel HOERMANN. They have worked with the Atomic Energy Commission's Laboratories, the National Bureau of Standards, Environmental Sciences Service Administration, the Naval Radiological Defense Laboratory, Texas Instruments, Denver Research Institute, Teledyne Industries, Tracerlab, Air Reduction Co., and Edgerton, Germenshausen & Grier. Those are the main ones.

Mr. ANDREWS. You spend your money through those companies?

Colonel HOERMANN. Yes, sir. Specific jobs are detailed out by contract.

General MCNICKLE. I would like to point out that the normal Air Force R. & D. organizations—the Air Force Systems Command and Office of Aerospace Research—have had little to do with this program.

Mr. MINSHALL. You just spend the money for it.

Colonel HOERMANN. There is money in our budget—and also ARPA's, not just the Air Force—for this activity.

PERSONNEL ENGAGED IN PROGRAM

Mr. ANDREWS. Are any Air Force people engaged in the operation of this project?

Colonel HOERMANN. Yes, sir.

Mr. ANDREWS. How many? Put it in the record.

(The information follows:)

AF PERSONNEL ENGAGED IN CLEAR SKY

Air Force people engaged in the Clear Sky program are presented in units of man-years for fiscal year 1970:

Military:	
Officers	433
Enlisted	2,253
Subtotal	2,686
Civilian	173
Total	2,859

USE OF INFORMATION PROVIDED

Mr. ANDREWS. They are paid from personnel funds. So, the cost of operating the project would be more than the $8 million or $9 million a year.

General PITTS. Operating costs would be primarily in the O. & M. and military personnel appropriations, that is correct.

Mr. ANDREWS. Adding to the cost of the program.

General PITTS. Yes, sir.

Mr. ANDREWS. How did the Air Force happen to be designated as the operating agency? Why?

General MCNICKLE. Some years ago, the Air Force was involved in projects in this area, and I think it is a carryover from those days.

General BOYLAN. ———.

Mr. RHODES. ———.

General BOYLAN. ———. Those are tasks performed by the Services.

Mr. RHODES. When you collect the data which you get from this system, who evaluates it?

General BOYLAN. I will have to provide that for the record, if I may.

Mr. RHODES. I wish you would clarify that for the record, and have the record indicate whether or not ——— is in on either the collection or evaluation feature of this project, and to what extent.

(The information provided the committee is classified.)

TOTAL PROGRAM COST

Mr. RHODES. The fiscal year 1969 budget estimated $10.1 million for this activity. How was the $1.2 million reduction made possible?

Colonel HOERMANN. We started some of the programs later in the year. This was used to offset part of the reduction because of the economy act last year. They just started later in the year.

As I said, some of these go over a 3-year period.

Mr. RHODES. How much money has been spent on this program from R.D.T. & E. funds to date?

General MCNICKLE. $32.85 million.

Mr. RHODES. Why should this be a continuing program?

General MCNICKLE. ———.

Mr. ANDREWS. Are you paying the operational costs of this program with R.D.T. & E. funds?

General MCNICKLE. No, sir. This part is an R.D.T. & E. program.

Mr. ANDREWS. If it is a continuing program and will be, why should R.D.T. & E. be interested in the program? You know what you want. You are not researching anything. It appears to me it would be more appropriate under the heading of "Intelligence."

General MCNICKLE. We are continually trying to improve ——— technology. However, the O. & M. and military personnel operating costs are not paid out of R.D.T. & E. funds.

Mr. ANDREWS. Then the program is costing far more than the $9 million or $10 million.

General MCNICKLE. Yes, sir, and we will put in the record the total annual cost.

Mr. ANDREWS. Do that.

(The information follows:)

FISCAL YEAR 1970 TOTAL COST OF CLEAR SKY BY APPROPRIATION

The entire proposed Clear Sky program is:

R.D.T. & E.	$9,600,000
Investment	7,842,000
Operation	38,273,000
Total	55,715,000

Mr. ANDREWS. We will adjourn until 2 o'clock, gentlemen.

AFTERNOON SESSION

PROMOTION OF GENERAL BOYLAN

Mr. SIKES. The committee will come to order.

I take particular pleasure in stating that I have just been informed that General Boylan has been nominated for promotion to lieutenant general.

Congratulations, General Boylan. A very fine deserved recognition.

MAPPING, CHARTING, AND GEODESY

Mr. SIKES. Has all of the activity under this program been terminated or is it included under another title?

General MCNICKLE. This is a move and the advance development is now carried in Program Element 63726–F. It is actually in support of the Aeronautical Chart and Information Center which is the title of that element.

Mr. SIKES. The program is continuing under another listing?

General MCNICKLE. Yes, sir.

NATIONAL MILITARY COMMAND SYSTEMWIDE REPORT

Mr. SIKES. National Military Command Systemwide Report.

There is a request for a million dollars for the initiation of a new development program. What is it?

General MCNICKLE. This is to give the NMC a greater capability. The million is intended to modify either an existing or prototype data management system with Government's right to meet third-generation computer based system requirements.

Mr. SIKES. How long do you think this program will continue and what will its total cost be?

Colonel Stewart. The prototype will be 1 year.

Actually, the effort is part of the worldwide military command post changeover to the third-generation computer and the follow-on work will be determined largely on the success of this.

TRAFFIC CONTROL, APPROACH AND LANDING SYSTEM (TRACALS)

PROBLEM WITH PRESENT SYSTEM

Mr. SIKES. Under "Traffic control, approach and landing system" there is a request for $1.5 million for further development. It is indicated that as part of the fiscal year 1970 program you plan to initiate development of a new generation of TACAN nagivation system equipment. What is the requirement for a new generation of this equipment?

Major SANDERS. We have discovered many deficiencies in TACAN equipment, both ground and airborne. We have taken stopgap corrective action. However, the equipments continue to be plagued by maintenance and reliability problems.

Our currently installed TACAN was designed approximately 20 years ago with the majority of in-use TACAN produced about 15 years ago. We intend to initiate an engineering development program to provide a modular type latest state of the art lightweight TACAN, both ground and airborne, starting in fiscal year 1970.

Mr. SIKES. What is the probably total development cost of the new equipment?

Major SANDERS. We expect to see a new generation of tacan avionics costing around $3.1 million, a new generation of tacan ground stations, about $2.2 million.

Mr. SIKES. For the record, tell us what deficiencies in the present TACAN system you seek to overcome.

(The information follows:)

OVERCOMING DIFFICULTIES IN TACAN SYSTEM

Present equipment is very complicated and difficult to maintain, has excessive failure rates, provides inadequate reliability, periodically exhibits a 40-degree error in heading, unlocks in the terminal area, is plagued by excessive maintenance problems, and will require eventual replacement due to wear.

The proposed development program will provide equipment specifically designed to overcome these deficiencies. There is a competitive demonstrated technology base for the cost-effective designed proposed by this project. Predominantly solid state designs are planned, utilizing components, and technology firmly in hand. Value engineering will be applied to prevent oversophistication leading to high costs without corresponding increases in performance and reliability.

USE OF FAA EQUIPMENT

Mr. SIKES. What will be the total procurement cost of replacing TACAN equipment throughout the Air Force with the new generation of such equipment?

Major SANDERS. A complete replacement of all our fixed TACAN ground facilities is estimated to cost ——— million. The replacement of TACAN avionics and 5,000 aircraft is estimated to cost ——— million.

Mr. SIKES. Does the Air Force utilize FAA-developed traffic control equipment?

Major SANDERS. Yes, sir; we utilize it to the greatest extent possible consistent with our requirements for mobility configurations of equipment.

Following are some of the examples of FAA-developed equipment in use: New control towers employed in Southeast Asia. Radar approach and control tower consoles, radar display units, and MPN-47 radars.

Mr. SIKES. Tell us in what areas the Air Force cannot utilize FAA-developed traffic control equipment.

Major SANDERS. Primarily in the area of deployable equipment, such as we use in Southeast Asia. For example, let's take our ground control approach radar.

Here in the United States the FAA uses very large, very complicated equipment that takes a lot of room. We of necessity cannot take that into combat zones, only lightweight, highly mobile equipment. In general, the reason we develop our own equipment is we cannot use something developed by the FAA.

Mr. MINSHALL. In other words, your primary reason for going down the road by yourself is for combat tactical equipment that is mobile in nature?

Major SANDERS. That is correct, sir.

Mr. MINSHALL. And how much of that type of equipment do you have now, if any?

Major SANDERS. We have quite a bit. I do not know exactly how many.

For example, we have mobile GCA's we use, we have six mobile communications groups which are equipped with this type of equipment.

Mr. MINSHALL. What do you have in Vietnam?

Major SANDERS. GCA's MPN such as the 14–16–18 radars, mobile control towers, mobile TACAN's, and so forth.

ADDITIONAL CAPABILITIES TO BE DEVELOPED

Mr. MINSHALL. What capability will the new equipment from your R. & D. give you?

You said it had shortcomings, both airborne and ground equipment. What capabilities will it give you that you do not have now?

Major SANDERS. You are talking primarily about TACAN?

Mr. MINSHALL. Yes.

Major SANDERS. That is not an FAA equipment, TACAN is military navigation equipment.

Mr. MINSHALL. Who maintains all of these sites throughout the country?

Major SANDERS. Some by the FAA, others by the Air Force, others by the Navy.

Mr. MINSHALL. Which ones do the Air Force maintain?

Major SANDERS. I think we have approximately 178 stations, if I remember correctly.

Mr. MINSHALL. At your own bases?

Major SANDERS. Yes, sir. We maintain those facilities installed on the Air Force bases.

Let me emphasize again that TACAN is a military navigation system not used by the civil airlines in general.

Mr. MINSHALL. Why could you not go to a civil aeronautics system?

Major SANDERS. The comparable unit in the civil aviation is VORTAC which uses the distance measuring equipment we use in TACAN. The azimuth measuring equipment is quite different. TACAN is in theory about five to six times as accurate as VORTAC.

Mr. MINSHALL. How accurate is it? Is not the civilian VORTAC accurate within a couple of degrees?

Major SANDERS. I am speaking theoretically, sir.

Mr. MINSHALL. How accurate do you have to be? That is my point. Why do you need the accuracy that the commercial people do not need?

Major SANDERS. We have high-speed aircraft for one thing.

Mr. MINSHALL. So do they.

Major SANDERS. Very high altitudes also. You have to realize our primary navigation aid on most of our fighter aircraft is TACAN alone. When you get into Boeing 707 and this type aircraft, you may have systems which are very accurate, all-weather radar, and so forth, whereas in our fighters and single place aircraft TACAN is normally the only en route navigation aid we have.

General MCNICKLE. Another requirement, beside mobility, is to be able to deploy and set up, oftentimes in pretty fast circumstances. You cannot depend on being able to put it in a building.

Mr. SIKES. Tell us for the record what was accomplished, will be attained with the $28 million program in fiscal 1969.

(The information follows:)

TACAN PROGRAM

The $28 million in fiscal year 1969 was provided for the design, fabrication, and testing of two TPN-19 radar approach control (GCA) facilities. The TPN-19 consists of three components: a precision approach radar; an airport surveillance radar; and an operations shelter. The TPN-19 is a planned development that will allow the USAF to control and land aircraft during inclement weather conditions. It is projected that production units of this facility will be a replacement item for 10-year-old equipment now in the USAF inventory that is less reliable, requires an abnormal amount of maintenance, and has a lower traffic handling capability.

Mr. SIKES. Further questions on traffic control approach and landing systems?

NEW TYPES OF TACAN'S DEVELOPED

Mr. MINSHALL. Before we leave the "Traffic control equipment, TACAN" or whatever it might be, how much liaison do you have with the Navy and FAA and the other people on work that they might be proceeding upon?

Major SANDERS. Quite a bit, sir.

We have a TRACALS system program office at Wright-Patterson. They have a man from FAA who is liaison part time with that office.

Second, we put all of our requirements in the TRACALS area through the FAA to see if they have equipment in being, under development or under consideration that will meet our requirements.

We have liaison with the Navy, of course, in this area. We are members of a TACAN steering committee, I believe is the formal name, which has representatives from the Army, Navy, FAA, Canada, Britain, and so forth. This committee meets approximately once every 2 months. At these meetings we discuss what each service has underway, what the other people are doing, and how we can take advantage of it, this type thing.

Mr. MINSHALL. You said you wanted portability. What were you talking about when you were talking about trying to develop a portable control system?

Major SANDERS. We have to differentiate between TRACALS and TACAN.

TACAN is one part of TRACALS, which latter is the whole control and landing system. We are looking for portability in the ground TACAN area, we are looking for portability in ground control approach radars, in control towers, and this type thing.

For example, our present-day ground TACAN weighs 13,000 pounds. We have now under procurement a TACAN for Southeast Asia, which will weigh about 1,100 pounds which will give us basically the same capability.

Mr. MINSHALL. This is already in procurement?

Major SANDERS. Yes, sir. That is the tactical TACAN. This unit is not pushing the state of the art either, it is simply updating our current TACAN to what the technology is capable of today.

Mr. MINSHALL. But you want even lighter than 1,100 pounds; is that it?

Major SANDERS. We have a requirement for ground TACAN of various types. We would like to have a man-sized TACAN, ideally have a TACAN that weighs less than a hundred pounds so a combat control team can take it into our air bases or forward deployment areas in support of, for example, the Army Special Forces camps and this type thing.

Our second requirement would be for a heavier TACAN with better accuracy, longer range, and this is the tactical TACAN which we now have under procurement for Southeast Asia.

Our next order of requirement is for an en route TACAN or fixed facility for the continental United States and Europe. There is no reason whatsoever we cannot use some of the components that we are developing or buying in this present current action for Southeast Asia to meet these other requirements, and we certainly intend doing it. In fact, with the money in fiscal year 1970 program we intend to take that equipment plus other components we have developed, put them all together and see what we can come up with as far as something to meet the requirement for the least amount of money.

Mr. MINSHALL. Thank you.

MOTORIZED EQUIPMENT

REQUIREMENTS FOR ROUGH TERRAIN TRAILER

Mr. SIKES. Do you still have requirements for the rough terrain trailer on which it was planned to initiate development in fiscal 1970?

General MCNICKLE. Yes, sir.

Mr. SIKES. What is the requirement?

General MCNICKLE. The need for this is to correct the deficiencies in present pallet trailers for rough terrain performance and to reduce repair and maintenance.

Mr. SIKES. What is the estimated total of development costs? Provide it for the record.

(The information follows:)

DEVELOPMENT COSTS—ROUGH TERRAIN TRAILER

The estimated total development cost of the rough terrain trailer is estimated to be $.120 million.

AIRCARGO MATERIALS HANDLING

Turning to "Aircargo materials handling," you are requesting $3 million, which is an increase of a million above the $2 million programed for fiscal 1969. The budget request for fiscal 1969 was $2.5 million. What items were deferred, and were these included in fiscal 1970 request?

Provide that for the record.

(The information follows:)

AIRCARGO MATERIALS HANDLING

A study on advanced aircargo materials handling was deferred. This study was intended to examine aircargo logistics anticipated in the 1970's and provide a basis for determining future equipment/techniques. This item was not included in the fiscal year 1970 request.

FISCAL YEAR 1970 PROJECTS

Mr. SIKES. I would like to have for the record a complete listing of the items included in the current $3 million program. I would like to know how much you are planning to spend on each in fiscal 1970.

(The information follows:)

The original fiscal year 1970 program consisted of:

C–5 cargo loading dock	$1.250
Lightweight 40" x 48" cargo pallet	.050
Improved pallet core	.050
Cargo containers	.300
Restraint devices for pallets and containers	.100
Cargo weighting equipment	.100
Aircargo handling analysis	.200
Forklift tine development	.030
Rough terrain pallet trailer	.120
25K tactical loader	.250
Air cushion conveyor	.300
Fiberboard container	.050
Advanced forklift design	.200
Total	3.000

ADVANCED FORKLIFT DEVELOPMENT

Mr. SIKES. What do you estimate to be the total development cost of the advanced forklift which you plan to initiate development on in fiscal 1970?

General MCNICKLE. At the present time, the advanced forklift is not included; the only remaining item in here that will be financed is the C–5 cargo-loading system.

Mr. SIKES. For the record, tell us what is your requirement for the advanced forklift and why you are unable to use a commercially developed forklift.

(The information follows:)

ADVANCED FORKLIFT

This item is needed to correct deficiencies in the present forklifts which are adaptations of commercial designs. Commercially developed forklifts have proven to be too heavy and large for practical air transportability. They require excessive maintenance, provide poor rough terrain performance, and, in some areas, are too high for use with Air Force aircraft because of the cargo door locations. The total development cost is estimated to be $.200 million.

Mr. SIKES. Are there questions?

Mr. PRESTON. Did your response indicate, General, that the advanced forklift part of this item has been dropped out?

General MCNICKLE. Yes, sir.

NEED FOR TACTICAL LOADER

Mr. SIKES. What is the Air Force requirement for its 25,000-pound tactical loader?

General BOYLAN. Mr. Chairman, the 25,000-pound tactical loader is different from the 40,000-pound loader and the 55,000-pound loader discussed here previously. It would be placed in use at semiprepared or forward airstrips specifically oriented to tactical airlift needs. Pri-

cipally, the current C–130, and C–5's, if they transit to that situation, and the light intertheater transport under development which has been discussed before the committee.

Mr. SIKES. What capability do we have now in loaders of this general type? Also, what will it replace?

General BOYLAN. The Air Force does have a rough terrain loader which was designed to not only offload but to also move the pallet from position A to B. It would supplement these current capabilities.

Mr. SIKES. It would be something that is better, or does it handle a bigger load?

General BOYLAN. Over the years we have been plagued with both maintenance and deficiency of our off-leading techniques in the forward areas. The 25,000-pound loader is designed to meet this continuing deficiency. It is in direct support of the tactical airlift capability.

Mr. SIKES. What is your estimate of the cost?

Provide it for the record.

(The information follows:)

COST OF 25K LOADER

The total development cost of the 25K tactical loader is estimated to be $250,0000.

DEVELOPMENT OF CONTINGENCY AIR CARGO TERMINAL

Mr. SIKES. Describe the contingency air cargo terminal which you plan to initiate development of in fiscal year 1970.

General BOYLAN. The contingency air cargo terminal is of the same family of capability as described in the 25,000-pound loader. It is forward area operation where no surface or vertical capability exists.

Mr. SIKES. What do you use now under similar circumstances?

General BOYLAN. We have had to in austere conditions off load from the installed rail roller system of the aircraft, either onto pallet trailers or in many cases directly onto the ground, and then manhandle through either forklift or manpower the materials to a collection and disbursing area.

In other locations such as Cam Ranh Bay and other more sophisticated combat zone terminals, we have put in permanent terminal capabilities.

Mr. SIKES. How many of these do you anticipate a need for?

General BOYLAN. I am not sure that requirement has been determined at this point, Mr. Chairman.

Mr. SIKES. Provide what information you can and tell us for the record the total development cost.

(The information follows:)

NEED FOR CONTINGENCY TERMINAL

The contingency air cargo terminal is an austere temporary facility for receiving and forwarding air cargo, personnel, and unit equipment. It is deployed as required to support contingency operations on a quick reaction basis. It consists of air transportable organizational cargo handling equipment operated by aerial port personnel on temporary duty. The size of the terminal will vary with each operation according to the volume and nature of the planned cargo flow. At present there are 14 aerial port units in TAC, MAC, and USAFE which can be used to deploy personnel and equipment to set up contingency air terminals of

various sizes. The contingency terminal concept has evolved by experience primarily through application/adaptation of existing equipment and techniques. For this reason, no direct development cost is applicable.

AUTOMATED AIR CARGO TERMINAL EQUIPMENT

Mr. SIKES. Would this not be a military construction item rather than an R. & D. development?

General BOYLAN. No, Mr. Chairman, this would be the transportable mobile equipment.

Mr. SIKES. So are mobile homes transportable.

General BOYLAN. But not the footings.

Mr. SIKES. You were talking previously about the contingency air cargo terminal. What is the advanced permanent air cargo terminal?

General BOYLAN. In our current air cargo terminals, and these principally are characterized by locations such as Travis AFB, McGuire AFB, et cetera, we have currently what is called the 463–L system. This is a mechanized automated system of roller conveyors, sorters, weighing station, pallet buildup locations, and so forth.

With the advent of larger aircraft and with the high demand for cargo movements, much of our cargo that has been shipped through these terminals over the last 2 or 3 years has had to bypass the system because of its first generation design, its natural bottlenecks, its inefficiencies. And so the work on the permanent terminal improvements is to seek greater throughput, more automation, for example devices which will read a transportation control and movement document, transcribe the pertinent data to manifest form, automatic pallet buildup, and so forth.

Mr. SIKES. Why could this not be a military construction item?

General BOYLAN. I do not think this type of improvement to these terminals would meet the definition of real property or construction. It is the development of equipment to be installed in a facility.

Mr. SIKES. For the record, if you continue development and procurement of all of the new items listed in the area of air cargo terminals handling, what we be the probable cost to the taxpayers for development and procurement of these new items?

(The information follows:)

COST/AIR CARGO MATERIALS HANDLING

None of the items have been carried to the point where the unit cost and total cost can be determined accurately. The estimated total development and procurement cost for all of the items is $15 million.

Mr. SIKES. Are there questions on air cargo materials handling?

MUNITIONS

DEVELOPMENT OF CONVENTIONAL MUNITIONS

You are requesting $7.9 million for conventional munitions as compared with $6 million in fiscal year 1969 and $5.2 million in 1968. How much of this increase is due to the industrial funding procedure which has been adopted for the Arnold Engineering Development Center?

(The information follows:)

CONVENTIONAL MUNITIONS

The total increase is due to the revised funding procedures at the Arnold Engineering Development Center.

CIVILIANS EMPLOYED AT ARMAMENT LABORATORY

Mr. SIKES. How many civilian personnel are employed at the Air Force Armament Laboratory? How much of the $6.6 million programed for the operation of the Laboratory is for civilian salaries? How many military personnel are assigned to this laboratory?

(The information follows:)

AIR FORCE ARMAMENT LAB

There are 307 civilian spaces authorized for which $3,773,000 is for salaries and benefits. There are 228 military personnel (146 officers and 82 airmen) authorized.

ACCOMPLISHMENTS OF ARMAMENT LABORATORY

Mr. SIKES. What have been some of the accomplishments of the Air Force Armament Laboratory in the past year?

(The information follows:)

ACCOMPLISHMENTS/AF ARMAMENT LABORATORY

Representative achievements stemming from the exploratory development program are: Random bomblet dispersion system: This is a munition concept which answers the requirement for the dispersion of antipersonnel bomblets over large pattern areas from low release altitudes. Autosterilization concept for munitions: A concept for autosterilization for munitions was demonstrated in the laboratory. Tungsten plating of gun barrels: Feasibility of this approach has been demonstrated. It promises to give longer gun barrel life.

Under the advanced development program, sufficient progress was made to release to engineering developing SWATM (shallow water antitraffic mine) and LVM (light vehicle land mine). The HSM (hard structure munition) warhead designed to burst massive concrete targets (dams, bridge abutments, concrete structures) is ready for release to engineering development.

The engineering development program released to production the following items: The CBU-34 wide area antipersonnel mine (WAAPM); the BLU-31/B (750-pound) land mine; and the CBU-38 (Ringtail) (13 pound) antimateriel bomblet.

REDUCTION IN FUNDING

Mr. SIKES. The fiscal year 1969 budget justifications indicated a requirement for $7,461,000 for conventional munitions. This was reduced to $6 million. What programs were dropped out in this reduction? Are the deferred programs included in the fiscal year 1970 request?

(The information follows:)

CONVENTIONAL MUNITIONS

The reduction of funds curtailed activity in the programs listed below. The programs identified by an asterisk were dropped out:

*Antipersonnel/antimateriel munitions.
Fuzing technology.
Area denial weapons.
New explosives.
Weapons analyses.
Lethality/vulnerability.
New gun concepts.

Tactical illumination.
Carriage and release.
*Incendiary munitions.
*CB defense techniques.
*CB medical defense.

The programs on incendiary munitions, CB defense techniques, and CB medical defense were not included in the fiscal year 1970 request.

Ground Electronics

MAJOR PROJECTS AND COSTS

Mr. Sikes. Ground electronics. You are requesting $40.5 million for fiscal 1970. This compares with $36.1 million in fiscal 1969, and $39.9 million in fiscal 1968.

What justification do you offer for the increase of over $4 million for the fiscal year 1970?

Colonel Stewart. Sir, about one-quarter of this goes to support the Rome Air Development Center operation.

As you know, about $19 million of the total program goes for such support and the increase of about a million in 1970 is to pick up some areas that had previously been paid for by AFLC, maintenance of R. & D. type aircraft, and so forth.

The other three-quarters or roughly $3 million goes into some 14 different projects, 14 of the some 25 different projects.

Mr. Sikes. Supply a breakdown of the major ones for the record.

Colonel Stewart. Yes, sir.

(The information follows:)

Ground Electronics—Major Projects

The six projects requiring the bulk of the increase are:

Project 4519—Surface and long-range communications techniques. Significant additional need—$645,000. This project will develop very high density integrated circuitry which can be used in Air Force communications equipment to provide unprecedented tactical mobility.

Project 4594—Nonnumerical data processing for intelligence. Significant additional need—$350,000. This project adapts and exploits general computer technology for the purpose of improving Air Force intelligence data handling operations.

Project 5519—Reliability and Maintainability Techniques for Electronics. Significant additional need—$350,000. This program insures the reliability of equipments based on advanced microcircuitry and integrated circuit technology.

Project 5573—Microwave Tubes and Devices. Significant additional need—$295,000. This project exploits solid state devices which offer many advantages in military use, such as long life, reliability, low cost, small size and weight, simplified maintenance, and reduced power supply requirements.

Project 5581—Information Processing Development. Significant additional need—$1,463,000. This project develops the advanced computer technology (hardware and software) required to improve the Air Force's capability in a wide range of information processing applications.

Project 6523—Applied Communications Techniques. Significant additional need—$500,000. This program will provide Air Force users with a compatible family of communication switching equipment.

EFFECT OF BUDGET REDUCTIONS

Mr. Sikes. You requested $38.8 million in this area in fiscal year 1969 at the time the budget was presented and the program was later reduced to $36.1 million. For the record, what was the effect of this reduction and which of the deferred items are included in the fiscal year 1970 request?

(The information follows:)

GROUND ELECTRONICS—FISCAL YEAR 1969 REDUCTIONS/DEFERRED ITEMS INCLUDED IN FISCAL YEAR 1970 BUDGET ESTIMATES

In general, the effect has been a decrease in the level of effort which could be applied to some programs, with resulting delays.

Some specific examples are these:

(*a*) One major item affected was the airborne reconnaissance display program which was eliminated from the fiscal year 1969 program. All other display efforts were minimally funded.

(*b*) The Russian language translation program was reduced to a minimal level and efforts in Chinese and German could only be continued as low-level efforts.

(*c*) The high-power nanosecond radar program has slipped over 1 year and the design goals have been limited to those previously considered to be intermediate goals.

Thirty-three work units within 17 projects, deferred in fiscal year 1969, and totaling $2.6 million, are included in the fiscal year 1970 budget. Some examples are as follows:

(*a*) Mathematically modeling complex communications receivers to predict their performance under various specific conditions of natural and manmade interference.

(*b*) Fabrication of an engineering development model of a high resolution and high-density airborne and spaceborne television, radar, and infrared reconnaissance display unit.

(*c*) Determining the feasibility of pulsed modulation communications techniques for the transmission of high-density data to provide a saving in bandwidth in the crowded electromagnetic spectrum.

ACCOMPLISHMENTS IN GROUND ELECTRONICS

Mr. SIKES. For the record will you tell us what you consider to have been the major accomplishments in the area of ground electronics as a result of funds spent in this area in the past year?

(The information follows:)

MAJOR ACCOMPLISHMENTS IN GROUND ELECTRONICS

Major accomplishments in ground electronics during the past year were:

A. HELICOPTER SUPPORTED RADAR

Initial flight tests of a helicopter-supported radar were completed which proved the feasibility of using this type of equipment to extend the low-level detection capability of existing ground-based radars. Data from the airborne radar are transmitted to the ground radar by data link. This has a direct Southeast Asia application.

B. ELECTRONIC RELIABILITY

The reliability of modern electronic microcircuits is a major concern of RADC. In the past year the first comprehensive guide to the selection and specification of optimized burn-in procedures was developed for several types of microcircuits. Also developed was the RADC reliability notebook which closes the gap between textbooks and reliability management documents.

C. EXPERIMENTAL SATELLITE FACILITY

The RADC UHF experimental satellite facility completed a calibration program which qualifies as a calibration standard for satellite research terimnals.

D. SPACE PROGRAMING LANGUAGE (SPL/J6) AND COMPILER TOOL

The problems of developing the software for programming spaceborne computers has increased tremendously over the past few years. The costs and leadtime associated with producing the hand coding and insuring quality control of the software required in the increasingly complex onboard space computers has skyrocketed. What was clearly needed was a space programing language designed to

solve complex spaceborne computations in their real time environment with minimum programer effort to produce optimum object code. The Systems Development Corp. (SDC) under RADC contract, has designed a space programing language as an extension to jovial (which has been adopted by the Air Force as a standard programing language for command and control). The official name of the space programing language is space programing language/jovial 6 (SPL/6). Almost as important as the language design is the milestone reached for its implementation. In order to develop a space programing language (SPL) compiler that can produce optimum machine code, can be built speedily, transferred readily to new computers, and costs relatively little, SDC developed an SPL compiler building tool, or compiler-compiler.

E. LASER IMAGE PROCESSING SCANNER (LIPS)

The laser image processing scanner (LIPS) will scan and digitize high-resolution photographic imagery and after computer manipulation will record the improved imagery on film. This effort is part of an overall signal processing effort that includes computer software for image smear removal and other computer image manipulations. The development of LIPS is significant because for the first time a high-resolution photograph can be quantized for computer manipulation. Not only can LIPS digitize film, but it can also record a computer image on high-resolution photographic film. This accomplishment was due to development of techniques that allow a laser beam to be focused to a small spot size. The spot size is presently 5 microns and will be upgraded to 2.5 microns. These spot sizes correspond to film resolutions of 100 line pairs/mm. and 200 line pairs/mm. respectively.

F. REVISED SPECIFICATION FOR INDICATOR GROUP AN/UPA–56

The technology achieved under the exploratory development modular display concept permitted a single specification to meet multiuser requirements. In addition to replacing the obsolete displays (AN/UPA–35, 48 and OA–99), the more sophisticated current needs of PACAF, AAC, USAFE, TAC, and other commands requirements are met with various basic options. Some improved features are high-performance reflection and digital sweep providing simultaneous display of sensor video and processed data; ditigal/analog data; and control inputs for interfacing with various tracking and processing equipment. A dual cursor feature with selectable azimuth-range numeric readout is included. Extensive use of solid state provides a 6-to-1 improvement in weight and volume, and a mean time between failure of 1,500 hours, compared with 50 hours for older equipment.

G. AUTOMATICALLY EQUALIZED DATA MODEM (AN/USC–19)

An automatically equalized data modem (modulator-demodulator) was developed by the Autonetics Division of the North American Rockwell Corp., under the direction and sponsorship of the Rome Air Development Center. The modem is a full duplex microminiaturized experimental model which simultaneously transmits and receives digital data over dedicated high-quality voice bandwidth channels at data rates of 1,200, 2,400, and 4,800 bits per second. At 4,800 bits per second, the error rate of the data is less than one error in every 10 million bits transmitted, which represents a 2 order of magnitude performance improvement over that attainable from presently available data modems.

H. RADC HIGH POWER LABORATORY

The most versatile high-power electronics experimental laboratory in the Nation now exists at Rome Air Development Center, Griffiss Air Force Base, N.Y. The instrumentation for R. & D. testing and evaluation of high-power RF amplifiers and components is virtually complete and test activity is now in progress.

The High Power Laboratory is designed to handle anticipated Air Force needs for the next 5 to 8 years and will be available to other Government agencies as well as private industry. The Laboratory is designed to handle a wide range of frequencies and devices. The heart of the system consists of two major high-voltage DC supplies which provide power independently to two separate test areas.

The availability of this Laboratory will preclude the necessity of instrumenting individual contractors for R. & D. testing and evaluation. This should result in a substantial saving to the Government since it is generally estimated that on the average, at least 25 percent of each R. & D. contract is set aside for test instrumentation. This is over and above the initial capital investment required for high-power tube development. The availability of this Laboratory should, in addition, encourage greater participation of small business in Air Force R. & D. programs. In most cases the cost of instrumentation is prohibitive for concerns with small capitalization.

I. TACTICAL AREA DEFENSE ALERTING RADAR (TADAR)

A radar technique was developed under exploratory development for locating personnel through dense foliage as encountered in base defense for Southeast Asia. Test results proved successful ———. After an evaluation in competition with other approaches, the Tadar-type radars are under quantity procurement by the Army.

J. INTERFERENCE CANCELLATION SYSTEM

Conventional UHF transceivers have a channelizing capability of 1750 channels over a bandwidth of 175 MHz. However, many problems have been encountered wherein only 35 of the 1750 channels can be used. These problems were caused by the strong interference encountered when radio transceivers were of necessity collocated due to limitations in available real estate, for example, Southeast Asia.

RADC has developed an interference cancellation system to alleviate this problem and thus provide site commanders with the capability to operate with the full 1750 channel design capability.

UHF communications equipments are utilized by various agencies of the Federal Government such as Air Force, Army, Navy, Defense Communications Agency, NASA, and FAA. The RADC developed adjacent channel interference control technique will be applicable for use by these agencies and will result in increased channel utilization (by a factor of 50) of the UHF frequency spectrum. In addition, the technique will permit collocation of transmitters and receivers (resulting in less real estate requirements), in lieu of the current practice wherein separate transmitter and receiver antenna farms are required for communications networks.

CIVILIAN EMPLOYEES AT ROME AIR DEVELOPMENT CENTER

Mr. SIKES. List for the record the number of civilian personnel at the Rome Air Development Center, the number of military personnel, and the number of contractor personnel at this facility.

(The information follows:)

CIVILIAN, MILITARY, AND CONTRACTOR PERSONNEL—ROME AIR DEVELOPMENT CENTER

As of May 31, 1969, the numbers were as follows:

Civilians	1,237
Officers	188
Airmen	148
Contractors	[1] 1
Total	1,574

[1] Contracted services ended June 30, 1969.

Mr. SIKES. What part of the $19.5 million requested for Rome Air Development Center is for the pay and allowances of civilian employees?

General PITTS. $15,800,000 in pay and allowances is programed for fiscal year 1970.

MAJOR PROJECTS

Mr. SIKES. Provide a list of the major projects included under this heading.

(The information follows:)

MAJOR PROJECTS AT ROME AIR DEVELOPMENT CENTER

Of the 25 projects included in Ground Electronics the following are forecast to be funded over $300,000 in fiscal year 1970:

Project No.	Project title	Fiscal year 1970
06DM	Rome Air Development Center operation	$19,500,000
3176	Spaceborne computation and control	400,000
4506	Electromagnetic surveillance techniques	2,500,000
4519	Surface and long range communication techniques	1,500,000
4540	Electromagnetic vulnerability reduction	1,100,000
4594	Nonnumerical data processing	1,150,000
5519	Reliability and maintainability techniques for electronics	1,450,000
5569	Advanced targeting and charting techniques	1,500,000
5573	Microwave tubes and devices	1,820,000
5581	Information processing development	2,863,000
5597	Display techniques for command and control	1,050,000
6244	Reconnaissance interpretation techniques	1,600,000
6515	Lightweight radar technology	350,000
6519	Electronic counter-countermeasures for contingency operations	350,000
6523	Applied ground communications techniques	1,300,000

HUMAN RESOURCES

COST AND NEED FOR PROGRAM

Mr. SIKES. Human resources: There is a request for $4 million. This is a new budget activity. It is indicated that in previous years this was carried under aerospace biotechnology.

What amounts under aerospace biotechnology were programed in the area of human resources in fiscal years 1968 and 1969?

Dr. LEHMANN. We programed $3 million in each of those 2 years in those elements in the aerospace biotechnology which are now in human resources.

Mr. SIKES. Why do you now need $4 million?

Dr. LEHMANN. Sir, we have something over a billion dollars we spend on training each year. We reviewed our programs and determined that we simply had to put some additional money into finding new ways of doing the training function better. We are spending in total less than 1 cent on the dollar in trying to find new ways to do the training more effectively and economically.

Mr. SIKES. What have you produced in the last 2 years in this area?

Dr. LEHMANN. We have produced numerous individual developments, but I think the most important single item is our planned program for the use of simulators in undergraduate pilot training.

We have not yet initiated this program. One of our detachments that we plan to initiate in fiscal year 1970 is a detachment at the Air Training Command's Williams Air Force Base for this purpose.

I believe we also developed simulators with the C-141.

Mr. SIKE. Complete the answer for the record.

Dr. LEHMANN. All right, sir.

(The information follows:)

PROGRAM FOR USE OF SIMULATORS IN UNDERGRADUATE PILOT TRAINING

SELECTED ACCOMPLISHMENTS IN TRAINING RESEARCH ADAPTIVE AUTOMATIC MONITORING AND SIMULATION

A prototype computer program has been developed and evaluated for automatically monitoring pilot performance in a simulator and recording training progress in summary form. A system of computer and mathematical models for deriving standardized human performance criteria and measurement methods has been developed. Requirements for automated pilot training for use with future AMSA flight simulators were incorporated in project specifications. Army was assisted in developing specifications for Army helicopter instrument trainers.

DIGITAL FLIGHT SIMULATOR FIELD RESEARCH

A research program using C–141 flight simulators was conducted at Tinker AFB and Dover AFB. This has had direct input to modifications to C–141A simulators and can serve in the C–5A program. Part of MIL–STD–876 came directly from this study. MIL–STD–876 is used in procurement of all military digital flight simulators.

LOW-COST IN-FLIGHT AUDIO/VIDEO RECORDING SYSTEM FOR AIRBORNE OPERATIONS

An airborne audio/video recording system, which records inside (instrument panel)/outside views of flight performance has been developed. It is lightweight, compact, self-contained, including power supply and modification of the aircraft is not required. It is used in pilot training for mission briefings, mission recording, and mission debriefing. Application in gunnery training is being investigated.

COMPUTER TECHNIQUES TO HANDLE AEROSPACE SYSTEMS HUMAN FACTORS DATA

I have already described the human factors data bank, which can be very cost effective in designs and specifications for new aerospace systems.

LEARNER CENTERED INSTRUCTION

This technique demonstrates that efficient job-specific courses can be developed in-phase with the building of a new weapon system. The chief method used is that of automated instruction with the student in an apprentice-like status. When applied to the F–111 system, the course of study resulting in a highly skilled airman-technician can be reduced from 24 to 15 weeks, with consequent savings in student and instructor time and costs.

HIGH RESOLUTION RADAR SIMULATION TECHNIQUES

A technique has been developed for simulation of high resolution radar systems with sufficient fidelity for aircrew training. Digital techniques appear to offer a means for providing limitless dynamic range in terrain contour representation and at the same time enable improved resolution of read out and offer more flexibility in programing and elimination of costly and difficult to update photographic transparencies.

F–4D GIB STUDY

The overall purpose of this study was to compare the effectiveness of pilots and navigators as guys in the back seat (GIB), of the F–4D aircraft. Results of this project will play a part in determining the training and manning policies for this aircraft and may be generalized to other aircraft, such as the F–111.

HUMAN RESOURCES LABORATORY

Mr. SIKES. You have programed $2,990,000 for the human resources laboratory. How does this operation compare with the amounts in the 2 previous fiscal years?

Dr. LEHMANN. It is up, sir.

In the 2 previous fiscal years it was $2.3 million.

There is an increase of $690,000 in fiscal year 1970.

Mr. SIKES. For the record, tell us why additional funds are necessitated.

(The information follows:)

HUMAN RESOURCES LABORATORY

The additional funds are needed to support the expanded training mission with the establishment of the flying training detachment, the technical training detachment, and the professional education detachment during fiscal year 1970, plus the general civilian pay increase which became effective on July 1, 1968, and the higher cost of support requirements.

HUMAN FACTORS COMPUTERIZED

Mr. SIKES. In talking of the accomplishments in this area while the program was still under biotechnology, the descriptive summary lists "computerized human factors task date for the C–5A and Minuteman II."

What was the purpose of this activity?

Dr. LEHMANN. When a pilot is coming in for a landing there is data as to how long it takes a pilot to read a gage and how much he can do in a certain period of time. What this program did was gather all such data together and put it on a computer so the design engineers could get it readily out of that data bank.

They tested this concept out on the C–5A, Minuteman II, and on Saturn–V with NASA. Some of the outcomes of this have been used, for example, in industry. McDonnell Douglas Corp. and their engineers are using this in their design.

Mr. SIKES. The speed at which you can read a gage depends on the individual?

Dr. LEHMANN. Yes, sir

Mr. SIKES. And his reaction time. I could have told you that.

Dr. LEHMAN. And also on the placement of the gage.

We are also using this concept of a computerized data bank for our personnel in training in the Air Training Command, they are working with pilot training.

DEPLOYMENT OF ADVANCED TRAINING DETACHMENTS

Finally, it has been used by our people in Air Force systems projects offices as they are looking at the design of their cockpits, and how the man functions in the aircraft.

Mr. FLOOD. It is indicated that in fiscal year 1970 training and educational development detachments will be established at operating bases. What kind of detachments are referred to, what are the detachments and how large will they be and at how many stations will they be established in fiscal 1970?

Will the cost of these detachments be included in this project?

Dr. LEHMANN. I can supply the cost for the record.

What we have are three detachments that we are planning to initiate in fiscal year 1970. We will initiate them first with 15 men at Williams Air Force Base in Arizona for pilot training. The second detachment will be in technical training, for the training of technicians at Lowry Air Force Base. We will be putting a detachment of 15 men

there. Finally in the area of professional education for military officers, such as squadron officer school, Air War College, and so on.

Mr. SIKES. This will be in fiscal 1970?

Dr. LEHMANN. Yes, sir. There will be a detachment of six for professional education at Maxwell Air Force Base. This totals 36 people. The R. and D. cost associated with these detachments is roughly something in the order of $200,000, which accounts for a significant portion of that increase.

(The information follows:)

COST TO DEPLOY DETACHMENTS

The cost of the detachments is included in this project for fiscal year 1970. This estimated cost is $180,000.

Mr. SIKES. Are there other questions on human resources?

VALUE OF COMPUTERIZED PROGRAMS

Mr. ANDREWS. Will this be a continuing program?

Dr. LEHMANN. The detachment?

Mr. ANDREWS. This program on human resources.

Dr. LEHMANN. Yes, sir. We now have a human resources laboratory, which has existed in the past and will continue to exist in the future.

Mr. ANDREWS. You had no money in 1969; you want $4 million in 1970?

Dr. LEHMANN. We had $3 million for the same activity, sir, under a different line item in 1968 and 1969.

Mr. ANDREWS. So we can expect this to be a continuing program?

Dr. LEHMANN. Yes, sir.

Mr. ANDREWS. From now on at the rate of about $4 million or better each year?

Dr. LEHMANN. Yes, sir.

Mr. MINSHALL. You have described one of the results of this program, namely to know how long it would take an individual to read the gages. What else?

Dr. LEHMANN. That was not what I described.

What I meant to say, sir, was that performance standards are in handbooks in existence. You can look in handbooks on industrial engineering and find out how long it takes to do a job. You have to look this up, get the data, and come back to the problems. This is the "manual" approach.

What they have done is take that same data, work it into an automated system and enter it into the computer program so now the engineer can use a computer to give him that information quickly, and make comparisons between let's say the C–141 and C–130 cockpits.

Mr. MINSHALL. Could you not have done that with the old-fashioned books?

Dr. LEHMANN. In principle you could, if you had enough people, sir, and time. We did not have the people and the time so it was not done.

This provides a tool for the design engineer which gives him a capability of a ready access to a memory; that is, all data which are in the computer file.

Mr. SIKES. Further questions?

STUDIES COMPLETED

Mr. ADDABBO. Have there been any other completed reports you have filed or any other completed studies made out of this $6 million?

Dr. LEHMANN. Yes, sir. We have about 750,000 airmen in the Service. We take in approximately something like 150,000 each year. These men come into basic training. We have to give them tests, and we have to make some kind of decisions as to where this man should be assigned. We have, for example, batteries of tests to determine where that man will perform most effectively.

We have had an experimental selection board working on new tests and related matters. As time changes and systems change, we have come up with better ways of identifying our people. This is another contribution.

We are also developing an airmen weighted factors promotion system. We are implementing this into the Air Force to serve the 750,000 enlisted men by providing a quick, responsive, and fair system of promoting people. The Human Resources Laboratory is intimately involved with the attempt to help staff personnel people in implementing this program. These are some others.

Mr. ADDABBO. We have been in Vietnam now say 10 years and every year we have been using a number of pilots. Have not these studies been made before?

Dr. LEHMANN. With regard to the pilots?

Mr. ADDABBO. Airmen, you are talking about 750,000. Did this 750,000 just come about last year?

Dr. LEHMANN. No.

One of the problems we have had, one of the chronic reasons for dissatisfaction and high turnover in airmen forces is they felt they have not been adequately recognized and the promotion system has not been equitable enough and rapid enough.

Mr. SIKES. They still feel the same way?

Dr. LEHMANN. Yes, sir; but we are working on it.

Mr. SIKES. That program has been going on a long time. What is new?

Mr. ADDABBO. You are talking about 4 million new dollars. Where have we gone with the new program or found out something we did not know 10 years ago?

Dr. LEHMANN. We have to make the case that we are doing a better job of using our human resources throughout the Air Force today than we were 10 years ago. We are doing a larger job I think with the same or smaller number of people than we had in previous years. We have been building in some productivity gains.

Mr. ADDABBO. What have we produced for $4 million?

Dr. LEHMANN. I cited some of the hardware to simulate—the C–141 simulator. I believe I cited the F–4D backseat study as to whether we need a pilot in the backseat or whether we can have a triple threat man or navigator in the backseat.

We are using these dollars to try to come up with better ways to use the people that we have.

Mr. ADDABBO. How long have we been trying?

Dr. LEHMANN. I guess we have been continually improving since the Air Force started.

Mr. ADDABBO. And we continue to spend money.

Dr. LEHMANN. That is right, and we are continuing to pay their salaries. I guess you never get a static situation with people.

Mr. ADDABBO. Your program is coordinated through the Secretary's Office as far as to see who is doing the work or if the work is being done by any other agency, Space or anything else?

Dr. LEHMANN. Yes, sir.

Mr. ADDABBO. No further questions.

USE OF COMPUTERS IN PROMOTION PROGRAM

Mr. ANDREWS. Do you use computers in this program?

Dr. LEHMANN. Yes, sir.

Mr. ANDREWS. You mentioned dissatisfaction on the part of some of the airmen about the slow rate of promotion.

Do you use computers to assist in determining who shall be promoted and who shall not be promoted?

Dr. LEHMANN. We use computers in keeping track of some of the factors on which promotions are based.

Mr. ANDREWS. So then you are telling me you do use computers?

Dr. LEHMANN. Yes, as a tool.

Mr. ANDREWS. The general is shaking his head.

General MCNICKLE. You do not promote by computer; we only use them as an aid to turn out data which is used by a board to consider applicants and eligibles for promotion. We do not use computers to determine who should be promoted.

Mr. ANDREWS. Let me reframe my question.

What part does the computer play in the promotion of a man?

General MCNICKLE. In providing more readily available data from personnel records.

Mr. ANDREWS. So then the computer does play a part in the promotion of the man.

General PITTS. By providing better information upon which a board can select people for promotion.

Mr. ANDREWS. Regardless of what it does, it plays a part in the promotion?

Dr. LEHMANN. Yes.

Mr. ANDREWS. Do the men in the service know you use computers to a degree in determining promotions?

Dr. LEHMANN. It is my understanding from people I have talked with, sir, that there is a strong confidence that all of the factors affecting promotion will be taken into account through this system, and there is optimism that once all of the facts are brought out the right man will be promoted. I think there is a natural skepticism of a great all-knowing computer somewhere which is going to make all of the selections by some fixed rules. But I think people understand that is not the case, the computer is used simply, as General McNickle said, in bringing out the record of the individual.

Mr. SIKES. Have you had a study yet to determine how frequently promotions are advanced or retarded because somebody hit the wrong button on the computer?

Dr. LEHMANN. No, sir. I do not think we will either.

Mr. MINSHALL. You can do away with the Adjutant General's Office, if you get the computer going.

General MCNICKLE. You could get a lot of records out of there.

DCA—SYSTEMS ENGINEERING FACILITY

CAPABILITY OF AIR FORCE TO PERFORM FUNCTION

Mr. SIKES. Getting to a slightly different field, last year DCA established an engineering facility laboratory within existing resources to conduct communications systems engineering and related laboratory work.

The fiscal 1970 DCA budget contains funds for lease of a new building to house the newly established DCA element. I find it difficult to understand that DCA would need an engineering systems laboratory in view of the tremendous resources and capabilities already available both in the military departments and outside the Government. Are there any elements in the DCA mission insofar as you know for this systems engineering and laboratory that the Air Force could not respond to by utilization of the existing capabilities and resources if so requested.

General MCNICKLE. This was a controversial item, Mr. Chairman. I think it was decided on the basis of the role and mission, and I think a number of agencies thought they could have performed the mission.

Mr. SIKES. Including the Air Force?

General MCNICKLE. Yes, if given the task.

Mr. SIKES. Was the Air Force asked whether or not it could provide systems engineering to DCA?

General MCNICKLE. I am not sure.

Mr. SIKES. Provide it for the record.

General MCNICKLE. I know they did fight the establishment.

Mr. SIKES. Provide an answer for the record, and for the record tell us the Air Force position and capability for responding to DCA requirements for R.D.T. & E. systems engineering.

(The information follows:)

SYSTEMS ENGINEERING FOR DCA

There is only an indirect relationship between systems engineering for the Defense Communications System (DCS) and R.D.T. & E. for the DCS. In general, the military departments have the capability and actually perform much of the R.D.T. & E. effort. This is supplemented to a certain degree by R.D.T. & E. contracts let by DCA. Systems engineering, on the other hand, is a task which should properly be performed by the systems manager, in this case the DCA. The Air Force did express certain reservations concerning the use of the systems engineering facility as it was proposed by DCA. While the Air Force fully supported the need for an improved systems engineering capability within DCA, there were reservations as to how the proposed laboratory would contribute to this purpose.

Advanced Devices

NEW AREA OF INVESTIGATION

Mr. Sikes. Under Advanced Devices there is a request for $6.5 million for fiscal 1970, the same amount as for fiscal 1969. However, fiscal 1969 funding jumped from $2.5 million in fiscal 1968.

What does the future hold in this area? Will this $6.5 million be a continuing level or can you give us any information in this area?

Colonel Stewart. In the program when we first started, and that program is specifically intended to exploit new technologies coming out of exploratory and research type work—in the beginning we concentrated on the molecular electronics, on the microelectronics area.

In 1968 some of the effort was increased in the reliability area. Last year we went into the cryogenic cooling area. All three of these areas are new areas where we can have high payoff.

In the future, if it stays in those three technologies, it will be about the same amount of money. If a new technology emerges similar to lasers, for instance, we think we should exploit, that might be an increased need. At the same time, the molecular electronics, for instance, might drop off a little bit.

Mr. Sikes. You can anticipate a possible drop?

Colonel Stewart. Yes, sir.

Mr. Sikes. What space requirements will your new starts in cryogenics support?

Mr. Hansen. The space requirements supported by this effort are the ——— where cryogenic temperatures ranging from ——— are required. A ——— requirement is to be supported in the advanced far infrared search and track program.

Mr. Sikes. Is all this work done under contract or is some of it done in-house?

Mr. Hansen. All of the work under this program is done on contract. Support costs and related in-house work are paid for out of exploratory development.

LEVEL OF FUNDING

Mr. Sikes. For how long a period of time have you carried this program and at what annual level of funding?

General McNickle. This program began in 1965 with fiscal year 1966 funding. The annual level of funding was $2.5 million in fiscal year 1966, $2.4 million in fiscal year 1967, $2.5 million in fiscal year 1968, and $5.4 million in fiscal year 1969. In fiscal year 1969, the scope increased with more reliability projects and the addition of cryogenic coolers. We are requesting $6.5 million in fiscal year 1970.

Mr. Sikes. Can you point to cryogenics systems which have been developed with funds in this program element and which are now utilized in operational aircraft, missiles, or space systems?

General McNickle. No, these cryogenic cooler developments, which began in fiscal year 1969, are oriented toward next generation avionics

equipment which may be used in current or advanced operational aircraft. The coolers being developed are still in design and test phases. Rapid advancements in detector design and performance, plus changes in operational needs, dictate that the cooler be integrated into sensor design. This is being done with the AAS-18 infrared scanner for the RF-4, where the overall detector equipment will be updated for higher resolution and new cryogenic cooling equipment will be included.

Mr. SIKES. Are there questions under "Advanced Devices"?

LORAN D

NEED FOR ADDITONAL DEVELOPMENT

Turning to Loran D, you are requesting $1.5 million, which compares with approximately $500,000 in previous years. Why is there a requirement for increased funding in Loran D?

Colonel STEWART. Loran D is a recently successful expansion upon the Loran C development work which has paid off and is being used in Southeast Asia.

Mr. SIKES. Has the enemy jammed Loran D in Southeast Asia?

Colonel STEWART. No, sir. They need more equipment than they presently have.

Mr. SIKES. This then is a new development an advance over Loran C?

Colonel STEWART. Yes, sir.

Mr. SIKES. What is the requirement for it? Is not Loran C doing an effective job?

Colonel STEWART. Yes, sir, it is. It is much heavier, more expensive and harder to maintain than we hope Loran D to be, also less flexible in its application in out areas and so forth.

Finally, we hope to use Loran D as a means of delivering weapons.

Mr. SIKES. Is the primary purpose of this program to overcome deficiencies found in operational Loran systems or are you attempting to develop a new generation Loran system?

General MCNICKLE. The present loran system has given excellent results in SEA; however, the system is complex, costly, and difficult to maintain. The purpose of developing a next generation loran receiver is to take advantage of new technology that has been or is being developed by industry. This includes:

(*a*) Modular receiver development. The number of circuits has been reduced by, in some cases, a factor of 10. This reduces the required number of parts and allows proper spacing which should improve maintainability and reduce costs.

(*b*) New technology such as a capability to use direct ranging techniques when available should be incorporated into next generation receivers.

(*c*) ———.

Mr. SIKES. It is indicated that a part of your fiscal year 1970 effort will be in the area of electronics counter-countermeasures. Has the enemy in Southeast Asia jammed our loran?

General MCNICKLE. No, sir; the enemy in SEA has not jamed our loran. The capability to effectively jam a loran signal requires a high-power transmitter and large antenna. Such a device could be con-

structed; however, it is susceptible to air attack unless located in a sanctuary. The purpose in investigating ECM is to develop a capability in a time frame that goes beyond SEA.

Mr. SIKES. Are there questions?

DESCRIPTION AND USE OF SYSTEM

Mr. ANDREWS. Will you describe Loran C and D briefly?

Colonel STEWART. It is a hyperbolic system using three ground stations, all of which provide a time difference reading to an aircraft and by the intersection of hyperbolic lines the aircraft can figure out his position with respect to them.

Loran D is a lightweight more precise, more maintainable version of Loran C. Loran C transmitters, for instance, are a fixed installation. Loran D is portable. Loran D receivers can work with a Loran C ground chain.

Mr. ANDREWS. What is the purpose?

Colonel STEWART. It is most useful in tactical situations.

Mr. ANDREWS. Does the purpose consist of navigation?

Colonel STEWART. Yes, sir.

General PITTS. And bombing.

Colonel STEWART. Precise location, which is for both navigation and which in case of Loran D can be used for delivery of weapons.

Mr. ANDREWS. How would it assist in bombing?

Colonel STEWART. It gets the aircraft to the correct spot in space to deliver a particular weapon.

Mr. ANDREWS. The pilot would have to know the target?

General PITTS. Loran D can position the pilot near the targets for visual acquisition. It is also a device to enable the pilot to deliver ordnance under night or all-weather conditions.

General MCNICKLE. If you know the latitude and longitude of the target, or the Loran coordinates of a predetermined spot, you can put the airplane over it.

Mr. ANDREWS. Loran D does not locate the target, the pilot has to do that?

General MCNICKLE. Or you have to know it in advance.

Mr. ANDREWS. It helps him in finding it?

General MCNICKLE. That is correct, when you know the target location in advance.

Mr. WALSH. It could be located separately by reconnaissance or other techniques to feed into the system the longitude and latiude.

Mr. ANDREWS. The pilot has to know the target, what target he wants, and Loran D helps him find the exact location?

Mr. WALSH. That is correct.

Mr. MINSHALL. How are you finding your targets over there now?

Colonel STEWART. Loran D is being used for some of them.

General BOYLAN. Is the question how you find the targets?

Mr. MINSHALL. Or how you deliver the weapon on the target, whatever you will.

General BOYLAN. The answer applies. I had misunderstood your question. They are using Loran, radar, visual, forward air controllers, and varous marking techniques.

Colonel STEWART. You have MSQ-77 radar system, which is a ground-based system able to pick up and direct aircraft out to line of sight ranges and to previously determined targets.

Mr. MINSHALL. You say Loran D is lighter weight. How much more lighter weight and how much more portable?

Colonel STEWART. I do not have the figures. I can provide them.

Mr. MINSHALL. Thank you.

(The information follows:)

LORAN D/WEIGHT AND PORTABILITY

Fixed Loran C transmitters used in SEA weigh 9,000 pounds and require a cleared area of 2,400 square feet for installation. Complete installation takes approximately 1 year. Portable loran D transmitters weigh 4,500 pounds and require an area of 600 square feet. Installation of the entire loran D complex including antenna can be accomplished and the station placed in operation by 16 men within 24 hours after delivery. Delivery can be accomplished by two C-130 aircraft.

Mr. ANDREWS. Do you have any facilities for locating the enemy under the foliage?

General MCNICKLE. It depends on the type of target.

For instance, if it is a truck we have a method of picking it up and finding out where it is.

Mr. ANDREWS. Through the foliage?

General MCNICKLE. Yes, sir.

Mr. ANDREWS. From an aircraft?

General MCNICKLE. Yes, sir.

Mr. ANDREWS. Did you develop that?

General MCNICKLE. Yes.

Mr. ANDREWS. How long ago?

General MCNICKLE. About 1 year ago.

Mr. SIKES. Their problem has been primarily in personnel as far as the difficulty in locating the target under jungle cover?

General MCNICKLE. Yes.

Mr. SIKES. You have been able for a long time to locate mechanical objects?

General MCNICKLE. Yes, sir, some of them.

Mr. ANDREWS. Are you doing any work in the field to try to come up with something to permit a pilot to hit a target down beneath the foliage?

Mr. WALSH. ———. One of the problems in trying to detect small moving targets from an airplane is the fact the airplane is moving itself, so essentially all of the ground seems to be moving. ———.

ADVANCED AIRBORNE COMMAND POST (AABNCP)

NEED FOR UPDATING COMMAND POST

Mr. SIKES. Under Advanced Airborne Command Post there is a request for $2 million for development. This is a relatively new program for which $400,000 has been made available previously. The budget presented to the committee last year requested $2.5 million. This would indicate that a number of other programs had a higher priority.

We have airborne command posts. What is visualized in an advanced airborne command post and why should the level be stepped up to $2 million at this time?

General McNICKLE. The JCS directed us to perform studies on future airborne command posts. Actually, the present airborne command posts, the national command posts, will become so saturated that we will need increased capabilities. The jobs to be done are to be on the order of C–5 or Boeing–747 type operations. Because of the complicated and extensive systems that will be required, we should be getting on with the system. ———. But the Advanced Airborne Command Post is still in the study stage.

Mr. SIKES. What timetable do you envision?

General McNICKLE. It still is in the future, and with the competition from other requirements, Mr. Chairman, I do not——

Mr. SIKES. What is the status of the program?

General McNICKLE. Still in the planning stage.

Mr. SIKES. When do you plan to initiate contract definition?

General McNICKLE. It is expected that during fiscal 1970 some contract definition will start, but I do not know that it will go very far, or very fast, because of the intense competition for funds.

Mr. SIKES. For the record, tell us what are the capabilities of the present advanced airborne command post aircraft and what are the deficiencies in their capabilities, as you see them, which will be overcome if you are permitted to go ahead with the new development.

(The information follows:)

PRESENT ADVANCED AIRBORNE COMMAND POST/CAPABILITIES

The current airborne command posts (ABNCP) are capable, under most circumstances, of passing the SIOP execution message, and little more. The ABNCP system provides a survivable alternative to our relatively soft ground based SIOP command and control system.

The current ABNCP system has the following deficiencies:

The aircraft are nearing the end of their normal lifetime;

Evolutionary growth of the command and control equipment has reached the weight and volume limits of the aircraft;

Because of the overloaded conditions, takeoff characteristics are marginal and an 8-hour peacetime mission can barely be accomplished;

Significant electronic equipment interface problems exist;

The system depends on UHF line of sight communications with ground relay points and uses relay aircraft that are normally in a vulnerable ground alert posture;

Does not have weight or volume capacity for SHF satellite terminals.

The reasonable solution to these many problems requires a larger, more modern replacement for the EC–135.

Mr. SIKES. How many aircraft do you foresee for this system?

General BOYLAN. The advanced airborne command post systems would require ——— C–5 or 747 type aircraft or a larger number of smaller cargo type aircraft such as the DC–8 or 707. ——— C–5/747 aircraft would provide ——— CINC's SAC/PAC/EUR and LANT for a continuous airborne posture, ——— the NMCS (NEACP) for a ground alert posture and ——— a central pool for command support and attrition.

ESTIMATED COST OF NEW COMMAND POST

Mr. SIKES. What is the total estimated R.D.T. & E. cost of this effort? The justification material indicates that the total estimated cost is undetermined, but estimates have been made in industry in the area of $100 million for the development program.

General McNICKLE. Estimated R.D.T. & E. costs will be directly influenced by the candidate system selected by OSD. The $100 million quoted by industry is fairly representative. Our best estimates give a range from $70 to $120 million depending upon which candidate system is selected.

Mr. SIKES. What is the best estimate you have now of the unit cost of the advanced airborne command post aircraft you desire? What would be the total cost of this program, including the development of the aircraft and all of the new communications equipment for it, spares, and special handling and testing equipment? For the record, would you break these items down and give the committee the total cost of this effort?

(The information follows:)

UNIT COST/ADVANCED AIRBORNE COMMAND POST

Our best estimate of the approximate unit cost for an advanced airborne command post could range from $19 to $48 million depending upon the airframe and capability selected. The estimated total cost, including 10-year operating costs could likewise vary from $1.5 to $2.1 billion, again depending upon the airframe and capability selected. As the number of alternatives for an advanced airborne command post are numerous, the breakdown of spaces, new communications equipment, and special handling and testing equipment cannot be made in a meaningful manner until a preferred system is identified.

Mr. SIKES. Also for the record, tell us the estimated cost of contract definition and what part of the $2 million you are requesting is for contract definition?

(The information follows:)

ADVANCED AIRBORNE COMMAND POST/COST OF CONTRACT DEFINITION

Contract definition has been estimated to require $7.5 million. This figure is based upon using two equipment contractors, MITRE support, and evaluating a single airframe. If a decision for contract definition is made by OSD, the $2 million will be used to initiate contract definition.

Mr. SIKES. Are there questions on the advanced airborne command post?

HIGH ENERGY LASER PROGRAM

STATUS OF DEVELOPMENT

Mr. SIKES. Turning to the high energy laser program, you are requesting an increase of 100 percent. Four million dollars was provided for this effort in the current fiscal year. You are asking for $8 million now. Toward what end objective is this program directed?

(Discussion off the record.)

Mr. ANDREWS. I do not know anything about laser development, but I believe that what you have in mind is away on down the road.

Dr. LEHMANN. It is not that far on down, sir.

Mr. ADDABBO. Speaking practicality, in dollars, you are requesting double the funds from 1 year to another, from $4 to $8 million. If we are talking about something that is away in the distance, 5 or 6 or 10 years, are we to double the cost every year as you come before us? Next year will you ask for $16 million, saying we have so much in the program now and we may get something practical? Will it cost $100 billion to get something practical?

Mr. HANSEN. I do not think it feasible to estimate the cost of this particular program. ———.

Mr. SIKES. Is this so far in the future and is it all so vague that it is really something hypothetical?

Mr. HANSEN. No, sir.

Mr. ADDABBO. We are talking about priorities. Isn't there some other field where you can concentrate a little more right now, instead of 20 years from now? Or are we saying because we may be out of Vietnam, let us get as much for every research program and try to develop something? There is a program financed for $4 million, and you say let's double it and get the $8 million, and maybe we will get a little further down the road. When you come before us today, you jump from $4 to $8 million.

Dr. LEHMANN. ———.

As far as doubling the money from $4 to $8 million, when you get a winner you put your chips on that one and you push it. That is what is happening here.

Mr. SIKES. You do not have a winner now. You do not seem to know exactly what you have.

Dr. LEHMANN. We are pretty sure this is a winner. Things are going right. It is pretty much straightforward engineering that we are doing, rapidly building a strong technical capability.

CONTRACTORS PERFORMING STUDY

Mr. ADDABBO. Where is the work being done?

Dr. LEHMANN. The work is being done primarily in two places with two contractors—United Aircraft Corp. down in Florida, and Avco in Massachusetts. We have some in-house work going on at the Air Force Weapons Lab at Albuquerque, N. Mex. However, these dollars will not be spent there. These dollars are contract dollars.

Mr. SIKES. How were these contracts awarded?

Dr. LEHMANN. I will have to provide that for the record.

(The information follows:)

CONTRACT/LASER

The United Aircraft contract is for development ———. The contract is a cost plus fixed fee R. & D. effort and was a sole source award. This was based upon the technical capability and special equipment that UAC had developed on their own funds over a 15 to 20 month period ———. This effort is funded by ARPA, Air Force, Army, and Navy.

Avco has two contracts. One is a laser science and technology program funded from AF exploratory development funds in fiscal year 1969 and is jointly funded with ARPA. This was a sole source contract award and is an extension of prior work done by Avco under jointly funded AF/ARPA exploratory development programs which started in 1966. The other contract at Avco is to procure three laser test devices for in-house laboratory work by the three services. The contract was awarded to Avco based upon requests for proposals to Avco and United Aircraft Corp. The contract is cost plus fixed fee and is funded jointly by the Army, Navy and Air Force.

Hughes Aircraft Co. has a contract for developing external laser optics. This was a sole source award. A subcontractor to Avco, Hughes has developed the internal optics (or laser cavity optics) for other experimental lasers on Defense Department contracts. Since the internal and external optics must be compatible, it was advantageous to award the contract to Hughes, based upon their unsolicited proposal.

Mr. SIKES. Is any university effort being applied to this program?

Dr. LEHMANN. Not that I know of. There are universities working on lasers. As we have indicated, lasers cover a very broad spectrum.

(Discussion off the record.)

MOON LASER BEAM

Mr. MINSHALL. I read recently they are going to shoot some kind of laser beam at the moon, with a dish or reflector up there. What do you know about that? How does it compare to what you are developing?

Dr. LEHMANN. That is to put a mirror or reflector up on the moon so we can hit it with the laser, and then get the laser beam to come back to us. That takes good power, in order to get a return over the great distance ———.

Mr. MINSHALL. That is primarily for distance measuring, I understand.

Dr. LEHMAN. That is correct. You can use the laser as a radar which measures distance. Radio detection and ranging is what radar stands for. You can measure the distance with the laser. You have the potential of using the laser as a communications system. These are additional applications that the Air Force is interested in. ———.

Mr. SIKES. What is the basis for your $8 million estimate?

Mr. HANSEN. The fiscal year 1970 funds are for incremental funding of the contract which was started in fiscal year 1969, as we discussed off the record.

OTHER LASER PROGRAM

Mr. SIKES. What other laser programs are included in the R.D.T. & E., Air Force, appropriation?

Mr. HANSEN. Other than the high energy laser program, the Air Force has three projects in exploratory development which are oriented toward advancing laser technology or toward exploiting lasers for specific applications. These are in the aerospace avionics program and are the coherent optical device physics, laser technology, and laser techniques for aerospace applications. They provide the basis for follow-on application programs where the laser device is part of an overall system and not necessarily the limiting factor. ———.

UNAUTHORIZED CONSTRUCTION OF LASER RESEARCH FACILITIES

Mr. SIKES. Mr. Nicholas.

Mr. NICHOLAS. In fiscal year 1968, the Air Force constructed a laser optic science laboratory at Kirtland Air Force Base, N. Mex., at a cost of $487,000. The surveys and investigations staff of this committee have looked into this construction. The committee was advised that Air Force officials admitted that there was no statutory authority to use R.D.T. & E. funds for this construction. What is your comment on this matter, Dr. Lehmann.

Dr. LEHMANN. Back in 1963, Mr. Zuckert, then Secretary of the Air Force, testified before a committee of the Congress that he had delegated some of his authority under the U.S. Code which we had interpreted as authority to use R.D.T. & E. funds to construct urgently

needed facilities in support of ongoing research programs, which we could not have foreseen earlier in the game.

The GAO looked into some similar projects, and they felt we did not have the legal authority on those projects. So, we have now instituted some tighter provisions for those cases where we used R.D.T. & E. funds to construct some facilities.

These situations arise because you need a big piece of equipment essential for R. & D. program, the equipment is coming in and you have to have some shelter to keep it out of the weather. That is the kind of thing we have done.

We would not build the laser optics facility down there at Kirtland today under the ground rules that we have now established, after the investigation. These ground rules, however, were not so interpreted or so understood at the time this laser lab was constructed.

General McNickle. Mr. Chairman, the Air Force was guilty of misinterpretation. We have replied to the committee as well as the GAO that in the future those facilities will go the military construction route.

Mr. Andrews. General, when the General Accounting Office catches you off base doing something you did not have authority to do, is that the only penalty? You just tell them you are sorry and you won't do it any more?

General McNickle. This was a controversial item which did take a lot of legal discussion. I think our lawyers finally agreed. We still do not 100 percent agree that this is black and white, but that is the decision.

Mr. Andrews. But in the final analysis, the final arbiter, the General Accounting Office, said you were wrong?

General McNickle. Yes, sir.

Mr. Andrews. You said you were sorry and you will not do it any more?

General McNickle. We said——

Mr. Andrews. That is about the only penalty that can be imposed by the General Accounting Office, if it is a penalty.

General McNickle. That is right, because there was no intent to do wrong. And the GAO agreed this was subject to misinterpretation.

General Pitts. And we had told the Congress.

Dr. Lehmann. There is a section of the United States Code which says the Secretary of the Air Force shall have certain authority to construct facilities necessary for the pursuit of research, development, test, and evaluation.

Mr. Andrews. The question, in my opinion, is if it is part of your research program, you have authority to construct the building. That is my opinion. You had no need for the building except to further your research work.

Dr. Lehmann. That is correct.

Mr. Andrews. To get your equipment out of the weather.

I am not the man who makes the ground rules.

Getting back to my original question, the only penalty you suffered was just an apology, if that is what it was, and a promise not to do it in the future?

General McNICKLE. Yes, sir; we still disagreed.

Mr. ANDREWS. A lot of people disagree with the judgment of a court or the verdict of a jury, but once it is rendered, it is final.

General McNICKLE. That is right. So we agreed to coordinate and go the other route.

Mr. HANSEN. I do not believe the GAO is a court in this case. They are a witness.

General PITTS. There is ample evidence that where there has been intent to do something wrong, people have been punished. I think that is the point you are getting to. I can think of a case in point where a major general was fired because he did things improperly with construction funds.

DUPLICATE DEVELOPMENT

Mr. PRESTON. The same report also indicates that each of the three services is developing ——— devices exactly alike. Is this the case?

Dr. LEHMANN. I do not think each of the three services is doing this independently. The Advanced Research Projects Agency of the Department of Defense, the Army and Navy are putting funds into ———. Some of the funds go through the Air Force weapons laboratory as executive agent for letting contracts. There are Department of Defense meetings to coordinate programs so that each of the people who is pursuing programs in these areas complements each other. The whole goes as a Department of Defense program.

Mr. PRESTON. Why couldn't this total effort for all three services have been accomplished utilizing one device, the Air Force weapons laboratory?

Dr. LEHMANN. There are advantages in competition that come in. Even within the Air Force, we found that costs came down and progress accelerated when the second of the two companies came in, having done a lot of the work on their own and saying "We can do this." So, the Air Force is supporting the two efforts that I mentioned, the Pratt & Whitney-United Aircraft effort in Florida, and the Avco effort in Massachusetts.

Mr. PRESTON. I am not sure we are talking about the same thing. Three are purchased from Avco.

Dr. LEHMANN. That is right. They will not be three identical devices. They will be similar but not identical. ———.

General McNICKLE. D.D.R. & E. specifically assigned portions of the ——— laser program and said, "Air Force, you take this; Army, you take this; Navy, you take this; and ARPA, you take this." That was just 2 years ago.

These programs are being directed right now by D.D.R. & E. and we are going in this specific direction.

TRISERVICE LIGHTWEIGHT TACTICAL RADAR

COST OF DEVELOPMENT

Mr. SIKES. You are requesting $1.7 million for development of a triservice lightweight tactical radar which is to be used by the Air Force and by the Marine Corps. How much money has been put into this program to date? How much of this money has been from the Air Force and how much from the Marine Corps?

General PITTS. Through fiscal year 1969, the Air Force has put $1.54 million on the triservice lightweight tactical radar program. The Marine Corps has not provided any funds to date.

Mr. SIKES. What is the total estimated cost of this development effort?

General MCNICKLE. The present program is $15.5 million; however, we will not have any firm figures until the design studies are completed in August 1969.

Mr. SIKES. What utilization will be made of this radar?

General BOYLAN. This will be the primary ground radar used to support Marine and Air Force tactical air operations in the post-1975 time period. Specifically, the radar will be used to provide surveillance and warning on aircraft and to assist in performing ground controlled intercepts. This advanced radar is presently in the study phase in which solid state phased array radar technology is being considered since it shows promise from the standpoint of versatility, reliability, and mobility. If the studies are successful, these radars will be developed for the purpose of replacing the AN/TPS-43 radar in the Air Force and the AN/TPS-34 in the Marine Corps.

EQUIPMENT TO BE REPLACED

Mr. SIKES. What equipment in being will be replaced by the triservice lightweight tactical radar? What are the major differences between the radar under development and present equipment?

General BOYLAN. This radar will replace the Air Force's AN/TPS-43 and the Marine Corps AN/TPS-34. The present radars cannot cope with the ——— post-1975 time period. The stacked beam system of the AN/TPS-43 ——— performance, low sidelobe requirements or required height accuracy at ———. The AN/TPS-34V beam radar has the same problems and is much heavier than the proposed radar. The triservice radar is being designed to have much higher reliability and simpler maintenance than any of the present radars.

BASE SECURITY

ITEMS UNDER DEVELOPMENT

Mr. SIKES. You are asking for a significant increase for development in the area of base security--$1.6 million is requested in fiscal year 1970 as compared with $1 million in fiscal year 1969. What is the reason for the increase in this area?

General MCNICKLE. The increase in the fiscal year 1970 funding represents both an effort to expedite the rate of program development and an expansion of the program scope. More specifically, this increased funding will result in an earlier capability to deploy a wide area remote sensor network around our airbases for the purpose of detecting rocket and mortar teams as well as infiltrators. In addition, this additional funding will allow investigation into other concepts for preempting and preventing damaging rocket and mortar attacks upon the high-value areas within our airbases.

Mr. SIKES. Submit for the record a list of the items in this area which are under development, and indicate which of those items are included in your fiscal year 1970 procurement program.

(The information follows:)

Items under development during fiscal year 1969 include:

(*a*) Composite seismic antenna loading detector (seed), a sensor designed to use two independent-type stimuli for sensor activation.

(*b*) A wide area remote sensor system for covert activity detection beyond the airbase perimeter.

(*c*) A remote sensor data transmission network for passing information of detections to the central security center.

(*d*) Preliminary development of a central security center display.

(*e*) A discrimination analysis study to develop techniques to determine specific information about the sensor activation stimuli.

(*f*) Continuing work on foliage penetration radar (fopen) with applications toward the base defense role.

Items developed during this year which should see procurement, test, and deployment during fiscal year 1970 include:

(*a*) An interim sensor system for wide area surveillance.

(*b*) Components of the sensor data transmission network, using technologies developed in the discrimination analysis program.

(*c*) A prototype model of the composite seismic antenna loading detector (seed) device.

Other items of the fiscal year 1969 program will be carried into development for fiscal year 1970, as planned, with test, procurement, and deployment in fiscal year 1971 or later.

DEVELOPMENT OF SECURITY CONTROL CENTER

Mr. SIKES. Describe the security control center which is under development in this program.

Colonel JARRETT. The security control center is an effort on our part to try to tie in the data inputs from a large variety of sensing sources, both our own sensing sources, the Army's, the Marines', whoever it is that has the responsibility for the protection of our bases beyond the perimeters.

The security control center would be an expansion of our command and control facilities such that we would have better response time, a watch-team concept so we can preempt these actions instead of reacting to them.

Our point of view is that if we are to beat the attacks that are being centered on air bases, our emphasis must be on preventing them, rather than reacting to them.

The security control center is the means of collecting the data and intelligence far enough in advance to respond and deter the attack before it ever occurs.

Mr. SIKES. That sure takes in a lot of territory. That was a good answer. I am not sure I know what it meant.

Just how are you going to deter an attack before it occurs?

Colonel JARRETT. There are several schemes that we are looking at. We do not by any means infer that this is going to be 100 percent effective, but we are aiming toward the best that we can produce through improved real time intelligence.

As an example, around our air bases we have troops in various sorts of configurations; artillery posts, listening posts, ground patrols, aircraft patrols. All of these sources of intelligence presently report to their own units and own organizations.

Currently we are trying to take advantage of all of these sources and put them in a single place.

Mr. SIKES. You are just going to use to better advantage the intelligence you are getting now?

Colonel JARRETT. Yes; with an additional input that we hope to have through better sensors and better transmission capabilities and trained people who are looking——

Mr. SIKES. Don't tell me we are going to have another communications system.

Colonel JARRETT. No, sir.

Mr. SIKES. I am a little puzzled. This is a very well-understood field. It still is not clear to me how you are going to improve what we do. Will you try again?

Colonel JARRETT. Yes, sir.

We have found in our experience in Southeast Asia that there are certain events that take place prior to attacks on air bases. We have found this out from experience we have had in these attacks. Some of them are repeatable instances, and we know if we watch for them we can prevent attacks.

Mr. SIKES. Like what?

Colonel JARRETT. For instance, when a rocket team or mortar team moves into a launch site, they take certain actions, such as prestorage of munitions. The activity around small villages in the area is at a normal level, and then this level suddenly increases.

Mr. SIKES. Good intelligence would be doing that now. What is new about it?

Colonel JARRETT. The intelligence that is doing it now is not currently tying this into a central point where people are trained and know what these signs are.

Mr. SIKES. If it were good intelligence, they would be tying it in.

Colonel JARRETT. Yes, sir. That is what we are trying to do. I do not believe that currently we are taking full advantage of all of these in one point. I think of the central security control center as two phases: One, putting the intelligence in one place for assessment by personnel trained to recognize threat indicators related to air base defense. Two, this is a triservice function. It is not just our own. We would like everyone participating in this respect. We are putting it all into a single place where trained people are looking for these events to take place, therefore giving us this preemption capability.

FUND FOR DEVELOPMENT

Mr. MINSHALL. You are asking for $1.6 million. How will you actually spend these dollars? Where will they go?

Colonel JARRETT. The $1.6 million is in the advance development portion of this whole system.

Mr. MINSHALL. What does that mean, advance development portion? What do we have there?

Colonel JARRETT. Let me address it this way. Let us take the ground sensors as an example. Currently one of the problems with ground sensors is discriminating between whether a man or an animal is walking over a ground sensor. A seismic sensor can be keyed off by thunder or lightning. This discrimination effort is part of this $1.6 million

development effort, eliminating from the sensing data everything except what we would consider threat information. Lightning events produce a signal on a seismic sensor which can now be eliminated through discrimination techniques. This development will refine that process even more and produce a more reliable system.

We will take the inputs from these sensors when they emit their signals, when they are stepped on, keyed off, and what-not, and place them into a complex where we can display their information and look at the total picture and see what is going on.

Mr. MINSHALL. Where do you actually plan to do this work? What geographic location?

Colonel JARRETT. The testing is being done, first of all, the development sensor portion, at Rome Air Development Center in New York. They have performed the Air Force sensor development work, the discriminator techniques work, and tied them together for compatibility.

We also do some of our testing at Eglin to simulate the Southeast Asia environment.

COORDINATION OF PROGRAM WITH ARMY

Mr. MINSHALL. How much liaison have you had with the Army on this program?

Colonel JARRETT. Sir, we are cooperating and using the Army expertise to the maximum extent that we can. We are taking advantage of their technology and development efforts by, first of all, making sure we do not duplicate what they are doing. We are looking at other sensor techniques they are not looking at that we think can be specially tailored to air bases.

Mr. MINSHALL. What is the difference between an air base and an Army camp as far as distinguishing the different signals, whether it be lightning, an animal, or a man? The Army, I think, has pretty well solved this problem.

Colonel JARRETT. One of the things we can use on an airbase which the Army does not like in their sensor equipment is a set of sensors which we can ——— and not have to make them mobile. This is contrary to some of the other types. We can harden this. ———.

The Army is looking at it more from a mobile standpoint, and would like to have theirs so they can emplace them where they encamp.

In contrast, the data collection pieces of gear that they use, we have already bought and introduced as part of our system, because they work the same way that we would like ours to work. We have bought a lot of their equipment.

The perimeter sensors that we have sent to Southeast Asia are modified Army-developed sensors.

On the other hand, there are some that we believe are improvements upon these and are more cost-effective and cheaper, and we think can do the job as well or better.

So, the sensor field is wide open. The Army is doing a lot and we are doing a small part for those that we think are uniquely adaptable to air bases in the situation on the air base.

Mr. MINSHALL. The big problem, then, if I understand you correctly, is getting a proper readout of what these sensors send back?

Colonel JARRETT. One of the problem areas is to make sure we rid ourselves of the false alarms of what we call phase I sensors, which record everything that occurs. As we improve our sensors, only those which we call targets would cause the sensor to kick off and readout. That is the second generation of sensors.

Mr. MINSHALL. From the practical point of view, how would you be using this in Vietnam today, say at Bien Hoa?

Colonel JARRETT. The way we envision this would work is that the perimeter would be such that we would not need large numbers of men stationed around defense lines but, rather, we would have a sensing capability for detection of troops infiltrating through the perimeter. We would have an observation post back in from the perimeter where a guard would monitor a given section of the perimeter itself. When the intrusion occurs, he can summon mobile teams to respond to it and reduce the need for larger numbers of men.

CAPABILITIES OF SYSTEM

Mr. MINSHALL. How does this differ from the so-called McNamara line?

Colonel JARRETT. It differs in the respect that we cannot afford the kind of sensors that are used there, and we are looking for a cheaper means of doing the job and the fact that we can tie it into a system that will work as a system.

General BOYLAN. As a measure of the potential here in terms of not only security but dollar savings to the Air Force, since 1964, through the end of May, we have had 199 ground attacks against our airbases which cost us ——— airplanes destroyed and ——— major damage.

Mr. ANDREWS. How many killed?

General BOYLAN. I do not have the figures on Air Force casualties, Fortunately, in most of the attacks our casualties were very light.

Mr. MNSHALL. Were these infiltration or mortar, or what?

General BOYLAN. All types.

Mr. MINSHALL. This is not to protect you from a mortar or artillery attack.

General BOYLAN. It depends on the situation that might exist. The range of some of these rockets is such that it might be outside the perimeter. Given this potential, there is no reason that advanced sensors cannot help us expand the perimeter.

Mr. MINSHALL. I can well understand how that would help against infiltration, a man trying to sneak through and blow up something, but not against a mortar attack maybe out a couple of thousand yards or so.

General BOYLAN. It would be effective against all acts of sabotage.

Colonel JARRETT. We are working on exactly the problem you are talking about. We are working with the ground forces in the respect that where they do not have the capability for ——— sensors in those key, preselected areas that we want to watch outside the perimeter

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Mr. SIKES. Thank you, Colonel.

Chemical and Biological Warfare

TYPES OF DEVELOPMENT ACTIVITIES

Mr. Sikes. You are requesting $1 million for a line item entitled "Biological Warfare/Chemical Warfare Program," and are also requesting $2,856,000 under the heading "Chemical-Biological Equipment." What is the relationship between these two programs? Is there duplication here?

General McNickle. The advanced development program evaluates feasibility of new concepts and the engineering development program develops the successfully demonstrated concepts. There is no duplication between these two line items.

Mr. Sikes. Why do both projects indicate emphasis on incapacitating agents?

General McNickle. Incapacitants cause no property damage. They also have a distinct advantage in reducing fatalities among both friendly and enemy forces. Enemy forces would be incapacitated to the extent that they could put up little or no resistance, thus reducing friendly casualties to a minimum.

Mr. Sikes. Describe some of the results of your efforts in this area in the last year.

General McNickle. Two aerial delivery munitions were introduced for operational use during the past year. These are the CBU-30/A aircraft dispensers and the BLU-52 chemical bomb.

Penetration Aids for Manned Aircraft

LEVEL OF EFFORT

Mr. Sikes. You are requesting $13 million for "Penetration aids for manned aircraft." This is compared to the $13.2 million programed in fiscal year 1969 and $4.2 million in fiscal year 1968. Why must this program be continued at a $13 million level?

General McNickle. Based on past experience and intelligence estimates of the threat, $13 million will be the minimum required for this program in fiscal year 1970. Since the program objective is to provide electronic and electro-optical countermeasures equipment for all manned aircraft—strategic, tactical, airlift, and so forth, and the fact that all aircraft in the USAF inventory may be subjected to enemy defense systems; for example, ground launched infrared missiles or antiaircraft artillery—in future conflicts, it appears that at least $13 million will be required in this program to support the operational requirements of the future.

INFRARED COUNTERMEASURE DEVELOPMENT

Mr. Sikes. One of the items mentioned as a task for fiscal year 1970 is infrared countermeasures. What infrared countermeasures are you considering, and what are their capabilities?

Colonel Garrigus. The infrared countermeasures we have reference to here are countermeasures against air-to-air infrared seeker missiles. In this particular task of the advanced development program, which is completely operational, new hardware techniques are being developed. ———

Mr. PRESTON. ———

Colonel GARRIGUS. This would be correct if we are fully successful with it. ———

Mr. SIKES. Tell us something about the task designated "Decoy payloads" and whether this is related to the new decoy cruise missile.

Colonel GARRIGUS. It is related to it; yes, sir. We are developing hardware techniques for decoys in general. ———

It would be adaptable to SCAD in terms of its technology.

PROJECTS UNDER DEVELOPMENT

Mr. SIKES. Will you submit for the record a list of the efforts which you plan to pursue for $13 million and indicate the sum planned for each?

The following projects are under development.

[Dollars in thousands]

Project No.	Title	Fiscal year 1970 funding
691A	Analysis and evaluation	3,000
691B	Threat avoidance	1,160
691C	Expendables	1,780
691D	Electronic degradation	1,680
691E	IR and optical degradation	3,744
691F	Ground data processor	1,636
		13,000

Note: The above is a breakout by projects within the element. These projects are further divided into 40 subtasks.

SIMULATOR FOR AIR-TO-AIR COMBAT

Mr. SIKES. Turning to simulator for air-to-air combat, for which you are requesting $1 million, is this a visual display which you will use in pilot training?

General MCNICKLE. Yes, sir.

Mr. SIKES. Will you describe it?

General MCNICKLE. It is a device for training pilots. You get two pilots in the simulator and they both have the sky in the background, and they will be able to swing around and maneuver their aircraft. Each pilot will see just exactly what he would see in the air.

There will be another portion of the display so that each pilot can find and attack the other aircraft. The aircraft will do exactly the same thing as if you sent two pilots out in two different airplanes in combat.

The simulator would have two cockpits and the pilots could actually engage in mock combat.

Mr. SIKES. What will you get for the $1 million?

General MCNICKLE. We are going to get the development of the visual portion of the simulator.

Mr. SIKES. This is a simulator.

General MCNICKLE. Yes, sir, but we will not get the entire simulator for the $1 million.

Mr. SIKES. What will you get for the $9.7 million which is the estimated total development cost?

General MCNICKLE. We will get the complete simulator, set up, and in operation, actually delivered.

Mr. SIKES. Only one? What is the total requirement?

General McNICKLE. The simulator will be evaluated in the performance of three missions—a pilot trainer, a means to develop combat tactics, and as a design tool for fighter aircraft.

General BOYLAN. We have not determined what the ultimate requirement will be, Mr. Sikes.

Mr. SIKES. The budget for fiscal year 1969 proposed a million dollars in this area, and only $500,000 was programed. What effect does the cutback have on the program? Are the deferred items included in the fiscal 1970 program?

General McNICKLE. Approximately $3 million is required to develop the visual cockpit subsystem for the simulator. Since this development has the highest technical risk associated with it, it will be done first. The initial program funding request was for $1 million in fiscal year 1969 and $2 million in fiscal year 1970 to complete development and fabrication of this subsystem. Because the fiscal year 1969 request was reduced by $500,000 and the fiscal year 1970 request was reduced by $1 million only the very basic and essential components of the visual subsystem will be fabricated and assembled for demonstration and evaluation in August 1970. The visual subsystem in each cockpit is composed of eight optical lenses, which when joined together, provide the full 340° hemispherical out-of-the-cockpit display. Only two of the eight optical windows, however, will be used in the visual subsystem to be demonstrated. The remainder of the visual subsystem will be fabricated in fiscal year 1971.

Mr. SIKES. Questions?

(No response.)

INTEGRATED CONTROL AND TACTICAL DISPLAY

Mr. SIKES. Under integrated control and tactical display, this is a new program costing $500,000. What is it?

General McNICKLE. This is to develop flight test, to demonstrate integrated control and display subsystems primarily optimized for a single pilot capability.

One system will be designed to provide the total airborne display for flight control, navigation, and weapons functions required by the fighter pilot in performing the air-to-ground mission.

Mr. SIKES. Is this a continuing program, or the development of one specific piece of equipment?

General McNICKLE. This is a continuing program to insure that advanced instrumentation subsystems are developed and evaluated before production decisions are made.

CIVIL ENGINEERING TECHNOLOGY

PROJECTS UNDER DEVELOPMENT

Mr. SIKES. Under civil engineering technology, you are requesting $2.5 million. Is this to be a continuing program?

General McNICKLE. Yes, sir.

Mr. SIKES. The descriptive summary indicates that you plan activities in such areas as the development of nonnuclear protective facilities for aircraft, personnel, POL and other high-value items.

Has this work been carried out heretofore in other areas?

General McNickle. No, sir. Only in those areas mentioned.

Mr. Sikes. It is altogether new?

General McNickle. Some of it is. We are trying to work in areas where there is not adequate information.

Mr. Sikes. This is not repetitive of any previously obtained activity?

General McNickle. No, sir. The weapons lab is working to fill the void of information concerning these critical facilities around airbases.

Mr. Sikes. How many personnel at the Air Force Weapons Laboratory at Kirtland Air Force Base are involved in this program?

General McNickle. Twenty-three people are involved in this program at the Air Force Weapons Laboratory.

Mr. Sikes. How much of this effort will be in-house effort and how much will be under contract?

General Pitts. All of the effort under this program element is by contract. However, in-house support is provided by the Air Force Weapons Laboratory, under program element, "Advanced weapons and applications."

Mr. Sikes. What are the requirements in the area of water supply and waste treatment which are unique to the Air Force?

General McNickle. Primarily, the treatment and reclamation of photoprocessing waste products and the treatment of electroplating wastes. This is in consonance with the Federal pollution control measures and the requirement to reclaim high-cost elements, such as silver, from these processing activities.

COOPERATION BETWEEN GOVERNMENT AGENCIES

Mr. Sikes. Both the Army and the Navy have similar problems to the Air Force problems in this area. The Government has new programs in these areas. Are their activities of no value to the Air Force?

General McNickle. Yes, sir, we take advantage of those programs. We will make sure the programs are coordinated and that there is no duplication, Mr. Chairman.

Dr. Lehmann. May I give an example on that briefly.

The Army, as you know, has the responsibility for the construction of pavements of air strips, for example, but the Air Force has the responsibility for the maintenance of that pavement. One of the new developments that is coming along is the C–5 and the 747 superjet aircraft. We have to come up with a program to see how our airfields are to be maintained under use by these large aircraft.

Obviously, the Army has competence because the Army has been working with this kind of thing. The Air Force has an interest in it. The FAA has an interest in it because they will be using them in commercial airports as well.

Something like half a million dollars of Air Force money is going into this program. A quarter of a million dollars of Army money $150,000 of FAA this year and another $140,000 next year of FAA money will go into it. It will be done by the Army.

The Waterways Experiment Station people at Vicksburg, Miss., are conducting this as a joint program with the Air Force, the Army, and FAA.

Again, there is the case of aircraft shelters. The Navy is working in this area. The Air Force is working in this area. Right now we are in the process of finishing some tests at Hill Air Force Base where the Air Force has three shelters and the Navy has one to try to protect aircraft in exactly the kind of situation General Boylan brought out, when———aircraft were lost in Vietnam. If we build adequate shelters we can avoid that. The three Air Force shelters and one Navy shelter are being attacked by Air Force, Navy, and Marine pilots, with bombing, strafing, napalm.

That is the kind of program we have. We are working with them and they are working with us on this.

Mr. SIKES. The Air Force has existed a long time without this program. Why is it now necessary?

General MCNICKLE. There is no question that we have been spending in this area. This is an attempt by the civil engineers and the R. & D. community to pull the thing together so there is visibility and we can coordinate all the effort that is going on.

As Dr. Lehmann pointed out, a lot will be done by the Army down there. Some will be done at this new University of Illinois Center that the Army is participating in.

REDUCTIONS RESULTING FROM CIVIL ENGINEERING RESEARCH

Mr. SIKES. Are there any offsetting reductions in other areas?

Dr. LEHMANN. We had something like half a million dollars in the exploratory development program last year, and that is out.

Mr. SIKES. Will you identify those for the record?

(The information follows:)

OFFSETTING REDUCTIONS BECAUSE OF CE TECHNOLOGY

Project 5713 "Basing Technology" in PE 62301F was funded for $535,000 last year. The work and funds appear in PE 63723F this year. Other projects are:

PE 64212F, Project 1597, "Protective Shelters for Tactical Aircraft, $195,000 in fiscal year 1969, $0 in fiscal year 1970.

PE 64708F, Project 1535, "Snow and Ice Removal," $65,000 in fiscal year 1969, $0 in fiscal year 1970.

PE 64708F, Project 5224, "Runway Flotation," $325,000 in fiscal year 1969, $0 in fiscal year 1970.

PE 62402F, "Rapid Site Preparation," about $409,000 in fiscal year 1969, $0 in fiscal year 1970.

NECESSITY FOR VARIOUS PROJECTS

Mr. SIKES. Is this $2.5 million level the probable funding level for the next several years?

General PITTS. Yes, sir.

Mr. SIKES. Questions?

Mr. MINSHALL. I would like to get back to the air landing platform, the strengthening of runways and all. How much money are you putting into this?

Dr. LEHMANN. This is for research and development on the maintenance of pavement to accommodate the superjet. The Air Force

is putting in $500,000. The Army is putting in a quarter of a million dollars. The FAA is putting in—I will have to provide the exact figure for the record, but $150,000 this year, and $140,000 next year.

Mr. MINSHALL. I get confused why you would have to research and develop it. You know what the pad is on this plane, however you refer to it. The C–5A is coming out with how many wheels?

Dr. LEHMANN. Twenty-four, on the main bogies and four on the nose gear.

Mr. MINSHALL. And it is supposed to have a lot less weight per wheel on the runway than the 747, for example.

Dr. LEHMANN. Right.

Mr. MINSHALL. If you know what the figures are, why do you have to have such a project as this? You know what the weight is, and the pad, and how much cement will hold.

Dr. LEHMANN. I think you are oversimplifying it in the sense that we knew how to build highways to accommodate ordinary trucks, but when we started putting on heavier and heavier trucks and as wheel or axle loadings went up, we had to start changing the kind of highways we built. The problem is in potential failure of the subgrade and fatigue at the concrete of existing pavements due to the total weight.

The three parties that are concerned with it——

Mr. MINSHALL. I just do not understand why a construction engineer could not get out his slide rule and figure this out based on past experience.

Dr. LEHMANN. I think the experience does not go to this kind of weight. That is the problem, sir. Our past experience took an aircraft which weighed 250,000 pounds. Now we have aircraft which are coming in at 750,000 pounds. It is just not quite safe taking the old handbook data and extrapolating that out and using slide rule to get up there by a factor of three. Also, extrapolation could result in over design and excessive construction costs.

This is a $1 million program, as you point out; $1 million represents a significant effort. But one of these aircraft is like $25 million just for the plane itself.

If I have an accident because of improper maintenance of my airstrip, I have saved pennies and lost dollars. That is the problem.

Mr. SIKES. That is an important consideration.

Mr. MINSHALL. FAA has been working on this. Navy has been working on this. Everybody is in the act.

General BOYLAN. Nobody has a pat solution.

Dr. LEHMANN. We just don't have the answer. If we had the answer, we would not do the work and we are working together.

TACTICAL INFORMATION PROCESSING AND INTERPRETATION

DEVELOPMENT EFFORT

Mr. SIKES. Is all of the funding for this effort, which is said to serve the Air Force, Navy, and the Marine Corps, Air Force funding?

General PITTS. No, the Marine Corps funds for its share of the effort; however, all funds are managed by the Air Force Systems Project Office.

Mr. SIKES. Why is the Army not included in this effort?

General BOYLAN. The Army feels that their present equipment, with some updating, is adequate until the mid-1970's. They, therefore, requested to withdraw from the TIPI development program and maintain liaison only. This was granted by OSD.

Mr. SIKES. What kind of equipment would be replaced by the new equipment under development in this program?

General BOYLAN. In most cases this program is filling a void rather than replacing equipment. Our capacity to gather information far exceeds our ability to interpret and analyze. For example, one tactical reconnaissance aircraft on one mission may return with several thousand feet of imagery. All of this must be processed and analyzed. The TIPI program is developing the equipment to automate wherever possible. It also provides additional aids to the interpreter such as measuring devices which can do a task in seconds that previously took an hour or more. In the area of film processing, we are replacing equipment with new devices which are faster and more reliable.

Mr. SIKES. The justification indicates $30 million total estimated development cost for this program. If this equipment is successfully developed, how many sets of equipment would be required by the Navy, Marines, and Air Force, and what will be the probable unit cost of this equipment?

General BOYLAN. First, the Navy has a unique requirement. Their equipment is more or less permanently affixed to a ship. The Air Force and Marines need mobile, air transportable facilities. This program is developing this capability for the Air Force and Marines. It will, however, be compatible with the equivalent Navy shipboard system. The TIPI system is composed of five segments. Each echelon, from squadron up to Air Force level, will have a capability tailored to its needs and consisting of one or more segments. Each segment has a specific function but may have a variable number of vans depending on the tasks being performed. For example, one organization may require color processing facilities within its segment while others will not. We are presently planning on buying 953 mobile shelters involving 19 different functions. Since several different functions and configurations are involved, an average cost will be quoted, remembering that individual segments vary in equipment and facilities. The Air Force expects to buy 66 image interpretation segments at $2 million each, 56 image processing segments at $1.5 million each, nine display control storage and retrieval segments at $4 million each, seven tactical electronic reconnaissance processing and exploitation segments at $2 million each, and a total support segment investment of $27 million. This adds up to $293 million production cost. The Marine Corps is buying a total of 10 systems for an average of $5.75 million per system. These systems are composed of segments with varying equipment and facilities depending on the operational need.

Mr. SIKES. How urgent a requirement is this? You budgeted $4 million in this area last year and reduced the amount to $3 million. Is the deferred effort included in the fiscal year 1970 request?

General BOYLAN. This requirement is very urgent. Our capacity to obtain information is continuing to increase more rapidly than our ability to reduce it to useable intelligence. It is very difficult to quantify

this in terms of reduced combat capability. On April 1, 1968 we did estimate the need for $4 million; however, we continued analyzing our needs. By July 1968 it was determined that we could reduce the fiscal year 1969 effort by $1 million without slowing the program. This saving was in two major areas: one, through leasing a computer and using facilities at Langley AFB, we could reduce our initial display, control/storage and retrieval segment costs; second, we felt that the fiscal year 1969 development costs for the image interpretation segment had been over estimated therefore we reduced the funding requirement. A new budget of $3 million was then submitted.

Mr. SIKES. How much of the work in this program is being done in-house and how much under contract?

General MCNICKLE. Nearly all funded work is under contract. We manage the program and provide test subjects, facilities, and some test materials, but the equipment is developed under contract.

JOINT ADVANCED TACTICAL COMMAND, CONTROL AND COMMUNICATIONS PROGRAM

DEVELOPMENT PROGRESS

Mr. SIKES. You are requesting $2 million for a project entitled "Joint Advanced Tactical Command, Control and Communications Program" $1.7 million was provided for this activity in the current fiscal year. This program is designed to improve the compatability of the command and control systems of the military services.

What progress can you report on this effort?

General MCNICKLE. In fiscal year 1969, $1.7 million was provided initially for this program, but $500,000 was subsequently reprogramed. Of the remaining $1.2 million, $500,000 was allocated to a mass memory development, $250,000 was allocated for the contract definition phase of the AN/TPQ-27 (ground radar bombing system for both the Air Force and Marine Corps), and $450,000 allocated later for the development phase of the AN/TPQ-27, $1.5 million is to be made available to the Marine Corps to continue development of the AN/TPQ-27, and $500,000 is to continue the mass memory development. Since the mass memory contract was only signed in June 1969 and and negotiations have not yet been completed on the AN/TPQ-27 contract, the first progress reports have not been received by the Government on either of these efforts.

Mr. SIKES. How does the U.S. Air Force lightweight mass memory project contribute to the compatability of command and control equipments of the three services?

General MCNICKLE. The Air Force lightweight mass memory project fills a void in the state-of-the-art mass memory developments. The memory is ruggedized and meets standards of all the services and, thus, could be used in aircraft, submarines, and gound vehicles. The extreme reduction in size and its modular construction make it appropriate to a very wide range of applications. The nature of the storage technique allows storage of data of any given word lengths. The mem-

ory will operate over a wide range of speeds and will interface with different computers by changing no more than six plug-in cards.

Mr. SIKES. How does the radar bombing system which is included in this item relate to command control and communications?

Mr. HANSEN. The radar bombing system can provide accurate position information to an aircraft to vector it to a surface target. This system provides the vital control information essential under adverse weather conditions or at night. When employed as described, a system like the radar bombing system becomes a major subelement of the command and control system controlling the strike aircraft.

TACTICAL JAMMING SYSTEM

RELATION WITH OTHER ECM PROJECTS

Mr. SIKES. You are requesting $2.4 million for a project entitled "Tactical Jamming System." How does this project relate to other ECM activities in the Air Force?

General BOYLAN. This program is related to other ECM activities in that they all fall within the realm of electronic warfare; however, this program element is more restrictive since it pertains to only tactical ECM support aircraft which augment the ECM capability of strike/reconnaissance aircraft.

Mr. SIKES. The fiscal year 1969 budget requested $3 million for this project. Only $1 million was allocated. Does this indicate difficulty in this program?

General MCNICKLE. It reflects first, a slip in the initial operational capability (IOC) date established for an advanced tactical jamming system (ATJS), and second, an indefinite postponement of an advanced system. We are now going to examine, in depth, tactical jamming modernization. If a new advanced system is deemed the most practical approach for providing an ECM capability, then additional funds will be required in fiscal year 1971.

Mr. SIKES. Are the items deferred in 1969 included in the 1970 request?

General MCNICKLE. No. These funds will be used to examine alternatives.

Mr. SIKES. Does the total estimated cost of ——— for this program include the ——— prototype EB-66 aircraft for which you propose to award a contract in early fiscal year 1970?

General MCNICKLE. No, the ——— figure was the estimated R. & D. cost for the program; the entire cost of the ——— prototypes was estimated to be ———.

Mr. SIKES. If the prototype EB-66 aircraft are successful in the test and evaluation phase, how many such aircraft do you plan to procure and at what cost.

General MCNICKLE. The proposed program was for two prototypes plus ——— production aircraft at a total cost of ———. However, there is some question that we will proceed with these aircraft—we are reexamining the whole question of tactical jamming.

Electronic Warfare Systems

MAJOR TASKS IN PROGRAM

Mr. Sikes. You are requesting $12 million in fiscal year 1970 for electronic warfare systems. The sum of $15.7 million was programed in this area in fiscal year 1969. List for the record the major tasks included in this program.

(The information follows:)

ELECTRONIC WARFARE SYSTEM

The major tasks under this program are:

1. Project 4700, electronic warfare quick reaction capability (QRC). This project provides the means for the Air Force to respond, on a quick reaction basis, to urgent operational requirements generated as a result of changes in the threat or threat estimates.
2. Advanced jamming system ———.
3. Electrically steerable antenna ———.
4. Expendable countermeasures ———.
5. Precision antenna measurement system. Design, fabrication, and installation of an antenna measurement facility to dynamically measure electronic countermeasures antenna patterns and antenna gain and to measure aircraft radar cross section.
6. Air Force electronic warfare evaluation simulator (AFEWES). Funds are used to update and modify the laboratory simulations of enemy radar systems contained in the AFEWES.
7. SADS III. SADS III (simulated air depense system) is a simulation ——— radar system to be installed at Eglin AFB, Fla., for flight testing of electronic warfare equipment and tactics.

OBJECTIVES OF PROJECT

Mr. Sikes. Why is not the development of the EB-66, which we just discussed, included in this program, which is described as providing for development of all tactical air command electronic countermeasures mission-dedicated operational aircraft?

Mr. Hansen. The objectives of this program are threefold: (1) provide for engineering development of electronic countermeasures systems and subsystems for all operational aircraft (tactical, strategic airlift, etc.); (2) provide for electronic warfare laboratory simulators; and (3) provide for electronic warfare R. & D. flight test simulations and instrumentations of enemy defensive systems. The scope of this program, as it now exists (funding and manpower), does not include development of complete systems, such as that proposed for the EB-66. However, as can be seen from the listing of major tasks under this program, it does include development of electronic countermeasures subsystems for the EB-66.

Mr. Sikes. Do you plan the development of any specific new systems under electronic warfare systems?

Mr. Hansen. Yes. For example, the advanced jamming system briefly described in the listing of major tasks will be a complete, integrated system consisting of a receiver, jammer, computer, and antennas.

Mr. SIKES. Describe the multiple engagement simulation facility which you propose to initiate development of in fiscal year 1970, under this program? What is the purpose of this facility and what will be its cost?

Mr. HANSEN. The multiple engagement simulation analyzer—MESA will be a laboratory facility which will provide real time simulations of several enemy radar systems simultaneously. Several aircraft, 20 or more, can be "flown" in this environment using multiple penetration aids ———. The result, or outcome, will be the determination of effectiveness of the penetration as a function of tactics and penetration aids used. It is anticipated that the MESA would be used primarily to evaluate operational penetration tactics along with multiple penetration aids in near real world multiple radar environment consisting of the whole spectrum of defensive radar systems—surface-to-air missile systems, airborne intercept radars, acquisition radars. The total cost of the MESA is estimated to be about $20 million over a 4- to 5-year period for design, fabrication, and installation.

OTHER OPERATIONAL EQUIPMENT

BARE BASE SUPPORT

Mr. SIKES. One of the new projects under the heading "Other operational equipment," for which you are requesting increased funds in fiscal year 1970 is "Bare base support," for which you are requesting $2,050,000.

What is the mission of this activity?

What has been accomplished in this area to date, and what are your future plans?

General BOYLAN. The bare base support project is developing the base operating support equipment and facilities required for rapid air deployment to and sustained operations from bare/austere operating locations. It includes billet and work shelters; hangars; expandable shelters with integrated aircraft maintenance equipment, kitchen and latrine facilities; utility systems; and airfield operating equipment. All equipment is designed for extended operational life, minimum weight and cube, erection by the user with minimum effort, and transportable by C–130. The basic objective is to develop a mobility capability for the required corollary support forces which can match the inherent mobility of strike aircraft; 30 development tasks have been supported through fiscal year 1969 with prototype production started on 23. A demonstration deployment of an F–4 squadron using this prototype equipment is scheduled which will highlight and define deficiencies in both current inventory equipment and the new prototype equipment. This project will continue in a new program element structured to support the pressing requirements of all USAF forces for common mobility support equipment. This will provide maximum standardization of equipment within the Air Force and, as much as possible, with the other services. It will also permit orderly incorporation of advanced concepts and techniques into this type of equipment with the goal of the optimal mix of mobility, investment, employment cost, and recoverability.

MEDICAL EQUIPMENT

Mr. SIKES. For the record tell us what kinds of medical equipment do you plan to develop under the aerospace medical equipment line, for which you are requesting $960,000 and have had in the area of $1 million in each of the past 2 years?

Also tell us what have been some of your recent accomplishments in this area?

(The information follows:)

AEROSPACE MEDICAL EQUIPMENT

The kind of medical equipment developed under the aerospace medical equipment line is principally oriented toward support of Air Force operations, such as transportable medical treatment facilities and evacuation of patients. The fact that over 300,000 patients were evacuated by air during the past year accentuates the need to provide optimal inflight medical care for these patients since a majority are combat wounded from SEA. For example, we plan to develop (1) a *Special Airborne Medical Care Unit* (SAMCU) to provide an enclosure in which the atmosphere can be continuously controlled and special medical care provided for very seriously ill patients. Thus such patients may be air evacuated without being exposed to the infections of other air evacuated patients. An excellent example of the use of the SAMCU would be for seriously ill patients with extensive burns who are to be air evacuated to the Army Burn Center in San Antonio.

Also (2) a *Forward Casualty Staging Facility* for receiving, sheltering, providing temporary medical care, treatment and processing of patients to be transported by air to definitive care centers from forward air strips and bases. (3) Additionally, an operational problem for the flight nurse is the ability to communicate with patients in a noisy inflight environment. Therefore, we will develop a new *Patient-Nurse-Call System* for Air Evacuation aircraft.

Some of our recent accomplishments in this area are:

(1) *Air Transportable Hospital.* Consists of seven modular elements (outpatient, medical ward, surgical ward, surgical treatment, combination pharmacy and supply, combination laboratory and X-ray, and dental) to provide the medical support of the bare base program.

(2) *Nebulizer-Humidifier.*—Provides a continually controlled humidity level for individual patients in Air Evacuation aircraft not containing humidity control. An example of patients requiring this would be those with cardio-pulmonary problems, where a marked deviation in humidity could produce an irreversible physiological condition resulting in death.

(3) *Isocare Unit.*—Provides a small environmental control system to isolate and provide medical care to the individual patient, especially those with communicable diseases. In this manner a patient may be air evacuated without jeopardizing the health of other onboard patients already in a weakened physiological condition.

Additionally a number of minor improvements in air evacuation techniques and procedures were developed, such as a portable liquid oxygen system, new litter suspension and lamp systems and disposable litter pads.

INTELLIGENCE/RECONNAISSANCE EQUIPMENT

OBJECTIVES OF PROJECT

Mr. SIKES. Describe the Tactical Intelligence Exploitation System, the development of which you propose to initiate in fiscal year 1970 with $900,000?

General MCNICKLE. The Tactical Air Forces Intelligence Exploitation System (TAFIES) is a single integrated intelligence system, utilizing standard equipment, procedures, and techniques to provide

total all-source intelligence for planning, development, training and operations of Tactical Air Command forces which may deploy to combatant commands or other Air Force component commands. The initial system will consist of a Tactical Air Force Intelligence Center (TAFIC) at Heaquarters TAC providing direct support to the numbered air forces and subordinate units. The total system comprises the organization, manning, facilities and programs, which, by utilizing the latest multisource intelligence data handling technology, will better serve tactical commanders on a timely basis. Program responsibility is assigned to the assistant chief of staff, intelligence. Research and development is supporting the TAFIC requirements analysis; tactical data base design; experimentation in an operational environment with on-line, multiple source intelligence analysis techniques under development; and prototype hardware required to generate, handle, and display both computerized and non-digital data base materials.

Mr. SIKES. How does this relate to the tactical information processing and interpretation project discussed earlier?

General BOYLAN. Deployable facilities of TAFIES elements are being developed under TIPI. The intelligence reconnaissance equipment program is responsive to the needs of fixed facilities (TAFIC). In the stateside garrisoned mode, TAFIES elements, using TIPI equipment, will receive updated data base materials from the TAFIC, and maintain them in a state of readiness to deploy. In the deployed mode, these elements will receive and process (using TIPI equipment) source information from collection resources and pass the products of exploitation to deployed command and control facilities and higher, lateral, and lower intelligence echelons.

AMENDMENT/ORDNANCE DEVELOPMENT

DEVELOPMENT OF LIGHT VEHICLE LANDMINE

Mr. SIKES. Discuss the light vehicle landmine, for which you are requesting $1.6 million in fiscal year 1970 and for which $1 million was programed in fiscal year 1969.

What landmines in the inventory of the Air Force and the Army will this proposed light vehicle landmine replace?

General MCNICKLE. The light vehicle mine is a small ——— mine, dispenser delivered, capable of destroying vehicles as heavy as armored personnel carriers. It utilizes a ——— warhead. Over 500 can be carried in each dispenser and delivered in either dive or level modes. ———. Cost effectiveness studies to date show it to be a very desirable addition to the inventory. A 30-month engineering development program begins in June 1969.

The LVM will not replace any air delivered mine currently in the Air Force or Army inventory. It represents a new capability. Only one other air delivered antivehicle mine exists. This is the CBU-33 which is specifically designed for use against tanks.

Mr. SIKES. Does the Army in its R.D.T. & E. program have any air-dropable landmines under development?

Mr. HANSEN. Close coordination is maintained with the Army in the mine development field. A joint services operational requirement for mines is currently being staffed by the services. To date all Army mine developments have been for low speed Army aircraft.

Mr. SIKES. Why should this item be developed by the Air Force rather than by the Army?

Where is the development of this item being done?

What is the total estimated development cost of the light vehicle landmine?

Mr. HANSEN. The Air Force is more familiar with the unique requirements imposed by high-speed carriage and delivery. The Air Force has had more experience in the development of air delivered mines. Mines are developed to satisfy Air Force requirements in deep interdiction as well as in support of friendly ground forces.

The LVM is being developed by the Armament Development and Test Center, Eglin AFB, Fla.

The total development program is estimated to cost approximately $5,500,000.

Mr. SIKES. What advantages will the landmine under development have as compared with other landmines in the inventory and under development by both the Air Force and the Army?

General BOYLAN. The only other air-delivered antivehicle mine in the inventory of any of the services is the CBU-33. It is specifically optimized to defeat tanks. The Army has one mine in development which is an antitank weapon. The light vehicle mine is much smaller and cheaper than either of these mines. It is designed for use against a range of vehicles from jeeps to armored personnel carriers. The LVM will cover much wider areas than the antitank systems. All cost effectiveness studies to date show that it will be a valuable addition to the inventory.

AERIAL CRATERING MUNITION

Mr. SIKES. You are requesting $500,000, the same amount as was provided last year for development of an aerial cratering munition. What is involved here, what are the objectives of this program, and what do you estimate to be the total cost of this development?

General MCNICKLE. The objective of the aerial cratering munition is to develop a munition that is capable of cratering—destroying runways, roads, bunkers, parking aprons, and similar targets more effectively than existing munitions. The munition will be compatible with tactical fighter-bomber aircraft. This will be the first munition specifically designed for this purpose and will be capable of supersonic carriage and dispensing either in a dive or low level delivery. The cratering mechanism of this munition is such that it will penetrate at least ——— of reinforced concrete and detonate below the penetrated surface. This subsurface explosion breaks up the surface of the target, producing cracks, mounds, and ridges and destroys the runway base material. This type of damage is much more difficult to repair compared to present munitions. The estimated total development cost is $900,000 over 3 fiscal years—fiscal year 1969–71. Because of a late start, only $300,-

000 was expended in fiscal year 1969. Anticipated fiscal year 1971 funding is $100,000.

GRASSHOPPER

Mr. SIKES. You are requesting $900,000 for the initiation of development of a new Grasshopper antipersonnel mine. What are you seeking in this program, what is your estimated total cost of the proposed Grasshopper mine and when do you plan to complete development of this item?

General MCNICKLE. The Grasshopper is a popup-type antipersonnel mine ———. With this item we are seeking a quantum increase in antipersonnel mine effectiveness with a munition that is also cost effective. ——— R. & D. cost is estimated to be $2.2 million. Development should be completed in 3 years.

REDEYE MISSILE

Mr. SIKES. You are requesting $2.9 million for initiation of development effort involving the Army's Redeye missile. What proposed Air Force application of this missile is contemplated?

Mr. HANSEN. In order to satisfy a requirement for a missile with a close-in dogfight capability, we examined several alternative solutions. One was to explore the feasibility of adopting the Army shoulder-launched Redeye for use in the air-to-air role as the Redeye air-launched missile, RAM. If these tests were successful, then additional development funds for preproduction would be required. Therefore, we requested $2.1 million. The $2.9 million you are citing includes additional funds for the Arnold Engineering Development Center. The tests indicated the Redeye would not offer advantages over current, or soon to be available, air-to-air missiles.

Mr. SIKES. What is the estimated cost and what is development time schedule of your Redeye missile effort?

Mr. HANSEN. The estimated cost for the Redeye missile development effort was $2.1 million to cover a 9-month period ending in June 1970.

IMPROVED AIRCRAFT FIREFIGHTING EQUIPMENT

COST AND BENEFITS OF PROGRAM

Mr. SIKES. You are requesting $1.5 million for studies in the area of improved aircraft firefighting equipment. Only $50,000 was provided for this effort last year. What is your requirement for the greatly increased funding in this area. Why could you not continue a study program in the area of $50,000 a year in this area?

General MCNICKLE. The basic purpose of the effort is to accomplish a triservice coordinated program in long-term development of crash rescue equipment. One of the first tasks assigned to the system program office was to develop, in conjunction with the Army and the Navy, a coordinated R. & D. program. This effort is represented in the fiscal year 1970–75 program. A few basic requirements were recognized in the original OSD directive which established the program; development of test criteria and development of techniques for relating size and capability of equipment to large aircraft. The $50,000 applied to this program in fiscal year 1969 was to initiate these efforts. Since al-

most no R. & D. effort has ever been applied to the crash rescue function other than component development, the study effort alone required to properly define the equipment requirements for future operational environments is extremely large.

Mr. SIKES. Commercial manufacturers frequently upgrade their firefighting equipment. As we discussed in the procurement hearings in this area, the advent of the new, much larger passenger-carrying aircraft will probably generate a requirement for new and large firefighting equipment for commercial airports. This commercial firefighting equipment must have a very high capability since many lives are involved in fires in commercial aircraft.

Why must you have an Air Force funded program in this area?

Mr. HANSEN. Commercial manufacturers of this type of equipment have historically made very little effort to conduct R. & D. in this area. Their improvements normally include only the incorporation of the latest model standard components. This point was stressed by industry spokesmen at the last national fire department instructors conference and the basic reason was that there is insufficient volume and profit in the business to justify it. This is particularly true in the crash rescue area which represents a small portion of the total fire truck industries volume. No single company can undertake the program required to produce a large increase in capability even in just improving the basic design of present equipment, much less the effort required to establish the design requirements for equipment needed to provide fire suppression for jumbo aircraft. This program includes very close coordination with the FAA to insure the work will be compatible with and will support civil aviation needs.

Mr. SIKES. Under your 5-year plan, what do you plan to spend in each of the next 5 years in this area? You can provide that for the record.

(The information follows:)

The planned program is as follows:

	Millions
Fiscal year 1970	$1.5
Fiscal year 1971	2.5
Fiscal year 1972	2.0
Fiscal year 1973	1.5
Fiscal year 1974	1.5

IMPROVED AIRCRAFT GUN SYSTEM

TYPES OF GUNS BEING DEVELOPED AND COST

Mr. SIKES. You are requesting $10 million for the initiation of a new program for the development of improved aircraft guns. What new guns are proposed in this program? Also, does this line item include both the new air-to-air gun using caseless cartridges to be used on the F–15 and the new 30 mm. air-to-ground gun proposed for the AX?

General MCNICKLE. Two major developments are included in the program. Both the new [25 mm.] caseless round gun system for the F–15 and the 30 mm. gun system for the AX.

Mr. SIKES. What is the estimated total development cost and time required for the new F–15 gun which is said to be a ——— mm. gun

which will use caseless ammunition as well as conventional ammunition?

General PITTS. To date we have spent about $1.6 million. We anticipate that the balance of the program will require ——— million and will be completed in time for operational use in ———.

Mr. SIKES. What part of this cost is associated with the development of a caseless ammunition?

General MCNICKLE. Approximately 40–60% of the total system cost is devoted to ammunition development and test.

Mr. SIKES. What is the estimated total cost and time period required for development of the new 30 millimeter close ground support gun proposed for the AX?

General MCNICKLE. Total development cost is estimated to be ——— million. The development program should be completed in time for operational use in ———.

Mr. SIKES. Would this gun be retrofitted into any other aircraft or is it exclusively for the AX as you see it now? What would be the cost of retrofitting the gun into other existing aircraft into which you anticipate placing this new gun?

General BOYLAN. At present the 30-millimeter gun is primarily for the AX, but it can be used on other tactical aircraft and gunships used to attack ground targets. It can be installed in a pod which can be carried under the wings of an aircraft. Firm plans have not been made to date for retrofit in other aircraft. Therefore, no estimate as to retrofit cost is available at this time.

NEED FOR DEVELOPMENT OF TWO GUNS

Mr. SIKES. Why must you develop two new guns? If you develop a new ——— millimeter gun for air-to-air, why could it not also be used in firing at ground targets?

General MCNICKLE. The ——— is optimized for air targets (aircraft) whereas the 30-millimeter gun is optimized for the tough ground targets including tanks. The targets determine the characteristics of the gun system. The ——— air-to-air gun will not be effective against the tough ground targets such as tanks. A general purpose gun will not be optimum in either of the two missions: Air to air and air to ground.

Mr. SIKES. For the record will you compare the rate of fire of the two new guns with that of the 20-millimeter M–61 gun which is now in the inventory?

(The information follows:)

20-millimeter gun M–61 (present gun), 6,000 rounds per minute.
——— gun ——— (variable).
30-millimeter gun ——— (variable).
The ——— gun will get up to its maximum rate of fire in less time than the 20-millimeter M–61. This is an important consideration when the enemy takes violent evasive maneuvers and the time on target is short.

Mr. SIKES. For the record will you also make a general comparison of the important characteristics of existing guns and the two new guns?

(The information follows:)

The current 20 millimeter gun M–61 is a general purpose gun whereas the 25 millimeter and 30 millimeter guns are optimized, respectively, for the air-to-air and air-to-ground roles.

The current 20 millimeter gun fires a copper cartridge cased round; the 30 millimeter gun will fire an aluminum cartridge cased round; the ——— gun will fire a caseless round. ———. In the case of the 25 millimeter gun the probability of hit is enhanced since the time of flight of the projectile is short. ———. In the case of the 30 millimeter gun the heavy projectile (almost one pound) will have an appreciable antitank capability and a greatly increased range against softer targets such as APC's, trucks, personnel, and so forth. ———.

Arnold Engineering Development Center

Mr. Sikes. You have changed the method of funding the Arnold Engineering Development Center by placing this center under industrial funding so that the users budget for the funds rather than the funds being budgeted in a line item for the center. For the record will you tell us how much money is scattered throughout the Air Force budget for the Arnold Engineering Development Center?

Also what is your estimated funding program at this center for fiscal year 1970 as compared with fiscal years 1968 and 1969?

(The information follows:)

The programed amount for fiscal year 1970 is $42,127 million. This compares to $42.6 million in fiscal year 1968 and $42 million in fiscal year 1969.

Test Instrumentation

COST OF PROGRAM

Mr. Sikes. You are requesting $6.5 million for test instrumentation. This compares with $6 million in fiscal year 1969 and $8.9 million in fiscal year 1968. The material submitted in support of the fiscal year 1969 budget last year indicated a fiscal year 1969 obligation of $14.1 million as compared with the $6 million estimate you now show, and indicated an estimated program of $10.8 million in fiscal year 1968 instead of $8.9 million actual amounts shown.

Explain these decreases, or did you shuffle the budget line items so that these are only apparent decreases?

General McNickle. The fiscal year 1969 test instrumentation program was reduced from $14.1 to $6 million; $5.7 million represents an actual program reduction in two increments, $2.9 and $2.8 million described herein.

The Air Force fiscal year 1969 test instrumentation program request to OSD was reduced from the $14.1 million program approved by Congress to $11.2 million. This reduction of $2.9 million was made because some of the Air Force test programs requiring instrumentation support were reduced or deferred. Accordingly, $11.2 million appeared to be sufficient instrumentation development support for the programs remaining in the fiscal year 1969 budget.

During the apportionment reviews, OSD/D.D.R. & E. reduced the $11.2 million program by $2.8 million to $8.4 million as a result of the Revenue and Expenditures Control Act of 1968 (Public Law 90–364).

The program was further reduced by $2.375 million because two projects in this element were transferred from this element to PE

64705F, electronic warfare systems. These were Project 4339, Air Force weapons effectiveness test elements ($790,000), and Project 6510, defense systems instrumentation ($1,585,000).

The result of all of the above changes was that the fiscal year 1969 test instrumentation program was reduced to $6.025 million.

The fiscal year 1968 program was retroactively adjusted to provide an adequate basis of comparison with the fiscal year 1969.

Mr. SIKES. What items deferred in fiscal year 1968 and fiscal 1969 are included in the fiscal year 1970 budget?

General MCNICKLE. The fiscal year 1970 test instrumentation program does not include items deleted or transferred from this program in fiscal year 1968 and 1969, except for one task at the Air Force Western Test Range. This task was a small study to determine a method to provide for impact location and recovery of missile hardware which lands in the Vandenberg Air Force Base offshore area.

INFORMATION ANALYSIS CENTER

REDUCED FUNDING IN 1969

Mr. SIKES. The justifications in support of fiscal year 1969 budget indicated that $3.2 million was programed for the Information Analysis Center in fiscal year 1969. Your data supporting the fiscal year 1970 budget indicates that $2.5 million was programed in this area in fiscal year 1969. What is the reason for this change?

Mr. HANSEN. The $3.2 million estimate for fiscal year 1969 was based on normal growth of the information analysis centers with continued full funding by the DOD. The reduction was made in anticipation of the implementation of service charges for the products of the information analysis centers in accordance with present DOD policy. Even though unforeseen difficulties prevented implementation of the charges as extensively or as rapidly as expected, the $2.5 million funding in fiscal year 1969 was adequate to maintain the level of effort essentially the same as in fiscal year 1968. (Fiscal year 1968 funding was $2.2 million.) This program is now under careful review to determine the actual extent to which service charges can be applied and how much of the operating costs of the centers they can be expected to offset. Future funding will be determined on the basis of experience gained in fiscal year 1969 and fiscal year 1970.

LOCATION OF CENTERS

Mr. SIKES. For the record will you tell us where these centers are located?

(The information follows:)

Defense Metals Information Center, Battelle Memorial Institute, Columbus, Ohio.

Thermophysical Properties Research Center, Purdue University, West Lafayette, Ind.

Electronic Properties Information Center, Hughes Aircraft Co., Culver City, Calif.

Mechanical Properties Data Center, Belfour Stulen Inc., Traverse City, Mich.
Defense Ceramics Information Center, Battelle Memorial Institute, Columbus, Ohio.
Machinability Data Center, Metcut Research Associates, Inc., Cincinnati, Ohio.
Reliability Analysis Center, IIT Research Institute, Chicago, Ill.

Mr. SIKES. Why could not user charge plans be established for these centers now? Why must you wait until fiscal year 1973 to take this action?

General MCNICKLE. User charges were being initiated by some of information analysis centers prior to fiscal year 1970 and are included in all centers in fiscal year 1970 with progressively decreasing Air Force funding planned for subsequent years. The fiscal year 1973 phaseout of Air Force funds is intended to assure an orderly transition while obtaining a more accurate appreciation of the longer range workloads and demands which will be placed on the various centers by Government and industry under this new arrangement. The intent of this gradual phaseout on our part is, therefore, to avoid sudden imbalances in financial support which could prove disruptive to the missions and operations of these centers.

JOINT TASK FORCE 2 INSTRUMENTATION SUPPORT

Mr. SIKES. Last year you requested $6.6 million for instrumentation support for Joint Task Force 2, which was engaged in the testing of aircraft and aircraft weapons. The justification material before us now indicates that no funds were programed in this area in fiscal year 1969. What happened to the $6.6 million and what was the reason for this change?

General MCNICKLE. The $6.6 million was reprogramed to various R.D.T. & E. programs by Reprograming Action No. 69-30, dated December 5, 1968.

The JTF-2 was established as a result of the Secretary of Defense approval of WSEG Report 74, "Concepts for a Program of Low Altitude Penetration Tests," on July 21, 1964. These concepts established basic guidelines for the conduct of a low altitude test program and for a joint task force test organization later designated JTF-2.

On March 16, 1968, the Deputy Secretary of Defense requested the Joint Chiefs of Staff complete an evaluation of the JTF-2 low altitude test program. Since funds and other resources required to support the JTF-2 program have become increasingly critical, due to Southeast Asia operations, the Joint Chiefs of Staff agreed with the Weapons Systems Evaluation Group that the JTF-2 program cannot continue to generate basic data for which there was no specific requirement.

On April 16, 1968, the Joint Chiefs of Staff recommended that the JTF-2 should be disestablished as early as practicable, but in any case not later than the end of the current year, 1968.

On April 24, 1968, the Deputy Secretary of Defense concurred in the recommendation to terminate testing by JTF-2 and to disestablish the force as early as practicable.

ELECTROMAGNETIC COMPATIBILITY ANALYSIS CENTER

FUNDING OF CENTER

Mr. SIKES. The project listing indicates that you are requesting $5.6 million for the Electromagnetic Compatibility Analysis Center in fiscal year 1970. You programed $5 million for this activity in fiscal year 1969 and $4.7 million in fiscal year 1968.

The justification book presented to the committee, in the analysis of the funding of the Federal Contract Research Centers, found on page 48, indicates a requirement for a $4.7 million for the Electromagnetic Compatibility Analysis Center. The Installation Analysis on page 24, shows a requirement for $700,000 for this activity.

What is the total amount programed for fiscal year 1970 and will you explain the inclusion of funds for the center in more than one place?

General PITTS. The total amount programed for fiscal year 1970 is $5.6 million, as stated in the project listing. The amount identified in the analysis of funding of the Federal Contract Research Centers represents only funds to be placed on contract. The remaining funds shown in the Installation Analysis represent in-house costs such as salaries and travel of Air Force civilian employees and related support costs.

Mr. SIKES. How many contractor employees are employed at the Electromagnetic Compatibility Analysis Center and what is the total cost?

General PITTS. Approximately 280 contract employees. The number varies slightly during the year according to the contractor's needs, and the turnover of employees. The fiscal year 1969 contract of $4.5 million in 11 months resulted in a total annual payroll of $3.6 million. Remaining contract funds went for rental and maintenance of the computer and related equipment utilities, supplies, and travel. Roughly proportionate distribution can be expected for fiscal year 1970.

Mr. SIKES. How many Government civilian employees are employed at this center, and at what total cost?

General PITTS. There are 43 civilian spaces authorized for fiscal year 1970 and $700,000 is programed to cover this cost. The cost is distributed as follows:

Civil service salaries	$661,000
Military/civil service travel	36,000
Training and awards	3,000

Mr. SIKES. How many military personnel are assigned to this center and what is the cost of the salaries and allowances of these personnel?

General PITTS. Nine Air Force personnel are authorized for fiscal year 1970 (4 officers and 5 enlisted men). The programed Air Force military personnel budget is $84,000 for their pay and allowances. In addition, the Army, Navy, and Marine Corps each assigns an officer to the center.

Mr. SIKES. For the record well you tell us the five top salaries of contractor personnel at the Electromagnetic Compatability Analysis Center?

(The information follows:)

The five top salaries of IIT Research Institute (IITRI) personnel, as of May 1, 1969, at the Electromagnetic Compatibility Analysis Center are:

Number:	Annual salary
2	$25,200
1	24,300
1	22,800
1	21,600

Mr. SIKES. The justification states that the Air Force provides all the funding for this center. Has this been true since the center was established by DOD in 1960?

General PITTS. No. Funding was distributed among the services in fiscal year 1967 and several prior years. The fiscal year 1967 distribution was approximately: Army—$1.5 million, Navy—$1.4 million and Air Force—$1.8 million.

PERIOD OF CONTRACT

Mr. SIKES. Discuss for the record the conversion from an 11-month contract in fiscal year 1969 to a 12-month contract in fiscal year 1970. Why was there an 11-month contract in fiscal year 1969?

(The information follows:)

Shortened contracts were used in several previous years as follows: fiscal year 1967, 11 months; fiscal year 1968, 10 months; and fiscal year 1969, 11 months. The purpose was to bring the contract period more into coincidence with the fiscal year so as to avoid forward financing and aline the contract funding with the fiscal year. The fiscal year 1969 contract expires July 31, 1969, leaving a month's interval between the beginning of the fiscal year and the contract date to allow for preparation and processing of the contract.

Mr. SIKES. Also for the record tell us some of the recent significant contributions to national defense made by this Center?

(The information follows:)

The center collects and maintains the DOD data base on equipment characteristics, locations, and terrain data. Computer programs accounting for propagation phenomena, frequency assignment, and the equipment characteristics allow interference prediction early in the equipment life cycle during concept or design rather than after the fact in the field. Important systems which have been or are being studied include Sentinel (Safeguard), Mallard, Harpy, Sanguine and OTH radar. The ECAC analysts not only conduct preliminary computer and paper studies, but they work closely with the system design engineers and field site survey teams to provide dynamic assistance as the work progresses.

LINCOLN LABORATORY

LEVEL OF EFFORT

Mr. SIKES. You are requesting $23 million for the Lincoln Laboratory, the same as the amount provided in the current fiscal year and $50,000 more than the actual amount for fiscal year 1968.

In addition to the $23 million in this line item, what other Air Force funds are programed for Lincoln Laboratory in fiscal year 1970, how does the total sum compare with those of the 2 previous years?

General PITTS. In addition to the $23 million shown in the line item, the Air Force has programed $6 million for ABRES and $50,000 for efforts on aerospace avionics. The total Air Force programs at

the laboratory during fiscal year 1968 and fiscal year 1969 were $28.74 million and $29.20 million respectively.

Mr. SIKES. Has the price of a technical manyear of effort at Lincoln Laboratory increased in the past year?

Mr. HANSEN. The cost per MTS has increased over the past year by roughly 5 percent due to inflation/cost of living increases. We expect this trend to continue during fiscal year 1970 and plan to reduce the MTS level at Lincoln by approximately 5 percent to offset the anticipated increased costs.

Mr. SIKES. The descriptive summary, in the discussion of the fiscal year 1970 program at Lincoln Laboratory, is very general. No specific programs are mentioned. Is Lincoln Laboratory pursuing any Air Force program other than the ABRES program?

Mr. HANSEN. In addition to the ABRES effort, Lincoln Laboratory is pursuing, for the Air Force, major programs in general research, military space communications and infiltration interdiction. The general research program includes advanced research in solid state electronics, information processing, radar, integrated circuits, and radio physics. The space communications program develops new technology and techniques to meet the basic requirements of future military satellite communications systems. The infiltration interdiction effort explores the use of advanced radar equipments to detect small individual targets under various conditions.

Mr. SIKES. The Lincoln Laboratory was brought into being in support of the semiautomatic ground environment (SAGE) system in the 1950's. Can you point to any significant contributions of the Lincoln Laboratory in the past year?

Mr. HANSEN. Lincoln's contribution during the past year has been significant in many areas. Unique communication experiments involving Lincoln experimental satellite No. 6 (LES–6) and terminals installed in highly mobile weapon carriers such as aircraft and ships have been conducted over extended distances. The services have procured limited terminal equipments and are using LES–6 to define an operational system. Decoys and jammers have been demonstrated under the ABRES effort. The general research effort has produced a CO_2 laser radar which has been used for precision satellite tracking. The infiltration and interdiction effort has produced equipments which permit detection of slowly moving vehicles at night or underfoliage from airborne platforms and detection of moving personnel in foliage at distances up to a few miles. These are a few examples of the application of Lincoln's efforts.

Mr. SIKES. What would be the effect of termination of the Lincoln Laboratory contract?

Mr. HANSEN. The Air Force depends upon Lincoln Laboratory to establish a technology base in the areas of data systems, solid-state research, radar, integrated circuits research, space communication and radio physics. We have been very careful not to duplicate the Lincoln capability elsewhere within the Air Force. Therefore, termination of the contract with Lincoln Laboratory would create a void in our overall technology program. In order to fill this void, an effort to cover the technology areas being investigated at the laboratory would have to be initiated at some other facility. This would be extremely difficult to do in a timely manner due to manpower ceilings and the impact on

the important programs now in progress at other Air Force laboratories. Further, the technical expertise of the Lincoln Laboratory staff in highly specialized fields would be most difficult to duplicate.

MITRE Corp.

FUNDING AND PERSONNEL SUPPORTED

Mr. Sikes. The request for the MITRE Corp. for fiscal year 1970 is $12.5 million. The same amount has been allocated for this line item in the 2 previous fiscal years.

For the record will you tell us the total sum anticipated to be spent with MITRE Corp. from R.D.T. & E. Air Force funds in fiscal year 1969 and how does this amount compare with the previous 2 fiscal years?

(The information follows:)

	Fiscal year—		
	1967	1968	1969
R.D.T. & E. (3600):			
Basic line	$12,500,000	$12,500,000	$12,500,000
Other separately funded programs	9,441,000	6,508,000	7,425,000
Total R.D.T. & E.	21,941,000	19,008,000	19,925,000

Mr. Sikes. How many personnel are supported from Air Force appropriations allocated to the MITRE Corp. and how many of these employees are supported with R.D.T. & E. funds?

General Pitts. The contract with MITRE Corp. is negotiated with the provision that the contractor shall furnish a specified number of direct man-years of technical staff effort plus the necessary support personnel. Requirements for support personnel are estimated on a 1.1-for-1 basis. The estimated number, subject to negotiation, of members of the technical staff (MTS) planned for MITRE support to the Air Force in fiscal year 1970 is 575, of which R.D.T. & E. supports 472 and other appropriations support 103.

SUPPORT OF COMMUNICATION SYSTEMS

Mr. Sikes. To what extent has the MITRE Corp. been responsible at least in part for the proliferation of communications systems in the military in the past decade? Does MITRE on occasion tell the Air Force that the Air Force needs a certain new type of communications system on which MITRE then undertakes a part of the development effort?

Mr. Hansen. In our opinion there has been no unwarranted proliferation in Air Force communications systems. These systems have expanded only to meet validated operational requirements. MITRE's unique contribution has been to assure that new systems which increase capacity are compatible with existing interrelated ground and airborne components, and subsequently assist in the required acquisition effort.

The mechanics of the Air Force/MITRE relationship place the final control of the MITRE program and tasks performed by MITRE

personnel in the hands of the Air Force. Initiative in development of the total program rests with the Air Force. In general, the bulk of MITRE effort is expended in performance of the systems engineering/technical direction (SE/TD) role on approved programs.

In the area of development planning in which new systems originate, the Air Force identifies its requirements largely from requirements statements originating with the using commands, or as a result of its own in-house planning activities. MITRE supports the Air Force by analyzing Air Force stated requirements in terms of Air Force proposed solutions.

The Air Force/MITRE relationship is however dynamic with the two activities working as a team. Clearly if an idea or modification to an Air Force originated solution is perceived by MITRE, the day-to-day relationship provides for the free exchange of this idea; but the decisionmaking authority and control remains always with the Air Force. This relationship has resulted in discarding some proposed systems just as it has generated new concepts for systems application. The proliferation of new systems has been no greater in Air Force communications than has been reflected in the rapid evolution and application of communications technology throughout American society.

In general, MITRE does not identify needs for new communications systems but rather assists the Air Force in validating requirements and directing the required acquisition effort. Experience over the last decade has been that the need for MITRE SE/TD support on approved programs has been so great as to limit their development planning and new systems application role.

NEED FOR LARGE PROGRAMS AT MIT

Mr. SIKES. The basic program for MITRE Corp. is $12.5 million. The basic program for Lincoln Laboratory, which is another offshoot of the Massachusetts Institute of Technology, is $23 million. MITRE is working on more than a dozen specific Air Force programs. Lincoln is working on only two.

Why must we spend so much more money with Lincoln for the basic program which keeps the laboratory in being than we do for MITRE?

Mr. HANSEN. While Lincoln and MITRE are both considered an FCRC, the specific role of each FCRC is different.

MITRE provides advanced planning support, and systems engineering/technical direction (SE/TD) of funded programs. The advanced planning role includes the technical analysis of requirements; formulation of objectives and innovative plans; and the formulation of systems performance and design criteria. The SE/TD role provides technical advice and independent problem solving capability during systems acquisition.

Lincoln performs advanced research and development pertinent to national defense with particular emphasis on advanced electronic, radar, communications, physics, and information processing. The effort under this project consists of studies in two areas—general research (solid state research, radio physics, integrated circuit research, radar, and data systems) and space communications. The ability to lead the field and successfully pursue advanced projects stems largely from the well balanced program in the basic sciences from which reservoir the

necessary talents are available to undertake selected projects from the Department of Defense.

The Lincoln Laboratory has maintained an essentially constant level of support (MTS). Due to the nature of their business, the requirement for indepth engineering investigation or research and experimentation, which is not required to the same degree to fulfill the MITRE role, creates a need for fabrication of working models and machinery and equipment for a dynamic research program whose objective is to advance the state-of-the-art in an era of expanding technology.

Aircraft Navigation System Verification

NEED FOR NEW RESEARCH ACTIVITY

Mr. Sikes. You are requesting $600,000 for the initiation of a new activity entitled "Aircraft navigation system verification." What is the purpose of this new program?

Mr. Hansen. The program is new in name only. In previous years it has been part of the advanced avionics program element. The objective of the program is to provide a means of implementing a DOD (D.D.R. & E.) policy which directs all services to test inertial systems at the central inertial guidance facility at Holloman prior to selection for a weapon system application and to make the selection based on the Holloman test data.

Mr. Sikes. Where is the central inertial guidance test facility to which reference is made in the justification material? Is this an Air Force facility or a contractor facility or an Air Force-owned contractor-operated facility, or what?

Mr. Hansen. The central inertial guidance test facility is located at Holloman AFB in New Mexico. It is an Air Force-owned, Air Force-operated, completely in-house "blue suit" effort. In recognition of this unique facility, DOD directed that all services test inertial equipment at the CIGTF prior to purchase for weapon system application.

Mr. Sikes. What is the anticipated annual cost of this effort for the next 5 years?

General McNickle. The anticipated annual cost of this effort is $600,000 per year.

PROGRAMWIDE MANAGEMENT AND SUPPORT

International Military Headquarters and Agencies

REASON FOR BUDGETARY CHANGE

Mr. Sikes. Describe the new program element "International military headquarters and agencies," for which you are requesting $474,000?

General McNickle. The Supreme Headquarters Allied Powers Europe (SHAPE) Technical Center (STC) located in The Hague, Netherlands, is assigned the mission of supporting SHAPE's scientific efforts. Its staff of approximately 100 highly qualified scientists from all NATO countries includes 19 U.S. civil service employees.

These U.S. personnel are involved in all of the broad spectrum of STC programs which encompass the areas of force structure analysts, command and control studies, communications studies within Allied Command Europe, engineering services, cost effectiveness studies, and research/support studies and services. This program element pays the salaries and allowances of the 19 U.S. civil service employees. Prior to fiscal year 1970, these personnel were supported from the military assistance program (MAP) rather than the Air Force R.D.T. & E. appropriation.

Mr. SIKES. Why was the decision made to change the funding of this effort from the military assistance program to the R.D.T. & E. program?

General PITTS. The Air Force acted in response to program budget decision 381, December 10, 1968. OSD furnished the Air Force the following explanation for the PBD.

Justification for transfer of International Military Headquarters funding from MAP to service appropriation. The program for International Military Headquarters is directly related to the support of U.S. forces and, therefore, is properly chargeable to the cost of U.S. forces. IMH programs for NATO, the costs of which comprise about 90 percent of the total, are closely related to the NATO infrastructure program. The infrastructure program was transferred in the fiscal year 1968 budget to the military functions budget, but the IMH program was not. It is our belief that IMH should be viewed in the same context as NATO infrastructure and transferred to the military functions budget. The IMH program finances the U.S. share of operating costs of the NATO command structure. This program is complemented by the military departments which provide military personnel, funded from service appropriations, to staff the command structure. In addition, the facilities and communications systems utilized by this command structure are constructed under NATO infrastructure. Completion of major systems; e.g., early warning, NATO air defense ground environment (NADGE), and NATO satellite communications system (Satcom), under the infrastructure program result in increased IMH costs for their operation. All three of these related programs are a function of the same factors that determine the relative size and cost of maintaining U.S. forces in Europe. None, including IMH, is a function of the factors entering into military assistance grant aid. Transfer of funding from MAP to service appropriations will permit more responsive programing, budgeting, funding, and administrative control of this program.

BUDGET ITEMS

Mr. SIKES. Are all of the 19 U.S. civil service employees whose salaries are included in this line item located in the Netherlands at the SHAPE Technical Center?

General PITTS. Yes. All are employed at the SHAPE Technical Center.

Mr. SIKES. What items other than the salaries and allowances of the 19 U.S. civil service employees are included in this item? How much of the $474,000 is for salaries and allowance of employees?

General PITTS. None; the entire amount of $474,000 is for salaries and allowances of the employees.

NATO is committed to pay the salaries of these employees at NATO pay scales which amounts to $260,700. This amount is returned to the United States and credited as part of the U.S. contribution to NATO.

INTERNATIONAL COOPERATIVE RESEARCH AND DEVELOPMENT

CONTROL OVER TRAVEL

Mr. SIKES. The fiscal year 1970 request for funding of international cooperative research and development is $200,000, as compared to the $225,000 programed in fiscal year 1969. How many military and civilian employees of the Air Force have traveled from the United States to Europe in connection with this effort in fiscal year 1969 thus far?

General MCNICKLE. There were 255 travelers from July 1, 1968, through June 30, 1969.

Mr. SIKES. How is this program monitored so that it does not become merely a nice trip to Europe for persons desiring such a trip? How do you attempt to be sure that each trip is necessary?

General MCNICKLE. The Office of the Assistant for International R. & D. programs, Headquarters, U.S. Air Force, reviews every trip in support of international cooperative R. & D. Before a proposal for an individual to travel is forwarded to Headquarters, U.S. Air Force, for review, it is reviewed and approved at major command headquarters.

During fiscal year 1969 an added degree of control was exercised when AFR 172–12 directed that all travel to international conferences be approved by the Vice Chief of Staff of the Air Force. This regulation was based on DOD Directive 5000.15, February 17, 1968, with changes 1 and 2, which implemented BOB Bulletin No. 68–8, February 14, 1968.

CONTROL OVER DISCLOSURE OF CLASSIFIED INFORMATION

Mr. SIKES. Review for the committee the security criteria in the information exchange program. How do we enter into information exchange agreements and programs and still protect our military secrets?

Mr. HANSEN. The security criteria for the information exchange program is derived from the "National Policy and Procedures for the Disclosure of Classified Military Information to Foreign Governments and International Organizations," published by the Department of State. These criteria are applied on a case-by-case basis.

We establish our information exchange programs with other countries by joint collaboration of technical people to establish the general scope of the program and the lowest classification at which meaningful work or exchange can take place. Each country then reviews this proposed program for compliance with its national disclosure policy and signs the necessary agreement. ———. Our agreements may specify any level of classification up to secret.

These agreements further specify the protection that each country will give the information obtained from the other. There are provisions for in-country review of the measures taken to protect U.S. information.

Mr. SIKES. As part of the fiscal year 1969 program, you mention exchange of information with Sweden in the area of ———. In general, what kind of information has been given by the United States in this effort and what information has been given to the United States in this effort?

General MCNICKLE. None, as yet. We are negotiating with Sweden for an exchange of this type.

TOTAL FUNDING

Mr. SIKES. In the O. & M. hearings, it was developed that the Air Force plans to spend O. & M. funds at some international R. & D. organizations. Why?

General MCNICKLE. When OSD, in program/budget decision 381, December 10, 1968, directed the transfer of funding of International Military Headquarters from MAP to the military services, they included a detailed breakdown of the service, type of funds, and organization being funded. O. & M. funds totaling $241,000 were specified as the Air Force contribution to international R. & D. organizations.

Mr. SIKES. Provide for the record a listing of the international R. & D. organizations to which you plan to provide funds and indicate the amount programed for each by appropriation.

(The information follows:)

From O. & M. for international R. & D. organizations:	
U.S. share (24.2 percent) of NATO approved fund allocation for the Von Karman Institute for Fluid Dynamics (VKI)	$115,000
U.S. civilian personnel at VKI	69,000
U.S. civilian personnel at the advisory group for aerospace R. & D. (NATO)	57,000
Total	241,000
From R.D.T. & E. for international R. & D. organizations:	
SHAPE technical center	$474,000

DEVELOPMENT AND TEST SUPPORT

FUNDING REQUIREMENT

Mr. SIKES. You are requesting $125.8 million in fiscal year 1970 for development and test support. This is $4.2 million more than the $121.6 million provided in fiscal year 1969.

Is there any other cause of these increases other than the classified civilian personnel pay raise?

General PITTS. The fiscal year 1970 request of $4.2 million over fiscal year 1969 is primarily needed for the civilian graded pay raise—$3.1 million—that was effective July 1968, and the range support contract—$1.5 million—at the Armament Development Test Center, Eglin Air Force Base, Fla. These increases totaling $4.6 million were offset by a decrease of $0.4 million for civilian position adjustments.

Mr. SIKES. Will you list for the record at this point the sum to be programed at each of the facilities receiving funds from this line item?

(The information follows:)

[Dollar amounts in millions]

	Fiscal year 1970
Air Force Flight Test Center	33,424
Air Force Missile Development Center	23,259
Air Force Armament Development Test Center	54,471
Air Force Special Weapons Center	14,667
Total development and test support	125,821

Mr. SIKES. What is the relationship between funds requested under this line item and funds requested for laboratories under the other budget activities?

For example, under "Missiles and related equipment," you are requesting $10.4 million for support of the Air Force Rocket Propulsion Laboratory operation at Edwards Air Force Base. In the line item which we are now discussing, you are requesting funds for support of the Air Force Flight Test Center at Edwards Air Force Base. Why is the center funded in this line item while the laboratory is funded under budget activity 3?

General PITTS. AFFTC is funded in the program-wide management and support budget activity since the latter provides across-the-board support to Air Force facilities other than the laboratories. Each exploratory development program element, however, is listed in the budget activity which most nearly characterizes its primary mission interests. This includes the operation of laboratory, as well as the contractural efforts which it sponsors. This arrangement has been instituted so that the laboratory commander may have all of his exploratory development resources in a single line, for maximum technical and administrative flexibility.

Mr. SIKES. The data on page 31 of the justification book in the installation analysis on the flight test center at Edwards Air Force Base indicates that it is proposed in fiscal year 1970 to obligate $32,998,000 at the Flight Test Center for "Air Force facilities operated by the Air Force."

In addition, it is estimated that $426,000 will be obligated under "Air Force facilities operated under contract." Are both of these sums included in their entirety in the development and test support line item?

General PITTS. Yes. Both of these sums are included in their entirety in the development and test support line item.

Mr. SIKES. What was the impact of the personnel ceiling imposed under section 201 of the Revenue and Expenditure Control Act on personnel funded under "Development and test support"? To what extent were these personnel funded here exempted as being related to the war in Vietnam?

General PITTS. The impact of the personnel ceiling imposed under section 201 of Revenue and Expenditure Control Act was a reduction of 342 authorizations in this program element.

Mr. SIKES. What additional personnel are requested in fiscal year 1970?

General MCNICKLE. The planned number of civil service employees in fiscal year 1970 is 158 less than authorized in fiscal year 1969. Therefore no new personnel will be requested.

Mr. SIKES. In round numbers, what part of the funds requested for "Development and test support" is for each of the three categories listed on page 331, that is, (1) the pay and related cost of civilian personnel, (2) travel transportation, rents, communications, and utilities, and (3) contractual services, supplies and equipment?

General PITTS. The total request of $125.9 million consists of: (*a*) pay and related costs of civilians, $70.9 million; (*b*) travel, transportation, rents, communications, and utilities, $11.2 million; and (*c*) contractual services, supplies, and equipment, $43.8 million.

Mr. SIKES. Under the new arrangement of program elements in this area, it is difficult to compare the activities of last year with activities this year. What is the total amount requested last year for the elements which now make up development and test support, and what is the amount programed?

General PITTS. The total amount requested last year for the elements which make up development and test support was $131.5 million. The current programed amount is $135.3 million.

ACQUISITION AND COMMAND SUPPORT

FACILITIES SUPPORTED

Mr. SIKES. You are requesting $182.9 million for acquisition and command support as compared with a sum for comparable activities in fiscal year 1969 of $168.9 million. What part of the requested increase is directly related to the classified civilian pay raise?

General PITTS. The overall increase of $14 million includes $5.6 million for the classified civilian pay raise which was effective on July 1, 1968.

Mr. SIKES. Provide for the record a listing of the organizational components which make up the requirement for $182.9 million, show the amount requested for each in fiscal year 1970, and the comparable sums for fiscal years 1968 and 1969.

(The information follows:)

[In millions of dollars]

Division	Fiscal year 1968	Fiscal year 1969	Fiscal year 1970
The Air Force Aeronautical Systems Division	71.2	74.9	76.8
The Air Force Electronic Systems Division	28.7	28.4	33.1
The Air Force Space and Missile Systems Organization	28.2	28.5	30.4
The Air Force Aerospace Medical Division	4.4	4.8	4.9
The Air Force Office of Aerospace Research	3.1	3.1	3.2
The Air Force Systems Command Headquarters	21.3	29.2	34.6
Total	156.9	168.9	183.0

The $14 million requested increase over fiscal year 1969 is primarily needed for depot level maintenance ($3.2 million), civilian graded pay raise ($5.6 million), items formerly funded for under other R.D.T. & E. programs ($2.4 million) and conversion of range telemetry system ($2.8 million).

Mr. SIKES. Are any new employees included in the request for fiscal year 1970?

General McNickle. The fiscal year 1970 request is 205 below the fiscal year 1969 level; therefore, no new personnel are requested.

Mr. Sikes. What was the effect of the personnel ceiling under section 201 of the Revenue and Expenditure Control Act on personnel paid under this line item?

General Pitts. The impact of the Revenue and Expenditure Control Act was a reduction of 306 personnel in this program element.

Mr. Sikes. Why are you requesting such a large increase in support of the Headquarters of the Systems Command? The justifications show that for requirements here, including the pay of 1,158 civilian personnel, you are requesting $5.4 million increase. This can be compared with your requested $2 million increase for the Aeronautical Systems Division which supports 5,120 civilian employees. It would not seem that the civilian employee pay raise would account for the magnitude of the increase in headquarters support? What other increased items are included here?

General Pitts. The increase of $5.4 million is primarily associated with depot maintenance industrial funding that was previously funded under other appropriations. In addition, a management support effort for the Eastern Test Range ($1.1 million) was assumed by Headquarters Air Force Systems Command and the cost of the civilian pay raise which became effective on July 1, 1968 constitute the balance of this increase.

Mr. Sikes. You are requesting an increase of approximately $4.5 million for the Electronics System Division in costs other than military personnel. The amount estimated for fiscal year 1970 is $33 million as compared with $28.4 million in fiscal year 1969. What is your justification for this increase?

General Pitts. The increase of $4.5 million is comprised of $3.9 million for the UHF conversion of the AFFTC and ADTC range telemetry systems (as directed by DOD for completion by May 1, 1970). The conversion program is managed by the Electronic Systems Division. The remaining $0.7 million consists of various small increases.

REVISED FISCAL YEAR 1970 RESEARCH PROGRAM

Mr. Sikes. I would like to have submitted for the committe's use the fiscal 1970 Air Force R.D.T. & E. program which has been proposed for apportionment, and I would like to know how this program differs from the revised budget program. There are differences and I would like to have them spelled out for the record.

General Pitts. We will provide that, Mr. Chairman.

(The information follows:)

Apportionment Approval

The attached table compares the fiscal year 1970 R.D.T. & E. budget submitted to the Congress, as revised, with the apportionment program proposed by the Air Force to OSD June 1, 1969. It should be noted that the totals of both programs are the same, and do not consider subsequent actions by the Congress. The table does not indicate the actions by OSD which resulted in a tentative approved apportionment pending final congressional action.

[In thousands of dollars]

Project No.	Project	Fiscal year 1970 President's budget	Fiscal year 1970 proposed apport.
610	AIRCRAFT AND RELATED EQUIPMENT		
11115F	FB-111A squadrons	84,920	45,400
11133F	SR-71 squadrons	3,000	3,000
27121F	A-7 squadrons	3,100	1,100
27129F	F-111 squadrons	73,737	126,300
27214F	RF-111 squadrons	15,000	10,000
35116F	Aerial targets	2,200	2,000
41119F	C-5A airlift squadrons	34,202	34,200
62201F	Aerospace flt. dynamics	30,819	33,200
63202F	Acft. propulsion subsys. integ	9,000	9,000
63203F	Adv. acft. navigation	7,000	5,600
63204F	Light intratheater transport	1,000	1,000
63205F	Flt. vehicle subsystems	7,600	7,500
63207F	Adv. fire control/missile tech	3,000	3,000
63208F	Adv. recon. and target acquis. tech	5,000	5,000
63211F	Aerospace struct. mats	9,500	9,500
63212F	Hypersonic vehicle tech	2,000	2,000
63214F	VTOL eng. dev	12,000	10,000
63215F	Adv. avionics	7,400	8,800
63216F	Adv. turbine eng gas gen	5,000	8,500
63217F	AMSA (B-1)	100,184	100,200
63225F	Subsonic cruise armed decoy	17,135	20,000
63226F	National clear air turb. prog	1,600	1,000
63229F	CONUS air def. interceptor	18,500	18,500
63230F	Close air support weapons	5,000	.....
64201F	Advanced rescue sys	3,000	.....
64206F	F-4 avionics	.....	6,500
64207F	V/STOL acft. (U.S./FRG)	1,000	2,000
64209F	F-15A	175,117	175,100
64210F	Adverse weather aerial delivery	4,500	4,100
64211F	A-X aircraft	12,000	11,000
64212F	Acft equipment development	14,500	14,500
	Total	668,014	678,000
620	MISSILES AND RELATED EQUIPMENT		
11118F	SRAM squadrons	84,668	84,700
11213F	Minuteman squadrons	339,440	334,400
11214F	MICCS	20,000	20,000
12429F	NIKE targets	8,000	7,000
62301F	Adv. weapons and applications	7,500	8,900
62302F	Rocket propulsion	28,680	25,200
63302F	Adv. ASM guid. tech	4,200	5,700
63303F	Air launch missile propulsion	1,278	1,300
63304F	Tactical AGM X-3	3,000	1,000
63305F	Adv ICBM technology	20,000	15,000
63306F	Short range tac. air-to-air missile	14,000	14,000
63311F	Adv. ballistic reentry system	121,434	115,000
63314F	Strat. bomber penetration	3,000	2,100
64301F	AGM-65A Maverick	39,600	39,600
64304F	AIM 4-D growth missile	2,700	4,800
64307F	Hard rock silo development	50,000	50,000
65301F	Western Test Range	68,465	69,800
65302F	Eastern Test Range	160,938	142,300
	Total	976,903	940,800
630	MILITARY ASTRO AND RELATED EQUIPMENT		
12816F	Program 949	73,719	73,700
31018F	Program 417	9,500	9,500
33110F	Defense sat. comm. sys	20,800	20,800
34111F	Special activities	159,800	159,800
35110F	Satellite control facil	37,200	36,700
35119F	Titan III space booster	41,968	41,500
35121F	MOL	525,300	525,300
62401F	Aerospace biotechnology	21,081	21,100
62402F	Aerospace propulsion	30,753	28,100
62403F	Aerospace avionics	50,108	46,400
62404F	Space studies	1,800	1,800
63401F	Adv. space power supply tech	2,000	2,000
63402F	Space exper. support	19,300	16,600
63404F	Satellites, balloons, and rockets	4,000	4,000
63406F	Adv. space guidance	7,044	6,000
63408F	Adv. liq. rocket technology	11,000	11,000
63409F	Def. subsys. dev. and demonstration	12,900	12,900

[In thousands of dollars]

Project No.	Project	Fiscal year 1970 President's budget	Fiscal year 1970 proposed apport.
630	MILITARY ASTRO AND RELATED EQUIPMENT—Continued		
63410F	Tactical satellite communications	8,000	4,600
63411F	Spacecraft tech. and adv. reentry	500	4,400
63416F	Expandable structures	500	----
63421F	Sat. sys. for precise navigation	1,000	3,000
63422F	Adv. Sat. 2d prop. sys	500	500
63423F	Space data relay subsystem	1,000	1,300
63424F	Adv. sensor technology	1,500	7,000
63425F	Graphitic reentry materials	2,000	----
644F	Satellite data relay system	----	600
65402F	Aerospace	24,700	24,700
	Total	1,067,973	1,063,300
670	OTHER EQUIPMENT		
11311F	SACCON	800	800
11312F	PACCS	500	500
11313F	ERCS	1,500	800
11321F	Special purpose com	5,000	4,000
12410F	AWACS	60,000	60,000
12417F	CONUS OTH radar	3,000	3,000
12425F	OTH radar system	3,000	2,000
27412F	Tactical air control system	3,700	3,200
28012F	Defense Com. Planning Group	19,000	15,000
31011F	Cryptologic activities	6,800	5,000
31014F	100th Strat. Recon. Wing	3,000	20,000
31015F	Tech. sensor collection	7,400	400
31017F	Clear Sky	9,600	8,600
31025F	Intelligence data handling system	2,200	1,500
32016F	NMCS-wide support (WWMCCSADP)	1,000	1,000
33112F	AIRCOM	1,500	1,500
35114F	TRACALS	1,500	13,400
41214F	Air cargo mats handling	3,000	1,000
62701F	Conventional munitions	7,958	8,500
62702F	Ground electronics	40,463	37,900
62703F	Human resources	4,000	5,000
63F	Nonnuclear kill technology	----	1,200
637F	Helicopter borne radar	----	1,000
637F	Missile and space defense	----	2,000
63702F	OTH radar technology	2,000	2,000
63703F	Air traffic control and landing dev	1,500	----
63704F	Advance devices	6,500	6,500
63706F	Adv. tac. command and control	1,500	4,000
63707F	Sat. com term., tactical	1,500	1,500
63708F	Airborne sat. com. term., strategic	2,000	2,000
63709F	Loran D	1,500	2,300
63710F	Adv. airborne command post	2,000	1,000
63711F	Hi energy laser program	8,000	8,000
63713F	Tri-service lt wt radar	1,700	1,700
63714F	Base security	1,600	1,600
63715F	Recon/intelligence exploitation	2,500	2,500
63716F	Conventional weapons	7,000	8,600
63717F	BW/CW program	1,000	----
63718F	Pen aids manned aircraft	13,000	11,000
63719F	Air-to-air combat simulator	1,000	1,000
63722F	Integrated ctrl. and tac. disp	500	500
63723F	Civil engineering technology	2,500	2,000
63726F	Aero Chart Info Center (ACIC)	2,500	2,000
63727F	Integrat con/nav/ident (CNI)	500	1,000
647F	EXOATMOS rad det sys (Have Bird)	----	300
64701F	Tac. info. process and interpretation	3,000	3,000
64702F	ATCRBS/AIMS	1,000	700
64703F	JATCCS	2,000	2,000
64704F	Tactical jamming system	2,400	500
64705F	Electronic warfare system	12,000	12,000
64706F	Life support system	4,000	8,400
64707F	C/B equipment	2,856	1,000
64708F	Other operational equipment	10,200	12,000
64709F	Lt. weight precision bombing	500	2,900
64710F	Int/recon. equipment	10,000	10,000
64711F	Systems survivability	1,100	1,100
64712F	ARM/ORD development	10,878	11,800
64714F	Improved acft. firefighting equip	1,500	1,000
64715F	Integrated prog. air base def	----	1,700
64717F	Improved acft. gun sys	10,000	13,700

[In thousands of dollars]

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64718F	Cobra Mist	13,600	13,600
64719F	AEDC testing technology	4,501	7,600
65701F	Test instrumentation	6,510	6,500
65702F	Info. Anal. Center	2,200	2,200
65704F	Electromag Compat, Anal. Center	5,600	5,400
65705F	Lincoln Laboratory	23,000	23,000
65706F	MITRE	12,500	12,500
65708F	Acft navig. sys. verification	600	600
	Total	385,16F	410,000
680	MILITARY SCIENCES		
61101F	In-house lab. ind. res	5,300	5,300
61102F	Defense res. sciences	94,873	90,052
62101F	Environment	11,000	9,800
62102F	Materials	25,737	24,100
63101F	Prelim. des./dev. planning	4,539	5,000
63102F	Innovations in educ. and training		3,500
65101F	RAND	15,600	12,600
65102F	ANSER	1,600	1,600
	Total	158,699	151,952
690	MANAGEMENT AND SUPPORT		
658F	Studies and anal., Air Force		748
65801F	International coop., R. & D	200	300
65805F	Development and test support	125,821	143,900
65806F	Acquisition and command support	182,950	176,700
01004F	International mil. hq. and agencies	474	500
	Total	309,445	322,148
	Total	3,566,200	3,566,200

Mr. SIKES. Thank you very much gentlemen for appearing here.

General PITTS. Thank you, Mr. Chairman.

Mr. SIKES. The committee stands adjourned until tomorrow at 10 a.m. when we will begin consideration of the budget estimates for research and development for the Department of the Army for fiscal year 1970.

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