DEPARTMENT OF DEFENSE APPROPRIATIONS FOR 1970

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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 5

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION

Department of the Army
Statement of Director, Advanced Research Project Agency
Statement of Director, Defense Research and Engineering

Printed for the use of the Committee on Appropriations

U.S. GOVERNMENT PRINTING OFFICE
86-554 WASHINGTON : 1969

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DEPARTMENT OF DEFENSE APPROPRIATIONS FOR FISCAL YEAR 1970

TUESDAY, JULY 1, 1969.

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION, ARMY

WITNESSES

CHARLES L. POOR, ACTING ASSISTANT SECRETARY OF THE ARMY (RESEARCH AND DEVELOPMENT)
LT. GEN. AUSTIN W. BETTS, CHIEF OF RESEARCH AND DEVELOPMENT
MAJ. GEN. LEONARD B. TAYLOR, DIRECTOR OF THE ARMY BUDGET
BRIG. GEN. BERNARD R. LUCZAK, PROJECT MANAGER, MAIN BATTLE TANK, ARMY MATERIEL COMMAND
COL. GEORGE M. SNEAD, DIRECTOR OF ARMY RESEARCH, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT
COL. NELSON W. TOBEY, DIRECTOR OF MISSILES AND SPACE, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT
COL. JOE B. LAMB, ACTING DIRECTOR OF DEVELOPMENTS, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT
COL. ALBERT E. JOY, CHIEF OF PROGRAMS AND BUDGET, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT
COL. ROBERT J. LUNN, CHIEF OF AIR DEFENSE AND MISSILES, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT
COL. MERRITTE W. IRELAND, CHIEF OF TECHNICAL COORDINATION DIVISION, OFFICE, MAIN BATTLE TANK PROJECT MANAGER
COL. ROBERT V. KANE, OFFICE, DIRECTOR OF THE ARMY BUDGET
LT. COL. LESLIE H. GILBERT, CHIEF OF AIR MOBILITY, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT
LT. COL. ROBERT A. BONIFACIO, AIR MOBILITY DIVISION, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT
LT. COL. DONALD A. NIXON, AIR MOBILITY DIVISION, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT
LT. COL. ROBERT L. RUSSELL, MISSILE DEFENSE AND SPACE DIVISION, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT
LT. COL. JESSE B. DOSS, MISSILE DEFENSE AND SPACE DIVISION, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT

LT. COL. WILLIAM C. HIESTAND, COMBAT MATERIAL DIVISION, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT

LT. COL. WILLIAM E. DISMORE, JR., NUCLEAR, CHEMICAL, AND BIOLOGICAL DIVISION, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT

MAJ. COLBERT L. DILDAY, COMMUNICATIONS-ELECTRONIC DIVISION, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT

DR. MARVIN E. LASSER, CHIEF SCIENTIST, DEPARTMENT OF THE ARMY

DR. IVAN R. HERSHNER, JR., CHIEF OF PHYSICAL AND ENGINEERING SCIENCES, OFFICE, CHIEF OF RESEARCH AND DEVELOPMENT

EUGENE W. TRAPP, DEPUTY CHIEF, JOINT ENGINEERING AGENCY, OFFICE, MAIN BATTLE TANK PROJECT MANAGER

PROGRAM AND FINANCING (IN THOUSANDS OF DOLLARS)

	Budget plan (amounts for research, development, test, and evaluation actions programed)			Obligations		
	1968 actual	1969 estimate	1970 estimate	1968 actual	1969 estimate	1970 estimate
Program by activities:						
Direct:						
Military sciences	162,544	171,849	182,400	163,050	172,200	182,500
Aircraft and related equipment	138,129	117,085	127,100	124,029	132,300	123,800
Missiles and related equipment	657,997	755,339	914,900	668,321	745,400	916,600
Military astronautics and related equipment	6,590	10,600	14,000	9,989	10,500	13,400
Ships, small craft, and related equipment	110	133	500	638	400	500
Ordnance, combat vehicles, and related equipment	173,624	170,656	193,100	167,607	170,400	193,200
Other equipment	347,950	350,831	363,400	327,891	359,500	366,100
Programwide management and support	35,210	52,650	54,100	34,196	53,000	52,900
Total, direct	1,522,154	1,629,143	1,849,500	1,495,721	1,643,700	1,849,000
Reimbursable:						
Military sciences	7,886	8,000	9,500	8,820	10,000	13,500
Aircraft and related equipment	6,799	5,500	4,000	3,822	5,600	2,800
Missiles and related equipment	13,495	16,000	18,870	16,188	15,400	18,100
Military astronautics and related equipment	695	300	500	696	270	370
Ships, small craft, and related equipment	38	30	30	30	30	30
Ordnance, combat vehicles, and related equipment	14,570	16,900	17,500	8,395	18,600	19,600
Other equipment	29,409	30,000	31,000	20,516	27,800	28,000
Programwide management and support	2,971	3,270	3,600	3,197	3,300	3,600
Total reimbursable	75,863	80,000	85,000	61,664	81,000	86,000
Total	1,598,017	1,709,143	1,934,500	1,557,385	1,724,700	1,935,000
Financing:						
Receipts and reimbursements from:						
Federal funds	−74,452	−79,070	−84,100	−74,452	−79,070	−84,100
Trust funds	−419			−419		
Non-Federal sources [1]	−992	−930	−900	−992	−930	−900
Unobligated balance available, start of year:						
For completion of prior year budget plans				−219,879	−243,789	−228,232
Available to finance new budget plans	−15,446	−67,540		−15,446	−67,540	
Reprogramming from prior year budget plans	−16,721					
Unobligated balance available, end of year:						
For completion of prior year budget plans				243,789	228,232	227,732
Available to finance subsequent year budget plans	67,540			67,540		
Budget authority	1,557,527	1,561,603	1,849,500	1,557,527	1,561,603	1,849,500
Budget authority:						
Appropriation	1,505,700	1,522,665	1,849,500	1,505,700	1,522,665	1,849,500
Transferred to other accounts	−127			−127		
Transferred from other accounts	51,954	38,938		51,954	38,938	
Appropriation (adjusted)	1,557,527	1,561,603	1,849,500	1,557,527	1,561,603	1,849,500
Relation of obligations to outlays:						
Obligations incurred, net				1,481,522	1,644,700	1,850,000
Obligated balance, start of year				772,490	819,916	864,616
Obligated balance, end of year				−819,916	−864,616	−1,030,816
Outlays				1,434,096	1,600,000	1,683,800

[1] The reimbursements from non-Federal sources are primarily collections for services provided to civilians and private organizations (5 U.S.C. 172d-1 and 10 U.S.C. 2481).

OBJECT CLASSIFICATION (IN THOUSANDS OF DOLLARS)

	1968 actual	1969 est.	1970 est.
Personnel compensation:			
Permanent positions	150,556	161,827	161,590
Positions other than permanent	5,406	4,089	4,113
Other personnel compensation	2,920	3,244	3,244
Total personnel compensation	158,882	169,160	168,947
Direct obligations:			
Personnel compensation	148,778	158,169	158,104
Personnel benefits: Civilian	11,005	9,932	9,900
Travel and transportation of persons	12,479	13,016	13,677
Transportation of things	4,993	5,793	5,866
Rent, communications, and utilities	8,310	8,865	8,805
Printing and reproduction	124	120	130
Other services	1,139,877	1,274,511	1,478,569
Supplies and materials	47,567	49,512	49,625
Equipment	122,490	123,702	124,239
Lands and structures	98	80	85
Total direct obligations	1,495,721	1,643,700	1,849,000
Reimbursable obligations:			
Personnel compensation	10,104	10,991	10,843
Personnel benefits: Civilian	758	780	759
Travel and transportation of persons	610	659	617
Transportation of things	91	95	93
Rent, communications, and utilities	953	955	958
Other services	41,757	60,035	65,300
Supplies and materials	3,893	3,941	3,880
Equipment	3,488	3,554	3,550
Total reimbursable obligations	61,664	81,000	86,000
Total obligations	1,557,385	1,724,700	1,935,000

PERSONNEL SUMMARY

Total number of permanent positions	16,609	14,596	14,781
Full-time equivalent of other positions	1,067	650	650
Average number of all employees	16,262	15,089	15,048
Average GS grade	9.6	9.6	9.6
Average GS salary	$10,482	$11,155	$11,284
Average salary of ungraded positions	$7,111	$7,444	$7,618

Mr. SIKES. The committee will come to order.

Mr. Secretary, General Betts, and gentlemen, this morning the committee will begin consideration of the Army fiscal year 1970 budget request of $1,849,500,000 for research, development, test, and evaluation. The total direct R.D.T. & E. program for fiscal year 1969 was $1,629,143,000, which is $220.4 million less than the fiscal year 1970 budget request.

We have with us today Acting Assistant Secretary Poor and General Betts, who will support the fiscal year 1970 request.

BIOGRAPHY OF CHIEF OF RESEARCH AND DEVELOPMENT

General Betts, you have been with us before, but I believe this is the first appearance for Mr. Poor.

Mr. Secretary, since this is your first appearance, I think we should have biographical information in the record, and it will appear at this point.

(The biographical sketch follows:)

BIOGRAPHICAL SKETCH OF CHARLES L. POOR, ACTING SECRETARY OF THE ARMY (R. & D.)

Mr. Charles L. Poor was appointed Acting Assistant Secretary of the Army (R. & D.) on December 6, 1968. Previously he served as Assistant to the Assistant Secretary of the Army (R. & D.) from December 1960 to May 1963; and Deputy Assistant Secretary of the Army (R. & D.) from June 23, 1963, to December 5, 1968.

Mr. Poor was born in New York City on May 21, 1919; graduated from St. George's School, Newport, R.I., in 1936; and received an A.B. in Aeronautical Engineering, Harvard College in 1941.

Mr. Poor served as an officer in the U.S. Navy from 1942–46 with assignments in Naval Aeronautical Research and Development, including duties with the Aeromechanics Division of the David Taylor Model Basin, as a member of the U.S. Naval Technical Mission in Europe in 1945 and as Chief of the Bureau of Aeronautics-Taylor Model Basin project in Germany in 1946–46.

In 1946, Mr. Poor joined the staff of the Army's Ballistic Research Laboratories at Aberdeen Proving Ground, Md., as Chief of the Supersonic Wind Tunnels Laboratory. In 1949 he was appointed Chief of the Future Weapons System Agency at BRL.

Mr. Poor has served on the Guided Missiles Aerodynamics and Structures Panel of the Munitions Board, and later of the Research and Development Board. He was appointed a member of the NACA Subcommittee on High Speed Aerodynamics in 1948 and served until 1958. He has been a consultant to Sandia Laboratory of the AEC, and a member of the U.S. delegation to Tripartite Conferences in the United States, Canada, and the United Kingdom.

Professional societies include: Associate fellow, American Institute of Aeronautics and Astronautics; American Physical Society; American Ordnance Association; and Association of the U.S. Army.

Mrs. Poor is the former Edith Cowles of Chicago, Ill.

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Home address: 2266 48th Street, NW., Washington, D.C. 20007.

STATEMENT OF ACTING ASSISTANT SECRETARY OF THE ARMY (RESEARCH AND DEVELOPMENT)

Mr. SIKES. We are very pleased to have you here, Mr. Secretary. You may proceed with your statement, Mr. Secretary.

Mr. POOR. Mr. Chairman and members of the committee:

It is an honor and privilege to appear before this committee and to discuss the Army's fiscal year 1970 budget request for Army Research, Development, Test and Evaluation.

Before General Betts presents the Army R.D.T. & E. program, I would like to discuss the fundamental problems facing those of us who must recommend to the people a prudent program, adequate to assure the security of the Nation.

The march of technology opens up ever new possibilities for new weapons systems development programs—a nearly inexhaustible set of opportunities. Each new proposal, each new opportunity, must be carefully assessed, so that we can answer the question "Is this trip really necessary?" for each significant part of our program. Thus, the design of our R. & D. program consists, for the most part, of choosing, from a large number of attractive proposals, only those that are of sufficient potential importance to justify the expense.

We must not react to the new technological possibilities in so conservative a fashion as to fail to seize important new opportunities for improving our security. You will hear in what follows, some examples of the payoff, in combat, of decisions, taken some years ago, to support new technical ideas. The new nonnuclear munitions now in the hands of our troops which will be described by General Betts represent an outstanding example of the way a new idea can flow, through prudent support of basic research, exploratory development, and development for production, into a significant advance in military capability.

The breadth of the Army's requirements, the wide-ranging needs for providing the tools for our soldiers to fight effectively, wherever they may be called upon to fight, makes the business of choice more difficult for us than for our sister services. We must make choices between such disparate matters as more support for malaria control or more research on new tactical communication systems. Better clothing for the soldier demands resources as urgently as better means of defending him against air attack.

The program General Betts is about to present represents our best attempt to balance the many needs of our modern Army, to exploit the technical possibilities in a prudent program offering the promise that, in the years to come, our Army will be as well equipped as we know how, without the extravagance of technical overcomplication, and without the false economy of undersophistication.

The program has been reviewed in depth by the prior administration, with the firm objective of presenting to you just what is needed, now, for meeting the task assigned to us.

As you will hear from Secretary Laird, Secretary Resor, and Dr. Foster, the present administration has reviewed it again. We are confident that it is well-designed to meet the needs of the Army, and merits your approval.

General Betts will detail the R.D.T. & E. Army budget as distributed among the eight major budget activities established by Congress.

Within DOD, we also structure the budget by R. & D. categories 6.1 through 6.7. We use these categories in planning, programing, and managing the overall research and development effort because they represent the stages through which ideas evolve into items of operational military equipment.

I will define these categories and illustrate each by an example.

a. Research (6.1). This category (representing 5 percent of the total) includes our effort in solving basic problems in the physical, engineering, environmental and life sciences. It includes all basic research and the applied research directed toward expanding knowledge in various scientific areas of interest to the Army.

For example, laser beams have been studied to understand the physical characteristics of propagation and modulation. Now we want to know more about laser radiation. From further knowledge in this field may come methods and improved materials for protecting against the hazards of equipment operation and eventually, even countermeasures against laser beams themselves.

b. Exploratory development (6.2) (representing 13 percent of the total) is directed to solve specific military problems short of major development effort. Characteristically it includes studies, investiga-

tions and breadboard models that evaluate the feasibility of proposed solutions to specific military problems. It develops and defines the parameters of hardware which is both practical and worthy of further development.

An extensive research and exploratory development program was initiated in the 1950's to increase the efficiency of the Army's nonnuclear antipersonnel weapons. The result is a controlled fragmentation munition with a large increase in lethality. This project was conducted under Ordnance, combat vehicles and related equipment (BP 5500).

c. In advanced development (6.3) (representing 22 percent of the total) are projects and hardware undergoing experimental or operational test to prove the concept. It is in this category that we test prototypes. Some systems are too large and expensive for the test of a complete prototype. In those cases, we test the major components.

As an example, we initiated the development of a new technology 1500 HP category gas turbine engine for aircraft application in fiscal year 1968. This program is being carried out by two separate contractors pursuing different approaches to demonstrate by hardware advances in turbine efficiency and reliability. At the conclusion of this program we will be better prepared and in a competitive position to enter engineering development of an engine for application to the follow-on utility tactical transport aircraft system.

d. In engineering development (6.4) (representing 10 percent of the total) are those projects being engineered for military service, but which have not been approved for procurement or operation use.

Typical of items under this development are field artillery munitions such as: 105mm and 155mm BEEHIVE projectiles; 105mm and 155 mm rocket assisted projectiles, which allow considerable increase in range from our current guns without modification of the gun, and a laser range finder, AN/GVS-3.

e. Management and Support (6.5) (representing 16 percent of the total) includes research and development effort directed toward supporting installations or operations required for general research and development use. The cost of test ranges, maintenance support of laboratories, and operations and maintenance of test equipment are included.

White Sands Missile Range (WSMR) is a national range managed and operated by the Army for the purpose of supporting missile, aircraft, and space vehicle tests of various national programs. WSMR supports tests of the military services, ARPA, NASA, and AEC. These projects are conducted under Missiles and Related Equipment (BP 5200).

f. Operation System Development (6.7) (representing 33 percent of the total) includes efforts directed toward developing engineering and testing of systems; support programs; and vehicles and weapons that have been approved by OSD for production and military employment.

TOW, our heavy antitank assault weapon will complete engineering and service testing this year. During fiscal year 1970, further environmental testing will begin using production line missiles. This system will soon be dropped out of the R. & D. category since our work is almost completed.

Now, if it please the committee, I would like General Betts to discuss the program in more detail.

Mr. SIKES. Thank you, Mr. Secretary.

LASER BEAM PROPAGATION

Before we hear General Betts, one quick question. You stated: "For example, laser beams have been studied to understand the physical characteristics of propagation and modulation."

These studies were not within the Army's program, were they?

Mr. POOR. Yes.

Mr. SIKES. What do you mean by propagation and modulation?

Mr. POOR. Laser beams are used for a number of purposes. One of them, as I think you know, is range-finding. You send a small pulse of light from a laser. It goes out and is reflected from the target and comes back to a receiver adjacent to the laser transmitter. The time required for the bundle of light to go from the laser to the target and back is a measure of the range. Thus, a laser is something like a radar equivalent.

Laser beams are also used for communication, and they are an important candidate for missile control.

Mr. SIKES. In what way has the Army studied laser beams in connection with propagation? What kind of propagation are you talking about?

Mr. POOR. The concern here is, if you use laser beams to transmit information through the atmosphere, the temperature distribution in the atmosphere refracts the light beam and distorts the energy distribution, and thus the turbulence in the atmosphere modulates the laser beam and changes the information content.

Understanding this is important in understanding the limitations of the application of lasers for a number of things; missile guidance and control, range finding and communication.

Under this program we have had some very successful work in this area.

STATEMENT OF CHIEF OF RESEARCH AND DEVELOPMENT

Mr. SIKES. All right, General Betts.

General BETTS. Mr. Chairman and members of the committee. It is an honor to appear before this committee and bring you the Army's fiscal year 1970 budget request for Army research development, test and evaluation. We are proud of the achievements of the past year and have selected some of the items of military importance, fiscal significance and technological promise to illustrate the achievements of R. & D. since we last appeared before you.

The R.D.T. & E. budget has been formulated with the objective of fulfilling the mission of research and development. That mission is to insure qualitative superiority of weapons, equipment and capabilities of the American soldier over those of any existing or potential enemy. In the coming fiscal year, we intend to continue to fulfill this mission.

The nature of the threat to the U.S. Army and the operational characteristics of material necessary to meet that threat determine the direction of the R.D.T. & E. program. Our development process is closely coordinated with these operational requirements and is keyed to yield timely results when the items or systems are needed.

I want to call to your attention how we are meeting some of these threats. The requirements of Vietnam have had a definite impact on current R.D.T. & E. The unique requirement to conduct operations in difficult terrain against unusual tactics is being met with such developments as improved helicopters, personnel sensing devices, and new equipment for the individual soldiers.

Besides the shooting war, there is another war in Vietnam that is concerned with counterinsurgency operations. Inevitably the military must face postwar insurgency operations as well. Applied social science research is conducting work directly related to these immediate military problems. It has examined intercultural relationships, such as in civic action and adviser-counterpart relations. Continued research in support of pacification, civic action and similar military activities can provide facts for use by Army commanders and staffs.

Nor have we forgotten the numbers and types of vehicles appearing in Central Europe. The defensive capability needed to meet that threat is our development of highly effective ground-launched antitank weapons systems, such as Shillelagh, TOW, and Dragon. The main battle tank that is being developed jointly with the Federal Republic of Germany will improve both our defensive and offensive capabilities.

To reduce our vulnerability to air attack within the field Army and the CONUS, we now depend on Hawk and Nike Hercules. SAM–D is being developed to replace these two systems for both high- and low-altitude coverage and adds the capability to defeat tactical launched ballistic missles. The Chaparral/Vulcan and Redeye systems will give close air defense coverage of the forward battle areas.

We recognize the potential threat of chemical and biological weapons for use in future conflicts and we are rapidly pursuing our own development of both offensive weapons and defensive measures.

Extensive improvement of artillery is being undertaken starting with the 155 millimeter self-propelled howitzer. A Multiple Artillery Rocket System (MARS) concept is in advanced development to determine its feasibility to fulfill the requirement for an indirect fire system with an antimaterial, particularly antiarmor, capability which can rapidly deliver a large volume of fire on a target.

Our entire program has the necessary impetus and continuing development efforts to meet new threats and maintain our technological superiority consistent with minimum feasible expense. Our fiscal year 1970 budget request is for $1.849 billion and includes the budget changes as recommended by the Secretary of Defense. This compares with a request in fiscal year 1969 for $1.622 billion. The fiscal year 1969 program was appropriated $1,522.7 million by Congress and authorized reprograming of $59.3 million from fiscal year 1968 funds. The program

has been increased by a $37.9 million transfer from the Defense Advanced Research Project Agency (ARPA) for radar operations at Kwajalein Missile Range and Ballistic Missile Defense advanced development programs. We had received about $1 million from OSD emergency funds to develop chemical agents and devices for control of insurgents at the time of fiscal year 1970 budget was prepared. Also, $8.24 million has been reprogramed from prior year funds to support SEA requirements making the total $1.629 billion. Since January 1969 we have received $37 million for SEA support from the emergency fund. These transfers have been reported to the Committee in reprog.aming actions.

The budget is based on a detailed analysis of R. & D. requirements in support of the Army's mission. It contains over 600 separately identifiable projects which can be grouped in broad industrial areas, such as aircraft, missiles, ordnance, and others.

I examine it, however, in a different manner, by a program content that more clearly defines the broad objective toward which we are working.

The program may be divided into four broad categories entitled: National programs, research and exploratory development, testing and management support, and Army tactical developments.

National programs is the portion that is devoted to these projects being conducted by the Army which are of major importance to national interest. Included in this category are such items as strategic missiles, missile range support and satellite communications systems. These national programs encompass about 42 percent of the fiscal year 1970 budget. Increases in fiscal year 1969–70 apply to our Ballistic Missile Defense.

Another portion of our budget is for research and exploratory development. We rely heavily on the results of scientific research and exploratory development for new technology as the basis for future hardware, and ultimately to meet our objective of more effective weapons systems. As such, it is the foundation of, and indispensable to, the continuous conduct of R. & D. Much of the work is accomplished in-house and principally on a level of effort basis; 19 percent of the fiscal year 1970 budget will go to this category.

A third category is called testing and management support. The dominant resource involved in this category is the people who manage the R. & D. program and skillfully test its products. Our testing effort is to confirm that development items, or systems, will fulfill their military purpose in a reliable and safe manner. These costs have over the years remained relatively stable at 6 percent.

The last category is Army tactical developments. This is the program that divides the principal systems and items of equipment to support the Army's tactical missions. The total SEA program is shown under this category because most of its costs are for hardware, almost all of which has worldwide application. Currently, SEA is programed at about $200 million. The final amount depends upon receipt of requests from SEA. For fiscal year 1970, we are programing 12 percent of the budget for SEA.

Subtracting SEA, what remains is for the development of all other hardware not specifically for SEA use. This program has been funded during the past several years by the residue of the R.D.T. & E. appro-

priation, after deducting the national programs and the rising costs for basic research and exploratory development. It is these projects that have in the past been paying the price of austere budgets. The increase in fiscal year 1970 is to reverse this history of inadequate funding and to compensate for the costs of inflation and sophistication that have so long eroded our Army tactical developments program.

For example, R. & D. on new guidance systems for antitank weapons has lagged. Air defense of the Army in the field is another good example. SAM–D, the successor to Hercules Hawk, and a successor system to the Chaparral/Vulcan has been delayed.

We are still using artillery fuzes that basically utilize 1930–40 technology. We are investigating entirely new concepts of fuzing that promise greater reliability and reduction of costs, weight, and complexity.

Other examples of inadequate effort because of lack of funds are avionics and infantry small arms.

In general terms, if we are to maintain the momentum essential to insure national security, we must fund Army tactical developments at a higher level than has been the case in the past. Our fiscal year 1970 budget submission is designed specifically to do this.

Before we begin the presentation of the individual projects, I would like to discuss a development which illustrates the coupling between research efforts and weapon application. The program has made improvement in the effectiveness of our conventional munitions.

An extensive research and exploratory development program was initiated in the 1950's to increase the efficiency and effectiveness of the Army's nonnuclear antipersonnel weapons. It considered the design of weapons on a scientific basis, accurately quantifying criteria by which lethality could be predicted and controlled. The result is a fragmentation munition with a large increase in effectiveness. This program has developed a number of munitions for all three services, ranging from hand grenades to missile warheads. These munitions are designed for use by infantry, artillery, and jet aircraft. Projectiles have been designed for the 105-millimeter, 155-millimeter, and the 8-inch howitzer. All promise significant increases in effectiveness against exposed personnel. Like all other ammunition, effectiveness will diminish when used in less than optimum conditions. However, these munitions promise to be worthy complements to our already proven, and highly effective, arsenal of high-explosive ammunition. Development of these munitions is continuing to improve their versatility and effectiveness.

In order to accomplish this development, considerable basic and applied research was required in aerodynamics, metallurgy, miniaturization, wound and projectile ballistics, environmental studies, and systems analysis. The payoff of all research and exploratory development efforts was the outstanding field performance of these munitions.

I have emphasized artillery munitions, but the research has also provided new munitions for the Air Force and Navy. Concurrent with the production and fielding of the first generation improved munitions, we have vigorously continued research efforts to further increase firepower effectiveness.

I hope that I have given some insight into the importance of our basic and applied research programs and their relationship to even-

tual hardware improvements. The achievements did not just happen, but were attained through methodical research and development.

To present the details of the budget, I will call upon the members of my staff who monitor the individual fields and projects encompassed in the R.D.T. & E. program. Presentations in their particular fields of expertise will be given by Col. George M. Snead, Director of Army Research; Brig. Gen. Thomas W. Mellen, Director of Developments; and Col. Nelson W. Tobey, Director of Missiles and Space.

Army R.D.T. & E. programs are contained in eight budget programs, 5,000 through 5,700 as indicated on the following chart:

SUMMARY BY BUDGET ACTIVITY

[In thousands of dollars]

Budget program	Title	Fiscal year 1969	Fiscal year 1970
5000	Military sciences	171,849	182,400
5100	Aircraft	117,085	127,100
5200	Missiles	755,339	914,900
5300	Military astronautics	10,600	14,000
5400	Ships, small craft	133	500
5500	Ordnance, combat vehicles	170,656	193,100
5600	Other equipment	350,831	363,400
5700	Programwide management support	52,650	54,100
	Total R.D.T. & E. program	1,629,143	1,849,500

This will be the order in which we will present individual projects representative of the items contained in each. Colonel Snead, will you begin.

MILITARY SCIENCES

Colonel SNEAD. Budget program 5,000 supports research across the scientific, engineering and medical disciplines as well as the environmental, behavioral and social sciences, thereby adding to the store of fundamental scientific knowledge and leading to applications of potential military significance.

Experience has shown, and in prior year presentations the Army has emphasized, the importance of achieving a balance between work done by in-house laboratories and work under contract in the research and exploratory development areas. To maintain our in-house program, able scientists and engineers are needed to convert advances in science and technology into solutions to Army R. & D. problems. Not only must our Army laboratories be properly staffed with competent personnel, but they must also be able to monitor, evaluate, and select R. & D. proposals submitted by external sources. We also get tremendous benefit from using the innovative talent of individuals outside of the Army laboratory structure for new and novel ideas. This is the basis for a strong contractual research and development program with universities, not-for-profit organizations and industry.

During the last few years, however, it has been increasingly more difficult to maintain an appropriate balance between our in-house and contractual efforts. To satisfy the urgent needs of the Army in Southeast Asia, we had to reduce the level of effort allocated to research and exploratory development work. Further, the cost of research and exploratory development continues to rise. It is our overall goal to offset these rising costs. Such a restoration would provide a balanced pro-

gram for in-house capabilities, yet allow us to take adequate advantage of proposals that offer potentially ingenious solutions to our military problems.

The Army research and exploratory development program thus covers a broad spectrum of both pure in-house and combined in-house/contractual efforts. I will now mention a few accomplishments of this program to demonstrate how they are used to strengthen our military posture.

Project Sand is an example of how in-house research capabilities can be exploited for immediate application to theater of operations requirements. The only known local sources for sand and gravel in the Mekong Delta were occupied by the Vietnamese people; dislocating these people would have only complicated operations. Since it had been necessary to import construction materials from distances of several hundred miles, the Engineer, U.S. Army Vietnam requested assistance in locating other usable materials. Under monitorship of the Office Chief of Engineers, three Army laboratories collaborated in addressing this pressing military operational problem. The work involved new image interpretation techniques resulting in a greatly enhanced ability to differentiate between usable construction materials and other deposits in remote and inaccessible areas. This work has continued with improved sensors and image techniques. An example of success is that a primary source of sand was located among the many silt bars in the river channels of the delta. It was identified by utilizing improved sensors and these new image techniques.

Research to improve medical care to troops in the field is another example of the coupling between in-house and contractual programs. Twenty-five to thirty thousand units of whole blood are now shipped to Vietnam monthly to insure an adequate supply. Basic research by the Army Medical Research and Development Command first established that the addition of adenine, one of a series of naturally occurring compounds, increases the shelf life of whole blood from 21 to 42 days. Subsequently Army and contractual efforts have demonstrated the safety and effectiveness of the fortified blood. These studies, both in the United States and Vietnam, indicate that adenine blood is functionally superior to that stored in the usual manner and is less subject to red blood cell damage during transportation. Logistical implications to the Army are enormous, with respect both to enhancement of medical care and cost reduction. The effects of this program can be equally beneficial to the civilian medical community in reducing the requirements for blood donors by approximately 40 percent. This represents a possible annual savings to the civilian community of 2.5–3 million units of whole blood and 75–100 million dollars.

The Army Institute of Surgical Research continues to direct its primary interests and clinical activities toward the analysis and management of severely burned patients. Sulfamylon ointment, a sulfa compound developed by the Institute's burn center, is now used on all burn casualties. The dramatic reduction in mortality rate is confirmation of the safety and efficacy of this drug. From 1962 to 1967, burn patient survival, in those cases where burns covered 60 percent of the patient's body area, has more than doubled. This represents a feat not accomplished by any other medical center in the world. The major portion of this effort is in-house with a rapid response by the drug industry in commercial synthesis of the sulfamylon preparation.

Another important Army research program has applied social and behavioral sciences to operational problems. We have produced more than 50 studies concerned with Vietnam that relate to military psychological operations, the Vietcong, and the cultural conditions under which we fight. These documents are widely used throughout the Army. As an example, our cold war orientation program has proven very successful in improving troop community relations in Korea and the research is now being extended to Thailand and Panama at the request of the operational field commanders involved. During the course of the next year, we anticipate further significant contributions to military civic action programs.

In the Army's statement to the 90th Congress last year, the technology of fluidics was presented as a program of strong Army interest. Fluidics is a field that uses fluid devices to perform amplification, sensing, logic, and control functions in a manner similar to electronics. The technology can produce systems that will survive in severe environments, such as temperatures, shock, and vibration. This program will receive increased attention by the Army in fiscal year 1970.

Army laboratories are in a unique position that often requires them to work on the problems that, initially, are of little concern to industry. One such task is the development of nonmetallic rotating bands for artillery projectiles. The gilding metal and sintered iron bands are now in use. The paper-epoxy band which is nonmetallic is the result of basic research in ballistics. Although now in the experimental stages, firing tests have demonstrated the feasibility of using nonmetallic rotating bands to provide spin and the gas sealing needed for artillery projectiles. Nonmetallic bands offer several advantages over the copper based gilding metal and the sintered iron bands—better accuracy at short ranges, elimination of the use of critical metals, extension of gun barrel life, and increased overall performance in round to round consistency.

Protecting the individual soldier from both small arms fire and fragmentation without adding an unsatisfactory weight burden has always been an Army research goal. We are studying some novel polyolefin films recently developed by industry as candidate materials for application in personnel armor.

Experimentally, laminated films of polyolefin have been found to have unusually high ballistic resistance when tested against small fragments from high explosive shells. This material is one of the many types of plastics that are finding increasing military and civilian usefulness. Through the use of fragment simulators, it was found that the weight of the new material required to prevent penetration was around 38 percent less than the weight of nylon fabric now being used in personnel armor.

As mentioned in my introduction, universities often provide a singular source of valuable research with widespread application. An Army sponsored university research program on wind tunnel testing of vertical and short takeoff type aircraft, including helicopters, is paying off in a significant fashion. The results of this research have altered the trends in wind tunnel design and have led to reevaluation of previous helicopter test and design data. These results have been confirmed by tests at the Army Aeronautical Research Laboratory, NASA Langley Research Center, and the Boeing Co.

Under Army sponsorship, the University of Washington has been conducting research on wind tunnel testing. It has established criteria for evaluating the limits to which a wind tunnel may be used for helicopter rotor testing. A realistic configuration of flow through a helicopter rotor in forward flight may be duplicated by a smoke trail. There are certain limits of model size, wind tunnel's test section geometry, and low forward flight speeds. When the limits are exceeded, the flow in the wind tunnel breaks down and does not represent that of actual flight. Under such conditions, the tunnel flow interacts excessively with floor and ceiling. This is not a realistic condition and data thus obtained is invalid. Contrary to previous belief, the evidence proved conclusively that for transition testing a rectangular cross section tunnel is superior to one with a square cross section. Consequently, a large V/STOL tunnel proposed for the Arnold Engineering Center has been changed from a 34 by 34 foot square square cross section to a 28 by 40 foot rectangular one. The flow investigations have proven that many wind tunnels used for testing helicopter design are not of the correct configuration and that some data previously taken is invalid.

This research has had a substantial impact on the design of several new industrial and governmental facilities and has caused existing testing programs to be modified. The final result will be better experimental assessments of the true aircraft performance potential.

This is also another example of using a capability outside the Government to produce results that are useful in a short time. The university research was sponsored because it had potential payoff, was readily available from a recognized source, and had widespread application.

Brigadier General Mellen will discuss budget program 5100.

AIRCRAFT AND RELATED EQUIPMENT

General Mellen. As representative of work under Budget Program 5100, Aircraft and Related Equipment, I will address the status of the Cheyenne helicopter, and Army concepts for a new tactical transport helicopter and heavy lift helicopter.

Technical problems have severely limited the progress of the AH–56 Cheyenne development program in the past year. Because of these problems, as well as for contractual reasons, the production contract was terminated on May 19 for default by the contractor.

Despite the limitations there have been some accomplishments: 455 flight test hours have validated a large portion of the flight envelope; the navigation system has performed satisfactorily as has the computerized fire control system; progress on the Cheyenne night vision equipment has been good; all of the five weapons on the helicopter have been fired successfully in flight.

Included in the weapons tests was the 7.62 minigun; 40mm grenade launcher; 30mm automatic gun; 2.75 inch rocket launcher; and the Tow. It is the Tow missile which gives the Cheyenne a unique antitank capability.

The development contract with Lockheed remains in effect. It is the intent and desire of the Army to continue a development program in fiscal year 1970 directed toward resolution of rotor stability and control problems and further testing—matters that have general application

to helicopter technology, and can assist in future decisions concerning some form of advanced armed helicopter. Continuation of development with Lockheed will hinge upon the attainment of a satisfactory contractual arrangement, and the Army is at this time examining the contractor's proposed revised development program.

The termination of the Cheyenne production contract will result in a loss to the Army of planned armed helicopter assets as well as an improved gunship capability.

To offset this loss, the Army will seek authority to buy additional interim gunships—the Cobra—in fiscal year 1970, and conduct the necessary research and development to provide the Cobra with a Tow antitank and night vision capability.

Fiscal year 1970 R.D.T. & E. funds, in addition to those in the President's budget for the Cheyenne and Tow will be needed for this purpose. The exact amount cannot be determined at this time; however, any additional expenditures will be more than offset by cost reductions accruing from Cheyenne termination.

The Army is presently considering a range of research and development alternatives for the Cheyenne and the Cobra and will promptly inform this committee when the review is complete.

The Army is continuing its program to develop a replacement for the current UH–1 troop lift helicopter. Referred to as the Utility Tactical Transport Aircraft System, or UTTAS, this replacement is projected for the time period when the majority of the present UH–1 helicopters pass their 10th year of service.

During the past 2¼ years the Army has been engaged in the examination and consideration of required performance characteristics, trade-offs, costs and schedules, as well as analysis of numerous condidate systems.

Desired parameters have been stated and reflect a significant improvement when compared with the present troop carrying helicopter. We are seeking improved reliability—in terms of aircraft availability, better performance and the ability to airlift a complete rifle squad of 12 men.

It is anticipated that concept formulation will be completed this year, and we intend to request proposals from industry, preliminary to award of a development contract.

The Army's interest in heavy lift helicopters goes back several years, and, following evaluation of the Air Assault Division culminated in the purchase of the CH–54, Fying Crane, which has a 9-ton lift capability. It is now in use in Vietnam.

Prompted by the demonstrated potential of cargo lift helicopters, and Soviet advances in this field, the Army has examined the requirement for and development feasibility of lifting larger payloads. These examinations have resulted in the statement of a requirement for a heavy lift helicopter with an increased payload.

An increased payload will provide tactical units with the capability to lift heavy artillery, armored personnel carriers and scout vehicles, bridging equipment, and other combat essential equipment; logistical and resupply capability will be greatly enhanced; and recovery of downed aircraft facilitated.

Our desire is to enter design competition and start engineering development with first production goal in the 1970's.

Colonel Tobey will discuss budget program 5200.

MISSILES AND RELATED EQUIPMENT

Colonel TOBEY. Budget program 5200 supports the development of missiles and related equipment.

During fiscal year 1969, events in the development of the Lance missile system have been encouraging. The causes for the technical problems associated with the propulsion unit have been isolated by a diagnostic program and an intensive test schedule has demonstrated the capability of a redesigned piston to correct the shortcoming. In addition, static firings of the new rocket engine have been conducted and test results correlate well with predictions.

Although we recognize that Lance could now be released for production with a limited range, the requirement for an extended range Lance has led us to the development of a new rocket engine. A significant accomplishment in the new engine program occurred on March 6 when the first flightweight version was successfully tested. Initial studies indicate that the production cost of the new engine will be comparable to the basic engine due to ease of manufacture. There are some firings scheduled in calendar year 1969.

Funds in the amount of $141 million are being requested in fiscal year 1970 to support the advanced ballistic missile development program. Our purpose is to provide qualitative improvements in ballistic missile defense technology and components to cope with a growing spectrum of threats. The fiscal year 1970 program consists of advanced development in several technologies. Missile systems, radar systems, discrimination technology, and optical systems require nearly three-quarters of the money requested. The remaining one-quarter will be used for research in data processing, nuclear effects, threat evaluation, and systems concepts. I will highlight a few very significant areas in interceptor missiles, radar, and systems concepts.

First are two developmental missiles, improved Spartan and Upstage. The improved version of the Spartan retains the basic first and second stages, but features certain other significant new improvements. For single target intercepts, the improved Spartan will have additional operational benefits. Thus, the improved Spartan would strengthen area defense and provide some additional capabilities.

Upstage is an extension of Sprint technology. It relates to determining the feasibility of defeating advanced-type reentry vehicles.

We are incorporating a number of advanced technologies into components of this new interceptor which will be capable of achieving small miss distances. The first test of the Upstage vehicle has been scheduled. Though the experimental vehicle is designed primarily for technology development and data gathering, it is essentially a full-scale missile that can be converted into a weapons system, should the threat require.

Radar is of the utmost importance to any ballistic missile defense system and it is essential that we support an aggressive program in this area. Our radar program develops advanced technology. In addition, studies are conducted and evaluation made of advanced components and techniques in order to advance the state of the art and achieve lower costs.

It is also essential that we constantly develop and examine new systems concepts in order to maximize systems capabilities and cost effec-

tiveness. Our systems study effort explores such concepts. An example is Virade (virtual radar defense), a method of obtaining a defense for our land-based offensive forces by making a radar attack expensive to the offense. It is one of several conceptual studies conducted by the Army. There is currently no development program.

SAM–D (surface-to-air missile development) is the Army's development program for an air defense weapons system. In fiscal year 1970, we are requesting funds for SAM–D to continue advanced development leading to integrated system demonstration and to initiate engineering development. SAM–D has evolved from studies dating back to 1962 and incorporates the latest technology—phased array radar, high-speed computers, and target-via-missile guidance. The system will be able to operate in the 1980's while defending against all aircraft, air-to-surface missiles, and short-range ballistic missiles.

We consider SAM–D an urgently needed replacement for both the current air defense weapon systems, Nike-Hercules and Hawk. These systems will have been in the field many years by the time that they can be completely replaced. They have served their purpose, but are reaching the end of their effective growth capacity. SAM–D will be deployed worldwide as a defense against a threat, such as that faced by our current Hercules/Hawk, but with half the manpower and at less than half the annual operating costs.

The principal elements of the SAM–D system are the fire control group, the launcher group, and a battery control group. The fire control group includes the multifunction phased array radar that performs all the functions that require several radars in our Hercules and Hawk system. In addition, the cabling required for these older systems has been replaced by radio data links, permitting a more rapid and flexible emplacement of equipment, thereby increasing the overall mobility of the system.

One SAM–D phased array radar can simultaneously search, track a multitude of targets, and provide data for those targets under engagement. In fiscal year 1970 we will complete fabrication and checkout of a prototype fire control group. The launcher group will fire six ready missiles singly or in rapid-sequence salvo. The missiles will be launched from canisters that serve as combination shipping, storage, and launch tubes. In fiscal year 1970 the advanced development model of the missile guidance system will be completed to include fabrication, checkout, and delivery of 14 units for use in the test program. Captive flight tests of the experimental model will also be conducted and completed. The missile propulsion system will undergo static tests and four vehicle flight tests will be conducted.

Advanced electronics techniques are being used throughout the system to provide higher reliability, maximum operating time, and minimum testing by the soldier operators. The missile will carry either an explosive fragmentation or a nuclear warhead.

Although SAM–D is being configured primarily as a field army weapon, current Army plans envision its employment in Conus as well as overseas. In Conus, SAM–D would defend against bombers, air-to-surface missiles, and submarine-launched missiles, as a complement to the Sentinel system. In the field Army overseas, Army air defense will be provided by a family of weapons, consisting of SAM–D complemented by Chaparral, Vulcan, and Redeye, or their follow-ons.

Visualizing SAM–D as a sophisticated air defense umbrella that will defend against aircraft, air-launched missiles, and tactical ballistic missiles, there is an additional need for simpler and smaller air defense weapons to provide local defense for small tactical units, bridges, and other critical targets in the forward areas of the battlefield. They can be attacked by low-flying aircraft while screened by the terrain from SAM–D radars. The Redeye, Vulcan, and Chaparral are now, or soon will be, providing that protection. Ultimately, these weapons will need updating or replacement. Under a program known as AFAADS (advanced forward area air defense systems) we are conducting the advanced development effort required to define a family of weapons to complement SAM–D. We are requesting funds for this work in fiscal year 1970. Specifically, we will do work on infrared seeker techniques, other optical and radar sensing techniques, and improved fire control techniques for guns.

As an example of the type of advances that are being made through our exploratory and advanced development efforts, I would like to call your attention to three fuzes. The XM 514 is a proximity fuze for 105 mm. and other artillery projectiles. It has been in use since shortly after the Korean war and its cost is approximately $35.

The XM 429 is a new proximity fuze used on the 2.75-inch aerial rocket and costs approximately $20. The XM 596 is a new proximity fuze for use on the 40 mm. grenade. Although its functions are the same as the two larger fuzes, the cost is about $5 in production quantities. This concept can be applied to other low cost, high volume production programs. A penny for research saves production dollars.

MILITARY ASTRONAUTICS AND RELATED EQUIPMENT

Budget Program 5300 at $14.0 million, funds military astronautics and related equipment. To meet the long-haul communication needs of the military, the Army is developing transportable satellite communications ground terminals.

The Army has consistently been a leader in the field of space technology, as evidenced by the Army's being first to achieve success in the launch of a satellite, with a Redstone booster placing the Explorer I satellite in orbit in 1958. The Army followed this in 1960 with the first active repeater communications satellite—Courier, and the first weather satellite—Tiros. We also developed the first electronic military satellite geodetic survey control system in 1964, known as SECOR (sequential collation of range). This system is currently employed operationally to establish the DOD geodetic survey control net around the equator. This net is expected to be completed by July 1969. The Army expects to continue its participation in space programs in close coordination with the Navy, Air Force and NASA. We currently are investigating the use of space technology to satisfy various requirements for the field Army. These include communications, weather, mapping and navigational aids for aircraft and ground vehicles. This effort, primarily in the study phase, is known to be within the capability of the current state of the art. It is becoming increasingly evident that one satellite can serve many purposes and that communications systems from the ground to the satellite and return are key developments to increased use of satellite technology.

The Defense Satellite Communications System has proven the increased quality and flexibility provided by the use of satellites for strategic circuits. In 1968, the system became a vital operational asset with deployment of Army developed terminals around the globe for use by elements of the defense communications system.

The Army has also recognized the tremendous potential of satellite communications for tactical forces. In 1968, the Army participated in a joint experimental tactical satellite communication test program using terminals built, in-house, by the Army. Extensive testing of these terminals has proved the operational flexibility of the tactical satellite communications concept. In 1969, the Army will test two technologically advanced families of tactical terminals consisting of five basic types.

The first terminal type is a one-man, battery-operated, portable, alert broadcast receiver for use with very small units such as long-range patrols. The second type, a team pack terminal, is also battery operated, and provides two-way communications capability for small units, where vehicular operation is not practical. The team pack breaks down into three man-portable packages.

Another type, the jeep terminal, permits operation in any terrain accessible to small vehicles. Increased communications is provided by two-way teletype in addition to voice communications.

The shelter terminal is transported by a 1¼-ton vehicle, helicopter or cargo aircraft. It can be operated either on the ground or while mounted on the vehicle. These terminals would be used for command posts at larger headquarters.

The last type is the airborne terminal which can be installed in either fixed wing aircraft or helicopters. It provides reliable communication for command and control where high mobility is required.

The testing of these terminals will begin after the launch of the TacSatCom I satellite into a stationary orbit. When operational, this newly developed means of communication will provide the tactical user with a reliable advanced communication system, whether it is 1 mile over a mountain or 9,000 miles across oceans and continents.

SHIPS, SMALL CRAFT, AND RELATED EQUIPMENT

Budget Program 5400 has the objective of modernizing Army items of marine craft required for ship-to-shore logistics operations. Development work is conducted by, or in conjunction with, the U.S. Navy so as to avoid duplication of efforts or overlapping of Army responsibilities with those of the U.S. Navy and Marine Corps.

ORDNANCE, COMBAT VEHICLES, AND RELATED EQUIPMENT

From Budget Program 5500, ordnance, combat vehicles, and related equipment, we have selected topics pertaining to nonlethal chemicals as illustrative examples. Our work over the past years has produced a series of weapons which dispense the tear-producing agent CS. Their use in combat has not only increased our fighting effectiveness, but reduced civilian casualties as well. My illustrations will include the tactical employment of CS weapons and white phosphorus mines in Vietnam, a new flame weapon, a new chemical agent warning device, and two items applicable to employment in civil disturbances or riots.

A filling of tear-producing riot control agent CS was developed for the standard illuminating round projectile in response to an urgent Vietnam requirement. The mortar round is capable of employment to reduce civilian casualties and property damage in urban fighting.

Americal Division infantrymen have used a portable CS launcher on a brigade perimeter bunker at Chu Lai. An expendable device, the CS launcher is used primarily for defensive purposes to disorganize and confuse attacking enemy forces. Weighing about 38 pounds, the launcher is fired either manually with a lanyard or electrically, and delivers 64 CS submunitions from the launcher. Subsequently, the submunitions burn and discharge a dense cloud of agent CS.

The portable CS launcher was used extensively by the Marines during the battle of Hue to reduce friendly casualties.

Engineers of the 9th Infantry Division have used the white phosphorus pop-up mine on fire support base perimeters near Saigon. The mine was used for defensive mine fields to prevent penetration of the defensive perimeters by enemy forces. A bounding antipersonnel mine, the XM 54, is filled with 15 pounds of plasticized white phosphorus. When activated either mechanically or electrically, the main part of the mine is propelled about 4 meters into the air where it explodes, spewing burning white phosphorus in all directions. The radius of effect is approximately 25 meters.

A lot more effective way of projecting flame is to use a new rocket approach called Flash.

This standard 50-pound flamethrower has been significantly improved upon this year, by the development of a new portable flameweapon. Using a new flame agent, factory filled into a rocket warhead, a lighter weapon with greatly improved range and accuracy was obtained.

The new flameweapon, utilizes components of the standard light antitank weapon (LAW) and is called the XM 191 multishot portable flameweapon. The rounds loaded into the weapon are rockets with the new flame agent warheads. Each of the flame rockets contains about a quart of the new flame agent. The weapon weighs 27 pounds when loaded with the four-round clip. The soldier fires the factory-filled flame rockets, one at a time, as fast as he can pull the trigger. Reloading takes 1 minute. The effective range for point targets, such as bunkers and automatic weapons emplacements, is considerable: for area targets such as personnel, significantly greater.

Using these new flame agent concepts, future efforts are being centered around the development of a factory-filled flame round for modern tank guns to replace the large special purpose mechanized flamethrowers currently being employed by our forces.

To replace these expensive vehicles, an accurate factory-filled round is being studied which could contain as much as 3 to 4 gallons of the new flame agent.

A prototype of a large caliber, rocket-launched flame round containing a new flame agent was fired from a test launcher, simulating a gun tube. The range achieved was many hundreds of meters.

New in the Army R. & D. is the development of material for control of civil disturbances. Of a family of several items, one is a liquid CS riot control agent dispenser containing 1½ quarts of agent. A 2-ounce projector similar to those employed by the civilian police has also been developed, but will contain a thrower, that has a range of 20 meters.

These projectors are highly directional, thus reducing area contamination. Range is proportionate to the size of the projector.

To discourage access to closed off areas and broken store fronts, a foam, filled with riot control agents, could be used without grossly contaminating the area.

During fiscal year 1969 we achieved a breakthrough in chemical defense and adopted as standard an automatic means to detect and warn of the presence of minute amounts of the highly toxic chemical agents.

The new alarm is rugged, compact, and lightweight. Complete with battery for 12 hours of operation, it weighs about 14 pounds. Light enough to be carried by the foot soldier, it also can be vehicle mounted or used in fixed emplacements.

At the opposite end of the warfare spectrum, our nuclear programs provide assurance that the Army can accomplish its mission at any level of nuclear warfare.

During this year the Army will continue to work very closely with the Atomic Energy Commission in support of developing a nuclear capability for systems such as Lance, Spartan, and Sprint. In addition, we are continuing the development of nuclear artillery projectiles and atomic demolitions to significantly improve our current capability.

We are maintaining a vigorous research program in nuclear weapons effects. This program supports Safeguard B of the limited test ban treaty (the maintenance of modern AEC and DOD nuclear laboratories, including research facilities, programs, and personnel) and provides the necessary technological base to insure the survivability and operational effectiveness of the Army in a hostile nuclear environment. We are also nearing completion of the development of a more versatile and effective family of radiation detection instruments for use by the field Army.

General MELLEN. Development and testing of the main battle tank is continuing. Eleven developmental pilot vehicles have been built—six United States and five German.

These pilots and associated test rigs have accumulated over 20,000 miles. Component performance has been tested, design changes, and joint selections have been made of components for subsequent development. The automatic loader, a unique feature of this tank, and the basis for reducing the tank crew from four to three, has demonstrated its basic capability to function as required. Refinements of this loader, involving durability and reliability, are being examined both in the United States and in Germany.

In a departure from conventional tank gun systems, the MBT gun launcher accommodates a high-velocity kinetic energy round in addition to the Shillelagh missile and the shaped-charge round. Firings last August, demonstrated the accuracy and lethality of this weapon system. Deliberate testing and refinement of previously unproven components will continue with the objective of validating the basic design concept of the MBT to include the secondary armament. The unique capability of the suspension system gives it a lower silhouette, a smoother cross-country ride and an ability to maintain a level attitude on sloping terrain.

During the past year, and as a result of a difficult but realistic assessment, it became apparent that it would not be prudent to commit sub-

stantial resources to production of the MBT until all components, and the total system itself, had demonstrated satisfactory performance. Accordingly, the Army target date for first production has been adjusted.

To counter lightly armored combat vehicles, the U.S. Army is upgunning the present M–114 reconnaissance vehicle with a 20-millimeter automatic cannon, and the first units in Europe soon will be so equipped.

For the new combat vehicles which are planned for the mid-1970's, we are developing a new weapon, the Bushmaster—or the vehicle rapid fire weapon system. This cannon will be a 20- to 30-millimeter automatic weapon designed to defeat lightly armored combat vehicles and personnel at long ranges. It will also have the capability to engage low, slow flying aircraft. Our intent is to request proposals from industry to start engineering development in order to meet our schedule for future production.

OTHER EQUIPMENT

Budget program 5600, "Other equipment," covers a broad range of items including communications-electronics and combat support equipment.

The first development item I will discuss in program 5600 is a tactical fire direction system, known as TACFIRE.

Tacfire is a tactical automatic data processing system for use by field artillery units. Its purpose is to provide increased accuracy, better and more rapid use of target information, faster reaction times, and greater efficiency in the determination of fire capabilities and the allocation of fire missions. The artillery forward observer will report target information or request fire missions using his small message entry device. Once transmitted, information is automatically entered into the fire direction center computer, and simultaneously displayed on a digital plotter map. Considering available fire units, the nature of the target, ammunition status and location of friendly units, the computer visually presents a fire mission to the fire direction officer. On his approval, the fire mission is automatically transmitted to and displayed on the battery display unit at the gun location. The fire mission is then executed.

Scheduled for future fielding, Tacfire will also provide an excellent basis for a comparable system for automation of operations and intelligence functions.

The second item in program element 5600 is Project Mallard.

Mallard is intended to provide a completely new tactical communications system for the field Army.

The objectives of Mallard are to develop a secure tactical trunking and distribution system with "mobile user" access to the ABCA Armies, that is, American, British, Canadian, and Australian, as well as the U.S. Navy and Air Force.

This international cooperative effort is based on an agreement that provides for cost and work sharing. Mallard is currently in the concept formulation phase during which three contractor teams have worked competitively to define and describe the systems to be developed. An international selection board has just completed examination of all the systems recommended for selection of the systems recom-

mended for selection of the best features and subsystems for incorporation into the final Mallard design.

The necessary verification of the feasibility of certain of the subsystems and network techniques will be accomplished, using functional models and simulation. A major portion of this will be done in fiscal year 1970. Competitive contract definition for selected subsystems will follow, leading to development of hardware, production, and field use.

We continue to devote effort and resources to the needs of the individual soldier. Special items of footwear have been developed for use in the delta region of Vietnam. To date, evaluation of these items and the effectiveness of a new medication are providing encouraging results toward a reduction in skin and foot fungus problems so prevalent in the delta.

We are engaged in a grenade launcher attachment development program called GLAD. Its purpose is to provide a detachable 40-millimeter launcher for the M–16 rifle, thus giving the infantry soldier in one weapon, a point and area type target capability, and replacing the standard M–79 grenade launcher in those units armed with the M–16 rifle.

Two competitive systems were subjected to a user evaluation at Fort Benning for the purpose of selecting one for further development, test, and production. The two systems are readily distinguished one from the other and from the current and popular shotgun-type M–79 launcher.

One is a smooth-barreled launcher that pivots to the firer's left for extraction and loading. The other is a knurled-barrel launcher that is pumped.

Based on this evaluation, and other factors, the Army has selected the pump launcher for further development. Engineering and service tests are scheduled to be conducted. The launcher alone weighs about 2 pounds, and in combination with the M–16 the total weight is about 10 pounds. Firing the same 40-millimeter round as the present M–79 launcher, the GLAD has an excellent range. If the GLAD is accepted after service tests, we can enter production at an early date.

Present ground surveillance radars cannot detect the movement of personnel in thick foliage found in many parts of the world and common to much of South Vietnam. Two recent developments have addressed and may solve foliage penetration problems.

One is a man-portable radar designed at the Limited War Laboratory. It weighs 35 pounds, including antenna and batteries, and fits in the standard pack frame. By virtue of its portability, this radar is ideally suited for patrol operations, night ambushes, hasty defense positions, and in operations such as those common to the DMZ in Korea. Tests in Panama and Puerto Rico have resulted in considerably long detection ranges. With the addition of a taller antenna, amplifier, and display unit this radar can be converted for use in base defense operations. A number of such radars will be sent to Vietnam this summer for evaluation.

The Army has been evaluating another foliage penetration radar in Vietnam since last fall. Using the same techniques as the man-pack version, this radar, called the Camp Sentinel, was designed for fixed base defense by the Lincoln Laboratories for the Advanced Research

Projects Agency. Based on the results of the initial evaluation, the Army is going to fabricate additional Camp Sentinel radars for employment in Vietnam.

MANAGEMENT AND SUPPORT

General BETTS. We are requesting $54.1 million in budget program 5700, "Programwide management and support," fiscal year 1970.

This program supports the costs of that portion of the Army research and development in-house effort that cannot be logically charged to a specific project conducted under one of the other budget programs. It includes costs for (1) International cooperative research and development; (2) A long-range program that trains our civilian employees; and (3) programwide activities which include the expenses of headquarters below Department of the Army, purchase of special purpose equipment, and minor construction.

The latter category—programwide activities—accounts for 98 percent of budget program 5700. This category provides the funds for the general and administrative costs headquarters operations such as personnel salaries, travel expenses and purchase of office supplies and equipment. Also included are the costs of facilities that support several R.D.T. & E. activities, such as Yuma Proving Ground and those costs which cannot be logically distributed to specific benefiting elements.

It also provides for the purchase of minor construction of less than $25,000, and purchase of special purpose equipment which benefits more than one project.

This then is the R.D.T. & E. program. It is based on operational requirements of the Army and develops equipment with characteristics necessary to meet both the present and future threats to national security. It does provide sufficient funds to support our highest priority projects, but some of the major development programs are not funded at the optimum level. It is becoming harder and harder to provide adequate funding, and I recognize, as you do, that it will continue that way for the foreseeable future.

I would remind you there has been an explosion of technology in the last 10 years, a great deal of which we have not had the resources to apply to Army programs. And while we could make effective use of funding levels considerably higher than provided, we recognize that this is an austere budget.

Mr. Chairman, this concludes my presentation. I will be pleased to answer any questions you may have.

IMPACT OF CAMPUS DISTURBANCES ON RESEARCH WORK

Mr. SIKES. Have you been forced to cancel or slow down any important research programs at universities because of faculty or student objections?

General BETTS. We have not yet, Mr. Sikes. As you know, we are very deeply involved at MIT. There was a period when we thought we might be forced to, but the faculty-student committee that advised President Johnson of the university agreed with the kind of work we were doing.

They took some issue with the Camp Sentinel radar that was being developed for us by the Lincoln Laboratory, but the issue they took

was that they did not think people from the laboratory should be sent out to Vietnam to test it.

Mr. SIKES. Has there been any outright refusal to perform any research and development, any R.D.T. & E. program, for the Army?

General BETTS. Not that I can identify, although it is obvious that we have slowed down our own approach to universities in classified areas with those universities that have expressed a desire to get out of classified work.

Mr. SIKES. You are reorienting your fields of activity in order to keep away from universities which have objected?

General BETTS. We have done two things. We have made a very careful review of the research we do in universities to be very realistic about classification so we do not overclassify. As I said, in a situation where a university like Stanford is trying to get out of classified research, we would not go back to one and urge them to take it. I would put it on that basis.

Mr. SIKES. When universities do not want specific types of Army R. & D., you are not giving them other research to make up for the type they do not want?

General BETTS. No, we are not doing it on that basis at all.

It may occur that there are universities—I cite the desire on the part of the University of Pennsylvania to get out of B.W. research. They decided to get out of B.W. research, and we did not go back there and try to strike the same level in something other than B.W.

Mr. SIKES. I am glad that is the case.

ARMY R.&D. PROJECTS AT UNIVERSITIES

Mr. MINSHALL. General, how many current R. & D. projects do you have at various universities and colleges around the country, and what is their dollar amount?

If you do not have it handy, you may put it in the record, and also detail the nature of the project, its classification, and where they are.

General BETTS. We have a complete summary of that which we can put together. I do not have it off the top of my head.

(The information follows:)

The Army has about 880 research and exploratory development contracts and grants with colleges and universities in the United States funded at approximately $53 million; this is an average of about $60,000 per individual contract or grant.

This work is in the whole spectrum of research and exploratory development of interest to the Army. More specifically both basic research and the application of this research work is supported in the physical and engineering sciences, mathematics, the environmental sciences, the biological and medical sciences, and the behavioral and social sciences.

All Army supported basic research is unclassified. Only a small portion of the exploratory work the Army supports at academic institutions involves any degree of classification.

In fiscal year 1969 the Army supported research and exploratory development work at colleges and universities in 46 of the 50 States.

(CLERK'S NOTE: The above summary, as referred to by General Betts, was supplied for the Record. The detail requested was not supplied.)

CLASSIFIED RESEARCH CANCELLATIONS

Mr. RHODES. How many universities have asked to get out of classified research for the Army?

General BETTS. I mentioned MIT's desire, but that was a committee-expressed desire. The university itself has not as yet put their finger on any specific piece of research that is classified and said they wished to discontinue it. In fact, they recognize that work in the Lincoln Laboratory must continue to be classified, and they have agreed that they will continue to do that work. So, even though the committee expressed some misgivings about classified research, I do not expect to see any significant change in the nature of the work we are doing at MIT.

Stanford University, not the Stanford Research Institute, has expressed a desire to get out of classified work. That related particularly to their electronics laboratory where they had several, quite a few, classified programs. I would have to dig back into the record, but as far as I know there was nothing in there that we felt was going to cause us significant problems in the long run.

You are aware of the fact that our Human Resources Research Office was being sponsored for us, administered for us by the George Washington University. They have asked to sever their relation with that office but we will retain the organization intact and give it a new home.

Same is true of the Center for Research in Social Systems that has been administered under a contract with the American University. They also have asked that arrangements be made to sever that relationship and we would expect to retain the capability of the Center under some other contractual arrangement.

Mr. RHODES. Were those classified programs?

General BETTS. They had classified work within them, they were not totally classified.

Mr. SIKES. Could it be said that campus unrest which often has an antimilitary flavor has had a detrimental effect upon Army basic research efforts?

General BETTS. Only in a psychological way, Mr. Sikes. I cannot identify any specifics that have occurred to us because of the unrest. We do recognize that over time there will be an interest on the part of individual investigators to go elsewhere for support just because they tend to sympathize with some of the dissident students, but we have seen no specific move in this direction.

Mr. RHODES. I would like to make sure that the General had completed answering my question. I do not know whether he had or not. Had you completed answering my question about the number of universities who have asked to get out of classified research?

General BETTS. I named the only ones that I can think of.

Mr. RHODES. If there are others, would you amplify for the record?

General BETTS. Let me turn to Colonel Snead on this.

Colonel SNEAD. Those are the only ones I know of.

General BETTS. We will check that out.

RESEARCH CONTRACTS TERMINATED

Mr. SIKES. I propose that we ask for a list of any research contracts which have been terminated or are now in the process of being terminated, with a listing of the universities involved; and I want also a listing of any of the FCRC's which have been terminated or will be terminated, together with a listing of the universities which are involved.

(The information follows:)

The Army has no information at this time as to universities in addition to Leland Stanford Jr. University, George Washington University and American University, that may wish to terminate existing research contracts. Most of our work at Stanford is actually with Stanford Research Institute, which is not closely tied to Stanford University; therefore, we expect no difficulty in continuing our work with them.

The Army is working with George Washington University and American University on appropriate methods to transfer contractual responsibility for the Human Resources Research Office and the Center for Research in Social Systems, respectively, to other corporate entities since both George Washington and American Universities have indicated they wish to withdraw from this type of defense contract.

Mr. SIKES. Is there anything else?

OVERSEAS RESEARCH

Mr. MINSHALL. How much of this work are you doing overseas, research work?

General BEITS. Our support of basic research overseas is in three centers: Europe, Japan, and in South America, with a very small amount of the work supported through the office in South America, and a little bit more through the office in Japan, spreading all through the Far East. The largest element or largest segment of this is supported in the European Research Office.

The total dollar amount is under $2 million. As of the end of March 1969, our records indicate the Army had approximately $1,480,000 in active research contracts and grants in its overseas program.

Mr. MINSHALL. You can put that in the record.

General BEITS. Yes, sir. The active file indicates approximately $712,000 supported through our European Office, $377,000 supported in the Far East through our office in Japan, $300,000 in Latin America through our office in Brazil, and $41,000 in Australia supported from the Army Research Office in Arlington, Va.

Mr. MINSHALL. Also provide for the record a table showing the amount of Army R.D.T. & E. used to fund research in these countries, by country, and compare this by fiscal year since 1967.

(The information follows:)

SUMMARY OF ACTUAL DOLLAR VALUE OF ARMY OVERSEA ACTIVE CONTRACTS AND GRANTS BY COUNTRY, AS OF MAR. 31, 1969, FOR FISCAL YEARS 1967, 1968, AND 1969

Country	Fiscal year— 1967	1968	1969
Australia	$10,440	$12,000	$41,000
Austria	62,596	34,696	27,140
Belgium	9,135	18,523	9,388
Denmark	16,350	16,350	4,350
France	21,645	71,525	79,900
Germany	408,902	332,337	106,657
Greece	5,000	0	0
Ireland	14,790	12,350	14,600
Israel	255,866	172,504	138,000
Italy	194,495	136,855	51,650
Netherlands	41,487	42,116	16,805
Norway	12,225	42,085	28,200
Sweden	91,256	79,495	37,840
Switzerland	24,726	27,152	26,540
United Kingdom	314,898	212,571	171,894
Argentina	65,205	53,500	0
Brazil	171,121	178,161	199,424
Chile	20,000	19,680	20,850
Colombia	12,488	10,700	10,700
Peru	167,752	221,928	66,746
Uruguay	28,000	2,900	2,900
Venezuela	15,000	0	0
Japan	233,570	237,400	138,837
Thailand	37,630	115,360	81,160
Philippines	22,110	61,492	46,979
Taiwan	19,613	43,061	36,574
Korea	9,400	22,726	40,194
Malaya	8,000	8,000	20,000
Sarawak	3,000	1,500	0
Okinawa	2,000	0	0
Sarah	1,000	3,500	0
Indonesia	0	3,338	5,000
India	0	5,000	6,000
Ceylon	0	0	617
Total	2,299,600	2,198,805	1,429,945

CLASSIFICATION OF RESEARCH PROJECTS

Mr. RHODES. I would like to ask a question about the extent to which you may have changed the classification of research projects. Have you changed any such classification in the last year?

General BETTS. At the request of Dr. Foster we went through all of the programs that we had within universities, to look at whether or not the classification was realistic. In other words, were we giving the universities problems unnecessarily? As a result of that effort, we may have declassified some but I don't recall that we did.

Colonel SNEAD. I think this is more a control on new programs, the action has been primarily to avoid unnecessary classification of new work.

General BETTS. I do not know of any case where we deliberately declassified just so that the work would continue.

Mr. RHODES. Have you changed your ground rules of classification at all?

General BETTS. We have told people to be more realistic in their assessment and not classify unnecessarily.

Mr. POOR. I think there is a small tendency on the part of any large organization to somewhat overreact. I think it is clear that we have erred on the side of overclassification in the past because it is easier. I believe that the Army people responsible for dealing with the uni-

versity research now fully understand that that is an undesirable thing to do. It is also important that we have in no case declassified a program just because of student pressure. I think it is important not to do that. I think it is also extremely encouraging that as time has gone by the universities almost without exception have taken a very responsible attitude toward Army research. I think the report to President Johnson of MIT is one of the most heartening things. It shows that the universities do recognize their responsibility to support the needs of national defense as well as those of the rest of the community.

Mr. RHODES. Mr. Secretary, in the past we have noticed there is a tendency to overclassify the transcript of these hearings. We hope the new policy will apply when you sanitize these hearings.

COOPERATION WITH NASA ON WIND TUNNELS

Mr. POOR. We will try very hard, Mr. Congressman.

Mr. MINSHALL. Mr. Poor, how much have you cooperated with NASA in these wind tunnel experiments?

Mr. POOR. There is a very close working relationship with NASA.

Mr. MINSHALL. I asked this question because I have in Cleveland the Lewis Flight Propulsion Laboratory which is quite an operation.

Mr. POOR. Through the Aeronautics and Astronautics Coordination Board there is a direct tie at the top level between DOD and NASA, as I am sure you know.

Under that, there are a number of working groups in which information is exchanged between DOD programs and NASA programs.

One of the important results of this work on test techniques for helicopter models has been the redesign of facilities at NASA-Langley to exploit these findings, the Air Force facilities at Tullahoma, which is another large aerodynamics-test installation, has been redesigned to exploit the same findings.

This particular set of work does not affect Cleveland because it does not work on helicopters, presently. However, in the engine development program there is a very close working relationship with Cleveland. I am personally a member of an Aerodynamics Committee of NASA, so that our work in the Army low-speed aerodynamics is fed right into the NASA program and it is flowing the other way as well. It is an extremely good arrangement of which I am very proud.

Mr. MINSHALL. Thank you very much.

CHEYENNE HELICOPTER PROGRAM

Mr. SIKES. Was the basic problem with the Cheyenne cost or lack of performance?

General BERTS. It was that we had a production contract package that was ahead of its time. In other words, we were committed to the long leadtime activities in a production program before we had solved the technical problems that were reflected in the accident this past winter.

Mr. SIKES. Does that mean that we can pick up the pieces and go forward again?

RESEARCH TO CONTINUE

General BETTS. We can, if the R. & D. program is successful and we are able to negotiate a price.

Mr. SIKES. And the R. & D. will continue?

General BETTS. It is our intention to continue the R. & D.; yes, sir.

Mr. ANDREWS. You do plan to go forward with the Cheyenne program?

General BETTS. We very much desire to go ahead with the research and development and to prove out these major weapon sub-systems, fire control, also the rotor dynamics themselves, the things that gave us the problems.

Mr. ANDREWS. Did the program ever get out of R. & D.?

General BETTS. It was committed to production at an early stage as part of an effort to get a firm production price out of the contractor early in the development cycle. Unfortunately, his costs were running well beyond that guaranteed price.

Mr. ANDREWS. So cost did figure into the cancellation?

General BETTS. Unquestionably costs would have figured if we had not stopped production when we did.

Mr. ANDREWS. How many contractors have expressed an interest in the Cheyenne program?

General BETTS. The major prime is Lockheed, but there were several important subcontractors, one of whom would be Emerson, one was General Electric, Teledyne had the fire control computer, Hughes had the TOW missile.

Mr. ANDREWS. Do you think if you got back into the Cheyenne program you could get competition for production and get a better price?

General BETTS. I do not believe that we could, in the first production run.

Mr. ANDREWS. You are not locked in with Lockheed, are you?

General BETTS. No, sir. As of now we are in the contract arrangement with them only for research and development. What we do about production would depend on what kind of a price we could negotiate, and then it would be a firm fixed price.

LITIGATION FOR DAMAGES

Mr. ANDREWS. Are you planning litigation against Lockheed for damages?

General BETTS. We have defaulted the contract, Mr. Andrews.

Mr. ANDREWS. Did the contract provide for damages in case of default?

Put something into the record about this.

General BETTS. I will give you the details in the record, but the way it works out, the contractor expended considerably more of his own money than he was reimbursed by the Government. So he is already in a loss situation. He will claim against us and we will claim against him. It will be settled by litigation.

(The information follows:)

Neither the development nor the production contract contained provisions for liquidated damages or other predetermined penalties.

We have requested a refund of approximately 54 million dollars for progress payments made under the production contract. Lockheed has appealed the determination that it was in default, and this matter will be settled by litigation.

BUDGET ESTIMATE FOR CHEYENNE R. & D.

Mr. ANDREWS. How much work remains to be done on the Cheyenne in R. & D.?

General BETTS. We have to straighten out the problem of the rotor instability which caused the fatal accident.

Mr. ANDREWS. Are you asking any money in this budget for Cheyenne R. & D.?

General BETTS. We are; yes, sir.

Mr. ANDREWS. How much?

General BETTS. In the President's budget as submitted we had for the Cheyenne aircraft $16.5 million, which included money that would have developed and applied the night vision equipment to this aircraft that had not been in the original program. We also had money in this budget that would have checked out and integrated the TOW missile with the Cheyenne aircraft.

Mr. ANDREWS. Since the program has been scratched by the Secretary, are you still asking money in the budget for R. & D. on Cheyenne?

General BETTS. We are; yes, sir. It is our desire to clean up the problems that are inherent in the difficulties that we had this past winter. It is also very important, in our judgment, to carry the testing program forward to find out how good these weapons systems are that we have on this aircraft.

Mr. ANDREWS. How many Cheyennes have actually been produced?

General BETTS. We built 10 prototypes and we have lost one of them. We have nine left.

Mr. ANDREWS. You got 10?

General BETTS. We did receive 10; you are right.

Mr. ANDREWS. Now, have any been produced under a production contract?

General BETTS. The production contract has run for some time, so that there were parts in the process, but there had been none, no completed aircraft.

CHARACTERISTICS NOT CURRENTLY AVAILABLE

Mr. SIKES. Would you provide for the record a listing of the characteristics which you are seeking to achieve in the Cheyenne which are not available in any currently produced aircraft?

General BETTS. Yes, sir; I would be pleased to give it in detail.

(The information follows:)

AH-56A Cheyenne characteristics:
Cruise speed in excess of 200 knots.
Tow missile antitank capability.
30 millimeter automatic gun multipurpose capability (antimech/vehicle personnel).
Standoff weapons employment capability (——— meter range).
Ability to effectively engage two targets simultaneously.
Highly accurate automatic fire control system.
360° field of fire for primary weapon.
Increased day and night target acquisition.
Night vision capability integral to fire control system.
Protection against 12.7 millimeter weapons.
Self-deployable capability (1,500 nautical miles).

Ammunition carrying capability (number of rounds):
40 millimeter grenade launcher 780.
7.62 millimeter minigun, 11,570.
2.75 inch rocket, 152.
30 millimeter automatic gun, 2,010.
Tow missile, 6[1]

General BETTS. I might point out we do not have a gunship now that can fire the TOW missile; we do not have an integrated night firing capability in any gunship now. Also, we do not have a cannon the size of the 30-millimeter gun that we would propose for the Cheyenne. Those are important capabilities.

INVESTMENT IN CHEYENNE PROGRAM

Mr. MINSHALL. How much money, General, have we put into the Cheyenne helicopter program since its inception?

General BETTS. I will have to dig that out.

Mr. MINSHALL. Put that in the record.

(The information follows:)

From inception through fiscal year 1969, R.D.T. & E. funds in the amount of $168 million have been provided for this program.

Mr. MINSHALL. How much money is in this budget that we are considering today for the Cheyenne program R. & D.?

General BETTS. As submitted in the President's budget, there was $16.5 million.

ADDITIONAL COBRA HELICOPTERS PROPOSED

Mr. MINSHALL. Didn't Secretary Resor send a letter up here just recently asking for some ——— million odd more?

General BETTS. After we had canceled production of the Cheyenne we reviewed the entire picture of gunships and asked that there be fiscal 1970 money taken out of the production money which had been allocated for Cheyenne to permit us to buy some Cobras, the Bell gunship we call the Cobra, in order to make up for the shortfall of production that we will not now receive.

Mr. MINSHALL. Are you going to the Cobra as a platform for these subsystems in order to test them out?

General BETTS. Since we did not get the production that we had planned of the Cheyenne we asked that the moneys that were recovered from that production item, or some of the moneys, be transferred to a procurement of additional Cobras beyond those now in the inventory.

In other words, just to make up for the number, the numerical shortfall. For those additional Cobras we believe it is prudent to spend money for night vision and for the TOW missile integration, and that is why we get into these additional R. & D. dollars, most of which will go for the additional capability for the Cobra.

Mr. SIKES. If you were able to provide these additional capabilities for Cobra, will you still need Cheyenne?

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[1]Normal load—with the installation of additional launchers wiring, and firing switches, this can be increased to 28.

General BETTS. Yes, sir. There is still, kind of a gross number, about 3 to 1 effectiveness of the Cheyenne over the Cobra.

Mr. SIKES. The Cheyenne is essentially a follow-on aircraft to the Cobra; is is not?

General BETTS. That is correct.

ROTOR STABILITY PROBLEM

Mr. MINSHALL. General, they have had considerable trouble with the basic element of this aircraft, namely, rotor stability as you referred to it. Do you think that you can lick this problem?

Mr. POOR. May I respond? The rotor system of the Cheyenne was tested successfully in considerably smaller size under an Army-sponsored program with Lockheed. That smaller machine reached speeds comparable to the speed requirement for the Cheyenne and there was initially very little reason to be concerned about the stability of the main rotor system.

In the course of development Lockheed really underestimated the problem of high speed stability of much larger rotor systems. We think, and they now think, they did insufficient testing and analysis of the rotor stability. They are still under contract to deliver a specification airplane under their R. & D. contract. We have had very careful review with outside experts, and Lockheed has put some new people on the team and have done recently a very substantial reanalysis of the rotor program. That leads us to believe that the current control system with appropriate modifications may well be made to work successfully.

Mr. MINSHALL. May well be, but when?

Mr. POOR. We are certain that with the modification of the control system of the rigid rotor that it can be made to work successfully.

Mr. MINSHALL. In what time period?

Mr. POOR. If the rotor with its present control system proves successful, we are hopeful it will be less than a year to successful demonstration of a substantially full flight envelope. If it is necessary to go to the backup control system we believe it may take as long as 2 years to get to the point of full flight system demonstration.

Mr. SIKES. At what cost will this work be done?

Mr. POOR. On the current rotor Lockheed is, as I said, under contract and that should be Lockheed's responsibility. On the backup control system, since we, the Army, share responsibility for the choice of the initial control system, we believe it is appropriate that we should assist by providing Army R. & D. funds if we ask them to work on a somewhat different system. So in that case the backup system would be largely Army's responsibility.

Mr. SIKES. Is the backup system a rigid rotor?

Mr. POOR. It is a rigid rotor with a modification of the control system. Analysis says it should be entirely successful.

General BETTS. I might make the point that it is not clear that the rigid rotor as such is the problem, but the question of how one controls the rotor as it turns.

Mr. ANDREWS. You still have a crying need for this type of aircraft in the Army?

General BETTS. We believe this is a very important combat capability for the Army.

Mr. ANDREWS. With it you would get a capability that you do not have today?

General BETTS. That is correct. From a quantity point of view it is several times as effective as the gunship that it would replace.

Mr. ANDREWS. It would be most useful in South Vietnam?

General BETTS. It certainly would. It will also be very useful in Western Europe if and when we are ever forced to flight there, because it will have a very good antitank capability and an antivehicle capability.

ALTERNATIVES TO CONTRACT CANCELLATION

Mr. SIKES. Was consideration given to a deferral of the construction under this contract rather than cancellation?

General BETTS. Yes, sir. The Secretary of the Army appointed a board to review the entire picture, and that board considered several alternatives. They considered a stretchout, an immediate cancellation, several patterns of stretchout, but eventually decided that we were sufficiently unsure of the time by which one could solve the technical problems. It was prudent to default the contract.

Mr. MINSHALL. On this backup system, will there be any change in the flight characteristics as to speed or performance?

General BETTS. It should not effect it; no, sir.

Mr. POOR. There is a possibility that the backup system would result in a very small increase in the top speed, otherwise the changes would be in stability and handling characteristics.

Mr. MINSHALL. You would use the same engine and everything else?

Mr. POOR. Yes; all the items stay essentially the same.

SUBSTANCE OF LETTER ON CHEYENNE REESTIMATE

General BETTS. The next paragraph will be replaced by the letter written to the committee. If it is agreeable, we will put in the record the substance of Mr. Resor's letter.

Mr. SIKES. Please do so.

(The information follows:)

The Army will seek authority to buy additional interim gunships—the COBRA—in fiscal year 1970, and conduct the necessary research and development to provide the COBRA with a TOW antitank and night vision capability. On June 27, 1969, the Secretary of the Army provided information to this committee which indicated that in addition to the $16.5 million and $6 million contained in the President's fiscal year 1970 R.D.T. & E. budget, an estimated ——— million will be required to accomplish attack helicopter development programs. This additional requirement will be more than offset by the cost reduction accruing from the Cheyenne production termination.

REDEYE IN AIR-TO-AIR ROLE

Mr. SIKES. The Air Force has made some tests of REDEYE on aircraft which apparently have not been too productive. Has the Army attempted to use REDEYE on helicopters?

Mr. POOR. No, we have not in the air-to-air role.

General BETTS. No.

Mr. SIKES. Do you visualize any such requirements?

General BETTS. We do not visualize the air-to-air battle as an Army responsibility. The Air Force has the mission and they configure aircraft to do that job.

OPERATING LIFE OF STATIONARY ORBIT SATELLITES

Mr. SIKES. What do you mean by stationary orbit?

Colonel TOBEY. It is positioned so that relative to the rotation of the earth it stays in the same relative position with respect to any spot on the earth's surface.

General BETTS. It seems to be suspended in space.

Mr. POOR. The orbit is such that the satellite sits over the Equator and goes around the earth at the same angular velocity as the Equator, so that it appears to stay still. As you probably know, several of the current communication satellites are so stationed.

Mr. MINSHALL. At what altitude have these been placed?

General BETTS. About 19,360 nautical miles (22,000 statute miles).

Mr. ANDREWS. What is the life of one of these?

Mr. POOR. The early ones have proved to be unexpectedly long-lived, in the order of several years. I can provide for the record data on the experience.

(The information follows:)

Satellite	Number	Launched	Decayed	Orbit	Active design life
LES-1	1	Feb. 11, 1965		1,700 miles	Passive.
LES-2	1	May 6, 1965		1,700 to 9,300 miles	5 years.[1]
LES-3	1	Dec. 21, 1965	Apr. 6, 1968	121,000 to 20,500 miles.	Do.[1]
LES-4	1	do	October 1968	124,000 to 20,900 miles.	Do.[1]
IDCSP	7	June 16, 1966		Near synchronous	6 years.[2]
IDCSP	8	Jan. 18, 1967		do	Do.[2]
IDCSP	3	July 1, 1967		do	Do.[2]
LES-5	1	do		do	5 yrs.[2]
IDCSP	8	June 13, 1968		do	6 yrs.[2]
LES-6	1	Sept. 26, 1968		Synchronous	5 yrs.[2]
TACSAT I	1	Feb. 9, 1969		do	Do.[2]

[1] Satellites thus indicated were mechanically timed to cut off and cease operation after 2 years. Higher design life was for the purpose of decreasing probability of component failure during satellite's active period.

[2] Satellites thus indicated are equipped with a command cutoff to permit the satellite to be shut off when necessary, or when the useful life is reached, thereby reducing the interference to succeeding satellites or replacements. Experience indicates that active design life will be exceeded in nearly all cases.

Note: At or near synchronous orbit, the satellite will remain in orbit for many thousands of years unless destroyed or deflected into another path. Without a cutoff feature, these satellites could cause serious problems to later satellites.

Mr. SIKES. Very well, gentlemen. The committee will have to suspend its hearings at this point and we will resume at 2 o'clock.

AFTERNOON SESSION

Mr. SIKES. The committee will come to order.

(Discussion off the record.)

CHEMICAL WARFARE—CS AEROSOLS

Mr. SIKES. Tell us something about the persistence of a few of the agents that you have illustrated?

Colonel TOBEY. The CS leaves the area almost immediately. It is nonpersistent. That was the only agent shown other than white phosphorus, which also is nonpersistent.

Mr. SIKES. How long does the foam persist?

General BETTS. Three to 4 hours in a 5-mile-per-hour wind. Half a day or a day under optimum conditions. It varies with the conditions.

Mr. SIKES. Most of the dispensers that you showed are obviously new. It is apparent that we are far behind in the development of dispensers that are up to date. You say this shortcoming has now been fully overcome?

Colonel TOBEY. Yes, sir; I believe it has been overcome.

Mr. SIKES. Are they present in adequate numbers in Vietnam?

Colonel TOBEY. Yes, sir.

Mr. MINSHALL. How harmful are some of those CS materials that you showed us? What are the results?

Colonel TOBEY. There is no lasting damage to the eyes or to the skin.

Mr. MINSHALL. Someone not too long ago conducted some tests in the military, and they said they were damaging to the eyes. Who was that and what kind of agent was it?

Colonel TOBEY. This was a newspaper article of 2 or 3 days ago.

Mr. MINSHALL. The one I am referring to was about a month ago.

General BETTS. There was a test of Mace conducted by the Army. We felt that it showed more irritation to test animals than does the CS agent which we showed you in this film.

Mr. SIKES. The police have Mace, and they do not have your CS?

General BETTS. That is correct, sir. There was some argument as to whether or not our evaluation was quite fair. I think the evaluation was a relative evaluation, not one that said that Mace is harmful as a police weapon.

Mr. MINSHALL. What is the reason the police are using Mace and not CS?

General BETTS. It is a matter of timing, as I understand it. CS has not been available as long as the other agent. With time, I believe they will shift over to the CS.

Mr. FLOOD. Can CS be readily acquired on the general market?

General BETTS. Not to my knowledge. I do not know that there is any basic reason that a good chemical company could not make it if they chose to do so.

Mr. FLOOD. You do not know why they do not?

General BETTS. I do not know.

Mr. SIKES. Is it not a fact that they are already manufacturing Mace, and that is what the police departments have been using and they have not changed over?

General BETTS. I think that has been the governing factor up to this time.

Mr. MINSHALL. Has the Army ever found CS harmful to either the skin or the eyes?

General BETTS. To my knowldege, we have never found a lasting damage resulting from the use of this compound.

Mr. MINSHALL. What kind of damage, even temporary, have you found?

General BETTS. Just temporary irritation. It also makes people nauseous, and that can be temporarily pretty debilitating, but not in a permanent way.

Mr. MINSHALL. Do you disperse CS in the same manner as Mace?

General BETTS. Yes, with an appropriate carrier. The Army has de-

veloped a hand held CS liquid agent dispenser which is under operational evaluation.

Mr. SIKES. There has been reference in the press to an Army study which found CS to be harmful, or at least irritating to the skin. Have you any information about such a study?

General BETTS. I do not have knowledge of the particular study to which you refer, Mr. Sikes. As far as I know, I do not know of any evidence of any permanent irritation. I will search this and give you an answer for the record.

STUDY OF EFFECTS OF CS AEROSOLS ON SKIN

Mr. SIKES. There has been reference to a study of about 3 years ago. The committee would like to be advised of any findings of this nature.

General BETTS. I will do so.

(The information follows:)

The effects of thermally generated CS aerosols on human skin was reported upon by U.S. Army Edgewood Arsenal, Md., January 1967 in Edgewood Arsenal Technical Report 4075. The report stated that at very high concentrations of CS (300 milligrams per cubic meter of air) for exposure times greater than 30 minutes under tropical conditions of heat (97° F) and humidity (100-percent relative humidity) with a moderate wind velocity (5 miles per hour) dosages (concentration x time) occur which produce first- and second-degree burns of the skin. This dosage is 900 times that achieved by standard U.S. grenades used for riot control or tactical purposes. Half of the volunteers exposed to these test dosages developed blisters on the skin. This report provided evidence that while significant skin effects can occur under extreme conditions, such effects would not normally be achieved with field aerosals generated for riot control or tactical purposes. A single thermally generating CS grenate of the type currently issued in the United States and Vietnam can produce the high concentration of CS used in the reported tests for only 20 seconds over an area of 12 square meters. As previously noted, an exposure in excess of 30 minutes is required to produce skin burns under tropical conditions. Under less than tropical conditions longer exposure times would be required to produce skin burns if they occurred at all.

MAIN BATTLE TANK–70

Mr. ANDREWS. What is the maximum speed of that tank you had in the film earlier, the MBT–70?

Colonel LAMB. Forty-four miles an hour has been attained.

Mr. ANDREWS. That is the best ever?

Colonel LAMB. That is the fastest for a tank.

Mr. ANDREWS. It is the best tank ever built?

Mr. MINSHALL. Supposed to be.

Mr. ANDREWS. Is it going to work?

Colonel LAMB. Yes, sir.

Mr. FLOOD. What is the matter with it?

Colonel LAMB. It is in development, and there are certain things to be done, but nothing directly.

Mr. FLOOD. What one thing don't you like?

COST AND DEMONSTRATED RELIABILITY

General BETTS. There is nothing about this tank that we dislike except the cost and demonstrated reliability. We need to improve the reliability and we need to work out, in our own analysis, what of the nice-to-have features we can give up to reduce the cost.

Mr. ANDREWS. Reliability in what respect, General?

General BETTS. One of the features you saw in the movie, the automatic loader, gives us some problems with respect to the ———. Under normal conditions, you do not have the problem of ———

Mr. ANDREWS. If the automatic loader conks out, can it be handled manually?

General BETTS. Yes, sir. We do not want to release the tank for production until we have done the best possible job of working out the reliability and maintainability questions.

TANK CONCEPT AND PROGRAM PROGRESS

Mr. SIKES. This tank is 4 years behind schedule, and that in itself is a frightening thing. It has cost a great deal of money. Are we ever going to have a firstline battle-tank from this that we can afford?

General BETTS. In my judgment, we are, Mr. Sikes. This is really the problem with our stretched-out cycle. With some reasonable degree of confidence, we could release this tank to production in its present configuration.

There would be reliability problems and there would be problems with respect to its cost that I think we can lick. In order to be most prudent and most conservative in that regard, we have decided to take the things we have found in this development model and build another set of test prototypes and go through a significant period of testing of that additional set of prototypes before releasing it to production.

Mr. FLOOD. A whole new set of prototypes from bottom up? I can remember the day McNamara sat in this chair where you are sitting and first gave birth to this idea. It seems right after the War Between the States. I was over there twice talking to the Germans about it, and they were not happy about it then. What do they think now?

Mr. POOR. They have accepted our schedule as a reasonable and prudent schedule. They have joined with us on target production.

Mr. FLOOD. They put the blame on you. That is over 3 years ago. They said it was our fault, and I believe them.

General BETTS. I do not know what it is they were blaming us for.

Mr. FLOOD. I don't know, either.

General BETTS. I might say the automatic loader, the thing that concerns us most with respect to reliability, was their development, not ours. We have taken over, with their agreement, the redesign and improvement of that loader so as to make it reliable.

I consider that a very important thing, because if we can eliminate one member of a crew over the complete life cycle of that tank——

Mr. FLOOD. I am not concerned about one gimmick or one thing. There are a million things. I was talking about the tank.

General BETTS. I cannot respond to their comment. As far as I am concerned——

Mr. FLOOD. Respond to mine, then.

General BETTS (continuing). I believe it has been a good, sound development program. The question of whether or not it is too conservative to decide to build another set of prototypes in order to be sure we have all the bugs worked out could be argued. Nevertheless, that

decision has been made, and that is why the program is now scheduled for ——— instead of ———.

Mr. FLOOD. You know the old story back and forth across this table, the old wheeze down at the Pentagon or any branch of the service, especially in weapons systems. If it works, it is obsolete.

How many years, Mr. Chairman, did we spend on the Army rifle? About 7? Then there were better ones in existence at the time we put the new one in operation, I think, and so do you.

Is this going to be another weapons system which, by the time we finish, will be obsolete? It works and it is obsolete.

General BETTS. Not in my judgment. I think it will be a very good tank.

Mr. FLOOD. That isn't what I said.

Mr. SIKES. Have the Russians developed a new tank since we started work on this one?

Mr. FLOOD. They have had a better one than this operational for 7 years, except they do not have the elevation on the side. The Czechs were talking about this. With a low silhouette.

General BETTS. It is a good tank, but I do not think the newest tank in their inventory is any better than our M–60 tank, which is also in our inventory. That is our overall judgment.

It is very difficult to compare item for item, because their concept of a tank is very different from ours.

Mr. ANDREWS. Can you dissociate yourself from the Germans and get out of that tank, or is there any problem involved in this?

Mr. FLOOD. If anybody thinks these Germans are not good, get it out of your mind. Those squareheads are good.

General BETTS. On one very major item of this tank, the engine, we had technical troubles with the U.S. engine and we have decided to buy at least for the next set of prototypes the German engine.

Mr. SIKES. Of the change orders made in this, how many were American and how many were German in origin?

Mr. POOR. I believe they were all joint. There is a joint users team that reviews the program periodically.

Mr. SIKES. Who proposed them?

Mr. POOR. The joint users team reviews the tank program roughly annually in great depth. It has both German and United States user participants.

Mr. SIKES. The Germans are outstanding tank people.

Mr. FLOOD. I should say.

Mr. POOR. We gained very much from the German participation in the design concept.

COMPARISON OF ORIGINAL AND CURRENT COST ESTIMATES

Mr. SIKES. What was the original estimated cost of this tank and what is the current estimated cost of it in production?

General BETTS. The best original guess was a number like ———. We have a major cost analysis underway at the moment, but the last time we made a cost analysis, the spread was from roughly ——— per tank. This is why I remarked that in making another prototype

we are going through a very considerable exercise of analysis to see whether or not there are features of this tank that cannot pay their way so we can reduce the over-all production cost to something that comes closer to the original figure.

Mr. FLOOD. The thing that burns me up about this is the engine. About 4 years ago, during the course of the debate on the appropriation bill for the Army, I went on the floor all hopped up about this tank. Let me tell you, I was good. There is no question about it. Everybody thought so, including me.

General BETTS. I think you are well aware of the problems we have had with some of the armored vehicles that we put in production with some risk of technical difficulties still in the production program.

Mr. FLOOD. I do not mean I am fed up with the tank. I want the tank tonight. But the whole show, to me, is bad.

General BETTS. I feel what has happened is that we have shifted over to a more conservative view of the question of when we would release to production.

Mr. FLOOD. You know what the mistake was. We should have let the Germans make this in the first place—period. Too many cooks spoil the broth.

General BETTS. I think our U.S. designers have made some considerable contributions.

Mr. FLOOD. I didn't say they should. We should have made it or they should have made it. This hands across the sea business on this did not work.

General BETTS. I might say for the record, the Army did not propose a joint development program.

Mr. FLOOD. I know. You are under the gun. I know that.

DEVELOPMENT OF DEAFNESS AMONG TANK CREWMEN

Mr. SIKES. Have there been instances where tank crews have shown a tendency, above those who deal with other weapons, to develop deafness?

General BETTS. I am not aware of a history of ear problems with tank crews.

Could you answer that?

Colonel LAMB. Sir, I know of both tankers and artillerymen that have problems with ears, but I cannot say one is worse than the other. They are similar.

Mr. SIKES. I would like to have for the record the results of any studies that have been made on this point. This matter comes close to home when you encounter it in your own people. I talked to a soldier a few days ago who has been told that the deafness which he is developing is due to his experience as a tank crewman.

General BETTS. There is a high noise level inside a tank. There is no doubt about that.

Mr. SIKES. Weapons firing is particularly noisy inside the tank. I would like to know what your information shows.

(The information follows:)

The U.S. Army Medical Research Laboratory Report No. 282, dated 1957, consists of a survey of a large number of personnel assigned to the combat arms, armor, artillery, and infantry, and who are exposed to extensive firing of all caliber of weapons. The results of the survey indicated that there was no difference between the loss of hearing of personnel assigned to tanks and those assigned to other weapons. However, all combat arms personnel suffer a 25–30 decibel hearing loss at speech frequencies within 8 to 10 years of exposure to weapons firing.

Mr. MINSHALL. Mr. Chairman I know we are going to go into this in much more depth when we get to tracked vehicles.

Mr. SIKES. Yes, we are.

Mr. MINSHALL. I know the Army is not familiar with the staff investigative report that I requested be made of the MBT–70 program. It is 181 pages long. There is not much in it that is good.

I have the highest regard for you, General. Eventually this report, I am sure, will be made available to you.

I have visited the Cleveland ordnance tank plant and seen the tank. I got in it. They admit out there that they have many problems with it. I think Mr. Flood hit the nail on the head to a degree when he said either we should have built it or maybe the Germans should have built it. When you have two people going at it this way, you have all kinds of problems. That is one of your problems.

OBJECTIVES OF MBT–70 PROGRAM

There were five main objectives for this tank, according to the staff investigation report:

The requirement of a main battletank for the 1970's.

The requirement for a NATO standard tank.

The U.S. requirement for an advanced main battletank available by 1970.

The establishment of a joint United States-German development program.

Then we went into the original agreement.

I really do not have time to go into this in detail today, but the objectives of the program in one sentence are: A significant improvement over existing tanks in combat-effectiveness; the operational availability of a U.S. production model by 1970; maintenance of a system cost at a level which would not offset the increased capability, reliability, and simplicity of operation and maintenance; development of a standard tank jointly with West Germany.

If I may, Mr. Chairman, I shall go to the two summary pages of the committee staff report, which is very thorough, which begin on page 179. I will read these observations.

From a review of the five objectives of the MBT–70 program and its progress toward these objectives, several observations can be made. The goal of providing the United States by 1970 with a new operational tank which will have substantially greater combat capability than existing tanks will not be reached. After 5 years of development and advanced production engineering effort, the schedule for delivery of the operational tank has already slipped by 5 years past the 1970 goal and the estimated cost for completion of the above effort of the United States, jointly and unilaterally, has risen to over ——— million. The technical problems existing in the development of the quantum jump in capabilities can no doubt be solved, but the time and money required raise serious uncertainties. One is whether the tank will be a significant improvement over other tanks exist-

ing at the time it becomes operational, or will it even be obsolete, at least in some features, by that time. The other is whether the effectiveness, even if it should be a quantum jump, will justify its considerable cost. In addition, there appears to be no question that the tank, as presently conceived, will be highly complex and will require more maintenance than existing tanks. The complexity raises serious questions as to the reliability, which cannot be answered at this stage of the program. It also raises doubts as to whether the capabilities achieved through this complexity are not outweighed by the probability that a tank crew in the field will not be able to maintain the complex features.

I might say, parenthetically, they just plain have gotten too fancy with this tank, and it is too sophisticated.

As to the objective of obtaining a standard tank, the extent to which the operational tank will be a common one for the two countries is uncertain.

The program has raised an interesting issue concerning which opinions can be found on both sides. The question is whether the advantages derived from two allies working together are more important than getting the tank promptly for the U.S. forces.

This is the point which has been brought out by my good friend Dan Flood.

I could go on here with the main objections to it.

INCREASE IN DEVELOPMENT COSTS

I went out to the Cleveland ordnance tank plant, and they were very cooperative and gave me an excellent briefing. They told me of the tremendous increase in the development costs.

What are they, do you remember, general?

General BERTS. The best first estimate was $138 million. There was an earlier estimate of $80 million that was before the tank had been designed and really has no validity.

Mr. MINSHALL. What are the development costs today?

General BERTS. Today, the joint program is $303 million, and the unilateral German plus the unilateral U.S. program goes above that.

Colonel LAMB. About ——— million.

Mr. MINSHALL. ——— dollars just for the development program, and we do not have much to show for it.

While I was out there, I got in the thing. I do not know too much about tanks, but I got in it and I said, "Where does the guy who sits in this seat put his knees?" They said they are going to have to have small men to operate this thing. This is ridiculous. As I sat in the seat on the left side of this tank, I had less than 1 inch with my back straight up against the back of the seat. One little bump, and I would not be able to walk for a month.

Colonel LAMB. That is the driver's station you were in. That was designed by the Germans——

Mr. MINSHALL. It was designed for a midget.

Colonel LAMB. It has been changed. The U.S. users looked at it and said, "We don't like it."

Mr. MINSHALL. I do not know how they will change it, because in back of it was the spare ammunition. I do not know where you are going to put your spares.

Colonel LAMB. Now a 6-foot-2 man weighing over 200 pounds can get in it.

Mr. MINSHALL. Where did you put the ammunition?

Colonel LAMB. By moving slightly forward a little bit. It is a matter of making the cylinder a little bit larger because it has to turn all the way around. It does not interfere with the ammunition.

Mr. MINSHALL. Just to be very generous with you, this tank has quite a few problems, to say nothing of the tremendous increase in research and development costs, the tremendous increase in estimated production cost, and your time lag of 5 years. I think you had better have another look at this whole program, General.

General BETTS. That is exactly why we have decided to build another set of prototypes so we can pick up all of this.

Mr. MINSHALL. You are starting all over again, practically.

General BETTS. No, sir. It means taking the basic designs and what we do not like about them, and correcting them.

Mr. MINSHALL. Why wasn't this done 3 or 4 years ago when you saw these problems?

General BETTS. We did not see any of these problems until we had the rolling prototypes.

Mr. MINSHALL. How long have you had the rolling prototypes?

Colonel LAMB. The first one came off in August of 1967.

Mr. FLOOD. General Betts, how long have you been on board in this job?

General BETTS. 3 years.

Mr. FLOOD. That long?

General BETTS. That is right.

Mr. FLOOD. In other words, you are about ready to go someplace else. That is the trouble. About the time we get ready to jump on somebody, he is in Alaska.

General BETTS. I will be pleased to stay around as long as the Army wishes me to. Just the very things that you are bringing up are the driving factors that led to the decision to create an additional set of prototypes so before we committed to production we would go through the drill of getting a tank that we could maintain, that is reliable, that does satisfy the U.S. user.

If we cannot do that, certainly the test of the additional test prototypes should prove this. I believe we can.

REVIEW OF TANK PROGRAM

Mr. SIKES. What is the time requirement for the additional set of prototypes? Does this mean an additional delay in the operational availability of the tank?

General BETTS. That set of prototypes is what changed the date from ——— to ———. The present planned production date is ———, and we see no reason why we will not be able to meet that date if the additional prototypes do in fact satisfy the users.

Mr. SIKES. One disturbing thing is that consistently through the years there have been reports which indicated that the program was not proceeding according to expectations. There have been disappointing delays in achieving the desirable results. Yet, during none of this period has there been a willingness on the part of the Army to admit you may have a lemon on your hands. Everybody said you were getting along fine. The record will show that.

General Betts. I think we have been very frank with this committee, Mr. Sikes. I do not think we have a lemon, by any means. I think we have a very fine fighting vehicle.

Mr. Sikes. It will be several years before we will know.

Mr. Poor. Mr. Chairman, I visited the Cleveland plant together with Mr. Packard 2 months ago. We went over in some detail the performance level being achieved by the components of this tank, particularly the automotive agility, the really very spectacular fire control system, the Shillelagh missile launcher, and, taken all together, it seems virtually certain that this tank represents, as hoped for, a major improvement in the speed and accuracy with which firepower can be delivered.

The stabilization system appears under test to be performing so well that the accuracy of the fire delivery from a tank moving at speed over rough terrain will be comparable to what we can get today with a tank standing still. It is a tremendous technological accomplishment.

It is also potentially a tremendously expensive accomplishment. The question that faces us is what value is this large improvement in quality? How much should we pay for it? How much must we give up? It is a very difficult choice. We are faced with the possibility that even a tank which is 10 to 1 better than the Warsaw Pact tank may cost so much that we are not willing to buy a 2-to-1 or 3-to-1 differential in number of tanks. It is difficult sometimes to outweigh numbers with quality.

So, I think it is likely that in the long run we will find there is a real need for a number of these sophisticated tanks because of the very great advantages they have on a 1-for-1 basis, and a need as well for simpler tanks in quantity to handle the large numbers that face us.

This we are working on. We are studying now the question how much we can take out of this tank so as to retain the automotive superiority, which is marked, some of the firepower superiority, but perhaps eliminate from some of the ones we buy the very costly night fighting capability, which is most impressive and very useful. How many of them can be built without stabilization, and so forth.

I believe the next step of a second set of prototypes is a very prudent way to help answer those questions.

As for technical accomplishments, I am extremely proud of the job that in particular AC Electronics has done in developing a fire control and stabilization system that vastly outperforms our fondest hopes. I think the program still has much promise.

I agree very much with the general conclusions of what I heard from Mr. Minshall's reading of the report. I would like very much the opportunity to read it and comment on it.

Mr. Minshall. You will, eventually.

Mr. Sikes. You will have such opportunity.

We will have further discussion of the matter.

I must say, Mr. Secretary, you have given us a good statement and a very useful statement for the committee's purposes.

COMPARISON OF TANK CHARACTERISTICS, U.S. AND U.S.S.R.

I would like at this point to have submitted for the record of characteristics which you have been seeking. Obviously, they are far ahead of the characteristics of any other tank.

Mr. POOR. I will be happy to provide the specifications for the record.

Mr. SIKES. What are the characteristics of our present main battle tank and of the best of the Russian battle tanks?

Mr. POOR. We will provide that to the best of our ability.

Mr. MINSHALL. Along the same line, this report is much too voluminous to put in the record, but I think it would be well to have the staff extrapolate and highlight the salient features of this report. I have a series of questions about this MBT program that I would like to ask, and I will supply them for the record whenever you suggest that I do it. It might be better to do it later.

Mr. SIKES. It would be better when we take up that program.

(The information follows:)

COMPARISON OF SELECTED DATA, MBT-70 AND CURRENT UNITED STATES AND SOVIET PRODUCTION TANKS

Characteristics	MBT-70	Soviet T62	United States M60A1
Firepower:			
Missile penetrations at all ranges (inches)	———	Not applicable	Not applicable.
Kinetic-energy round penetration plate at 60°, 1,000 meters (inches).	———	———	———.
Stabilization main gun	Based on sight; very accurate.	———	None.
Night sight and typical useful range limit	Passive; ——— meters.	———	Active (IR); ——— meters.
Range determination	Laser	Estimation	Optical range-finder.
Main gun rourds carried	———	———	63.
Mobility:			
Suspension system	Hydro-pneumatic.	Simple torsion bar.	Prestressed torsion bar.
Ground clearance (inches)	May be varied 6-25.	———	18.
Gross engine/horsepower per ton	27	———	14.
Crusing range (no auxiliary tanks) in miles	———	———	310.
Maximum road speed (m.p.h.)	40+	———	30.
Protection:			
Frant upper hull armor thickness and obliquity	———	———	———.
CBR protection for air supply	Entire crew compartment.	———	Mask for each crewman.

Mr. RHODES. May I ask one question, please.

EARLY BASIC DIFFERENCE IN UNITED STATES-GERMAN COOPERATION

As I remember this report, which I read rather carefully some weeks ago, one of the main problems involved was, I suppose, inherent in a consortium like this if you do not plan adequately, and that was problems of interface caused by the use of different measuring systems by the two parties.

I would think the first thing you would do in entering into an arrangement like this would be at least to standardize things like this. Wasn't that done?

General BETTS. It was attempted, Mr. Rhodes, but we had rather serious disagreement, and it took some time to get it resolved at the minister-to-minister level.

Mr. RHODES. I cannot imagine going ahead with hardware until that was done.

General BETTS. We did not go ahead with hardware until it was done. The resolution of that question was in process while we were going along with parametric design studies and that kind of thing.

Mr. RHODES. I believe when you read this, General, you will find

some instances cited of failures on the part of components properly to interface because of a difference——

General BETTS. I would not deny we had such failures, but the basic issue was argued early in the game and finally decided between the Secretaries at a time which should have prevented that sort of thing.

Mr. RHODES. In the first place, I hope we never do this again. In the second place, if we do it again, I think we ought to get at least the rudimentary ground rules settled before we start spending a lot of money.

Mr. ANDREWS. Did the State Department get in on this deal?

General BETTS. Not in any significant way; no, sir.

(Off the record.)

PROBLEMS WITH COMBUSTIBLE ROUNDS

Mr. FLOOD. Mr. Sikes asked you about the incidence of deafness as a result of service in this tank, or any tank for that matter. Would you have the Surgeon General give you, if there is any, the illnesses that are identified as peculiar to tank service, psychological or physical? And, second, these combustible rounds that you are using in this one. I am concerned about fragmentation, the high vulnerability of these stored and combustible rounds inside the tank. The slightest incident would cause sure death to the crew. With the high temperature and the toxic gases, they would be dead pigeons. Certainly, the combustibles would be easier to penetrate than the brass cases.

General BETTS. I will have to correct that, Mr. Flood. Before we go further, we are going to take steps to design the automatic loader so each round will be held in a container that will provide a degree of protection fully equivalent to a brass cartridge. That will not be a problem.

Mr. FLOOD. I am speaking of the combustible rounds that are standing by in reserve.

General BETTS. The ones that are carried in the automatic loader itself will be covered in the way that I mentioned, and those that are stored within the tank will be given comparable protection.

Mr. FLOOD. In firing these rounds, have you the trouble we had with the Sheridans with the gummy residue in the breech after firing?

General BETTS. We will have the same kind of air pressure scavenger system, but there is one thing going for this tank that is not available in the Sheridan, and that is that the tube is longer. The period of burning is longer, therefore, and the incidence of residue will be much less if there is any at all.

Mr. FLOOD. Any kind of problem at all with this combustible shell scares me to death. In the Sheridan you had the scavenger in there to blow it out. Even now, these combustibles stored scare me to death.

Mr. POOR. I share your concern, Mr. Flood. I have asked that several things be done. We do have a program——

Mr. FLOOD. The combustible idea is great, because you cannot have those brass casings in this small area. I know that.

Mr. POOR. Some form of disposable case is a great idea. Combustible cases may be the best way if the cases are properly protected in stor-

age in the tank. Disposable cases of another form which go out the muzzle may also be a good idea.

We have several programs going today, looking at cases made of ———. It is possible that one of these rounds may turn out to be the principal round for the main battle tank and, incidentally, may serve somewhat to reduce the vulnerability of current inventory weapons.

I am persuaded that the combustible round as stored in an MBT design today is at least as safe as the kinds of conventional rounds that we have had in tanks in the past.

After all, when conventional cased rounds are penetrated by a shaped charge round it does set off the propellant and they do burn and release gases inside the tank.

Mr. FLOOD. A mere fragment is enough.

Mr. POOR. You do need a direct hit.

Mr. FLOOD. A fragment through a shell case would produce an explosion.

Mr. POOR. The point is that as the combustible cases as stored in the MBT will be afforded as much metal protection as the conventional brass cases in the present tanks, and we hope to be able to design them in such a manner that their vulnerability is actually less——

Mr. SIKES. How can that be?

Mr. POOR. The loader is a device which consists of tubes which enclose the whole round on a conveyor belt. To load the round of ammunition, the conveyor belt is indexed to put one of the rounds in its tube right in line with the breech of the gun. They are protected in the case. Then the loader pushes the round into the gun, the breech is closed, and it retracts.

I think you saw some of that in the movie.

The rounds in reserve in the loader, some ——— odd, are all encased in metal. The rounds in ready racks beyond those ——— are also encased in a similar way.

Colonel LAMB. Nylon bags

Mr. POOR. We believe the vulnerability will not be increased.

Mr. SIKES. What is the point of the combustible round if you have to have this protection?

Mr. POOR. It saves the metal, the brass case. That is, of course, expensive.

General BETTS. And it saves you one motion in firing. You do not have to have the extraction motion.

Mr. FLOOD. You propose to have metal coverage for the rounds stored in the tank?

General BETTS. That is correct.

Mr. SIKES. You are saying to the committee there is no greater danger of an explosion of the rounds of ammunition within the tank with the combustible round than with the brass casing?

Mr. POOR. In the MBT design, I hope that will be true. I am confident that will be true.

USE OF SHILLELAGH MISSILE IN MBT–70

Mr. MINSHALL. Speaking of ammunition and firepower, the SHILLELAGH missile also will be in the tank, is that correct?

Mr. POOR. That is correct.

Mr. MINSHALL. If I remember reading the report correctly, the SHILLELAGH missile was not tested from a moving platform.

Mr. POOR. The design of the tank as currently arranged does not contemplate firing a SHILLELAGH from a tank in motion. The stabilization system is so good it is relatively simple to adapt it so it can do that.

There are currently in hand studies to see how much more it would cost to give the tank the capability of shooting the Shillelagh on the move. We will then, of course, determine whether that extra cost is worth it. I think it might be very valuable.

PROGRAM DECISION ON MBT–70

Mr. MINSHALL. If you had to make a decision as of July 1, 1969, what road would you follow as to proceeding with or scrubbing, or whatever you will, this MBT–70 program? What are we going to do about it?

Mr. POOR. I would recommend that we continue the program essentially as currently planned. It is a slow program. It is a careful program. It will cost more in development than it would cost were we to decide to go into production earlier. However, it will give us a great deal higher assurance that the tank will be reliable. It will give us time to try to learn how to reduce the maintenance.

Mr. MINSHALL. How long have you been in the program yourself?

Mr. POOR. I have been aware of the program virtually from the beginning. I have not been directly responsible for the program until essentially this fall.

Mr. MINSHALL. Last year?

Mr. POOR. The 5th of December, I think, was when I took on this job.

USE OF TANK TO DELIVER CHEMICAL MUNITIONS

Mr. FLOOD. At the beginning of this program, I asked the people who were here then, did they intend to have this gun interchangeable in its shell for chemical-biological warfare. In those days, there was great talk about utilization of tanks, because of the low silhouette, to break through at a given point and fan out port and starboard, and then use this rifle for chemical and biological purposes.

Have you talked to the chemical and biological people about a shell to be used interchangeably with this 52?

Mr. POOR. I have not. I do not know whether there is a program on hand for it. I believe the development of a shell for delivery of chemical munitions from this tank would be a very simple matter.

Mr. FLOOD. I believe that. All I want to know is, did everybody stop talking about it the day I did 4 years ago?

General BETTS. It is not now in the development program.

Mr. SIKES. Let us proceed.

Mr. MINSHALL. I want to say for the record, as I said earlier, that I hold General Betts in the highest regard, but I am very apprehensive about this program. I am going to recommend that the committee give it very careful scrutiny to decide, moneywise, how much more we should appropriate, if any, for this program.

General BETTS. Mr. Minshall, we were really concerned about this from the very same point of view that you are expressing, as these costs became apparent. We asked General Polk the $64 question: ———. His answer was very interesting to me, because he is over there in Europe facing the problem. With some ——— Warsaw Pact main battletanks that can confront his forces within ——— after the beginning of an operation, the best he can do is ——— tanks.

His point was that he sees no possibility any time in the future of ——— and our general approach to the priority of military over other things. Therefore, he felt that we should insist on the ———.

Mr. MINSHALL. I do not want to belabor this because we are going into it later, but if you had to start this program over, would you have so many fancy gadgets and gimmickry on this tank as you presently are trying to put on it?

General BETTS. These are the things that make it effective.

Mr. MINSHALL. You have a television camera up in the front, or you did. It was originally planned. It beats the devil out of me how they are going to keep the lens clean. I do not understand it.

General BETTS. The same way you keep the windsield of an automobile clean.

Mr. MINSHALL. Going through those mudholes that you just showed it going through?

General BETTS. With a wiper.

Mr. FLOOD. You won't have a prototype of these tin cans until October 1970.

Mr. POOR. We have prototypes now operating. What we are doing is learning our lessons from the prototypes we are currently testing, and incorporating them into a new set of prototype designs which should be a substantial improvement over the current set, at which point we do have the opportunity to decide what to take out.

Mr. FLOOD. There is an old story with this committee. We hear it year after year. Members of this subcommittee were here during the war. That may be an advantage or a disadvantage—it is a matter of opinion. I have often said and you have read that we have sat here and seen Secretaries and Assistant Secretaries and Deputy Assistant Secretaries and full colonels and 4-star generals come and go, across the table where you sit, for 20 years, like Greyhound buses, and we are still sitting here. We have heard these stories. We saw the airplane prototypes. There was a war on. They wanted planes in England.

All we were getting were designs and prototypes and designs and prototypes.

Finally, we had to say, "Look, children, they want planes tonight; no more prototypes."

We went through this. All we saw were designs and prototypes.

Mr. SIKES. Let us proceed.

EFFECT OF WAR IN VIETNAM ON R. & D. PROGRAMS

Mr. SIKES. Let us discuss generally two or three applications of the R.D.T. & E. program. Now, I would like both the Secretary and General Betts to comment on this question:

What, in the main, have been the effects of the war in Southeast Asia on the Army's progress in this area? Has it tended to accelerate and stimulate your program by virtue of the impetus which war always gives to developmental activities? Or has it by tending to direct your efforts more specifically to certain applications and directions and to prevent more general research, which you otherwise would have carried on, has it been harmful? Would you care to comment on this?

Mr. POOR. Mr. Chairman, I will start and I would like General Betts to correct and supplement in any way he sees fit.

It seems to me that there has been a little of both the effects which the chairman suggests. There has been a great deal of stimulation and acceleration of very fruitful work in such things as the foliage penetration radar which General Betts mentioned earlier. The fruit of this work and work in night vision devices, advanced sensors in general, should be, I believe, that as the war in Vietnam gets turned over more and more to the South Vietnamese people, we will be able to leave them a heritage of devices which will make their task far easier. The night vision devices program is really a spectacular development which has taken the night away from the enemy and let us work on more than equal terms with him. The remote sensing devices started with the idea that they might provide a ———.

Nevertheless, the focusing of attention on these matters may have caused us to deflect our attention from the situation in Europe. We have tried very hard not to do that. We have tried very hard to maintain a balanced program. We have been fortunate in being able to supplement our program in some respects for the South Vietnamese effort through extra funds from the DOD Emergency Fund. In balance, I think that the R. & D. program has not suffered severely. I think we have gone far faster in some special areas than we could have gone otherwise or might have gone otherwise. General Betts?

Mr. FLOOD. Are you doing anything special in the area of desert warfare?

Mr. POOR. Not that I know of.

Mr. SIKES. That is the sort of thing that tends to be passed over as a result of emphasis on jungle warfare.

Mr. POOR. That is correct.

Mr. SIKES. General Betts?

General BETTS. I would agree with Mr. Poor's assessment but I would add to it that in the process of finding priority funds for these requirements as they appear, and lacking any contingency money in our budget—by definition, this is something we have never been allowed—it has meant that we had to rather disrupt the orderly process of doing subsystem and state-of-the-art exploration in our in-house laboratories.

Now, I cannot point to any one specific thing that is going to be catastrophic because it isn't that sort of situation. It is my general intuitive feeling which I have, that 5 years from now we will find that there are things that should have been pursued.

Furthermore, with inflation, which flows in some measure from the war in Vietnam, it is a very real factor in our whole planning cycle. We have found ourselves forced to decrease in significant measure that part of the exploratory work that we supported in industry.

Whereas, we used to have something on the order of 40 percent of our exploratory effort paralleling the work in the in-house laboratories, that effort is considerably less at this time. In one laboratory that I looked at, it had dropped to 10 percent and their projection was in fiscal 1970 it would drop even further. The problem there is that one tends to lose the coupling with the research and development effort that industry does for itself. So I see that as a long-range problem and one about which I cannot do anything immediately. If indeed we get this budget the way we have submitted it, there are some funds to try to redress this situation in small measure.

EFFECT OF WAR ON FORCE MODERNIZATION

Mr. SIKES. There is much concern on the part of the Air Force and the Navy about a lack of modernization, particularly in aircraft, not altogether as a result of the war, but as a result of the war plus being tied to the concept of an aircraft which did not give them the modernization they were hoping for, the 111 and its various concepts.

Have you suffered in modernization as a result of the problems of war or have you been able to accelerate modernization other than the main battle tank, which I think is a separate category?

General BETTS. In my overall assessment with respect to aircraft, because we have been able to buy significant numbers of both people-carrying aircraft, gunships, and the heavy lift helicopter CH–54. With some product improvement funds we have been able to keep these programs in better shape than they would have been under a nonwar situation. Where I see the problem ahead of us is that since we did build up our air capability all at one time, so to speak, you now see ahead of us a utility tactical transport aircraft, a heavy lift helicopter, a new gunship, the Cheyenne, and a new surveillance aircraft.

I just don't see the possibility of our getting enough money to carry four parallel developments in the near future. So one of those or two of them, something of that order, are going to have to suffer. Now, that doesn't leave us with no capability, by any means, because we have product-improved the CH–47 and we have product-improved the UH–I's as we went down the line with production. I still have very strong hopes we will be able to get out of the present technical difficulties with the Cheyenne and come up with a good gunship.

Mr. SIKES. Mr. Secretary, you commented on a number of new and sophisticated advances in equipment. Has the enemy made corresponding advances in Vietnam? I am going to get to others areas later, but in Vietnam have there been exciting new developments put to use by the enemy?

Mr. POOR. I am not an expert on the air war around Hanoi which, as you know, has been abandoned. I am under the impression that in that portion of the combat the enemy at least had the opportunity to test in a very realistic and sophisticated environment some of his proposed new antiaircraft systems.

Mr. FLOOD. Are they Czechoslovakian or Russian?

Mr. POOR. Russian. I am sure the Air Force can discuss this far better than I.

Mr. SIKES. Our Army has had no such comparable opportunity to test its ground-to-air weapons?

Mr. POOR. No. We really have not because there is no real air war over South Vietnam. I think the battle in South Vietnam is much more characterized by extremely imaginative use of very simple weaponry, sophisticated guerrilla techniques, and lately increasingly larger scale conventional operations. I think it is true that this kind of war is only representative of the kind of war that one would get in a very limited situation. It is a matter of some concern to me that in learning to counter this, in developing the techniques of employment of the helicopters which have proven to be spectacularly successful there, we have not really faced, except analytically, the question of how to use this exciting new capability in a more intense environment such as one might find in Europe.

Mr. SIKES. Has he utilized new weapons against helicopters?

Mr. POOR. It is my understanding that he is using only small caliber guns and conventional antiaircraft weapons, with some fire control support. Our helicopter losses, as I think you know, have been gratifyingly low in that environment. One of the characteristics of helicopters that we are now convinced is of the greatest importance is the fact that they have a sort of built-in parachute. Should the engine be damaged, should the machine be damaged in such a way that it cannot continue to fly, it can land safely. So the recovery rate of helicopters has been spectacularly high. I would hope that the same thing would also apply in a more sophisticated, more difficult environment. I think the CHEYENNE, if we are successful with it, will represent a major advance for the sophisticated environment as well.

Mr. FLOOD. Have you seen any new, very exciting or dramatic small arms in the other fellow's hands, from either the Czechoslovakians, the Russians, or the Chinese?

Mr. POOR. We have seen a very high quality of reliable small arms in the hands of the enemy. I understand the AK–47 is a first class weapon. Our people have a great deal of respect for it. We have also seen a device called the RPG–7 which is an antitank rocket, somewhat like our LAW. It is a shaped charge device that can be launched by a single man, a latterday version of the Panzerfaust.

This weapon in the hands of the enemy has been awkward for our armored vehicles. Our people's assessment of the weapon is that while it is an excellent shape charge round, it is remarkably sensitive to winds and is difficult to fire very accurately. We contemplated as a result of the request from Vietnam that we might copy that weapon and concluded that we should not because of its inaccuracy in flight.

USE OF MORTARS

Mr. FLOOD. Now, with respect to mortars, why is it that every time we get mixed up in any of these affairs with these kooks, the Japs, the Koreans, and now these jokers, that they can drop a mortar piece right in your vestpocket, all of them. Why are they so much better than we are at mortars? You can take a squad of three kooks, and he can put a piece of mortar right in your hip pocket. They have been doing it for 20 years. Now, why is that?

Mr. POOR. I am not sure that their capability is any different from ours, Mr. Flood. Their mortars are no better.

Mr. FLOOD. It is a very unpleasant weapon.

Mr. POOR. It is a very unpleasant weapon in either hands. It is a weapon peculiarly well suited for guerrilla-like operations. A very small group of men can move through the woods close to a well-defined perimeter and be very hard to detect, and shoot and be off before we can react.

Mr. FLOOD. Did you ever see these kneeplate mortars that the Japs had?

Mr. POOR. I saw them, but I believe that they could not be fired from the knee. That was good way to break your leg.

Mr. FLOOD. I know, but they were firing them from the ground.

Mr. POOR. From the ground, yes.

Mr. FLOOD. They don't have some gimmick in their mortars or their hardware that we do not have, do they?

Mr. POOR. I know of nothing in their mortars that is unusual.

Mr. SIKES. The mortar is a very simple and very effective weapon.

Mr. POOR. Yes. And very cheap to make.

COMPARISON OF AK–47 AND M–16 RIFLES

Mr. SIKES. I have been somewhat interested in the differences between the AK–47 and the M–16, both very good weapons. Now, each possesses some advantage over the other. Have you found any indications—can you report any indications—where our troops have by preference picked up the enemy's AK–47 and used it, and conversely, any instances where the enemy has by preference picked up and used our M–16?

Mr. POOR. I would like to refer the question to Colonel Lamb.

Colonel LAMB. I have talked to several returning lieutenants and platoon leaders, long-range patrol people, and some units. Now, I will take one, the 25th Division, one battalion which formed a special platoon and they accumulated A–47's in first class shape, checked them out, zeroed them and gave the members of this unit a choice of the M–16 or the AK–47. These were all hand-picked individuals who had been in the theater for 5, 6, or 7 months, outstanding combat types. On the first opportunity, two men in the platoon, in the one platoon that I talked to the platoon leader, did take AK–47's. After the first operation there were 100 percent M–16's. In other words, they came back and switched them for the M–16's. I do know that the——

Mr. SIKES. Did they give reasons?

Colonel LAMB. Yes, sir; lighter, more accurate, if you have to fire one shot; you can carry more ammunition for the same amount of weight.

The soldiers very seldom give reasons. The lieutenant had not asked them. I was looking for incidents to follow up and tried to find out if the AK–47 was preferred. I came to the conclusion that it was not; that, given a choice, they took the M–16.

Mr. SIKES. Do you have any reports of instances where the enemy has by choice picked up and used the M–16 over the AK–47?

Colonel LAMB. I know of none with respect to the enemy, but I am sure there are some, but I do not know of them personally.

General BETTS. I have heard none reported. I would suspect that if it was available they would use it. Whether they would use it as a choice over the AK–47 I do not know. One must point out, though,

that the AK–47 is a very good weapon because it has been around a long time and has been product-improved. We can learn a lot from the way they product-improved it to make it reliable. In fact, that is one of the primary goals of the present M–16 program, the improvement program, to see if we cannot pick up some of these same things to make it rugged and reliable above its present capabilities.

Mr. SIKES. Are there any instances where other weapons or equipment are being pirated from us or copied by the enemy for use against us?

General BETTS. Certainly, they have copied the Claymore mine and made tremendous use of this, since it is rather easy to fabricate.

RUSSIAN PROGRESS IN GENERAL FORCE WEAPONRY

Mr. SIKES. Now, let's move into a broader area. In the field of sophisticated advances what can you tell us about Russian progress in the general areas that we have discussed today?

Mr. POOR. Mr. Chairman, in the strategic weapons systems it is relatively easy to discuss Russian advances because they are much more visible. It is hard for us to get from our intelligence very much detail on the small weapons that characterize the Army. For example, one of the questions that I do not know the answer to, which I have asked, is the question whether or not the Russians have developed or have in their inventory a weapon similar to our Redeye. It is difficult to find out. We do know that the tanks, the two most recent versions of the Russian inventory tanks do have stabilization systems, and at least a limited fire-on-the-move capability. The quality we are not certain of. We have a great deal of information on their major ordnance, guns. We are concerned about the large number of long-range artillery systems such as the free-rockets-overground and we are concerned about the slightly longer range weapons which may be suitable for delivery of nuclear or chemical munitions. The detail is very difficult to come by.

We do know that they have developed guided missiles for their tanks which probably are not equivalent to the Shillelagh system or to the TOW system, but we are a little uncertain as to what we may face should it come to combat where you really see what they have.

I don't know whether this is the kind of answer that is useful.

Mr. SIKES. It is.

General BETTS. I would think the greatest differences we see between our forces in Western Europe and the Warsaw Pact forces is that there are proliferations of things that we have in very small numbers. Air defense, for example, is very heavily deployed throughout the Soviet division. They have been very clever about their bridges for stream crossings. They are well made and rugged.

Mr. SIKES. Do we have a comparable development? I have seen films of some of theirs and it is rather an exciting concept. Are we doing the same thing?

General BETTS. Our approach has been more toward the self-powered floating-bridge concept that will permit us to put in a bridge very quickly. But it is more expensive and not as simple as the Soviet approach.

Mr. SIKES. And not as quick?

Mr. LASSER. Can I comment on that, please? We have seen that bridge and we are running some tests on it now, and we intend to build the same kind of bridge if the tests work out well. We see it as a useful bridge and we are interested in it.

Mr. MINSHALL. You mentioned a moment ago how heavily the Soviets emphasized their antiaircraft defenses within their division structure. What do they use? Do they have anything like Redeye?

General BETTS. ———. They do have radar-controlled guns. That is the difficulty. We have seen a very heavy commitment of 57's and 75-millimeter equipment.

Mr. MINSHALL. If they ———.

General BETTS. We know they have the technological capability because they have an ———.

Mr. MINSHALL. If they had as much development trouble as we did, they would have trouble sweating it out.

General BETTS. They would be discouraged.

ANTITANK WEAPONS

Mr. SIKES. What do we have in antitank weapons that is new? Or I should say, what do they have in new antitank weapons?

General BETTS. We mentioned the shoulder-fired rocket, also some wire-guided rockets.

Mr. SIKES. Like TOW?

Colonel LAMB. Yes, sir. They are different from TOW. The missiles that we know of are roughly 2,500 meters in range, and piloted. The man has to look at the target and fly it into the target, comparable to our SS–11 or Entac that we did not find too satisfactory because it was a tremendous training problem to train a man to fly this bird into a tank. We do expect their T–62, the latest tank which they are equipping their units with today and in production of about ——— per year, that some time in the next ——— to ——— years we expect they will put a missile capability on that tank, probably mounted on the outside, similar to TOW.

Mr. SIKES. Are they equipping the individual troops with improved weapons?

Colonel LAMB. The individual troops of the latest squad that we know of in the Russian Army—and it is a ———.

Mr. FLOOD. They don't spend so much time or money on uniforms or chow, either, you know.

Mr. SIKES. What about the allied forces, are any of our allies using or have any of them developed anything new and exciting that you would like to have in the inventory and do not have?

General BETTS. We are very interested in the bridge approach that the British are developing. They have the kind of a medium girder bridge that is a sort of successor to the Bailey, which looks very good. We will evaluate that, and may well either buy it or work out production arrangements.

Mr. SIKES. What else is there? You should know what they are doing.

General BETTS. Yes, but you conditioned it by saying "something exciting that we want," and I don't know of any development of any of our allies that is so far ahead of anything of ours that we do want.

Mr. SIKES. I wonder if any of your supporting witnesses would have anything to contribute either from the standpoint of what the Russians are doing or what our allies are doing that we could well be doing. You have a lot of talent there. We ought to give them an opportunity to volunteer.

General BETTS. I think the big thing they do is produce them in much larger numbers and then face us with the problem of numbers. But qualitatively speaking, they have a heavy lift helicopter that we very much would like to get.

Mr. SIKES. Are there any volunteers in the back rows?

Gentlemen, you are very modest.

Mr. FLOOD. Never volunteer, Mister; they learned that a long time ago.

General BETTS. Their 130-millimeter gun, for example is a ———.

Colonel TOBEY. The Europeans, the allied Europeans are doing work with air defense guns on self-propelled carriages with complete fire control, that we are following rather closely. There is nothing there that we think we want to duplicate as yet but they are doing more work along that line than we are at the current time.

BUDGET LIMITATIONS NOT AFFECTING IMPORTANT PROGRAMS

Mr. SIKES. What programs, if any, that are important had to be eliminated from the fiscal 1970 program because of budget limitations?

General BETTS. I do not identify any that I would qualify as important because if they had been important we would have done without something else.

The major problem with the 1970 budget is that in some major programs like the SAM–D we could move much faster in that development effort than the money that was in the Presidents budget would permit. I suspect—certainly, the same could be said about the heavy lift helicopter. There is a technology program we would like to have pursued, for moving out the general technology of helicopters that we just had to eliminate from the program. We had a competition, you will remember, and Lockheed proposed a stowed rotor, Bell proposed a tilt-rotor as the kind of technology that ought to be explored. We were not able to pursue either. Both were technology programs, not final developments.

Mr. FLOOD. What is the fastest speed we have achieved in our choppers now, in miles per hour?

General BETTS. Bell advertises that they have gone 314 miles per hour. That is the Bell research helicopter, straight and level flight.

Mr. SIKES. Are we fully prepared to take advantage of the capabilities of the C–5A to move troops and equipment?

General BETTS. I think we are. That is primarily a problem of proper operational planning rather than a development problem because the aircraft is roomy enough so that virtually anything that we have can go in it. It was designed for that reason.

Mr. SIKES. Are you exploring as carefully as you should the techniques for river crossings using equipment or devices that permit fording at depths at which normally equipment could not traverse streams?

General BETTS. We would expect our MBT–70 to be able to ford with appropriate kit treatment.

Mr. SIKES. What about present day equipment?

General BETTS. The M–60 has the capability. One has to provide a kit in order to do this.

AIRDROP TECHNIQUES

Mr. SIKES. What about the airdrop technique? The Soviets have displayed new and rather exciting capabilities in this area. For instance, they use retrofiring rockets to slow the descent of heavy equipment which, as far as I know, we have not done.

General BETTS. Presently, exploratory development is underway. Actual airdrops have been conducted at El Centro, Calif. The system appears to be very promising.

Mr. SIKES. You do get some material badly damaged in airdrop do you not?

General BETTS. Presently, very little damage is being experienced. One of the better approaches that we have seen for airdrop is the Rugalo wing guided into a landing because it is relatively independent of weather conditions, can be very accurately placed from altitudes like 30,000 feet. It is possible to bring it into a circle 100 to 200 feet in diameter.

Mr. SIKES. What about retrofiring rockets to slow the descent of heavy drops to keep from destroying the equipment?

Colonel LAMB. Retrofiring rockets are being tested primarily in order to lower the airdrop altitude. We are working very hard on techniques to deliver, and resupply directly from the rear of equipment such as the C–130 transport without use of recovery parachute and without landing. Now, we can do that with ammunition, with food and with many things. We are running experiments with this type of equipment.

Mr. SIKES. How do you do it?

General BETTS. We pull it out of the end of the aircraft in what we call low altitude parachute extraction system (LADES).

Mr. SIKES. What is the status of that situation?

General BETTS. It is undergoing a joint Air Force/Army evaluation at Fort Bragg/Pope Air Force Base, N.C.

Mr. SIKES. And the status of development?

Colonel LAMB. I believe we have some of the equipment being used in Vietnam at the present time but it is not standard A. It is still in the test phase. I saw it at Fort Bragg 3 or 4 months ago. It is just a little parachute that drags it out and slows it down very rapidly, about 150 feet after it hits the ground. It slides on runners which can be reused.

REPROGRAMING OF FUNDS

Mr. SIKES. On reprograming, Congress appropriated $1.522 billion for fiscal 1969. Your statement indicates that a total of $67.5 million was reprogramed from fiscal year 1968 and prior year funds. What programs were reduced as a result of these reprogramings? Provide that for the record.

(The information follows:)

The $67.5 million reprogramed from fiscal year 1968 were funds deleted and frozen by the Department of Defense during consideration of the supplemental requirements for fiscal year 1968. During the review of the fiscal year 1969 budget, the Congress approved the use of $59.3 million of these funds to finance the fiscal year 1969 Army RDTE program in lieu of new obligational authority.

The remaining $8.2 million were subsequently released to finance unforeseen fiscal year 1969 SEA requirements. The $67.5 million was derived from the following fiscal year 1968 elements:

	In thousands
Activity 1: Military sciences:	
Defense research sciences	$6,575
Information processing	175
Materials	800
Environment	300
Subtotal	7,850
Activity 2: Aircraft and related equipment:	
Aeronautical research	1,000
Demonstrator engines	465
Subtotal	1,465
Activity 3: Missiles and related equipment:	
Vulcan/Chaparral	1,000
Missiles	1,100
Missile propulsion	1,500
Advanced forward area air defense system (AFAADS)	500
Nike X advanced development	5,000
Nike X	8,075
Missile effectiveness evaluation	2,400
White Sands missile range	5,000
Subtotal	24,575
Activity 4: Military astronautics and related equipment: Satellite communications	2,100
Subtotal	2,100
Activity 6: Ordnance, combat vehicles, and related equipment:	
SHILLELAGH	1,000
Surface mobility components and techniques	500
Firepower other than missiles	1,000
Power systems and converters	3,000
Antitank weapons systems	500
Howitzer, lightweight, SP, 155mm	1,500
Medium antitank assault weapon, DRAGON	4,000
Wheeled vehicles	1,000
Tracked and special vehicles	1,500
CB weapons	2,000
Subtotal	16,000
Activity 7: Other equipment:	
Electronic warfare, quick reaction capability	2,000
Communications—electronics	1,000
Electronics and electronic devices	1,200
CB defense	100
Combat support	500
IFF	200
Communications development	1,100
Tactical communications	1,200
Image interpretation	250
Joint advanced tactical C^3P	2,000
U.S. Army electronic proving ground	1,000
Testing	4,000
Subtotal	14,550
Activity 8: Programwide management and support:	
Programwide management and support	1,000
Subtotal	1,000
Total	67,540

Mr. SIKES. What percentage of your program has been involved in reprograming for each of the last 3 fiscal years?

(The information follows:)

Fiscal year:	*Percent*
1967	11.6
1968	9.2
1969	11.1

Reprograming includes increases provided from the emergency fund, from transfers, and from prior year accounts. The fiscal year 1968 rate reflects R.D.T. & E. program reductions originally made to provide for supplemental requirements.

APPLICATION OF FUNDS TRANSFERRED FROM EMERGENCY FUND

Mr. SIKES. You have stated that $1 million of OSD emergency funds were transferred to R.D.T. & E. to develop chemical agents and devices for control of insurgents. Would you want to give us some more detail on this requirement?

General BETTS. You will see further on in the statement, subsequent to our first submission of the statement, that we received $37 million additional from the emergency fund. I will give you for the record the complete breakout of that, project by project.

(The information follows:)

Program element/project	Title	Amount (thousands of dollars)
6.21.10.A, 3A062110A811	Biomedical investigations, medical research program Southeast Asia.	400
6.21.12.A, 4A062112A859	Terrestrial investigations, military engineering design and expedient construction criteria.	400
6.26.03.A, 1W562603A295	Firepower other than missiles fuzes AR	450
6.32.05.A, 1F163205D649	New surveillance aircraft, LT FW reconnaisance aircraft	
6.32.06.A	Aircraft Weaponization:	
1X163206D182	Evaluate aerial weapons delivery	1,300
1X163206D050	Missile rocket weapons	450
6.32.07.A, 1H163207D235	Avionics, avionics advanced development	500
6.42.01.A, 1H164201D325	Avionics systems, avionics ground system	1,000
6.36.07.A, 1W563607D642	Army small arms program, special purpose weapons	450
6.46.02.A, 1W564602D366	Field artillery weapons, munitions, and equipment, artillery tank ammo fuzes.	400
6.46.07.A, 1B564607D637	CB Weapons, Tac Cml ground munitions	
6.37.01.A, 2X663701D718	Limited war laboratory	550
6.46.08.A, 1W564608D339	Army small arms program, pryo signal markers	240
6.37.09.A, 1Z663709D249	Ground surveillance and target acquisition ground combination surveillance and target acquisition.	3,600
6.47.02.A, 1H664702D486	Tactical communications, avionics communications	1,200
6.47.05.A	Ground Based Surveillance System:	
1H664705D511	Metro Equipment System	2,200
1H665705D513	Ground Surveillance System	2,250
6.47.14.A, 1Z664714D561	Night vision development, viewing illumination	200
6.47.17.A, 1G664717D589	General combat support, Powerplants portable	2,400
6.57.02.A, 1T665702D620	Testing, munitions effect testing	3,650
2.80.12.A, 1X628012D268	Defense communication planning group	
6.47.03.A, 1X664703D494	Tactical ADPS equipment	6,300
6.32.05.A, 1F163205D159	New surveillance aircraft	
Total emergency funds received		36,790

Mr. SIKES. Was this as a result of the demands from the field for weapons more effective for their requirements?

General BETTS. Those were all related to priority requirements from Southeast Asia.

CAMOUFLAGE TECHNIQUES

Mr. FLOOD. What have you done in the area of camouflage lately?

General BETTS. The most important thing is to get on board with a development in Europe of a camouflage net that does not soak up water the way our old burlap nets used to do and to apply the technique of making things with plastic that look like leaves and keep their color, general texture, and are lightweight.

Mr. FLOOD. We are still wedded to the theory of camouflage?

General BETTS. We still use camouflage where we feel it will do some good.

Mr. SIKES. I note that modernday camouflage is sharper in color, the colors are deeper, more conspicuous than camouflage of a few years ago. Is that deliberate?

General BETTS. I would say that in the new techniques we are able to do a better job with new materials. I do not know that I could identify a deliberate program to make for sharper colors or color difference, that sort of thing.

Mr. POOR. It would be a better match with the background.

Mr. SIKES. It might be because of jungle warfare that you would make some change in the color pattern.

General BETTS. This undoubtedly influences our selection of materials and colors.

Mr. SIKES. Have someone provide a more definite answer on that for the record.

(The information follows:)

There have been some basic changes in camouflage philosophy since World War II. During World War II we used camouflage primarily as a defensive measure. As a consequence we aimed at a relatively short standoff distance, that is, the range at which a man can distinguish a camouflaged object. This leads to subdued, small patterns Now we use camouflage in the offensive and have increased our standoff distances. This means a somewhat larger pattern. In addition, many of our troops in Vietnam wear "tiger fatigues" which have an extreme contrast pattern. These are not a standard U.S. uniform but a Vietnamese items that the men acquire through purchase or trades.

FOOD RESEARCH

Mr. MINSHALL. If I may interrupt, Mr. Chairman, you were speaking about food. What are you doing with respect to food, field rations?

General BETTS. We still have a very extensive program at Natick in the general area of freeze-dried food as well as pursuing the testing program to prove out the acceptability of the irradiated food. You are probably aware of the fact that the Food and Drug Administration has recently asked us to go back and do extensive testing of some of the foods we had previously thought were acceptable. I think the most interesting thing from the point of view of the field soldier has been the freeze-dried field rations that have been provided for patrols and people on the move.

Mr. MINSHALL. How long have they been issued? Are they in regular use now?

General BETTS. Yes, sir, they are in regular use. What we have been doing is extending the menus. They have been available in some measure for a couple of years.

Mr. MINSHALL. It is an improvement on the old C and K rations?

General BETTS. A considerable improvement.

Mr. SIKES. What happened to the irradiated developments? Have you given that up?

General BETTS. No. We have been doing more testing in order to satisfy the Food and Drug Administration on the safety and acceptability.

PENDING REPROGRAMINGS

Mr. SIKES. Are there any reprogramings pending at the Pentagon at this time involving fiscal 1969 funds?

General BETTS. The Division Tactical Operations System or DIVTOS is still pending. That is before this committee.

You are aware that this committee said "No" to our request for a quiet aircraft reprograming. We are discussing that with Dr. Foster's people at the present time. I believe that in the nature of your turndown of that that we have information that apparently was not made available to you.

Mr. SIKES. I would be interested in seeing or hearing that information.

General BETTS. I believe we can convince you that we need that reprograming. We will get that information together, discuss it with Dr. Foster and gain his support, if we can.

Mr. SIKES. Very good.

FOOD RESEARCH

Mr. MINSHALL. Are you still using C and K rations?

General BETTS. We still use the C ration. However, the K ration is no longer in the system.

Mr. MINSHALL. What do you call it now, just canned foods?

General BETTS. No. We have for standard rations: A, B, C, and the long-range reconnaissance patrol packet. The first two are fresh and canned foods respectively that would be served in a garrison, base camp, or other relatively secure area. These are so-called "hot meals" and require preparation by mess personnel. The C ration is technically called the meal, individual, combat, and requires no preparation. The long-range reconnanssance patrol packet is a combination of vacuum-packed and fresh-dried components.

Mr. MINSHALL. But in Vietnam for patrols, a patrol which gets away from the unit where they do not have cooking facilities, they are using these freeze-dried foods; is that correct?

General BETTS. We would give them the patrol rations; that is correct. In some cases enterprising front-line units are feeding their people hot meals right up there where they are fighting. They haul them up by helicopter from the battalion kitchen.

Mr. MINSHALL. This is the garrison rations?

General BETTS. Yes. The A and B rations.

Mr. MINSHALL. What is the cost of a ration today?

General BETTS. I would have to get that for you.

Mr. MINSHALL. It is not really in your shop, is it?

General BETTS. I am told it is $2.19 for a C ration (three meals) and $3.27 for the patrol packet (three meals).

Mr. MINSHALL. How much are these freeze-dried rations? What do they cost?

General BETTS. We would estimate a complete freeze-dried ration (three meals) to cost $4.05.

BALLISTIC MISSILE DEFENSE

Mr. SIKES. The committee is not going to try to get into the ABM situation at this time, but under the title of "Ballistic Missile Defense" I note that $37.9 million was transferred to Army R.D.T. & E. from ARPA for radar operations at Kwajalein Missile Range and ballistic missile defense advanced development programs. Will you explain something about the reasons for this transfer?

General BETTS. Yes, sir. You will recall that for years ARPA has supported a program they call Defender. That was an advanced ballistic missile defense study, analysis, and experiment program. Growing from that program, there is a large complex of radars on Roi and Namur in the Kwajalein atoll that they call PRESS or Pacific range electromagnetic signature studies.

What they were doing was studying reentry physics, discrimination techniques, the whole engagement question at several different frequencies using these large radars, and with several different capabilities for resolution, which is very important to the discrimination studies. It was apparent when we made the decision to go in with the Sentinel, now Safeguard, deployment, that there was still a great deal of advanced technology that should not be involved in the Sentinel-Safeguard program but would back it up. Now, some of that effort was already going on in the Army under the total Nike X program that we had been pursuing, and some of it was going on in Defender in this Press effort, and in the reentry measurements program. It was decided by the D.D.R. & E. that he would take that part of the ARPA program most closely related to the kind of things we were doing and turn it over to us, this complex of radars that was involved. Now, the money in there is to operate those radars and continue experimentation.

Mr. SIKES. As a result of the Secretary's budget review in March of this year the Nike X advanced development budget activity was reduced by $34 million which deferred effort on the Common Aperture Multi-Function Array Radar. Will you explain the reason for this action and its effect on the program?

General BETTS. There is quite a bit of a history here, Mr. Sikes. You will remember at one stage the Nike X program had a massive four-faced multifunction phased array radar that was to be the center of a city defense. With the decision to go ahead with Sentinel, it was clear that we would not need that radar for deployment, but in the meantime the construction of the concrete building in which to put it at Kwajalein for test purposes had already gone ahead. It was also apparent that none of the radars in the ARPA complex that now are turned over to the Army, could ———.

So the question was asked the Army: What could we do, what could we provide by way of a much less expensive radar than the old MAR or Multi-Function Array Radar, to do that kind of a mission at Kwajalein. Well, we reduced it to a design that we call this Common Aperture Multi-Function Array Radar, to change the basic structure and reduce the cost, get away from some of the complexity. The name

describes the fact that instead of having one aperture for a transmitter and one for a receiver, as was the original design, that we would now be able to do this with one aperture. We also removed some of the total power and that also reduced the costs. But it was still a very expensive radar. In the process of reviewing the Army's program Dr. Foster's staff questioned whether or not we should go ahead with a radar that was that expensive since it had no role to play as a system component in the ultimate deployment, and asked whether or not it was possible to do the kind of experimentation we wanted to do and should do with a less expensive radar. While we were going forward with this additional study they deferred the funds. I suspect we won't get those funds in fiscal 1969 at all. At this moment I just cannot answer the question.

We are in the process of taking another look at this. An independent committee has studied the subject for Dr. Foster and recommended against it. That is why I am rather pessimistic that we will go ahead with the common aperture radar.

Mr. POOR. That committee did recommend that we develop a test bed of some sort to perform this function. It is of great importance to do it. The only question is whether with technology and the best of current technology we cannot take a less expensive and almost equivalently good cut at the problem. This is under careful study by our Advanced Ballistic Missile Defense Agency today.

Mr. SIKES. Gentlemen, thank you very much. The committee will meet again at 10 o'clock tomorrow morning.

WEDNESDAY, JULY 2, 1969.

Mr. SIKES. The committee will resume its hearings for the requirement of the Department of the Army for Research, Development, Test and Evaluation for fiscal 1970.

REQUESTS FOR EQUIPMENT BEYOND POSSIBILITY OF FULFILLING

Yesterday we discussed generally efforts in the area of research and development in connection with Southeast Asia. What requests have been made, Mr. Secretary, for weapons or equipment by the troops in the field that seem beyond the realm of possibility and which you either have not attempted, or attempted and dropped?

Mr. POOR. I am not immediately aware of any requests for weapons beyond possibility. Under the Ensure program we have had a large number of requests for advanced systems. Perhaps the nearest to a terribly difficult program that I can think of requested from Vietnam which has been very hard to fill is the request for a ———.

The contractor has been able to build a demonstration system, but I understand under the current tests of the system which in theory has the sensitivity to ——— we are having difficulty with the ——— and things of this sort. Equipment delivery has been substantially delayed. I believe it is under test at Aberdeen Proving Grounds to see if we can do anything with the data processing equipment to discriminate out the ———.

General Betts may be able to add to this list.

By and large, I think we have been quite successful in delivering things which have worked well. There are, of course, a number that have not worked as well as expected.

Mr. SIKES. Is one of the principal difficulties the problem of detecting what is underneath the jungle canopy?

Mr. POOR. That certainly is a difficulty and in this area I think we have been rather surprisingly successful in the two radar developments we mentioned yesterday. I would like General Betts to comment on the things that have not worked as well as we hoped.

General BETTS. It is very rare that we get requests from the theater that, let's say, are invented in the theater. Usually the requests are the result of an effort on our part to acquaint the people in Vietnam with the possibilities of things that we have in either concept or early hardware back in the continental United States.

ITEMS UNSATISFACTORY IN FIELD TEST

I do have a list here of things that were sent out to the theater with their concurrence for actual test and evaluation to see if indeed they would satisfy the theater.

Let me give you some examples. They asked for an improved flame projector and the one that we sent out did not work very well. This whole list I have is the "did-nots." They were very much interested in a blow-up kind of fabric boat as they got down in the delta where there is a lot of water. We gave them several models, one of which was a four-man boat that proved to be less durable than they would like to have it. We strained too hard to reduce the weight. So that did not prove to be very satisfactory.

We gave them a canal bridge that was light enough to be carried on patrol, and while in very still water under certain favorable circumstances the bridge will work all right, it was not reliable enough under all conditions to put the patrol at risk and that did not prove to be adequately suitable.

We sent out an infrared target designator that I believe will prove to be suitable, but in its first model they were not very enthusiastic about it.

We gave them a mine detector based on microwave technology to solve the perennial problem of detecting nonmetallic mines, and that has not proved to be suitable.

SOURCE OF IDEAS FOR NEW EQUIPMENT

Mr. SIKES. Where primarily do ideas for new equipment and new weapons originate, in your shop?

General BETTS. Within the in-house laboratories and in some measure within the structure of what I would call the Army's requirement process. You recall we have a Combat Development Command.

Mr. SIKES. How are these screened in order to determine which are feasible and needed in the field and which would be so much excess baggage?

General BETTS. We have a unit in Vietnam, the Army Concepts Team that has some technical competency within itself. We have temporary duty people that go out to the theater from the AMC Commodity Command Laboratories so that there is technical capability within Vietnam to give a preliminary evaluation to ideas

that appear on the scene. But within our continental U.S. structure, the Combat Development Command does have the responsibility for creating new requirements. They are in reasonable contact with the Army Materiel Command structure and have access to new ideas as they may appear within the Commodity Command, and of course industry itself is very active in producing new ideas, bringing them to our organization on an unsolicited proposal basis.

From all of these sources the information would wind up in the Army general staff where the Assistant Chief of Staff for Force Development is concerned about justifying the requirement, the people in my office, my staff, are concerned with making sure that the technical feasibility is there and that they have resources to do something about it.

At the staff level we take steps to resolve the question of whether we are warranted to go ahead with a new development effort or in some cases procurement of some new idea for test.

Mr. SIKES. How long does this process require, the process of deciding whether you should go ahead with a new idea?

General BETTS. I do not think I could put a good figure on that, Mr. Sikes. It can vary all the way from a few months to a year or more, depending on the scope and controversy that may be involved. The more controversial items take considerably longer.

Mr. SIKES. Do you think there may be a tendency to spread yourself too thin and undertake more projects than space and money and personnel warrant?

General BETTS. Before we make a serious start on any project, we must have the resources available, and as I remarked yesterday we have no contingency money available to us other than that is available in the Office of the Director of Defense Research and Engineering, emergency funds. If the project is new and we can adequately justify it to Dr. Foster and his people, we can obtain funds from the Emergency Fund to get a new effort started.

On lesser efforts or things that are perhaps an extension or modification of some program within the Army that is already underway, our source of funding is to reprogram from the lesser priority efforts within the Army structure.

But the limit on available resources automatically limits the scope of the efforts that we can undertake because we will not start a new effort unless we can see our way through to concluding it.

SOUTHEAST ASIA RELATED RESEARCH

Mr. SIKES. Under Southeast Asia Related Research, $8.2 million was reprogramed from prior year funds to support Southeast Asia requirements and you have asked that $47 million be transferred from OSD emergency funds for Southeast Asia support. To date $37 million has been approved. You have already discussed the $8.2 million. Now tell us the requirements of the $47 million.

General BETTS. The list I have available has about 25 individual projects for which we asked $47 million and got about $37 million. I could pick out a couple of examples here of what it was we asked for.

Mr. SIKES. I think it will be adequate to provide the list for the record.

(The information follows:)

EMERGENCY FUND REQUEST FOR FISCAL YEAR 1969 R. D. T. E. REQUIREMENTS IN SUPPORT OF SEA

SUMMARY

	Dollars in thousands
Military sciences	(1,950)
Biological-medical investigations	1,150
Terrestrial investigations	800
Aircraft and related equipment	(9,850)
New surveillance aircraft	6,600
Aircraft weaponization	1,750
Avionics (adv. dev.)	500
Avionics systems (engr. dev.)	1,000
Ordnance, combat vehicles and related equipment	2,890
Firepower other than missiles	450
Army small arms program (adv. dev.)	900
FA weapons, munitions, and equipment	400
CB weapons	900
Army small arms program (engr. dev.)	240
Other equipment	(32,081)
Ground surveillance and target acquisition (expl. dev.)	250
Limited war laboratory	550
Communications development	3,050
Ground surveillance and target acquisition (adv. dev.)	6,700
Airborne surveillance and target acquisition	2,500
Therapeutic development	1,500
Tactical communications	1,200
Tactical ADPS equipment	3,300
Ground based surveillance system	4,450
Night vision	200
General combat support	4,731
Testing	3,650
Total	46,771

PROGRAMS DIRECTLY IN SUPPORT OF SOUTHEAST ASIA

Mr. SIKES. For the record, what part of the $1.8 billion request for fiscal 1970 is for programs directly in support of Southeast Asia?

Supply the major programs and describe them in this total.

General BETTS. In our statement we named about $219 million. I can supply the details on that for the record.

(The information follows:)

$219.897 million will be applied to Southeast Asia requirements. Of this amount, $30,251 million will go toward exploratory developments. Major projects in this category and planned fiscal year 1970 funding are:

	Dollars in millions fiscal year 1970
Missile propulsion	———
Develop propellants with greater density capability of withstanding extreme environmental conditions with a high degree of reproductibility.	
Surface mobility components	———
Improvement of tactical vehicles by improving track and wheeled vehicle components.	
CB Weapons	———
Firepower other than missiles	———
This program enables the Army to advance the state-of-the-art across the entire spectrum of Army weapons and ammunition except missiles. Some of the SEA efforts are in land combat weapons effect design, mortar improvement, and improved fire tables, ballistic data and fuzes.	

Dollars in millions fiscal year 1970

Biomedical investigations 9.822
This program is to conduct research directed toward the solution of medical problems having a major impact on military operations in SEA, with the exception of malaria which is a separate study. Some of the problems under study include fevers of undetermined origin, fungus diseases, parasitic infestations, psychophysiology, anethesia, blood plasma expanders, thermal burns and wound healing.

Surface mobility studies 1.075
Laboratory and field experiments to improve Army land warfare capabilities for transporting soldiers, their equipment and essential supplies.

Air mobility ..... ———
To improve methods of reducing the vulnerability and detectability of Army aircraft, to include ballistic materials, crash resistant fuel systems, and survivability design criteria.

Army small arms program ..... ———
Developments in individual weapons and special purpose weapons.

Combat support 2.615
This program supports 18 projects that produce new materials, equipment and techniques to provide better support to the Army in the field and improve the combat effectiveness of the individual soldier.

In advanced development the following major projects support Southeast Asia:

Aircraft weaponization ..... ———
The objective of this program is to obtain data upon which to base ultimate engineering development of heliborne armament. SEA related effort is in fire control equipment and gun type weapons.

Avionics ..... ———
SEA tasks in this program include all-weather approach and landing, terrain and obstacle avoidance, navigation, formation flight, instrumentation and environment sensing.

Mine warfare ..... ———
Evaluation of new approaches to increase mine effectiveness, versatility and reliability. Principal SEA efforts are in the fields of mine neutralization and scatterable mines.

Army small arms program ..... ———
Primary source of military small arms research and development for all services. Includes grenade launcher attachment for rifles, 40-mm.-grenade-launcher ammunition and especially the family of signal and marker rounds needed in SEA.

Limited war laboratory 5.000
The Army's quick reaction R. & D. laboratory for response to SEA requirements. Work at the laboratory includes 114 active tasks. Others will be undertaken as they arise during the fiscal year.

Night vision 4.023
Advanced development of components, devices and accessories for night vision systems. Includes the SEA night operations program for expedited development and fielding of 14 different night vision devices.

Ground surveillance and target acquisition ..... ———
Includes completion of the service test of the AN/TPQ-28 and ———. Development of a replacement for the AN/TPS-25 surveillance radar. Completion of development and testing of the integrated device.

Airborne surveillance and target acquisition ..... ———
———.

Electronic warfare ..... ———
———.

	Dollars in millions fiscal year 1970
Therapeutic developments	10.000
Development of new oral prophylactic and therapeutic agents to combat drug resistant malarias. New drugs will be brought to the level of preclinical testing. In engineering development, major SEA efforts include:	
Avionics systems	———
Initiate engineering development of the AN/PSN or AN/PSN-2 Loran Manpack. Continue avionics engineering support of quick reaction and special operational support of Vietnam operations. Conduct tests of AN/ARN-94 airborne Loran receiver.	
Field artillery weapons, munitions and equipment	———
Complete development of 105-mm.-rocket-assisted round, 105-mm. HEAT round, tank gun 105-mm. BEEHIVE round, XM569 fuze, XM563 mechanical time fuze and laser range finder, XM23.	
Fortifications, mines and obstacles	———
CB weapons	———
Tactical communications	———
Complete development of the AN/ASC-16 airborne command post communications facility. Award contract for joint service tactical automatic telephone central office.	
Ground based surveillance systems	———
Complete modification of AN/MPQ-4A countermortar radar to extend range. Initiate development of counterbattery radar. Continue development of meteorological data-sounding system and AN/PPS-9 surveillance radar.	
Supporting development for communications	———
Monitor and supervise development of a variety of special warfare communication equipments. Included is the AN/PRC-70 lightweight backpack radio and a new short range mission-radio. Improvement of jungle communications and psychological warfare equipment.	
Electronic warfare	———
Combat feeding, clothing and equipment	1.811
Development of a variety of individual items such as lightweight loadbearing equipment, POW name identification kit, aviation crewman's summer uniform, and cold-water detergent.	
Night vision development	4.415
Training devices	1.660
Complete development of the simulated helicopter flight training system.	
General combat support	7.924
Development of equipment for countersurveillance, logistics, mobility, maintenance and medical aid. Included are design changes on the MUST hospital, an improved aluminum airfield matting and a portable water purification set.	

Under the general category of testing, the Army is devoting $18.206 million to test of equipment for SEA. Included are munitions effectiveness testing, meteorological equipment testing, and test of Army security agency equipment.

There are several operational systems developments that must be included in SEA efforts:

Shillalagh	———
For completion of a developmental family of conventional 152mm ammunition. Improvements in current combustible casing and development of a second general consumable casing. Completion of suitability testing of the high explosive round and subsequent issue to troops.	
Defense communications planning group	———
Cryptologic activities	———

COMPARISON OF PROGRAM 1964–1970

Mr. SIKES. For the record, how does the fiscal 1970 program for Southeast Asia compare with the previous fiscal years since 1964?

You can supply that.

Also show the percentage of the R.D.T. & E. budget, including fiscal 1970.

(The information follows:)

Prior to 1966 developments for SEA were not identified separately in the Army R.D.T. & E. budget. The Army buildup in 1965 and the establishment of the priority research and developments objectives for Vietnam operations support in 1966 required a separate identification of the developments in response to the requirements from the field.

The fiscal year 1966 R.D.T. & E. support for SEA was $97.000 million or 6.4 percent of the total budget. The fiscal year 1967 SEA portion was $188.000 million or 11.8 percent of the budget. The fiscal year 1968 SEA portion was $328.000 million or 21.5 percent of the budget. Total fiscal year 1969 support of SEA in all R.D.T. & E. categories amounts to $247.797 million. Total fiscal year 1969 R.D.T. & E. program is $1,629.143 million as indicated in fiscal year 1969 column of fiscal year 1970 President's budget. The percentage of the total fiscal year 1969 R.D.T. & E. budget for SEA support is 15.2 percent.

Total fiscal year 1970 support of SEA in all R.D.T. & E. categories amounts to $219.897 million. Total fiscal year 1970 R.D.T. & E. program is $1,849.5 million as indicated in fiscal year 1970 column of fiscal year 1970 President's budget. The percentage of the total fiscal year 1970 R.D.T. & E. budget for SEA support is 11.9 percent.

The total R.D.T. & E. budget for fiscal year 1970 is $220.4 million more than for fiscal year 1969. In support of SEA the fiscal year 1970 R.D.T. & E. budget is $27.9 million less than fiscal year 1969.

Mr. SIKES. Are there any areas of which you are aware in which new weapons within the state of the art are needed for the war in Southeast Asia and which are not included in you fiscal 1970 program?

General BETTS. None comes to my mind I could identify specifically with Southeast Asia because we have given that program priority in our own consideration. Consequently, as we trimmed back the budget from our original request at the beginning of this budget cycle, we went through the budget and trimmed in many areas but protected the priority of efforts for Southeast Asia. So I cannot identify any that would fill the description, Mr. Chairman.

Mr. SIKES. Mr. Andrews?

Mr. ANDREWS. Are you thinking in terms of 10 or 15 years what we will need in Southeast Asia?

General BETTS. No, sir; our look at the Southeast Asian environment is very short range.

Mr. ANDREWS. I would suggest you lift that range because I hate to say it, but I frankly believe we will be there 15 or 20 years from now. I think it is going to be a way of life for the American people if they will put up with it. We have been there now 8 or 9 years.

Mr. Secretary, do you want to comment?

Mr. POOR. I would like to comment on that. I think it would be prudent and I think the Army R. & D. request will permit our changing the emphasis of the program for Southeast Asia support toward the objective of providing in theater those kinds of equipment that will make it easier for the people of South Vietnam to support themselves. The material to be provided by us should include the sophisticated kind of warning devices, communication devices, road building equip-

ment, all things that make it easier for them to conduct their own war.

In the last year—I tried to describe it yesterday a little bit—we have I think made a good deal of progress in the field of senser development, intrusion warning, under the canopy radar, night vision equipment, equipment which is suitable for detecting people in motion at night from aircraft. And as the war progresses to the point where we can take more and more of our people out, it would seem to me to be sensible to emphasize the kind of equipment that will help under those circumstances, cut the load of American people required to actually fight the war and put them in technological support.

Mr. ANDREWS. I agree 100 percent.

Mr. POOR. That is our objective and I think we will be working on that for a number of years to come. And the program as constituted does contemplate continued effort in the field of sensers, radar detection, engineering equipment and equipment that is appropriate to this end. We will try very hard to make sure that is the case.

Mr. ANDREWS. I would not set my sights too close. You have to look at needs 15 or 20 years from now. We are going to supply the South Vietnamese. If they can take over we are going to have to give them the tools to do the job.

General BETTS. I think we can say generally about our program that the matter of dealing with counterinsurgency is going to be with us as far in the future as we can see, so from that point of view we will take a long-range look. The things that come out of that kind of a program will be applicable to Southeast Asia as well as other places where we may have to deal with counterinsurgency.

EFFECTIVENESS OF WEAPONS IN VIETNAM

Mr. SIKES. Equipment and weapons are subjected to an unusual harsh environment in Vietnam because of climate, moisture and jungle conditions generally. Have you been confronted with the necessity for substantial modifications in types of equipment, or methods of manufacture to cope with this problem?

General BETTS. We have been confronted with substantial corrosion problems, some of which have been fairly well taken care of in the original design of the equipment and some have not. You are undoubtedly aware we have a tropic test center in Panama we have had for some years. We have had access to Thailand for testing and have made extensive use of that environment in order to work out some of these problems before we get to the production stage.

As I remarked, we have a testing team in Vietnam itself. I could not identify a trend in our equipment that says we have failed to take account of this, but we clearly have had problems with some things that did not adequately take account of it in the design phase.

Mr. SIKES. How well have the new weapons and equipment which have been sent to Vietnam in operational quantities performed?

General BETTS. By and large, I think we have had good success with the new things that have been furnished to Vietnam. I can identify things that did not work out well.

For example, the PPS-5 radar, but it did have problems in that environment and we have had to go through modifications to correct it.

On balance, looking at the total program, I think our experience has been good.

Mr. SIKES. Provide for the record a listing of those which have been most successful and those which have not lived up to expectation.

(The information follows:)

1. Items that worked as well as expected:
   Airborne personnel detector (ENSURE No. 235).
   Adjustable ranging telescope for M–14 rifle (ENSURE No. 240).
   Retransmission device for AN/PRC–25 radio.
   Landing zone directors signals for directing helicopters and aircraft.
   Remote area refrigerators for medicines.
   Flight gloves, fire retardant for aircrews (ENSURE No. 207).
   Individual lightweight survival kits for aircrews (ENSURE No. 68).
   Chemical munitions, M79/40 mm. CS cartridge (ENSURE No. 37.3).
   Chemical munitions, 4.2-inch mortar tactical CS cartridge (ENSURE No. 87.4).
   Communication systems for airboats (ENSURE No. 132).
   Integral smoke generator for helicopters and airboats (ENSURE No. 132).
   Rappelling attachment for CH–47 helicopter.
   Individual flotation gear.
   Trail cutting machete.
   Armament pod, aircraft (M18E1 for AH–1G aircraft)—7.62 mm. machinegun pod.
   Armament subsystem, helicopter (M27E1 for OH–6A helicopter)—7.62 mm. machinegun.
   Armament subsystem, helicopter (XM28 for AH1G)—7.62 machinegun and 40 mm. grenade launcher.
   Fuze, airburst, proximity, 40 mm. (XM596).
   Attack helicopter—AH–1G, Cobra.
   Light observation helicopter—OH–6A Cayuse.
   Armament subsystem, helicopter (XM41 for CH–41 helicopter)—7.62 mm. machinegun.
   Armament subsystem, helicopter (XMB for OH–6A helicopter)—40 mm. grenade launcher.
   Visual airborne target location system (VATLS), AN/UVS–1.
   Seamore—Southeast Asia Mohawk Revision.
   Personnel marking and identification system (PMIS).
   Fuze and burster, XM925.
   Handsid I—Hand delivered seismic intrusion detector.
   Minisid—Miniature seismic intrusion detector.
   Magid—Magnetic intrusion detector.
   Handsid II—Hand delivered seismic intrusion detector (second generation).
   Pirid—Passive infrared detector.
   NBB/ARFBuoy—Noiseless button bomblet/automatic radio frequency buoy.
   ADSID I—Air delivered seismic intrusion detector.
   Portable—Radio frequency monitor set, AN/USQ–42.
   Miniscope.
   Foxhole digging aid.
   German barbed tape with dispenser.
   German barbed tape concertina.
   General purpose barbed tape obstacle.
   Canadian foxhole cover.
   Wheel-type tent-mounted rollers (expendable).
   APC mounted wire cutter.
   Tunnel verification drill.
   AN/PRS nonmetallic mine detector.
   ROMD—Remotely operated mine detector.
   Sandbags—(polypropylene and acrylic).
   Lightweight water purification system.
   IMID—Infrared miniaturized intrusion detector.
   Forward area refueling system.
   Rucksack.

Footwear items—boots, sneakers, socks.
Variable armor.
Lightweight combat clothing (20 items).
Collapsible waterbag.
Body armor vest.
Survival kit.
Jungle hammock.
Rain suits.
AN/PPS radar.
Inspect repellent.
Ammunition vest, M79.
Nylon poncho.
Landing light (ELCO).
Insect repellent.
Battlefield illumination system.
Free drop water container.
Mine firing switch.
Fragmacord.
Jungle kit.
Remote firing device, XM63 (XM122).
Loran manpack receiver, PSN–2.

2. *Items that did not work as well as expected.*

———.

Mr. SIKES. Have there been any instances in the past year where the enemy has been able to effectively downgrade any of our weapons which previously were effective?

General BETTS. I cannot identify anything that they have countered in a really effective way. It must be recognized that we have gone into the theater with things like helicopters, they have managed to get support from the Soviets to bring in radar-controlled antiaircraft guns. They are not widely spread through the theater, but they have not been completely shortchanged either.

You are aware that we have done a great deal with sensor equipment to help our intelligence processes in finding the enemy. There is a considerable amount of evidence that they have been very ———. I could not identify something that has been negated in a totally effective way.

Mr. SIKES. Generally, have the so-called McNamara line devices been effective or ineffective? In other words, has the enemy been able to downgrade these?

General BETTS. I would say in general they have made an effective contribution to our intelligence process. Whether one can make a case for cost effectiveness or whether they have paid off the tremendous investment, I could not say.

NEW ENEMY WEAPONS IN VIETNAM

Mr. SIKES. What new weapons have the enemy introduced in Vietnam in the last year?

General BETTS. I would have to figure that out, Mr. Chairman. I do not identify any.

Mr. SIKES. If there have been, will you tell us how effective they have been?

General BETTS. Yes, sir.

(The information follows:)

Records show that only one new enemy weapon was introduced in South Vietnam in fiscal year 1969. A 122-millimeter gun was captured in the A Shau Valley on February 27, 1969. The gun has a range of 21,000 meters, it fires a 55-pound projectile, and has a maximum rate of fire of six rounds per minute. Its effectiveness is unknown because there is no evidence that the weapon was employed against U.S. forces.

PARTICULARLY EFFECTIVE ENEMY WEAPONS

Mr. SIKES. Are there any enemy weapons in use in Vietnam with which we have had particular difficulty in coping such as mortar fire on our bases and rockets?

General BETTS. Mortar fire and rockets are very difficult to cope with because it is so easy for the enemy to slip out of the jungle, fire and run away.

But the specific one that plagues our people most is the RPG–7 antitank rocket that is very effective at short ranges and fairly light. A couple of men can go through the jungle with these and suddenly appear wherever we might supply armor, and the shaped charge warhead will go through ———.

Mr. SIKES. Do I understand we are now studying or adapting this for our own use?

General BETTS. We have looked carefully at that, but we think there are better ways to accomplish the same purpose.

Mr. SIKES. Do we have those better ways in inventory?

General BETTS. We have a light antitank rocket that is deployed and we are in the process of improving it with a better warhead for greater penetration.

Mr. SIKES. How was this deployed, how was it fired?

General BETTS. It is a shoulder-fired rocket that is deployed in infantry squad units.

Mr. SIKES. You do not feel there would be an advantage then to abandon that concept for the new one now in use by the enemy in Vietnam?

Mr. POOR. If I could comment, I think I mentioned in passing yesterday, but perhaps not in enough detail. The RPG–7 is a device not terribly dissimilar to our light LAW.

Mr. SIKES. What is the name of our antitank rocket?

General BETTS. We call it LAW. LAW—light antitank weapon.

Mr. POOR. The RPG–7 has a little bit bigger warhead, but it has rather bad flight characteristic in a cross wind. In very calm air the RPG–7 is a reasonably accurate weapon. If there are very heavy cross winds, it is very difficult to hit the target with. Our people at the Army Missile Command have studied this problem in some depth and have concluded it would not be prudent to copy the RPG–7 but, rather, to use what we do understand about flight mechanics to further improve our current inventory weapons.

I have gone into this matter in some detail with them and I think the decision is a prudent one.

AN/TPQ–28

Mr. ANDREWS. Last year you testified before the Senate and discussed the AN/TPQ–28 and said it will look 360 degrees and you stated, "We hope there is some immediate use in Southeast Asia this summer"—speaking of last summer—"for field evaluation."

General BETTS. Yes. That was the 360 degree ———.

Mr. ANDREWS. It is not as satisfactory as you had hoped?

General BETTS. That is correct. And we do not plan to deploy it to Southeast Asia for evaluation until we have what we consider to be a good working system.

Mr. ANDREWS. That will be a most helpful ——— will it not?

General BETTS. It will be because it ——— but under many circumstances will also ———.

Mr. ANDREWS. Do you have any time estimate when you hope to get it deployed and in operation in Southeast Asia?

General BETTS. It is now in test at the Yuma Test Station. I do not have a date on when we would hope to get it out to Vietnam for evaluation, but it is indicated here that we would hope to have complete acceptance tests by the ———. That may or may not be met.

This is one of those technical problems. One cannot invent on schedule. If we can solve the problems of ——— I believe it will be a good ———.

SOVIET RESEARCH AND DEVELOPMENT

Mr. SIKES. Turning to Soviet research and development, according to the best intelligence estimates available, how does the amount the Army is requesting for R.D.T. & E. compare with the amount that the Soviet Union probably is spending for the Soviet Army?

Mr. POOR. (Off the record.)

Mr. SIKES. When you say ——— are you evaluating the dollars and the Russian ruble in terms of pay scales and other factors?

Mr. POOR. It is my understanding this statement is based on the notion of equivalent effort, the rubles are adjusted appropriately for the cost of hiring people and therefore it is intended at least to be a measure of the amount of manpower and material that is put into the program by the Soviet.

And I think our concern is that if the Soviet ———.

Mr. ANDREWS. From intelligence sources or through observations in Europe, what new weapons has the Soviet Army placed in its operational inventory in the past years?

Mr. POOR. I think for the past year we will have to provide that for the record.

General Betts may have some general comments on the new Soviet weapons.

General BETTS. I do not know of one being identified within this time frame of the past year. The one that is of particular interest to us in the recent past is their T–62 tank. They do have some new artillery that I referred to yesterday, 130-millimeter size projectiles, ranges out to ——— kilometers which is rather ———.

I would like to dig and see if I could not identify specifics for the record. I might ask my staff if they have comments.

(The information is classified and was submitted to the committee.)

Mr. SIKES. Several times in recent years this room was full of captured weapons from Vietnam. Some of the experts told us they were just as good as any we had and in some instances better, all made in Russia and Red China. Does that same situation exist today?

General BETTS. It does, although I do not identify new ones that have come into the North Vietnamese Army inventory within the past year.

Mr. SIKES. But the enemy in South Vietnam does have good weapons?

General BETTS. He is adequately armed with good weapons, that is correct.

SOVIET ARMORED VEHICLES IN CENTRAL EUROPE

Mr. SIKES. You mentioned increasing numbers of improved armored vehicles appearing in central Europe. What are they and how are they improved over what had been seen heretofore?

General BETTS. The T-62 tank was the primary basis for that remark. The intelligence numbers that I also mentioned yesterday is approximately ——— tanks that could be available to the Warsaw Pact forces in the central region of Europe within ———.

Mr. SIKES. In your judgment do the Russians have more tanks in Europe today than they had a year ago?

General BETTS. No, sir; I do not think that the number of tanks is particularly greater, but they are ——— and going back to the increased number of ———.

I do not have specific numbers on this.

Mr. POOR. I am informed there are a number of significant new developments, for example, in Soviet artillery. The Soviets have a ———.

Another matter that indicates the activity of the Soviets in modernizing their artillery equipment is the new ———.

———. We understand that testing has been essentially completed on this, but we do not yet know how fast they will deploy it. The latest system of this class, the ——— system, have new wheel transport launchers as a substitute for the older track laying vehicles giving them better ground speed and less vibration and almost as good cross country characteristics as the track transporters. So we do have evidence on a number of kind of very active development and continuing modernization of the Soviet forces.

As you know, they started a major modernization back in 1958 and that has been carrying forward with a relatively short leadtime.

Mr. SIKES. Do most of their big artillery pieces have atomic capabilities?

Mr. POOR. I know they have a great many rockets with atomic capability. I am not well-informed on the nuclear capability of their tube artillery. This again is the kind of thing that is ———.

General BETTS. As far as we know, they have ———.

Mr. POOR. ———.

Mr. SIKES. Insofar as we can determine, have there been new developments in Soviet Army weapons or equipment which require that we improve or modernize our own or that we develop new concepts to meet the challenge.

Mr. POOR. One of the things that I think should be a cause for concern is, again going back to the tank inventory, I am told the ———. It is a matter of considerable concern that we do not now have fieldable a stabilized tank. We hope to have a stabilized tank of very high quality in the new Main Battle Tank.

Mr. SIKES. Is theirs presently available?

Mr. POOR. ———.

Mr. SIKES. Are we making efforts to acquire a similar capability in the tanks which we now have operational?

Mr. POOR. We are making an effort. It has been a very disturbing program—to fix the M–60 tank, M–60A1E2 which does provide a degree of stabilization and a missile-firing capability.

This program has been plagued by technical difficulties. It is currently under a very careful review. We have enlisted the aid of the Missile Command experts in complicated mechanisms of this sort to review the design, and I am pleased to report that it appears now that that tank can indeed be fixed and we will be able to modify the inventory tanks to get an interim capability with that machine.

Mr. SIKES. In what time frame could this be achieved under optimum conditions?

Mr. POOR. It is difficult to put time frames on development programs, as you know. I am hopeful that we will have adequate information on which to select the improvements that are needed by late this summer, and depending on how much change is required, it may be possible to start back into production with those stabilized tanks within a few months after that, or perhaps as long as a year and a half or 2 years. This will depend on the degree of modification that is required.

General BETTS. Mr. Chairman, we have also developed a kit that would add stabilization to the M–60A1 that is presently in inventory in fairly large numbers. That testing has been complete and we have decided that it is a satisfactory system, but no decision has been made to produce these other than in very small numbers for an extended operational testing.

Mr. SIKES. In view of the larger numbers, much larger numbers of Soviet tanks, and in view of the added capability which their stabilization system provides, does the Army recognize the extreme importance of obtaining this new development for our own tanks in inventory?

General BETTS. It is that recognition that led us to make a decision to put stabilization in production in the M60A1E2. However, we got into technical difficulties with the production models and that is the problem Mr. Poor spoke about earlier.

Yes, I think we do recognize its importance. We also have concern that it not be an unnecessary and undesirable complication to both the tank from the technical point of view and to the training from the

point of view of maintenance. Consequently, while we have gone through the development cycle with the M–60A1 kit I mentioned, we have not yet made a firm decision to go ahead and buy the kits to put them on the M–60A1 tanks.

Mr. SIKES. I am not sure I follow you.

If this matter is as serious as I would think it is, I would think you would be pressing with all possible vigor to overcome the deficit.

General BETTS. I find that the Army is in some controversy within ourselves on this subject because of the additional complexity and maintenance problems introduced by the stabilization.

Mr. SIKES. If the enemy has two or three times as many items of any particular weapon as I have and his weapons are better for any reason, I would certainly be concerned about that situation.

General BETTS. Yes, sir, I would agree.

Mr. SIKES. But it does not appear the Army is really pressing this one as hard as it might. You seem to be arguing among yourselves.

General BETTS. There is a very real disagreement among tankers on the importance of stabilization. We have gone through the R. & D. cycle with respect to the kit I mentioned, but although it has been brought up to the point of decision for production on prior occasions, the Army has not yet decided to produce it and put it on all of these tanks.

Mr. SIKES. The committee would like to be kept informed on actions taken in this area.

All right, Mr. Rhodes.

Mr. RHODES. Do the Soviets have any tanks which are invulnerable to our antitank weapons. Do we have means of killing all of the known varieties of Soviet tanks?

General BETTS. Yes, we do. I do not know of any way to make a tank invulnerable to a good shaped charge warhead. The weight commitment is just too great for any practical sized tank.

TANK PRODUCTION

Mr. ANDREWS. What is our best and most modern tank?

General BETTS. Our present best tank is M–60A1.

Mr. ANDREWS. What about our inventory tanks, M–60's, are they in production now?

General BETTS. They are still in production.

Mr. ANDREWS. What rate?

General BETTS. About ——— a month. ———.

Mr. SIKES. How many in inventory?

Colonel LAMB. In the neighborhood of ———. I might be off a hundred.

Mr. SIKES. How many of the T–62's do the Russians have?

Colonel LAMB. We know that we have seen ——— with the T–62. We know that they are producing them at the rate of ——— per year and they have been doing that for at least ———. I do not know the ———.

Mr. ANDREWS. What is our total annual rate of production?

Colonel LAMB. ——— a year.

Mr. ANDREWS. Is that all we are producing of all types of tanks?

Colonel LAMB. Of main battle tanks, that is right.

Mr. ANDREWS. And they are producing at the rate of ——— a year?

Colonel LAMB. Yes, sir.

Mr. ANDREWS. ———.

Colonel LAMB. Yes.

Mr. SIKES. That is a sustaining rate to keep the line open. What is our capability?

Colonel LAMB. I would have to look that up for the record, sir. But that is the minimum economical rate of production.

Mr. SIKES. As I said, it is a sustaining rate to keep the line open.

Mr. POOR. In that same connection, Mr. Chairman, you asked what sort of new Soviet weapon causes concern.

They appeared to be interested in ——— in particular. ———. ———.

It is for that reason that we feel that the SAM–D development, the new anti-aircraft missile system which will have the capability of operating well in a ——— and ———.

SOVIET CHEMICAL AND BIOLOGICAL WEAPONS

Mr. SIKES. The statements indicate that the Soviets have made extensive progress in chemical and biological weapons. I would like you to provide for the record a statement which shows what they are doing in this area and with some indication of their capabilities in this area.

Mr. POOR. We will be happy to provide that.

(The information follows:)

The Soviet Union is better equipped defensively, offensively, militarily, and psychologically for chemical and biological warfare than any other nation in the world. She has placed a great deal of emphasis on these systems in her military machine. Utilizing a wide spectrum of chemical munitions, the Soviets consider that chemical tactical weapons would be used in conjunction with nuclear weapons or separately, as the case may dictate. The Soviet agent stockpiles include a variety of agents and munitions capable of creating a wide range of effects on the battlefield. The Soviet soldier is well equipped defensively. He trains vigorously and for long periods of time utilizing his equipment. He looks upon chemicals as a real possibility in any future conflict, and respects his protective equipment. The research program in the Soviet Union for chemical warfare and biological agents has encompassed every facet from incapacitating to lethal effects, both offensively and defensively.

(Additional classified information was supplied to the committee.)

MAJOR NEW PROGRAM STARTS

Mr. SIKES. What are the major new program starts which you plan to include in fiscal 1970?

General BETTS. We had hoped and would expect to get heavy-lift helicopter work underway.

You recall that I say that this at the moment is technology effort on subsystem, is not a full scale commitment for a final aircraft.

We would also hope to get the armored reconnaissance scout vehicle development underway. We would hope to get the vehicle rapid-fire weapon system, although in effect that has started out for competition. This is in the very beginning stages.

I would expect the Safeguard system manager to get the improved third stage work under way for the Spartan missile.

Mr. SIKES. Complete that for the record.

(The information follows:)

Major new program starts are defined as programs scheduled either to proceed into advanced development or to be approved by DA for conduct of contract definition (*) during fiscal year 1970. Following is a list of such programs:

Selective effects armament subsystem (SEAS).
*Mechanized infantry combat vehicle, XM723.
*FAMECE (A family of engineer construction equipment).
*Mass scatterable mines.
Chemiluminescence device for biological detection and warning.
*Improved Spartan interceptor.
Counter battery radar.
*Mallard.
Multiple artillery rocket system (MARS).
Unmanned aerial surveillance system (UASS).

Mr. SIKES. For the record, tell us how the number of significant new starts in fiscal 1970 compares with those for the last 3 fiscal years.

(The information follows:)

Number of significant items that are scheduled to proceed into advanced development or are to be approved by DA for conduct of contract definition (new starts) during fiscal year 1970 is 10 compared to seven in fiscal year 1969, 10 in fiscal year 1968, and 14 in fiscal year 1967.

COMPLETED R. & D. PROJECTS ENTERING INVENTORY

Mr. SIKES. What new weapons and equipments have been added to the operational inventory, and what significant breakthroughs have you had through the efforts of the R.D.T. & E. program since your testimony last year?

Do not include items mentioned last year or weapons you only anticipate will be completed during the current fiscal year.

Also indicate the development cost involved and the degree to which it is superior to the item to be replaced.

(The information follows:)

NEW WEAPONS OR EQUIPMENT ENTERING OPERATIONAL INVENTORY IN FISCAL YEAR 1969

New weapon or equipment	Developmental cost (in millions)	Improved performance
Vulcan air defense system	$26	Does not replace any system. It will provide much needed low-altitude air defense for the Field Army forward areas.
Pershing 1a	69.6	(1) Reduced reaction time; (2) increased preflight reliability; (3) increased maintainability; (4) improved road mobility; (5) improved command communications; (6) increased effective life; (7) simplified operation and maintenance.
Improved LAW M72A1E1	0.77	20-percent increase in penetration power.
Land combat support system, LCSS	47.3	Provides a new capability of automated multiple-check-out equipment for missile guidance systems.
Free drop liquid container	.15	Provides a new capability of delivering water by free drop from helicopters.
XM-41 armaments system for the CH-47 helicopter.	.02	Provides a new capability of firing a 7.62-mm. machinegun on the ramp of a CH-47 in Vietnam.
XM-158A1, 2.75-inch rocket launcher	.02	Provides a new capability to the AH-1G. This allows the pod to be jettisoned in flight.
XM-76 Antioscillation sight	.15	Replaces the binocular. The sight will not oscillate during flight. This is a marked improvement over the binocular for target location.
Variable body armor	.25	Provides a new capability of stopping a 30-caliber round at pointblank range.
Lightweight entrenching tool	.10	40-percent lighter than the old tool. It is less cumbersome and stores in a compact carrier.
Jungle hammock	.025	Costs less; 65-percent lighter and is easier to erect than the old hammock.

See footnotes at end of table.

NEW WEAPONS OR EQUIPMENT ENTERING OPERATIONAL INVENTORY IN FISCAL YEAR 1969—Continued

New weapon or equipment	Developmental cost (in millions)	Improved performance
Low channel (6/12) capacity radio relay system	.57	This is the first of a new family of radios. It provides a lightweight, very reliable multichannel communication system at the division level. This is a ¼-ton trailer-mounted system which will replace 2½-ton trailer-mounted system.
FM man-pack radio set, AN/PRC-77	(1)	This is a product improvement of the AN/PRC-25. It includes all solid-state components, increased reliability, and permits use of voice security equipment for the first time in man-pack FM sets.
Mobile audiovisual unit, AN/MSQ-85	.13	Replaces a commercial item. It is more rugged and has increased reliability and maintainability.
Speech security equipment, TSEC/KY-38	(2)	Provides speech security for 3 man-pack FM radios.
Suppressor, electrical transient, XM 788 GRC	(3)	Provides improved protection against vehicular engine voltage transients for vehicular FM radios.
Sheridan, armored reconnaisance vehicle, M551	34.7	This replaces the M-41 light tank. It provides a 50-percent reduction in weight, an airdrop capability, swimming capability, and a vastly improved firepower.
Gun, 20-mm. HS820/L85 (Hispano Suiza), M-139	5.49	Provides our armor personnel carriers in Europe with a high-velocity, explosive, rapid-firing 20-mm. gun capability. This replaces the 50-caliber machinegun.
Cartridge 90-mm antipersonnel XM 580E1 (Beehive).	1.0	This provides a new antipersonnel capability ofr the 90-mm. tank gun.
Mask, riot-control agent, XM28R4	1.7	Superior to the M-17 protective mask for use in operations employing riot-control agents in that it is ⅓ the weight and ⅓ the size.
Personnel detector, airborne, XM3	9.9	Does not replace any standard materiel. This is the first item that can detect people by their body vapors or activities (fires, engines).
Multishot portable flame weapon, XM191 (Flash)	6.35	Will replace the M2A1-7, ABC-M9-7 and M9E1-7 portable flamethrowers. It has a superior range, ——— for point targets ——— or area targets versus 45 to 60m for the napalm flamethrowers. Greatly reduces the logistical burden in being factory filled, thereby not requiring field mixing of the flame fuel and compressors for pressurizing the units. Its weight with 4 rockets is 26 lbs. versus 50-52 lbs for the flamethrowers.
Cartridge, 105-mm, tactical CS, XM629	.75	This will not replace any standard items. It is the first field artillery projectile containing a riot-control agent.
Cartridge, 40-mm, riot control, CS, XM674	.65	This will not replace any standard item. It is the first nonhazardous projectile designed for civil disturbance control. It has a nonhazardous rubber body containing CS. A riot-control agent cloud can be laid down at double the range (70m) a CS handgrenade can be thrown.
Service unit; flamethrower, tracked vehicle mounted, XM45E1.	.67	Will replace the M4 and M4A2 truck-mounted flamethrower service unit. This unit can accompany the track-mounted flamethrower unit into the combat area, which the truck-mounted units could not do, thereby greatly increasing their combat efficiency. It carries twice the flame fuel load and can mix and transfer the fuel in ½ the time.
Cartridge, 40-mm, tactical CS, XM651	.95	This item will not replace an existing item, but is used in place of the M7 CS hand grenade. It provides the infantryman with the capability to place riot control agents on point targets at 200m and on area targets up to 400m. A 40m range was the capability with the hand grenade.
Cartridge, 4.2-in, tactical CS, XM630	.26	This item will not replace an existing item. It provides the infantry battalion with the capability to engage targets with riot-control agents using their organic mortars.
Lightweight nylon poncho	.05	45 percent lighter and more flame resistant than the issue poncho.
Air crewman summer uniform	.35	Provides a new capability. It is flame resistant and very durable.
Tropical nylon rucksack	.050	Provide an increased load capacity for long-ranges patrols.
Vest ammunition, M-79	.02	Provides a greater capacity for carrying M-79 grenades.
50-gal.-per-minute filter separator	.027	Reduces size by ⅛% and weight by 40 percent.
Forward area refueling equipment system (FARES)	1.0	Provides greater throughput fuel with greater fuel cleaning capacity prior to use.
6-in. fuel pump	1.0	Provides 3 times the pumping pressure and replaces 3 types of old pumps.
1-kw. Xenon searchlight	.85	This item replaces a 2.2-kw. searchlight. It produces the same light output with less than ½ the electrical input.

See footnotes at end of table.

NEW WEAPONS OR EQUIPMENT ENTERING OPERATIONAL INVENTORY IN FISCAL YEAR 1969—Continued

New weapon or equipment	Developmental cost (in millions)	Improved performance
9,000 BTUH air conditioner	.068	The size and weight have been reduced to ½ of the original unit. Life has been increased by a factor of 5.
18,000 BTUH air conditioner	.567	The size and weight have been reduced to ½ of the original unit. Life has been increased by a factor of 5.
Acrylic sandbags	.025	Increases life expectancy by a factor of 3.
Lightweight 420-g.p.h. water purification unit	.345	Provides a new capability of having an air mobile unit.
Operations center, communications, AN/MSC-31A	(1)	This equipment provides an improved weather shelter for the center. It is lighter in weight and gives greater thermal and water protection.
Radio terminal, AN/GRC-163	(4)	This equipment was developed by off-the-shelf procurement. It will provide improved reliability with a 4-channel voice radio teletype and radio relay at the brigade level.

1 No R. & D. funds.
2 NSA funded.
3 In-house.
4 Developmental cost $7,500.

SIGNIFICANT RESEARCH AND DEVELOPMENT BREAKTHROUGHS

Area of breakthrough	Cost	Significance
Recovery parachute	$150,000	A 135-ft. recovery parachute was developed by NLABS to be used in clusters to recover a 50,000-lb. airdrop load from the C-5A. Exploratory test indicates that a cluster of 5 parachutes can recover a 50,000-lb. airdrop load. This item will replace the G-11A parachute (takes 10 to 12 for 50,000 lb.).
G-11A parachute with pull down vent control.	50,000	By adding a centerline to the parachute the airdrop capacity of the parachute has been increased from 3,500 to 5,000 lb. Airdrop release altitude can be lowered from 1,100 ft. to 650 ft. Item will be used for resupply by airdrop.
YO-3A aircraft	18,735,000	During fiscal year 1969 the YO-3A quiet aircraft and sensor were developed. The aircraft has demonstrated a capability to perform quiet surveillance missions which will provide the Army with an important increased capability to perform night battlefield surveillance. The sensor is presently undergoing test and is performing in an acceptable manner. The total system will enable the Army to determine its total requirements for this type aircraft.
MONTARDES	1,400,000	MONTARDES consists of the use of a MTI radar with the UH-1 helicopter. It was tested during the AF base defense test program at Eglin AFB in December 1968-January 1969. It demonstrated its superiority over all systems tested. ——— of all targets were detected. MONTARDES will be integrated into the SMASH program for the Huey Cobra.
2.75-inch rocket resistor capacitor (RC) time fuze.	1,100,000	The RC time fuze was developed to penetrate jungle foliage. It has a delay accuracy of ——— and the fuze can be set from the cockpit of the aircraft.
AVROC 40	550,000	AVROC 40 is a 40mm. boosted grenade round designed to be fired from helicopters. The range of the round has been increased by ——— and at the same time reducing the time of flight by ———. No modifications are needed to the launcher.
Out-of-battery howitzer	500,000	The feasibility of applying the fire-out-of-battery principle to 105 mm. howitzers was successfully demonstrated. A military potential test model of a soft recoil howitzer applying the principle is being fabricated for user evaluation.
Surveillance radar AN/PPS-9.	1,190,000	The development and production of the lightweight moving target indicating (MTI) surveillance radar AN/PPS-9 in a significant breakthrough through the efforts of the RDTE program. The system incorporates various developed techniques for the first time into a compact, lightweight (10 to 13 lbs. depending on battery and auxiliary equipment) hand held surveillance radar. The radar is unique in the extensive use of solid state integrated micro-miniature circuitry, printed circuit antenna and correlation of a phase-shifted pseudo-random code to determine range and to provide range resolution. The system will greatly increase the foot soldier's capability to detect and locate enemy movement during periods of poor visibility and adverse weather conditions.
Airborne laser equipment for real time surveillance (ALERTS).	2,420,000	The ALERTS employs a laser-type ——— mounted in a utility-type helicopter. The laser ——— located in the cargo compartment. This system permits ———. This system provides the Army with a new capability, and will be integrated with existing surveillance equipment.
Fuel cells	1,500,000	The logistic use of fuel cells without extensive preconditioning provides a much needed capability.
Metallic radars	350,000	This radar provides for the detection of weapons, boobytraps, etc. It is greatly needed for counter-insurgency operations.

Area of breakthrough	Cost	Significance
Reverse osmosis in water treatment.	220,000	The feasibility of purifying water with a reverse osmosis process has been proven. This will be a much greater capability than we presently have.
New flame agent	2,100,000	New technology was achieved in applying a new flame agent, triethyl aluminum (TEA), to a factory filled flame rocket warhead for the XM191 multishot portable flame weapon (FLASH).
Marking compound	1,000,000	A personnel marking agent compound system based upon ——— was developed and tested.
Incapacitating agent	3,500,000	A chemical incapacitating agent having ——— hour effects] was developed and tested.
Liquid CS agent	400,000	A nonhazardous liquid CS agent was developed for use in riot control.
Incapacitating chemical ——— agent.	3,500,000	A very low hazard incapacitating chemical ——— agent having a ——— hour effective time was tested and its field chracteristics established.
Advance nuclear componentry.	1,080,000	The most noteworthy nuclear breakthrough has been in the area of developing advanced componentry for nuclear weapons such as projectiles, atomic demolition munitions, special devices, and warhead sections for rockets and missiles. Included in this category are recent advances in amorphous semiconductors fluidic safing and arming devices, high-g. inertial components, explosive logic, hybrid fluidic/electrical/optic connectors, and techniques for microelectronic warhead section packaging. All of these developments have as their potential the reduction in size, complexity, weight, and vulnerability of adaption kits used in conjunction with AEC provided nuclear devices in planned weapon systems. Bonuses associated with this effort are increased reliability, accuracy, and safety.
Electromagnetic pulse susceptibility.	120,000	A methodology was developed to determine the susceptibility of Army weapons systems to the effects of the electromagnetic pulse (EMP) generated by a nuclear detonation. This technique was successfully used to establish the susceptibility and vulnerability of the Hardware criteria have been established to insure survivability of this system to the EMP threat.
Pulmonary failure in massive trauma.	(1)	During the past year the surgical research team in the Republic of Vietnam, backed up by supporting research at the Walter Reed Army Institute of Research, has made major contributions to the understanding and treatment of pulmonary failure in the massively wounded soldier. These are soldiers who in all previous conflicts stood no chance of survival. Pulmonary failure, commonly referred to as the wet lung syndrone, has been found to be the leading cause of death in combat casualties admitted to U.S. Army hospitals. The gross and microscopic pathology of the disorder has been studied in detail by taking sophisticated labor capability to the field. Precise procedures for management of blood loss and fluid and electrolite disturbance in these patients has been developed, as have techniques for stabilizing changes in body fluid pH and from mechanically controlled volunteers of the lung application of these procedures has greatly improved morbidity and mortality in the massively wounded soldier. In addition, the results of this research effort will directly apply to civilian medical practices, particularly to patients injured in car accidents.
Dental research	(1)	The FDA has approved the use of Army developed cyanoacrylates for producing hemostasis in the mouth. Clinical trials are being conducted at several Army installations. Medical grade silicone rubber is being used in the early temporary management of extensive soft tissue wounds of the mouth and face. Silicone rubber can easily be molded by the surgeon to restore the soft tissue continuity.
Skin diseases	(1)	Pyoderma, a mixed infection of the skin, has been difficult to treat due to a lack of understanding of the basic mechanisms of the disease. In the past, study of this conditions was limited because it could not be produced experimentally. This limitation has now been resolved and an experimental model for studying pyoderma has been developed. Studies using this model are resulting in more definitive treatment.
Meningococcal vaccines	$220,000	Vaccines for the immunization of recruits against meningococcal meningitis have been developed. Presently vaccines composed of group A and group C meningococcal antigens are being evaluated. Since January 1969 about 17,000 recruits in 5 basic combat training centers have been immunized to determine the effectiveness of the group C vaccine. Additional efforts are also being made in the preparation of a group B vaccine. The program for the development of vaccines for immunization against meningococcal meningitis presently consists of a basic research effort funded at a level of $60,000 per annum and a contract effort for the development of methods for producing vaccines funded at $163,000 per annum.
Biological agent detector	1,000,000	A new technique of detecting airborne biological agents employing a chemiluminescent principle has been advanced to the basic engineering level.
Silicon rubber foldable	250,000	A new foldable silicon rubber and new molding techniques were used in th development of the lightweight riot control agent mask XM28.

See footnotes at end of table.

Area of breakthrough	Cost	Significance
Transparent armor materials.	(1)	In the transparent armor research area, investigations are underway to develop new, lighter weight transparent armor materials with ballistic properties, equal to or better than those now used. Transparent laminate glass armor of World War II vintage required an area density of 30 pounds per square foot to defeat a .30-caliber ball projectile at 0° obliquity and point blank range. Recent work with transparent varieties of magnesium oxide, polycrystalline spinel and single crystal aluminum oxide indicates that these materials can defeat a .30-caliber armor piercing projectile at an area density of approximately 8 lbs. per square foot. This is nearly as effective as the best current opaque ceramic armor material in use. Implementation of mass production of large sized transparent ceramics that can defeat .30- and .50-caliber armor piercing projectiles is underway. These transparent armor materials will then be used in applications requiring transparency such as windshields for vehicles operating in combat and guerrilla warfare areas, vision blocks in tanks, face shields, for pilots, and helicopter canopies.
Associative group analysis technique.	(1)	The importance of clear mutual understanding of intent is critical to the success of overseas military operations. Working relationships between American military and host country personnel require a reduction in the cultural barriers that interfere with mutual understanding. These relationships are best when the words used are meaningful and specific to particular foreign audiences. However, experiences with psychological operations programs have shown that effective appeals in English often become distorted when translated into foreign languages because of different meanings attached to the same words by various cultures. Basic research on the associative group analysis (AGA) technique has resulted in a promising method to obtain valid information about the meanings of certain words and the meanings of certain words and ideas for various foreign audieneces. The AGA technique provides for each country specific data on the central meanings of words and similarity between words. This technique, by providing current data on cultural meanings of terms as understood by foreign peoples, and by providing similar data collected on American culture for comparative purposes, should increase the effectiveness of U.S. Army communications with foreign populations. These data will be directly applied to such military tasks as psychological operations and generally to all overseas operations where human elements are important.
Dynamic responses of the human head and neck to impact acceleration.	(1)	The purpose of studies on this subject is to provide the basid data required to permit development of restraint systems and ejection harnesses which will provide maximum protection of air crash in helicopters and low-performance fixed-wing aircraft in the event of crash and of extreme maneuvers. Current injuries and death rates could be significantly reduced by improved restraint systems and harnesses. The studies utilize volunteers on the horizontal, linear, sled equipment accelerator, at rates of acceleration known to be safe under conditions used. The Army provides the basic funding. The work is conducted jointly by the Army at the Aero Medical Research Laboratory, Fort Rucker, Ala., and the Navy at the Naval Aero Medical Institute, Pensacola, Fla. Observations from the accelerameter attached to the volunteer and from very high speed photography have revealed great variations in acceleration of different parts of the human body in response to acceleration of the speed at a known rate. For example, during the last several months, measurements have revealed acceleration of the mouth in excess of 48 g., when the torso was fixed to the sled providing a force level of 10 g. at an acceleration rate of 500 g./sec. This means that the volunteers mouth was accelerating to a degree 4 to 5 times the acceleration of the torso. Similar observations on different parts of the head and neck have been made at various velocities and rates of acceleration during the past year. These kinds of findings have not been recorded in the past and have not been applied to the development of restraint systems and ejection harnesses.
Canine detection of mines and tunnels.	550,000	Feasibility for dogs to detect hidden mines, boobytraps and tunnels was demonstrated by Behavior Systems, Inc., in the spring of 1968. The 60th Infantry Platoon (Scout Dog) started training at Fort Gordon, Ga., using the the techniques developed by the contractor during the pilot program.

[1] Undetermined.
[2] Annually.

Mr. SIKES. Will you list separately the new items which you anticipate will have completed development, but which are not yet in the hands of the field in operational quantities?

(The information follows:)

The following projects are currently scheduled to complete development during fiscal year 1970:

———.
Launcher, rocket, aircraft, 2.75 inch, XM200.
Projectile, 155 mm., Beehive, XM396.
40 mm., M5E1 subsystem.
HEAT round for M75 launcher.
Grenade launcher, 40 mm., XM129.
Demolition kit, projectile charge, XM127.
Cartridge, 40 mm., multiprojectile, XM576E.
Cartridge, 105 mm., booster artillery projectile, XM548.
Cartridge, 90 mm., AP XM580 for M41 gun.
Cartridge,, 40 mm, XM433 and XM434.
Projectile, 155 mm., HE XM483.
Projectile, 8 inch, XM509.
Antipersonnel mine, practice, XM35.
Aircraft gun-type subsystem XM28.
Truck, tractor, 22½ tons, XM746 (for HET–70).
Collective protection for M577 command post vehicle.
Radar set AN/TPS–41.
Laser, rangefinder, XM23E2 (AN/GVS–3).
Combat boot, mountain and ski.
Night vision goggles.
Powerplant, portable, 15 kw. turbine generator, 400 cycle.
Bridge, armored personnel carrier launched, class 12 and launcher.
Uniform, armored vehicle crewman (winter).
Meteorological measuring set, AN/TMQ–22.
Surveillance radar, AN/PPS–9.
Radio set, AN/GRC–98.
Radio set, AN/GRC–108.
Aerial radiac system AN/ADR–6.
Nuclear yield measuring device AN/TSS–6.
Controlled air drop cargo system.
Platform assembly, cargo airdrop, wooden load bearing.
35,000 lb. capacity airdrop system.

(CLERK'S NOTE.—The information provided is useful but not responsive to the question.)

CANCELED PROJECTS

Mr. SIKES. For the record, tell us what development efforts of significance have been canceled or terminated since our hearings on this subject last year.

(The information follows:)

During the last year no signficant development efforts were canceled or terminated; however, the following lesser programs were terminated:
Harness, parachute, divestible.
Cartridge, 81 mm., illuminating, XM 512 series.
Cartridge, 105 mm., HE, XM 607.
Cartridge, 90 mm., HE, XM 591, w/Fuze, MT, XM 593.
Mobile pipe mill.
Detecting set, IR, AN/AAS–10.
Night observation device, medium range.
Infrared target detector.
Countermeasures set, AN/GLQ–11.

COST INCREASES IN R.D.T. & E. PROGRAMS

Mr. SIKES. Under "cost increases," what programs, systems and projects in the R.D.T. & E. have experienced significant cost increases above the amounts estimated last year?

MBT-70

General BETTS. I would have to insert that in the record for all of the programs in order to be completely responsive. But it is clear that in the MBT-70 program, as we get into the turbine work, the R. & D. costs will go up. I think this is appropriate in that this is an additional effort.

CHEYENNE HELICOPTER

Our contract with Lockheed on the Cheyenne was a ceiling R. & D. contract, but nevertheless, there are additional things we want to develop in whole and integrate into the fire control system. That plus night vision, will increase the money committed to the total Cheyenne program.

I hesitate to call this a cost growth yet. From a total program point of view it is, but it is an additional effort we believe we should pursue.

Mr. SIKES. Complete that for the record.

(The information follows:)

[In millions of dollars]

Program element and title	Estimate in fiscal year 1969 data	Estimate in fiscal year 1970 data	Increase
2.36.25.A Advanced aerial fire support system	186.5	[1]189.1	2.6
2.22.33.A SAM Hawk/Hip	170.5	———	———
2.22.34.A Chaparral/Vulcan	89.6	———	———
2.22.51.A Division support missile Lance	377.1	[2] 427.2	50.1
6.33.02.A Surface to air missile development (SAM-D)	674.7	[3] ———	———
2.36.19.A Main battle tank	257.1	[4] 322.5	65.4
2.36.24.A Heavy antitank assault weapon (TOW)	100.8	[5] ———	———

[1] This figure, contained in the "Descriptive summaries", is an estimate through fiscal year 1971. Subsequent to the development of this estimate, further data availability and refinement resulted in a revised current program of —— million through fiscal year 1974. At this time there is no total current estimate for the R.D.T. & E. program since the program is being redefined.

[2] This estimate is in the process of being refined. The Program Status Report for June 30, 1969, reflects an estimate of $429,300,000. This figure includes $255,900,000 which was expended prior to January 1968 for development in connection with the basic Lance. It is estimated that ——— million will be required to complete development of extended range Lance.

[3] This estimate is n the process of being refined.

[4] Data excludes cost of M60/Shillelagh Turret. These dollar figures were not shown in the descriptive summaries.

[5] This estimate developed after "Descriptive summaries" were printed.

REDUCTIONS IN FUNDS APPLIED TO CERTAIN PROGRAMS

Mr. SIKES. Are there those programs which are less costly than had been anticipated?

General BETTS. None comes to mind, but we will search for them.

Mr. POOR. It is clear in adjusting the budget during the course of the year there are a large number of programs on which we spent less than we planned, because this is our principal source of reprograming.

I would be happy also to provide for the record those programs on which less effort was expended than had been planned.

[In thousands of dollars]

Program element	Title	Program approved by Congress	Current program	Reduction
	Military sciences:			
6.11.02.A	Defense Research Sciences	78,212	73,826	386
6.21.02.A	Intelligence and Electronic Warfare			
6.21.06.A	Military Personnel Performance	2,614	2,415	199
6.21.10.A	Biomedical Investigations	21,060	20,487	573
6.21.01.A	Information Processing	3,750	3,550	200
6.21.07.A	Military Training and Leadership	3,400	3,347	53
6.22.01.A	Aircraft Weaponization	1,050	957	93
6.22.03.A	Air Mobility	15,960	13,685	2,275
6.22.04.A	Aeronautical Research	4,260	3,751	509
6.22.02.A	Avionics	2,780	1,948	832
6.32.02.A	Operation Evaluation V/STOL	1,000	250	750
6.32.06.A	Aircraft Weaponization	3,760	3,621	139
6.32.01.A	Demonstrator Engines	6,000	5,750	250
6.42.03.A	Aircraft Engines	1,800	140	1,660
6.42.04.A	Supporting Developments, Air Mobility	4,670	3,590	1,080
	Missiles and related equipment:			
6.23.01.A	Missiles	18,300	17,858	442
6.23.02.A	Missile Propulsion	12,550	11,651	899
6.43.03.A	Missile Effectiveness Evaluation	5,200	1,000	4,200
2.22.54.A	PERSHING	11,432	9,500	1,932
2.22.31.A	NIKE HERCULES	3,400		3,400
2.22.33.A	HAWK/HIP	4,700	4,093	607
1.22.14.A	SENTINEL Defense System	312,900	311,470	1,430
3.31.11.A	Military Astronautics: STARCOM	6,000	5,727	273
6.45.01.A	Ships, small crafts: Sea to Inland Logistics Systems	600	100	500
	Ordnance, combat vehicles:			
6.26.01.A	Surface Mobility Components and Techniques	4,110	3,924	186
6.26.02.A	CB Weapons			
6.36.03.A	do			
6.36.01.A	Power Systems, Converters	9,300	7,836	1,464
6.46.01.A	Small Arms Program	9,600	4,415	5,185
6.46.02.A	FA Weapons, Munitions, Equipment	10,830	6,960	3,870
6.46.03.A	Nuclear Munitions	1,900	1,345	555
6.46.05.A	Tracked, Special Vehicles	8,300	6,781	1,519
2.36.37.A	Medium Anti-Tank Assault Weapon, DRAGON	14,600	12,995	1,605
	Other equipment:			
6.27.01.A	Communications Electronics	5,060	4,892	168
6.27.03.A	Airborne Surveillance and Target Acquisition	3,300	3,128	172
6.27.06.A	CB Defense	16,551	14,754	1,797
6.27.09.A	Night Vision	4,200	2,135	2,065
6.37.07.A	Communications Developments	5,070	4,990	80
6.37.08.A	Image Interpretation and Photo Processing	100	10	90
6.37.11.A	Intelligence-Electronic Warfare Development			
6.47.01.A	Strategic Communications	1,100	400	700
6.47.02.A	Tactical Communications	11,850	9,484	2,366
6.47.06.A	Nuclear Surveillance—Survey	700	600	100
6.47.07.A	Support Intelligence Operations			
6.47.09.A	IFF Equipment	1,800	800	1,000
4.47.12.A	Joint Advanced Tactical C3P	3,000		3,000
6.47.14.A	Night Vision Developments	2,165	1,912	253
6.47.15.A	Training Devices	3,900	3,242	658
6.47.18.A	CB Defense	6,200	2,652	3,548
2.22.43.A	Electronic Warfare Quick Reaction Capability			
6.37.17.A	Project MALLARD	9,040	8,000	1,040
6.37.18.A	Missile Electronic Warfare			
6.58.01.A	Management and support: Facilities and Installation Support.	86,218	84,735	1,483

[1] Congress approved ——— reclassification action (fiscal year 1969-2) reduced level to ———.

Expenditures, Obligations, and Balances of Funds

RECOUPMENTS

Mr. Sikes. I would like to have provided for the record the amount of recoupments by fiscal year since 1967, together with your recoupment objectives for fiscal 1970.

(The information follows:)

R.D.T.E., Army recoupments

[Amount in thousands of dollars]

Fiscal year	
1967	10,196
1968	32,167
1969	------
Amount reported in fiscal year 1970 budget	67,540
Amount recouped following submission of the budget	[1] 11,316
Total recouped in fiscal year 1969	78,856

[1] Includes $6,366,000,000 reported on reprograming action fiscal year 1969–14 (DOD fiscal year 1969–92 P/A), quiet aircraft.

No specific dollar recoupment objective has been established for fiscal year 1970. However, in the processing of managing the R.D.T.E. program, unobligated balances are continually reviewed to obtain maximum usage of all available funds. Periodically, funds are reprogramed, and once each year all unobligated balances over 4 years old are recouped. For example, in October 1969 we intend to recoup all unobligated balances pertaining to fiscal year 1966 and prior years. The amount recouped will be reprogramed for higher priority programs.

UNOBLIGATED BALANCES

Mr. SIKES. I would like to have submitted for the record a listing of the original estimates of unobligated balances for fiscal years 1963 through 1968, the actual amount unobligated at the end of each of those fiscal years.

(The information follows:)

[Dollars in thousands]

	Estimated	Actual
Fiscal year:		
1963	$40,925	[1] $182,546
1964	76,695	[2] 279,224
1965	138,637	[3] 290,217
1966	252,095	225,427
1967	249,105	235,325
1968	197,125	[4] 311,329

[1] The fiscal year 1963 unobligated balance exceeded the estimate by $141,600,000. This unanticipated increase consisted of $60,000,000 COMSAT funds reserved by the Bureau of the Budget; $3,000,000 emergency funds received in May and June 1963; $9,600,000 on reimbursable (customer) orders; $2,300,000 reserved for SD–5 termination costs; and $3,400,000 DOD funds in excess of the DOD estimate not controlled by the Army. The remaining $63,300,000 is attributed to the reorganization of the Army and initiation of fiscal controls (Title 10, sec. 3679 RS) at budget subactivity level.

[2] The fiscal year 1964 unobligated balance exceeded the estimate by $202,500,000. This unanticipated increase consisted of $62,500,000 funds deferred by OSD on June 1, 1964; OSD emergency funds received during May and June 1964, $11,500,000; $19,500,000 on reimbursable (customer) orders; and $3,100,000 DOD funds in excess of the DOD estimate not controlled by the Army. The remaining $105,900,000 was primarily attributed to the initiation in fiscal year 1963 of fiscal controls (Title 10, sec. 3679 RS) at budget subactivity level.

[3] The fiscal year 1965 unobligated balance exceeded the estimate by $151,600,000. This unanticipated increase consisted of $29,400,000 OSD deferrals as of June 1, 1965; $26,500,000 emergency funds released on June 30, 1965; and $32,100,000 reimbursable (customer) orders. The balance of $63,600,000 resulted from insufficient experience data under the application of fiscal controls at the budget subactivity level.

[4] Actual unobligated funds available to Department of the Army were $211,300,000. The remaining $100,000,000 was held by the Bureau of the Budget in connection with the fiscal year 1968 supplemental. $32,400,000 was released in June 1968 in lieu of a supplemental. The remaining amount was reprogramed to finance fiscal year 1969 requirements in lieu of new obligation authority.

UNEXPENDED BALANCES

Mr. SIKES. As to unexpended balances, how does your currently estimated unexpended balance for fiscal year 1969 differ from the estimate given the committee last year?

Mr. POOR. May we provide that for the record?

Mr. SIKES. All right.

(The information follows:)

The estimate in the fiscal year 1969 budget was $1,043,106,000. The present estimate is $1,092,848,000, an increase of $49,742,000. This increase results pri-

marily from additional obligational authority provided the Army after submission of the fiscal year 1969 budget, consisting of emergency funds, transfers from the Advanced Research Projects Agency and releases from the Bureau of the Budget Reserve. The reserve originally totaled $100 million and represented R.D.T.E. fiscal year 1968 funds earmarked for transfer to other appropriations to finance urgent SEA operations (fiscal year 1968 zero supplemental). Subsequently, the $100 million was released to Army R.D.T.E. as follows:

[Thousands of dollars]

(a) Released in fiscal year 1968 to finance urgent R. & D. items in support of Southeast Asia	32,460
(b) Released in fiscal year 1969 to finance fiscal year 1969 requirements (in lieu of new obligational authority)	59,300
(c) Released in fiscal year to finance urgent R. & D. items in support of Southeast Asia	8,240
Total	100,000

Following the initial release ((a) above), the balance remaining as of June 30, 1968 was shown in the fiscal year 1970 R.D.T.E. budget as an unobligated balance available to finance subsequent year budget plans ($67,540,000).

AVAILABLE FOR EXPENDITURE

Mr. SIKES. Including the amount anticipated to be unexpended at the end of fiscal year 1969, and if Congress grants the full budget for 1970, what will be the total amount available for expenditure in this appropriation in fiscal year 1970?

Mr. POOR. May we provide that?

General BETTS. We will have to provide that.

(The information follows:)

The total amount available for expenditure will be $2,942.3 million, consisting of $1,849.5 million new obligation authority; $228.2 million prior year unobligated balance brought forward; and $864.6 million unliquidated prior year obligations.

UNEXPENDED BALANCES, 1967–69

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

(The information follows:)

[In thousands of dollars unexpended balance]

Fiscal year:	
1967	1,007,815
1968	1,131,245
1969 (estimated)	1,092,848

PERCENTAGE NEW OBLIGATIONAL AUTHORITY EXPENDED

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

(The information follows:)

Percentage of new obligation authority expended

Fiscal year:	
1963	47.3
1964	53.5
1965	52.2
1966	50.1
1967	55.1
1968	49.2

UNEXPENDED BALANCES BY FISCAL YEAR APPROPRIATED

Mr. SIKES. Will you provide a table showing the unexpended balances anticipated for fiscal years 1969 and 1970, indicating in which fiscal years balances remain unexpended?

(The information follows:)

[In thousands of dollars]

Fiscal year in which appropriated	Fiscal year 1969	Fiscal year 1970
1963	4,050	3,200
1964	7,600	4,000
1965	18,500	7,500
1966	34,000	15,750
1967	64,000	35,000
1968	205,000	55,000
1969	759,698	200,000
1970	0	968,548
Total	1,092,848	1,288,998

EXPENDITURE ESTIMATES AND ACTUALS

Mr. SIKES. The committee would also appreciate having for the record a table showing the actual expenditures compared with your budget estimates, together with the percent expended, for each fiscal year since 1963. Please refer to the table on page 301 of last year's hearings.

(The information follows:)

ACTUAL EXPENDITURES, COMPARED WITH BUDGET ESTIMATES

[In thousands of dollars]

	Total available for expenditure	Expenditures	Percent expended
Fiscal year 1963 [1] Actual expenditures	2,225,974	1,354,425	60.8
Fiscal year 1964 [1] Actual expenditures	2,273,132	1,338,005	58.9
Fiscal year 1965 [1] Actual expenditures	2,336,894	1,344,396	57.5
Fiscal year 1966:			
Budget estimate	2,341,598	1,375,000	58.7
Actual expenditures	2,456,596	1,412,279	57.5
Fiscal year 1967:			
Budget estimate	2,549,386	1,420,000	55.7
Actual expenditures	2,641,764	1,633,950	61.9
Fiscal year 1968:			
Budget estimate	2,646,014	1,566,000	59.2
Actual expenditures	2,857,315	1,433,096	[2] 50.2

[1] Not included in budget estimate.

[2] The reduced expenditure rate for fiscal year 1968 resulted from the change in procedures for payments to the Army Industrial fund. Effective January 1, 1968 a progress payment procedure was instituted in lieu of the advance payment procedure. All advances were returned to the customer appropriations. Approximately $140,000,000 was refunded to the Army R.D.T.E. appropriation in fiscal year 1968.

EFFECT OF LIMITING AVAILABILITY FOR EXPENDITURE

Mr. SIKES. What would be the effect of a limitation in the law which would make funds appropriated for R.D.T. & E. available for expenditure for not to exceed 4 or 5 years, rather than having them remain available until expended?

General BETTS. I do not think that would have a significant impact, Mr. Chairman. I would have to analyze our budget history. They do not generally carry that far.

Mr. SIKES. What about the main battle tank?

General BETTS. I do not think it would be there, either. Each year we will add fiscal year increments. As we spend that, we spend out the older increments.

Mr. SIKES. There are very few where it would have any impact, but you might research it for the record.

General BETTS. I will do so.

(The information follows:)

The impact would be primarily in the contractual area, and involve contracts on which the last payment is being delayed pending final audit and settlement. As of April 30, 1969, there were 66 program elements in the fiscal year 1963 program still showing unpaid obligations. For the fiscal year 1964 program there were 86 program elements in this category, and for the 1965 program 105 elements. A program element may contain several contracts, so the number of contracts involved would be much higher than the number of program elements. The main battle tank is one of the program elements in the 1964 and 1965 programs, but shows unpaid obligations of only $52,000.

To reply to your basic question, there would be an impact if R.D. & E. funds were restricted for expenditure to a 4 or 5 year period. It would be an undesirable impact in that it might cause a tendency to "expend against the clock," and some provision would definitely be required to effect final settlement of those contracts which run beyond the time period. Such a restriction would not be advantageous to the Army research and development effort.

TRANSFERS TO OR FROM R.D.T. & E. FUNDS

Mr. SIKES. What transfers of funds have there been, either into R.D.T. & E. or from R.D.T. & E. into other accounts, such as O. & M., during fiscal year 1969 or for fiscal 1970?

General BETTS. None for 1970, the Second Supplemental Appropriation Act (Public Law 91-47) authorizes the transfer of $1.5 million from R.D.T. & E. to O. & M. ARNG. In addition there has been transferred from R.D.T. & E. Defense and Emergency Fund, Defense, $77.5 million.

STUDIES AND ANALYSIS

FUNDS PROGRAMED

Mr. SIKES. Under "Studies and analyses," provide for the record a table showing by fiscal year the amount of funds programed for studies and analyses. In this connection, show the amounts for fiscal years 1967, 1968, and 1969, as well as the estimate for fiscal 1970.

(The information follows:)

Research, development, test, and evaluation funds in thousands programed for studies and analyses are as follows:

Fiscal year 1967	12,445
Fiscal year 1968	12,510
Fiscal year 1969	9,650
Fiscal year 1970 (estimate)	10,000

IN-HOUSE, CONTRACTOR EFFORT COMPARED

Mr. SIKES. Can you tell us what percentage of your total studies and analyses effort is done in-house compared with those done by contractors?

General BETTS. I do not think we have that percentage readily available.

(The information follows:)

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION FUNDS IN THE STUDIES AND ANALYSES LINE

[In percent]

	Fiscal year			
	1967	1968	1969	1970 estimate
In-house	2	15	3	2
Contractor	98	85	97	98

USE OF INNOVATIVE TALENT OUTSIDE ARMY LABS

Mr. SIKES. Page 11 of your statements mentions the tremendous benefit received from using the innovative talent of individuals outside the Army laboratory structure for new and novel ideas. May we have some examples?

General BETTS. Yes.

I think one of the most interesting is the vehicle that the Lockheed Co. calls the Twister that is completely their design. We have yet to make up our minds as to what specific application we would make of this kind of mobility technology. Nevertheless, it is perfectly obvious that the approach is different, and its mobility is outstanding for a wheeled vehicle.

I think one must give the Bell Helicopter Co. credit for the Cobra concept. It is clear that the Army wanted a gunship when we put armament on the Hueys. It is also clear that the reconfiguration of the Huey would add to speed and improve the effectiveness of that aircraft as a gunship. I believe we have to give Bell credit for the innovation.

Mr. SIKES. If there are others, you may provide them.

(The information follows:)

Outstanding examples of research supported by others and of benefit to the Army include:

Secor, meaning sequential collation of range, is an electronic distance measuring system designed to make use of artificial satellites for determining geodetic positions on the earth. The system concept was developed by the Cubic Corp. of San Diego. The Army's Engineer Topographic Laboratories continued the development and improvement of the system. Development, test and evaluation were conducted by personnel of the Surveying and Geodesy Division USAETL.

From our Army Research Office at Durham we provided the funds for M. G. Bekker to compose the text which was published as a book in May 1969 titled "Introduction to Terrain-Vehicle Systems." Dr. Bekker originated the soil value system that bears his name. He conducts lunar and terrestrial ground locomotion research at General Motors. He has served on a panel of the President's Scientific Advisory Committee and as a consultant for a Basic Research Advisory Committee of the National Academy of Sciences. His work represents the first attempt to show practicing engineers how they can apply systems analysis to the design of off-road vehicles. It shows to analyze competing alternative designs in conjunction with various kinds of terrain so that the best one can be selected for a specified mission.

In the Army computer-administered instruction program the crystal clear emphasis on what material is taught, how it is presented and when it is introduced, as opposed to the usual emphasis on computer hardware innovations, must be attributed to the Human Resources Research Office.

The American Institutes of Research developed a new conceptual framework for the orientation of Americans overseas. As a result of the Army support to AIR in order to develop these concepts, military training programs have now been introduced by the Eighth U.S. Army in Korea and the materials have been adapted by the Navy and Marine Corps for use in Vietnam.

The Army coordinates research on influenza with national, international and Defense commissions under Army sponsorship. Universities, principally the Uni-

versity of Michigan, conduct research to develop new influenza vaccines for the military.

Investigators at the National Institutes of Health, coordinating with Army investigators, have isolated a virus which appears to be the causative agent for infectious hepatitis. Hope now exists that an effective vaccine can be developed.

The concept of the liquid land mine capable of immobilizing a 2-ton vehicle was developed and demonstrated by the Explosives Corp of America. The system has potential advantages of greater safety and ease in handling and dispensing, and unique potential for neutralization and controllability.

The development by General Electric Corp. of an ion membrane to replace the liquid electrolyte in a fuel cell made possible the design of small portable fuel cells for the Army.

Developments based on initial work outside of the Army laboratories on the controlled solidification of metals are reaching the proportions of a major breakthrough. The improvements in metal properties and production processes are following a deeper understanding of the mechanism of freezing and the control thereof. The results are now being applied to large gun tubes and other critical components of Army equipment. Greatly improved fatigue life is the result. This longer life of metal parts in turn reduces the need for replacements and minimizes the possibility of catastrophic failures.

Kaman Aircraft is pursuing an approach that may match better the helicopter blade performance at hover or low speed to that of high speed. The concept is known as the controllable-twist rotor. The concept employs the Kaman servo flap to control an outboard section of a torsionally elastic rotor blade and a pitch horn to control the root end of the blade. This concept improves the capability to control the airload distribution around the azimuth of the rotor blade, decrease power requirements and increase flight speeds without stall. The program includes an Army contract with Kaman to perform a parametric study to determine the optimum configuration to best benefit from the controllable twist rotor approach.

MANAGEMENT OF CONTRACT RESEARCH

Mr. SIKES. You also speak of a strong contractual research and development program with universities, not-for-profit organizations, and industry. Who awards and monitors this research? Is it the Army Research Office, the in-house laboratories, or someone else?

General BETTS. The focal point of the management is the Army Research Office in Durham, but they use the technical capability within our in-house laboratories, and they use the National Academy of Sciences as people who will help us evaluate new proposals and whether or not we should continue to support work that is currently under way so we may be sure the principal investigator is of requisite professional competency and that the work is indeed important.

BASIC AND APPLIED RESEARCH

IN-HOUSE AND CONTRACT PROGRAMS

Mr. SIKES. For the record, tell us how many basic and applied research projects are supported by (a) the Army Research Office and (b) in-house laboratories.

(The information follows:)

The U.S. Army Research Office, Arlington, Va., and the U.S. Army Research Office (Durham), Durham, N.C., support approximately 450, and the Army in-house laboratories support approximately 650, basic and applied research contracts and grants with academic institutions, research institutions, and industry.

FISCAL PROGRAM 1967–69

Mr. SIKES. For the record, what has been the total program of such research in the last 3 fiscal years?

(The information follows:)

In fiscal year 1967 the Army contractual effort was approximately $41 million in basic research and approximately $78 million in exploratory development. In fiscal year 1968 this contractual effort was approximately $35 million for basic research and approximately $50 million for exploratory development. The fiscal year 1969 contractual program was approximately $35 million for basic research, and exploratory development was approximately $54 million.

BASIC RESEARCH RELATION TO ARMY MISSION

Mr. SIKES. Can you at this time tell us how much of this basic and applied research is of general nature, and how much is directly related to an Army or military mission?

General BETTS. As far as I am concerned, we require that everything we support be relevant to the Army mission and satisfy one of our military themes. This is the way we give guidance to the Army Research Office, Durham, and to the people who evaluate new proposals, and whether or not we continue effort.

The point to a military theme is a deliberate effort to couple advances in basic research that are basic by definition, to some ultimate military capability. Those military themes are Army mission-related by design.

PROJECT THEMIS

Mr. SIKES. To what extent is the financial dependence of universities and FCRC's the primary consideration for continuing research projects, and to what extent is it actually needed for the project?

General BETTS. I would say categorically, not at all. Our mission is not to furnish support to universities. It is to put ourselves in a position to be aware of what is going on in the forefront of technology.

It is almost impossible to maintain that awareness on a continuing basis without having direct and continuing responsibility for work with the universities.

Mr. POOR. I think there may be one exception. As you will remember, the DOD did, I think a couple of years ago, establish a project called Themis. This project has the purpose of increasing the base of university competence to support activity of interest to the Defense Department.

We have participated in Themis. It has broadened the base, and even in the case of Themis, the projects are subject to the same sort of review for relevance as the General has stated.

With this one exception, I think General Betts' answer is completely correct. We are simply not in the business of supporting universities or FCRC's because they have their hands out for money. We are looking for value received and, by and large, are getting very good value received.

Mr. RHODES. Are you intimating that the Themis is not in that category?

Mr. POOR. I am saying that Themis is in that category, but there is a small element of pump-priming involved to try to assist a competent department in a university, through contract support, to grow in its competence to help.

(Off the record.)

BASIS FOR RESEARCH PROJECT MANAGEMENT

Mr. SIKES. Are the research projects in universities and the FCRC's managed on the basis of need and relevance, or is it done on a dollar level or sustaining research basis?

General BETTS. They are managed on the basis of our judgment as to what the appropriate level of effort should be with respect to that particular technical effort. In other words, we look at the principal investigator and how many people he needs to support him to do this task adequately, and then that determines the dollar level of effort at which it would be supported.

The FCRC's, as you are aware, are limited in the total amount of effort that we can put with them by ceilings established by the Congress.

Mr. SIKES. How much of your basic and applied research budget is committed within the first 6 months of the fiscal year?

Colonel SNEAD. In past experience, sir, approximately 35 to 40 percent.

Mr. SIKES. Do your contracts require that progress reports of accomplishments be submitted monthly or quarterly?

Colonel SNEAD. I think this varies from organization to organization. All of them are monitored continually. The dollar accounting system I believe is quarterly. There is a summary accounting on awards.

Mr. MURPHY. We were not referring to financial reports, but reports of accomplishment. Do the contracts require that quarterly reports of accomplishment or reports every 6 months be provided the Army, or is this handled on a field trip basis, or just how?

Colonel SNEAD. It is a combination of both, sir. We handle it by periodic reports. These can vary, depending upon the pace or the nature of the research being accomplished. There are also visits by the principal monitor, made to the investigator's location. They are also monitored by the presentations of the investigators in the normal scientific exchange media of publications in scientific periodicals, presentations at conferences, and symposia.

So, there is a broad spectrum of monitorship. There is a definite accounting each year as to the total of all of this, of what actually has been accomplished during the year.

Mr. MURPHY. You did not answer the question. Do the contracts require that reports be provided?

Colonel SNEAD. Yes, the contracts do require reports.

Mr. POOR. But the period of reporting varies from contract to contract.

General BETTS. If it is a very small effort, it is usually inappropriate to ask for more than an annual or semiannual report. Where it is a larger effort, we might ask for much more frequent reports.

Mr. SIKES. Are trip reports prepared showing progress being made under a particular contract?

General BETTS. Yes, sir.

Mr. SIKES. Are results of all research contracts evaluated as to their relevancy and quality?

General BETTS. Yes, sir.

Mr. SIKES. Do you check on the availability of the principal researcher or investigator and how much time he spends on a project to insure these studies are not made by students?

General BETTS. Yes, we do. We do not run it on a time-clock basis, but we are in adequate touch with the details of the effort. We would know right away if the principal investigator sloughed off the effort to someone else.

ARMY RESEARCH OFFICE

NUMBER OF EMPLOYEES

Mr. SIKES. How many employees does the Army Research Office have, and where are they located? You may provide that for the record.

(The information follows:)

U.S. ARMY RESEARCH OFFICE AND SUBORDINATE ACTIVITY PERSONNEL

	Civil service	Military	Contract
U.S. Army Research Office, Arlington, Va	106	46	14
U.S. Army Research Office, Durham, N.C	75	6	0
U.S. Army Research & Development Group (Europe), Frankfurt, Germany	4	5	5
U.S. Army Research & Development Group (Far East), Tokyo, Japan	3	1	3
U.S. Army Element, Defense Research Office, Latin America, Rio de Janeiro, Brazil	2	0	2
Total	190	58	24

RESEARCH OFFICE FUNCTIONS

Mr. SIKES. Explain the purpose and function of Army Research Offices, located in Arlington, Va., Durham, N.C., and Frankfurt, Germany, Tokyo, Japan, and Rio de Janeiro, Brazil. You may provide that for the record.

(The information follows:)

The U.S. Army Research Office, Arlington, Va., is a class II activity with nine offices and divisions that exist as subordinate elements of the Office of the Director of Army Research.

The Director of Army Research exercises general staff supervision through the Army Research Office of: The research program of the Army (with the exception of some research in the atomic energy field and a portion of chemical and biological warfare research); assigned exploratory development; development and test of meteorological materiel and electron devices (tubes, transistors, resistors, and so forth); the Army Medical Services R.D.T.E. program; the Army operations research program; and the Army behavioral and social sciences research program.

The Army Research Office assists the Director of Army Research in the formulation of plans and programs in assigned areas of Army research and development by:

1. Reviewing the adequacy and balance of assigned portions of Army research and development operating programs;
2. Providing input to current research and development and status of component developments; and
3. Exercising staff responsibility for the development and analysis of project proposals, determination of technical capability to develop and produce, and selection of conceptual approach.

The Army Research Office provides the Director of Army Research with a general staff element responsive to the Assistant Secretary of the Army (R.D.), Chief Research and Development, and his deputy, for those research and advanced technology activities assigned to the Director of Army Research in their relations of a scientific and technological nature with the Office of the Director of Defense Research and Engineering, Navy, Air Force, other Federal agencies, and the general scientific community.

The Army Research Office provides a scientific analysis and evaluation capability for OCRD in those areas of research and advanced technology assigned

to the Director of Army Research, and awards and administers research contracts and grants in selected areas.

The Army Research Office assists the Director of Army Research in directing the activities of the U.S. Army R.D. Operations Research Advisory Group, the U.S. Army Research Office (Durham), the U.S. Army R. & D. Group (Europe), the U.S. Army R. & D. Group (Far East), and the U.S. Army Element, Defense Research Office, Latin America, and assists him in his responsibility for: (1) General support and stimulation of science and technology in, and supported by, the Army; (2) monitorship of Army science information activities; (3) preparation of the annual Army long-range technological forecast; and (4) planning and programing for, and supervision of the execution of the Army Research Office portion of the Army research and development program.

Finally the Army Research Office supervises and coordinates the activities of four contract organizations: Research Analysis Corporation; Human Resources Research Office; Center for Research in Social Systems, directly; and the Mathematics Research Center, through the Army Research Office—Durham.

The U.S. Army Research Office, Durham, N.C., coordinates and administers contracts and grants in the United States with academic institutions, research institutes, and industrial laboratories, for basic research in the mathematical, physical, engineering, and environmental sciences.

The three oversea Army offices, U.S. Army Research and Development Group (Europe) in Frankfurt, Germany; the U.S. Army Research and Development Group (Far East) in Tokyo, Japan; and the U.S. Army Element, Defense Research Office, Latin America, in Rio de Janeiro, Brazil, represent the Department of the Army at oversea scientific meetings, coordinate technical exchange visits and arrange exchanges of technical reports with the foreign scientific communities. Their main activity lies in the evaluation of proposals, coordination of contract and grant funding, and the monitoring of contract and grant execution for research contracts and grants with individual foreign scientists and foreign research organizations.

BEHAVIORAL SCIENCE LABORATORY

Mr. SIKES. How does the Behavioral Science Research Laboratory differ from the other Army research offices?

General BETTS. The Behavioral Science Laboratory is involved in actual research effort, whereas the other organizations that we mentioned are responsible for monitoring the work of others. In the Behavioral Science Research Laboratory, we have psychologists working on problems that relate to the interests of the Army, either with respect to the human factors involved in new equipment evaluation, or in the selection tests that we have used over the years.

You are familiar with the tests we give each soldier to assess his aptitude. The refinement of those, the analysis of results, and their application to changes that we may propose—this kind of activity is done right within the laboratory itself.

Mr. MURPHY. The reason for that question is that the justification book indicates this lab comes under the Army Research Office. Is that correct?

General BETTS. Yes, sir; it reports directly to the Army Research Office, and is under my control.

Mr. MURPHY. Do all your in-house laboratories report directly to that Office?

General BETTS. We have that laboratory and we have the Limited War Laboratory reporting to my level. The Limited War Laboratory is monitored by the Director of Development, the Behavioral Science by the Director of Research.

Mr. MURPHY. Maybe you could provide something for the record indicating why this is so.

General BETTS. We can put it in the record or answer now.

Limited War is because we wanted a very quick reaction capability that we could use to support Southeast Asia without the time involved in going through other levels of administration.

The Behavioral Science Research Laboratory conducts research very closely coupled to activities armywide, including those of the Director of Personnel with respect to new inductees and that kind of thing.

You are aware that they are a technical group immediately available to us to help us in the problems that appear when we get into the difficulties of large acquisitions of soldiers. It could be made to report through some other mechanism, but there is really no other element of the Army that could make the same broad uses that the Army general staff does. I think it appropriate that it report to my level.

BEHAVIORAL AND SOCIAL SCIENCE RESEARCH

Mr. SIKES. I would like provided for the record a table showing the amount of funds made available and programed for behavioral and social science research.

(The information follows:)

In the basic research area that we are talking about, the amounts are:

Behavioral and social science research

	Million
Available (fiscal year 1969)	1.4
Programed (fiscal year 1970)	1.7

COORDINATION OF RESEARCH PROGRAMS

Mr. SIKES. Under "Coordination of research programs," in what way do you utilize scientific research which has been funded by other military services and by the civilian agencies of the Government?

General BERTS. As was discussed yesterday, we are very closely coupled with the NASA laboratories that work in aircraft programs. We have from time to time found it very helpful to use the National Bureau of Standards, both on a reimbursable basis and a nonreimbursable basis.

We have isolated cases where we have used either Air Force or Navy laboratories to help us in various programs.

I could fill that out with specific details.

Mr. SIKES. I would like some recent examples of Army utilization in major Army programs of research funded outside the Army.

You may provide that for the record.

General BERTS. All right.

(The information follows:)

Outstanding examples of research supported by other Federal agencies and used by the Army include:

The original work on fuel cells (all outside the Army) led to the development of electrodes and the design of the anode and cathode that were utilized in the Army R. & D. program for development of fuel cells. These include the work by Bacon (England) in 1930-50; Justi (Germany) 1950; Union Carbide Corp. (1957); recent work by Pratt-Whitney Corp. and General Electric Co.; and the recently funded program by NASA in the fuel cell program for space flights.

One of the accomplishments of the NASA funded fuel cell program for space flights led to the development of high rate oxygen electrodes. This development made possible the recent development of the zinc-air battery as a high energy density battery for Army use. Before this development of oxygen electrodes, the metal-air batteries were limited to use only a low power rates.

Research on aging, cancer, and heart disease, for example, is conducted by the National Institutes of Health. Results from this research are utilized by the Army.

Boeing Vertol Division, through a U.S. Air Force contract, confirmed the materials research findings of the U.S. Air Force Materials Laboratory that boron fiber/organic matrix composite materials have major implications for improving aircraft design. The Army is now adapting similar materials for use in its aircraft. The use of these materials instead of metal alloys will (1) provide for economically feasible improvements in aerodynamic configurations; (2) retain better structural integrity after damage by small arms fire; (3) reduce defective finish problems and decrease corrosion susceptibility of the overall aircraft; (4) enhance the fatigue life of parts permitting a greater number of flight hours between overhauls; (5) simplify repair of parts in comparison to metal items; (6) substantially reduce component manufacturing costs; (7) reduce susceptibility to handling damage; (8) provide structurally inherent/internal damping, thus minimizing vibrations; (9) reduce radar reflectivity.

A multi-image correlation system, located at the University of Kansas, has been developed using multiple agency funding. Investigations which led to the theory for this system were funded by National Science Foundation. Initial development was NASA funded and further development was funded by ARPA. This system represents a new technique for processing and displaying remote sensor data for improved interpretability and produces unusual image enhancement effects on demand.

A number of examples relate to our social science research. On military civic action and on selection and training of military advisers we have utilized the results of previous research conducted by the Institute for defense analysis as well as the results of research conducted by human sciences research incorporated for the U.S. Marine Corps. We have also used the results of research done at the University of Illinois on intercultural simulation under Navy sponsorship. AID research results on attitudes of Koreans have been used in recent research on improving communication through the associative group analysis technique currently sponsored by the Army.

Research results of the Bureau of Mines in explosives obtained over a number of years, and more specific results obtained recently, have been used in the development of Army capabilities to destroy enemy tunnels in Southeast Asia.

Mr. SIKES. Questions on research?

FAILURE TO CLOSE FRANKFURT OFFICE

Mr. RHODES. Mr. Chairman, I am reminded that we had directed that the research office in Frankfurt be closed and combined with the one in Brussels. Has this been done?

General BETTS. The groundwork for this has been laid. Unfortunately, the proposal as it evolved in the Office of the Director of Defense Research and Engineering recommended that Navy, Air Force, and Army all assemble in London by the summer of 1970.

We have made the analysis and preliminary planning for this, but at the moment have also been faced with the fact that there is no space available in the Keysign House to handle it.

That was the case. Colonel Snead says that is now resolved.

What I am saying is that the planning has gone ahead and the actual move has not taken place. There were some roadblocks along the way that needed resolution.

Mr. RHODES. Is there any request for funds in this budget for the operation of the Frankfurt office?

General BETTS. There are funds in the amount of about $500,000 for continued support of research in Europe that at the moment would be monitored by the Frankfurt office. At the time of the move to London, they would continue to be monitored from there.

Mr. RHODES. How soon will you close the Frankfurt office?

General BETTS. The plan is the summer of 1970.

Mr. RHODES. Why does it take so long to react to a pretty definite demand of the Congress to close that office?

General BETTS. In this case because, in the first instance, you recall, the directive was to assemble on the mainland, but further study indicated that there might be a better way to do this that would cost the Government less money.

Mr. RHODES. So, while you are studying and deciding to do this, you are proceeding just as you had been before, without paying too much heed, or any heed at all, to what I thought was a pretty fair direction?

General BETTS. On the contrary, the program has been scaled down very considerably from what it was when this subject was first raised within the Congress. We have been gradually readjusting so the move could be made most efficiently.

Mr. RHODES. Do I understand correctly that rather than have the Frankfurt office of the Army consolidated with the Air Force Office in Brussels, both the Army Office and the Air Force Office will now be consolidated with the Navy Office which is in London?

General BETTS. That is Dr. Foster's present plan for us.

Mr. RHODES. The timetable for that is the summer of 1970?

General BETTS. That is correct.

Colonel SNEAD. I can expand on the reasoning behind this.

The question of the availability of economical space in London was just resolved within the past week. We have been watching very carefully our personnel planning so that at the time of change of the staff we will have the minimum number of personnel transferring to London because of the gold flow and movement cost expenses.

We are tailoring it so that the London office will have a new team, essentially, other than the minimum number to maintain continuity, are transferring from the Continent. The new team will come from the United States to replace them. There are significant dollar savings in this.

SAVINGS TO BE EFFECTED

Mr. ANDREWS. Put something in the record, Colonel, about how much we can expect to be saved by this consolidation, in manpower and in dollars.

(The information follows:)

The U.S. Army Research and Development Group (Europe) had a total strength of 19 on July 1, 1968 (5 officers, 2 E–7's, 4 GS–15's, 1 G7–7, and 7 local nationals). On July 1, 1969 the office had 14 personnel (4 officers, 1 E–7, 4 GS–15 and 5 local nationals), and on July 1, 1970 the office will reduce to 12. Total savings in manpower is 7 over a 2 year period. Three officers and one civilian will return to the United States by June 30, 1970 and will be replaced in London; the one officer and three civilians replaced in Frankfurt this year will move to London for continuity. We estimate that by conducting the move to London in this manner and by moving so as to be in London on July 1, 1970, a total savings in excess of $37,000 is realized.

EUROPEAN CONSOLIDATION AGREED IN 1966

Mr. RHODES. I find the situation is even blacker than I had indicated, because in April of 1966, Mr. Mahon and Dr. Foster had a colloquy regarding the consolidation of the three service research offices in Europe. It was indicated at that time that there was a study completed for the consolidation of two of them, and it was just a matter of a very short period of time before the third would be ground into the equation and the job would be done.

This is 3 years later, and it still has not been done. I think our patience has been—I was about to say exemplary, but perhaps I should say something else.

I really hope it can be speeded up. In this 1966 colloquy there was talk about savings which would be made. Obviously, savings can be made. Maybe this is a good way to do it.

General BETTS. Mr. Rhodes, I think what one must say about this is that subsequent and more detailed analysis rather indicated that the savings would not be made and, consequently, as we looked for other solutions, we took a great deal more time at it than had originally been anticipated.

You see, the problem is, in each of the centers of interest there are very different considerations with respect to costs. It was rather consistently the Army's position that the least cost solution was the center in Frankfurt. We did not manage to sell that point of view to anyone else.

INFORMING CONGRESS OF CHANGES IN PLANS

Mr. RHODES. This is a good example of the thing I was talking about the other day when I said the military, the Department of Defense, should really take more pains in keeping the Congress informed about changes in plans, to include overruns and all the other things that we get surprised with when you come up every year.

We realize the fact that when you are building sophisticated military equipment, it is not like building an automobile which is very similar to the automobile built the year before. We know that.

At the same time, we also know that at some time in the production or perfection of weapons, either the previous cost estimate given the Congress has been pretty well verified or it has been determined that it is away off base.

At the time that determination is made, you would be much ahead in the ballgame if you would just let us know ahead of time that you are in trouble, that the costs are going to be excessive and state the reasons why.

This is a small thing, but it is a fairly good example of the military unilaterally changing a decision which the Congress as a whole has made. We were entitled to know, and be given an opportunity to change our position, if that seemed necessary, or insist upon it.

General BETTS. It is a reasonable request.

Dr. HERSHNER. As you pointed out, the original decision was to move the Frankfurt office to Brussels. About the time instructions were being prepared to accomplish this, it became necessary to move SHAPE and other activities out of Fance and the new location selected was Brussels. This greatly altered the situation and it was decided not to compound the problem in Brussels by moving the Frankfurt office there.

General BETTS. We should then have informed you.

Mr. RHODES. At that time we should have been informed that you could not proceed as you had planned.

General BETTS. It is a reasonable request, I agree.

Mr. RHODES. Thank you, Mr. Chairman.

Mr. SIKES. I must support the statement made by my colleague, Mr. Rhodes. We are trying to accomplish the same thing, and it is important that we be kept informed on matters of his nature.

Mr. Poor. Mr. Chairman, may I ask for advice. As I understand it, we do report all major reprograming actions to this committee and 3 other committees of the Congress. Have you a suggestion as to how this system is not working or how we could improve our relationships by perhaps supplementing the mechanics of reprograming requests?

Mr. Sikes. Yes. I think we could be kept more fully informed of changes that do not necessarily require reprograming, changes such as the one just referred to.

If you would notify the chairman of the committee when there have been significant changes in programs, it would at least keep us more fully informed and keep us up to date on your activities.

Mr. Rhodes. That is exactly what I had in mind. Certainly, when reprograming action is indicated, we are informed.

Mr. Sikes. Much of that is mandatory, but there are many changes that do not come under reprograming, where an activity has been justified or a statement has been made regarding a specific activity which is to be accomplished, and then if we are not advised when changes are made, we are left rather high and dry, particularly when it comes to our efforts to explain to our colleagues in the House what you are doing and what you are not doing.

I think also that reprograming actions do have limitations in that they are not too detailed in advising the Congress exactly why cost increases are necessary, and they also do not indicate that the total estimated cost of the completed project has changed upward.

I do not know how this could be improved, whether it should be accompanied by a short letter pointing out you are having technical difficulties in resolving a particular problem and, therefore, the overall cost of developing this weapons systems will increase from this to that.

Mr. Poor. We are working with the Department of Defense to try to improve the method of reporting reprograming.

Civilian Personnel

Mr. Sikes. Page 9 of the justifications indicates that the total number of permanent civilian positions will increase by 185 during fiscal year 1970. Why is this increase necessary?

General Betts. It is a plan to get our numbers back up to our authorized level. We have not been able to recruit to our authorized level in the recent past.

Mr. Sikes. I do not understand the point. You are reducing manyears by 41. Is that because of the fact that you have not been able to get up to the authorized level?

General Betts. You recall during the past year the total Department of Defense has been under very stringent limitations to get down in manpower. The way this was directed to those of us trying to run a program was that we would be permitted to hire so many people for every given number that we lost.

Since we were able to hire fewer than we lost, our numbers trended down. That was to help get to the overall ceiling of the Department.

Within each appropriation, one may or may not be over ceiling. In our case, we were not over ceiling. We were under our authorized levels of manpower as recognized by our own authorities.

I am saying in this we would hope during this coming year to be permitted to go up to our authorized strength.

Then with respect to the overall ceiling, those adjustments would be made outside of our appropriation.

RECRUITING PROBLEMS

Mr. MURPHY. General Betts, you mentioned earlier you were having a recruiting problem.

General BETTS. It is because of the hiring restriction. We could not recruit to fill the positions we had authorized.

Mr. MURPHY. I thought you said you were having problems recruiting people.

Mr. POOR. No. The hiring restrictions have made it very difficult for us to put on the payroll some very good recruitees. It must be clear there are long delays under this kind of restraint. Sometimes the candidates for employment will have found another job by the time we sort out the authorization.

General BETTS. That really describes the problem.

I would add, you recall it was only a little over a year ago that we started to build up the new Army Ballistic Missile Defense Agency, and have not been able to recruit to fill that authorization because of the overall hiring limitations.

END STRENGTHS, CIVILIAN PERSONNEL, 1967–1970

Mr. SIKES. What is the total number of civilian personnel to be supported in this appropriation in fiscal year 1970?

General BETTS. 15,431.

Mr. SIKES. For the record, show how this compares with the three previous fiscal years.

General BETTS. All right, sir.

(The information follows:)

Research, Development, Test and Evaluation, Army, End Strength of Civilian Personnel

Fiscal year:	
1967 actual	19,099
1968 actual	17,670
1969 estimated	15,240
1970 estimated	15,431

NOTE.—The decrease between fiscal year 1967 and fiscal year 1968 is primarily the transfer of the installation support personnel at Fort Huachuca, Ariz., from the research, development, test, and evaluation, Army appropriation to the operations, Army appropriation. The Strategic Communications Command became the Post Commander at Fort Huachuca on July 1, 1967, necessitating the transfer of these spaces.

The decrease between fiscal year 1968 and fiscal year 1969 is primarily the estimated attrition reductions resulting from the application of section 201 of Public Law 90-364, elimination of summer hire and temporary spaces, and a pro rata share of the Department of Defense productivity reduction.

Mr. SIKES. Page 9 of the justifications indicates that the average number of all employees, including part-time employees, funded directly in R.D.T. & E. is 15,048. On page 20, however, the average number of civilians paid out of R.D.T. & E. funds is shown as 27,548.

Does this mean that more than 12,500 man-years of civilian employment are paid from the Army industrial fund and indirectly charged to R.D.T. & E.?

General BETTS. Yes, sir.

Mr. SIKES. Has that always been the situation?

General BETTS. Yes, it has.

Mr. SIKES. For fiscal year 1970, total man-years are reduced by 41, and total military personnel are increased by 132. Is there a relationship?

General BETTS. There is no relationship.

Mr. SIKES. In other words, are you reducing civilian personnel and using military?

General BETTS. This is not a deliberate program. These are adjustments to the two different accounts that go back to many different places.

CIVILIAN EMPLOYMENT, BY INSTALLATION, 1968–70

Mr. SIKES. Provide for the record a list showing the civilian employee man-years funded directly and those funded indirectly from R.D.T. & E., by installation, for fiscal years 1968, 1969, and 1970.

(The information follows:)

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION, ARMY INSTALLATION ANALYSIS, GOVERNMENT CIVILIANS PAID OUT OF R.D.T.E. & E. FUNDS

[In man-years]

Installation	Fiscal year 1968 actual			Fiscal year 1969 estimate			Fiscal year 1970 estimate		
	Direct	AIF	Total	Direct	AIF	Total	Direct	AIF	Total
Aberdeen Proving Ground, Md	335	2,107	2,442	144	2,223	2,367	144	2,223	2,367
U.S. Army Research Office, Arlington, Va	293	.....	293	282	.....	282	282	.....	282
U.S. Army Tank-Automotive command, Detroit, Mich	558	.....	558	543	.....	543	543	.....	543
Harry Diamond Laboratories, Washington, D.C	.....	1,461	1,461	.....	1,419	1,419	.....	1,419	1,419
Dugway Proving Ground, Utah	163	337	500	.....	485	485	.....	485	485
Edgewood Arsenal, Md	.....	1,477	1,477	.....	1,435	1,435	.....	1,435	1,435
Fort Belvoir, Va	1,482	.....	1,482	1,458	.....	1,458	1,458	.....	1,458
Fort Detrick, Md	.....	1,185	1,185	.....	1,152	1,152	.....	1,152	1,152
Aviation Materiels Laboratories, Ft. Eustis, Va	334	.....	334	308	.....	308	308	.....	308
Fort Huachuca, Ariz	358	.....	358	346	.....	346	346	.....	346
Fort Monmouth, N.J	3,086	.....	3,086	2,906	.....	2,906	2,096	.....	2,906
Fort Rucker, Ala	192	.....	192	186	.....	186	186	.....	186
Frankford Arsenal, Philadelphia, Pa	.....	933	933	.....	915	915	.....	915	915
Kwajalein Test Facility, Pacific Ocean	71	.....	71	116	.....	116	126	.....	126
Natick Laboratories, Mass	797	.....	797	722	.....	722	722	.....	722
Picatinny Arsenal, Dover, N.J	.....	20,60	2,060	.....	2,000	2,000	.....	2,000	2,000
Redstone Arsenal, Ala	.....	1,792	1,792	.....	1,738	1,738	.....	1,738	1,73
Rock Island Arsenal, Ill	92	269	361	.....	352	352	.....	352	35
Walter Reed Army Medical Center, Washington, D.C	551	.....	551	536	.....	536	536	.....	536
Materials & Mechanics Research Laboratory, Watertown, Mass	.....	519	519	.....	483	483	.....	483	483
Watervliet Arsenal, N. Y	.....	307	307	.....	298	298	.....	298	298
Waterways Experimental Center, Vicksburg, Miss	625	.....	625	607	.....	607	607	.....	607
White Sands Missile Range, N. Mex	4,528	.....	4,528	4,294	.....	4,294	4,294	.....	4,294
Yuma Proving Ground, Ariz	842	.....	842	805	.....	805	805	.....	805
Miscellaneous installations	1,955	.....	1,955	1,836	.....	1,836	1,785	.....	1,785
Total	16,262	12,447	28,709	15,089	12,500	27,589	15,048	12,500	27,548

CONTRACT CIVILIAN EMPLOYMENT

Mr. SIKES. Page 20 of the justifications discloses that 4,768 contractor civilians will be paid out of R.D.T. & E. in fiscal year 1970. They are employed at five Army installations, at three of which (Fort Huachuca, Fort Rucker, and Kwajalein) the contractor employees outnumber the Government civilian employees.

What are the reason for the larger number of contractor hire at these installations?

KWAJALEIN

General BETTS. Let me take Kwajalein first, since that is one of the most obvious.

The activities out there with respect to the Safeguard program are related to the testing of the system developed by the major Safeguard system contractors. The activity out there related to the Pacific Range electromagnetic signature studies, the Press program that I mentioned earlier, is operated by the Lincoln Laboratory, primarily, with some support from other subcontractors.

With that pattern developing on a contractual basis, about all we need to do with Government employees is to monitor the contract effort to be sure the Government is in fact getting its proper return.

The support of the establishment, maintenance of vehicles, running the schools, and that kind of thing, is done on a contractual basis. I suspect more or less historically, because when we took over Kwajalein from the Navy, that is the way it was being done.

I suspect the reasoning was that civilian salaries that we could pay were not adequate to attract people to that island.

Mr. SIKES. Has this been a fully satisfactory and successful operation?

General BETTS. I think it has been very satisfactory. It was not initially. With the present contractor, it has been a very good operation.

We monitor their effort very closely. We have recently gone through a competition to see if we could get a different contractor in there, or at least open it up to competition, and he clearly came out as the best choice from a dollar and experience point of view.

Mr. ANDREWS. How many people are on Kwajalein now, General?

General BETTS. I would have to pin it down for the record, but it is approximately 4,000.

(The information requested follows:)

The present nonindigenous population of Kwajalein Missile Range is 4,650 people. This population is divided approximately as follows: Military, 53; civil service, 99; contractor, 2,723; dependents, 1,775. In addition, the logistic support contractor employs approximately 550 Marshallese workers. These Marshallese are employed by agreement with the Government of the Trust Territory of the Pacific Islands. The Marshallese workers reside on Marshallese islands that are not a part of the range.

Mr. ANDREWS. Do you have adequate housing facilities?

General BETTS. No, sir; we do not, but we do not believe we should put up more housing. It is a rather small island physically. We have adjusted the level at which we will provide housing for the different contractors. Some of their people just cannot have housing, that is all.

Mr. ANDREWS. You mentioned schools. Do you have a school system on the island?

General BETTS. We do have schools there for dependents of the people who live on the island. It is operated by the support contractor.

Mr. POOR. I was out there this past winter on my fourth or fifth visit. I have the impression it is going extremely well. The school system is an interesting one in that it is run by the contractor, but a good many of the teachers in the school system are wives of the military or contract employees there.

There is a very strong effort to keep the population of the island down and to keep the people on this very small island busy and occupied. I was most impressed by how well it goes.

Mr. ANDREWS. Does it have a good airstrip?

Mr. POOR. It is an excellent airstrip. It was a Japanese airstrip originally, and it has been updated. Air supply is very easy.

Mr. ANDREWS. Is there a good water supply?

Mr. POOR. Water supply is reasonably good, and electric supply is excellent.

Mr. ANDREWS. How do you meet that requirement?

General BETTS. It is a diesel powerplant.

Mr. POOR. There has to be a lot of electricity because they have to run the big radars. There is also a diesel plant for the radars. They have had little difficulty with water or electricity.

The housing is not very wonderful. A lot of it is made of trailers which are put out on coral landfill made by dredging up coral sand and putting trailers on it. The people living there quite quickly plant palm trees and try to get a little shade and upgrade the area.

Mr. ANDREWS. How long do you foresee that level of activity on the island?

Mr. POOR. I should think it would go on for a long time to come, because Kwajalein has a very important role, not only in testing possible ballistic missile defense systems, but also in assessing the performance of our own reentry vehicle systems.

Mr. ANDREWS. Of the approximately 4,000 people on the island; how many are military?

Mr. POOR. We could provide that for the record. It is a very small number.

General BETTS. Thirty-one is the number we have at the moment.

Mr. POOR. That could change, of course.

(The information follows:)

There are 31 military personnel authorized for the Kwajalein Missile Range. The present assigned strength is 30 military personnel as follows: 24 at Kwajalein Island; two at field offices (one each Honolulu and Vandenberg Air Force Base) and four at the Kwajalein Range Directorate, Huntsville, Ala. In addition, other military personnel stationed at Kwajalein are assigned as follows: two, Conare central training facility; one, Air Force liaison officer; one, resident engineer, Honolulu Engineering District; 25, Safeguard system.

A total of 53 military personnel are stationed at Kwajalein Missile Range.

IMPACT OF REVENUE AND EXPENDITURE CONTROL ACT

Mr. SIKES. According to the justifications, in fiscal 1969 the total number of permanent positions decreased about 2,000 below fiscal year 1968. Is this the result of the Revenue and Expenditure Control Act?

General BETTS. Normal attrition, the elimination of temporary spaces, and hiring restrictions resulting from the act.

Colonel JOY. The act would have brought us back to the June 30, 1966, level. That level was 17,000-plus. We never got to that level. We have been below it all the time.

Those reductions are essentially attrition and the lapse in hiring, and things of that nature.

Mr. SIKES. As the number of Government employees decreased in fiscal 1969, the number of contractor employees increased. Is there a direct relationship?

Colonel JOY. No, sir.

General BETTS. No, sir. You will recall our program was increased because of the additional things we took on during that year.

Mr. SIKES. What impact has section 201 of the Revenue and Expenditure Control Act actually had on your R.D.T. & E. program? In other words, in what areas and in which grade levels were the cutbacks made, and were these adverse to the program?

General BETTS. I would like to analyze that.

Mr. SIKES. You may provide the detail on the numbers for the record.

(The information follows:)

The impact of section 201 of the Revenue and Expenditure Control Act varies from installation to installation, depending upon the local labor market and degree of personnel turnover. At some installations with little turnover the impact has been small; at others where the Army is in competition with industry or civilian institutions the impact has been more severe. The impact is heaviest in the support area, in both service and administrative type personnel of the middle and lower grade levels, with a somewhat lesser impact in the scientific and professional areas. There has been some overall deterioration in the support area, despite a modest, carefully controlled use of overtime. Some slippage in other research and development projects has occurred in order to give priority to Southeast Asia and other high priority projects. However, the real impact will be felt through the developing imbalance of skills out of proportion to the approved program. This will impact directy on the in-house effort, and on contractual efforts which are planned, guided, monitored, and evaluated by the in-house research and development staff. It is already requiring some scientific and professional personnel to devote an increasing proportion of their time to administrative and service tasks with a resultant degradation of the research and development program. This degradation is actual, and impacts adversely on the quality of expertise applying for technical positions. Specific details as to numbers and grade levels of personnel affected by section 201 of the Revenue and Expenditure Control Act cannot be given as its impact is mixed with other personnel changes due to reorganizations, transfers of missions between commands, lapses in hiring, and other similar actions.

Mr. SIKES. Can you tell us how many employees were engaged in Southeast Asia-related work and, therefore, exempt from the act?

General BETTS. None in my appropriation.

FEDERAL CONTRACT RESEARCH CENTERS

Mr. SIKES. Under Federal contract research centers, last year for the first time in several years, the committee did not place a specific limitation on the funds to be spent with Federal contract research centers.

In the report on the bill, the committee made 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.

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 the effort was allocated to the Federal contract centers, are proposed in fiscal 1970 compared with fiscal year 1969? Do you have that answer, or will you have to research it?

General BETTS. We have it here, but we would have to dig it out of the book.

Mr. SIKES. Give us a general statement, and provide details for the record.

PROGRAM INCREASES BY CENTER

General BETTS. Generally we stayed at the same level, with a slight increment to adjust to inflation. You will recall that there was a rather considerable additional effort placed on the Human Resources Research Office in a program we called computer-assisted instruction.

Dr. Foster agreed that we could move up in that program. I can give you the specific numbers.

The Mathematics Research Center, actual in 1968 was $1.3 million That went up $50,000 in 1969.

The Human Resources Research Office was $3,165,000 in 1968. That went up to $3,190,000.

The Center for Research in Social Systems was $1,560,000 in 1968. It went up to $1,960,000.

The Research Analysis Corporation, from both appropriations, R.D.T. & E. and O. & M., went from $8.15 million in 1968 to $8.35 million in 1969.

We have some work at the applied physics laboratory. Our portion of it went from $725,000 in 1968 down to $550,000 in 1969.

We have some in Aerospace that was $1.7 million in both of those 2 years.

Mr. SIKES. You may provide further details for the record.

(The information follows:)

In fiscal year 1970 the Army estimates its funding for Federal contract research centers will be as follows: The Mathematics Research Center $1,455,000; the Human Resources Research Office $4 million; the Center for Research in Social Systems $2,100,000; the Research Analysis Corporation $9,050,000; the Applied Physics Laboratory $1,635,000; Aerospace Corporation $2,075,000; and Lincoln Laboratories $23,150,000.

Mr. SIKES. How do the actual amounts programed for the various centers in fiscal year 1969 compare with the amounts presented to the Congress in the justifications last year? Do you have that before you?

General BETTS. This is essentially the same as was justified, except for the one increase I mentioned in Human Resources Research Office.

Mr. SIKES. The justifications on page 50 show an increase in funding for Federal contract research centers of approximately $8.2 million. How is this increase justified?

General BETTS. The largest portion of that is in Lincoln Laboratory. and represents an adjustment of effort between the work that was supported by the Advanced Research Projects Office and is now being supported by the Army.

There is also an increase in HUMRRO from 1969 to 1970.

SALARY INCREASES IN FCRC'S

Mr. SIKES. Have there been requests for salary increases from the FCRC's?

General BETTS. Yes; there have been some. I do not know of any of great significance. I would have to research that in detail. I am sure there have been some.

Mr. SIKES. I would like an answer for the record showing what increases have been allowed, and for what level of personnel.

Mr. POOR. We will provide that for the record.

(The information follows:)

The Federal contract research centers do not request approval for individual salary increases, but do request approval for increases in salary ranges. In fiscal year 1969 the Research Analysis Corp. requested and obtained approval for an increase of 8 percent in its salary ranges. A similar request was received from and approved for the Human Resources Research Office for a 5-percent increase in salary ranges. Approval does not constitute an automatic salary increase. Neither the Center for Research in Social Systems nor the Mathematics Research Center requested an increase in salary ranges for fiscal year 1969. The Federal contract research centers have granted to a majority of their personnel in all categories merit increases and cost of living increases during fiscal year 1969.

Mr. SIKES. In general, have there been increases in costs at the FCRC's 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 year 1970 than you paid in fiscal 1969?

General BETTS. I would have to get that in detail. I am sure it has gone up some because of the general cost growth that we call inflation. Some of this is also the reason why our 1970 is higher than our 1969.

Dr. Foster has specifically agreed that there ought to be a 3- or 4-percent increase allowed for inflation.

Mr. SIKES. Are you getting comparable levels of work in the 2 fiscal years so that the dollar comparisons are also reasonably accurate workload comparisons?

General BETTS. I would say they are a reasonably good reflection of the workload as adjusted for inflation.

SUPPORT OF FCRC'S, BY APPROPRIATIONS, 1967–69

Mr. SIKES. For the record, provide a table showing FCRC support, by appropriation, for the past 3 fiscal years.

(The information follows:)

ARMY FEDERAL CONTRACT RESEARCH CENTERS SUPPORT, BY APPROPRIATION, FISCAL YEARS 1967, 1968, AND 1969

[In thousands of dollars]

	1967 actual	1968 actual	1969 estimate
Mathematics Research Center, University of Wisconsin, R.D.T. & E.	1,300	1,300	1,350
Human Resources Research Office, George Washington University:			
R.D.T. & E.	2,799	3,165	3,190
Operations and maintenance	217		
Total, Human Resources Research Office	3,016	3,165	3,190
Center for Research in Social Systems, American University, R.D.T. & E.	1,939	1,560	1,960
Research Analysis Corp.:			
R.D.T. & E.	6,034	6,722	6,450
Operations and maintenance	1,825	1,428	1,900
Total, Research Analysis Corp.	7,859	8,150	8,350
Aerospace Corp., R.D.T. & E.	1,238	1,700	1,700
Applied Physics Laboratory, Johns Hopkins University:			
R.D.T. & E.			
Operations and maintenance	900	725	550
PEMA	123		
Total, Applied Physics Laboratory	1,023	725	550
Electromagnetic Compatibility Analysis Center, R.D.T. & E.	1,500		
Lincoln Laboratory, Massachusetts Institute of Technology, R.D.T. & E.			[1] 19,020
Total program by appropriation:			
R.D.T. & E.	14,810	14,447	33,670
Operations and maintenance	2,942	2,153	2,450
PEMA	123		
Total, FCRC's	17,875	16,600	36,120

[1] Project Defender, transferred to Army in fiscal year 1969, ARPA associated radar operation at Kwajalein Missile Range.

PROJECT THEMIS

Mr. SIKES. Under Project Themis, I would like you to provide for the record at this point a tabulation indicating the estimate for fiscal year 1970 for Project Themis, and the amount programed in each of the years since the inception of the program.

(The information follows:)

Project Themis funding since program inception:

Fiscal year 1967	$5,500,000	Fiscal year 1969	$8,800,000
Fiscal year 1968	8,300,000	Fiscal year 1970 (estimate)	10,200,000

Mr. SIKES. Can you give the committee an evaluation of the Themis program insofar as the Army is concerned?

General BETTS. Yes, sir.

I think that those efforts that we support have been of comparable quality and measure up very well with respect to the kind of work that we have supported in other universities.

There are one or two exceptions, because we have decided not to extend.

Mr. SIKES. What are those?

General BETTS. One of the efforts that we were supporting we will not extend in the next contract period.

Do you want to add to that, Colonel Snead?

Colonel SNEAD. We have operated our Themis program in very close coupling with our basic research facilities. For each of our Themis contracts, we have in fact assigned the monitorship of that to the Army facility that is primarily concerned with that type of work.

This has brought our Themis contractors along, we feel, in a very rewarding way.

Mr. SIKES. What is the one that is not to be renewed?

Colonel SNEAD. The contract with the University of Alaska will be phased out under the Themis reduced 3-year funding procedure.

Mr. SIKES. For what reason?

Colonel SNEAD. The primary reason was that the university was unable to attract the staff and graduate students that they hoped to attract and retain.

Mr. SIKES. On Themis, generally, would you say that you have had enough experience with the program to state that it is a valuable part of the Army R.D.T. & E. effort?

Colonel SNEAD. It is definitely a valuable part. It is different in certain respects.

Mr. ANDREWS. You mean some projects have been good and some have been bad?

Colonel SNEAD. There have been varying levels, but we are quite encouraged in all of the Themis programs.

Mr. ANDREWS. What do you mean when you say it has been good in certain respects?

Colonel SNEAD. I said it is different in certain respects, sir, in that the initial year or two of the Themis program was the expansion of an existing capability at the university, rather than its being an established total capability at the day of start.

RESULTS OF THEMIS PROGRAM

With this recognition, we have a growing number of very important and significant contributions coming out of the Themis program.

Mr. SIKES. List some of those for the record.

(The information follows:)

Some of the significant contributions are:

The Georgia Institute of Technology has made many contributions as a result of its Themis program. One of the major contributions has been developing a method that can be extended to determine, nondestructively, the critical buckling load for structural elements of various types. This has application to components with cutouts or cracks involving a nonuniform prebuckle stress struts and can contribute to reducing the expense of testing structural components to failure.

Another contribution from Georgia Institute of Technology is a theoretical and experimental analysis of a jet in a crosswind. A better understanding of the wake flow behind the jet has been realized. The results of this specific effort can be applied where crosswinds interacting with a jet can influence the performance of V/STOL aircraft, including the helicopter.

The University of Florida has been doing some very important work in mathematics and statistics as applied to logistics. In conjunction with their research, they have given direct assistance to Army, Navy and Air Force facilities: Warner Robbins AFB, Jacksonville Navy Air Rework Facility and Fort Belvoir and Frankford Arsenal. The research results being obtained in Inventory Theory will be fundamental in designing and operating future procurement and distribution systems.

A significant contribution has been made to the Army's radar detection capabilities by the progress in the Stevens Institute of Technology Themis program in the development of improved absorption refrigeration methods in the extreme low temperature range.

The University of Delaware work is contributing to a better understanding of gas-liquid mixture and has established mathematical models for describing the behavior of liquid solid interface. The measurement of thermal conductivity and viscosity under extreme conditions and the influence of turbulent mixing

reaction rates is pertinent in the development of advanced fluidic systems for Army equipment.

The Texas A. & M. Themis program has contributed to the understanding and compressibility effects on oscillating rotor blades in hovering flight. By better understanding the phenomena associated with blade compressibility during helicopter improved blade designs can be made. The major importance of this work is the advent of helicopters operating with high rotor blade tip speeds. This specific program contributes to designs where there is a compromise between hover and high speed flight performance. All of these aspects are very important for advancing the design and performance of Army aircraft and helicopters.

Auburn University is doing some work on automatic design methods by use of computers. The computer programs have been written but have not been verified. When they are verified, they will be made available to Army organizations, among others, who are involved in mechanical design work.

Mississippi State University has been very productive in its theoretical and computational analysis of the aerodynamics of rotors and propellers. One part of the effort has concentrated on an airfoil design that has application to improving the aerodynamic performance of rotors and propellers. This is an area that has been void for several years since the need for improved airfoil design was countered by the inability of fabricating something other than a symmetrical and nontapered blade. The ability to fabricate new materials, composites, permits realizing the benefits of improved aerodynamic airfoils in Army aircraft.

Work at Lehigh University has led to the discovery and investigation of a new phenomenon, deexcitation shocks, which occur in nonequilibrium gas flows including vibrationally relaxing gases. It is believed that this phenomenon may well exist in a wide range of situations involving gas flows, whenever nonequilibrium expanding flows are encountered; for example, in rocket and jet engines.

The University of Cincinnati is performing a basic analytical and experimental study of the heat transfer of a jet impinging on a flat surface. This involves determination of the local heat transfer on the surface and knowing the pressure distribution in the stagnation region of the jet. It is through these types of basic studies that contributions can be made to improving the performance of air-breathing propulsion systems.

The University of Iowa has evaluated the sensitivity of large systems to errors in estimation of mass and stiffness characteristics. This has been applied to analyzing the interaction forces of weapons and vehicles.

The Ohio University has selected a method for study and experiment, for very accurate determination of aircraft position in low-level navigation. Extremely accurate time measurements are to be used, as may be obtained with atomic clocks, to control and measure electromagnetic signals and thus to determine range information. Successful results from this work should add materially to our capability in low-level navigation.

The most significant accomplishments of Louisiana State University include research in acute respiratory diseases in the tropics; a technique has been developed that has surpassed previous methods for isolating viruses suspected of being bound in a virus-antibody complex; and development of a time guide to treatment of snake bit.

Mr. SIKES. Are there questions?

Mr. RHODES. Yes, Mr. Chairman.

I understand you are going to list the accomplishments for the record, but have you anything that you can point to now? Are you getting any output from the Themis program which has some significance to your research?

EVALUATION AND ASSIMILATION OF THEMIS RESULTS

No. 2, how do you evaluate and assimilate the results of these various experiences? Do you have a central agency which takes these results and grinds them into the overall research equation, or just what is the end product?

Colonel SNEAD. The primary means is that they are monitored exactly in the same procedure as our other research efforts. That is, the particular Army activity that is responsible for and has the expertise in the area serves as the principal Army monitor.

They then incorporate the results of this into the broad procedure that the Army has in monitoring and distributing and getting judgments from other elements of the Army on the products of the work.

In addition, Themis does have a central review conducted by the Office of the Director of Defense Research and Engineering yearly, in which all three services participate with D.D.R. & E. in evaluating the results of the programs.

Mr. RHODES. How much is in the budget for the Army portion of Project Themis?

Mr. POOR. $10.2 million.

Mr. RHODES. Thank you.

Mr. SIKES. Thank you very much, gentlemen.

The committee will resume its work at 2 o'clock.

AFTERNOON SESSION

Mr. ANDREWS. The committee will come to order.

USE AND COST OF CONSULTANTS

Mr. Secretary, I would like to ask two questions you can answer for the record.

Compare the number of consultants used in fiscal year 1969 with the number in fiscal years 1968 and 1967.

(The information follows:)

The number of individual consultants employed in fiscal year 1967 was 480; fiscal year 1968, 493; fiscal year 1969, 470.

Mr. ANDREWS. Compare the costs of consultants in fiscal years 1967, 1968, and 1969.

Mr. POOR. Mr. Chairman, may I ask for clarification?

I think there is a practical problem in getting down into the lower echelon of the system. At the individual laboratory levels, for example, there are part-time advisers who come in for a few hours or days. Is this to be restricted to sort of an Army staff and major command level, or what did you have in mind?

Mr. ANDREWS. Consultants as they are generally known, in Government terminology.

(The information follows:)

The daily rate (fee) paid to consultants has risen along with the cost of living from 1967 to 1969. The daily rate paid to individual consultants to the Army hired through civil service personnel procedures ranges up to $128. The limitations are set forth in section XXII, part 2 of the Armed Services Procurement Regulation. The number of days for which an individual consultant may be paid is limited to no more than 130 days in 1 year. The fee is based on the compensation rate for GS–15 to GS–18 civil servants and depends upon the consultant's education, experience, reputation, and availability. Travel expenses and per diem are allowed on the same basis as for civil servants.

Mr. ANDREWS. What is your projected use of consultants in fiscal year 1970?

General BETTS. I do not think we have that. We have not analyzed it on that basis. I will have to furnish that.

(The information follows:)

The number of consultants that will be required at any particular time cannot be projected with any accuracy. Consultants are called in only when a specific need or problem arises; however, no significant increase or decrease is anticipated.

Mr. ANDREWS. To what extent do you use employees of Federal contract research centers with which you contract as consultants?

General BETTS. We use them extensively in a consulting capacity, but we do not contract with them individually. We ask the center to make them available on committees or analyses, as the case may be. I do not have a number on that.

Mr. POOR. We pay their salaries under the contract, where they are on the payroll of the Federal Contract Research Center. We simply make use of their services without any special reimbursement.

PAY RATES FOR CONSULTANTS

Mr. ANDREWS. What is the rate you pay consultants, specialists you call in?

Mr. POOR. I would have to provide that for the record. There are ceilings on this and I do not have them in mind.

General BETTS. It varies.

Mr. ANDREWS. I think the ceiling overall is around $100 a day, it used to be about $50.

General BETTS. I will check this out.

(The information follows:)

The armed services procurement regulation provides that consultants to the Army may be paid per diem equivalent to salaries of GS–13 to GS–15 range or, in the case of professional engineering services involving research and development or professional services involving physical or natural sciences or medicine, the highest rate payable to a GS–18 which is $33,495 per annum or $113 per day. Travel and other expenses are in addition to the daily rate.

Mr. ANDREWS. To what extent do you use faculty members of colleges and universities as consultants at the same time they are working under Army research grants or contracts?

Mr. POOR. I think I would have to do some research and answer that for the record.

We do make extensive use of university consultants, but the extent to which they are at the same time working in sponsored research programs, we need to research.

Mr. ANDREWS. Put in the record what you pay over and above the contract you have with the university.

(The information follows:)

Faculty members of colleges and universities working under contracts or grants are used as consultants but do not normally receive additional compensation except for travel and related expenses.

Mr. ANDREWS. For the record, what has been your average daily rate of pay for constultants in fiscal years 1967, 1968, and 1969?

What average rate is projected for fiscal year 1970?

(The information follows:)

As has been indicated in earlier testimony, records are not maintained in such a manner that we can give a precise answer. However, a sampling indicates that the average daily rate paid to consultants for fiscal year 1967 was $81; fiscal year 1968, $84; and fiscal year 1969, $86. While costs increase annually

because of inflation, it is not anticipated that there will be a significant change for fiscal year 1970.

Mr. ANDREWS. For the record, what has been your average yearly amount paid to individual consultants in each of these 3 years?

(The information follows:)

A review indicates that the average yearly amount paid by the Army to individual consultants including fee, travel, and per diem for fiscal year 1967 was $1,213; for fiscal year, 1968 $1,339; and for fiscal year, 1969 $1,505.

Mr. ANDREWS. 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?

General BETTS. I know of no example of that. We will research it to see.

(The information requested is as follows:)

No instance has been found where people were classed as consultants to avoid personnel reductions imposed by the Revenue and Expenditure Control Act.

ARMY INSTALLATIONS

FORT MONMOUTH, N.J.

Mr. ANDREWS. The committee notes that the contractor employees will be phased out completely in fiscal year 1970 at Fort Monmouth. How were you able to accomplish this?

Mr. POOR. We will have to provide that for the record.

Mr. ANDREWS. Contract civilians, as shown on page 31, paid out of research, development, test and evaluation funds for 1968, 21; for fiscal 1969, six; estimated for 1970, none.

Mr. POOL. I will supply that.

(The information follows:)

The contractor civilians paid from R.D.T. & E. in fiscal year 1968 and part of fiscal year 1969 were required for on-site engineering services in support of the satellite communication terminals. During fiscal year 1969 the terminals became operational and responsibility for maintenance of the terminals was transferred to O. & M. A.

Mr. ANDREWS. The civilian and military personnel remained the same in fiscal year 1970 as the current fiscal year, but total obligations increased $2.6 million. Why is this?

General BETTS. I will have to go back into that program in detail, Mr. Chairman. I do not have the answer on it.

(The information follows:)

The total obligations shown at Fort Monmouth include, in addition to salary costs, provision for travel, contracts in support of the in-house effort, and the purchase of supplies and equipment. The increase shown for fiscal year 1970 is primarily for cost of living increases in the latter areas.

FORT RUCKER, ALA.

Mr. ANDREWS. Employees remain stable in fiscal year 1970 at Fort Rucker, but total obligations decrease $1 million in fiscal year 1970. What is the explanation for this, especially in view of the civilian and military pay raise in the current year?

General BETTS. Our total program has gone down in some measure. I will have to look into the detail on that.

Mr. ANDREWS. The question states the employees remained stable, but obligations decreased by a million dollars.

General BETTS. I will supply that for the record.

Mr. POOR. It would certainly have to be a decrease in the amount of external contracting, but we will research it for the record.

(The information follows:)

In addition to funds for the payment of salaries, the dollar level of effort forecast for Fort Rucker includes travel, contracts in support of the in-house effort, and the purchase of supplies and equipment. The reduction reflected in the fiscal year 1970 estimates is in the contractual effort.

KWAJALEIN TEST FACILITY

Mr. ANDREWS. The total estimated obligations during fiscal year 1970 for the Kwajalein test facility totals $83.1 million, an increase of $24.1 million over the current fiscal year. The increase is in the Army facilities operated under contract.

Will you provide a table showing the contractor-operated facilities at Kwajalein and the reason for the increase?

General BETTS. I will provide the table for the record, but the reason for the increase is the transfer of the management of the large radars that used to be handled in the ARPA program.

Mr. ANDREWS. General Betts, would you also include what the ARPA program was for this operation as a comparison?

General BETTS. Yes.

(The information follows:)

CONTRACTOR-OPERATED FACILITIES—KWAJALEIN MISSILE RANGE

[In thousands]

Operation	Fiscal year 1969	Fiscal year 1970	Note
Technical range support	$9,409	$10,059	1
Logistical range support	18,045	20,504	2
Discrimination radar and target tracking radar (former NIKE radars)	9,575	11,464	3
Kiernan reentry measurement site (former ARPA radars at Roi Namur)	10,606	25,405	4
Communications and instrumentations		4,268	5
Total	47,635	71,700	

1. The $650,000 increase is due primarily to the range assuming funding responsibility for optical data reduction from Safeguard System Command.

2. The $2,459,000 increase is due to increased workload and the fair standards labor law reduction of work week from 42 to 40 hours.

3. The $1,889,000 increase is due to the transfer of the funding responsibility for the wideband coherent recorder system and the battery control building to the range and a modification to the target tracking radar.

4. The ARPA program for fiscal year 1969 for the Tradex radar was $15.8 million. ARPA funded Lincoln Laboratory $6.9 million and transferred $8.9 million to Kwajalein Missile Range. The additional $1.7 million was funded by the Advanced Ballistic Missile Defense Agency to start procurement on a modification to the Tradex radar. The $14.799 million increase in fiscal year 1970 is due to the transfer of the ARPA long-range tracking and instrumentation radar (Altair) radar from ABMDA to the range, $8 million; a full year funding for the Tradex radar, $4.4 million; and modifications to the Tradex and Altair radars, $2.399 million.

5. Facility improvements in communications and instrumentation are required to integrate the reentry radars, and furnish support to the strategic offensive and defensive systems.

Mr. ANDREWS. How are you able to increase Government civilians by 10 in fiscal year 1970 at a cost of $100,000, and at the same time absorb the pay raise?

General BETTS. This is still at Kwajalein?

Mr. ANDREWS. Yes.

General BETTS. I would have to check that out in detail, but I suspect it is because the employees we are talking about are not of the higher level of management. In addition to salaries, the total R.D.T. & E. obligations shown in the budget include materials and supplies and contracts for support services. Salaries for the 10 additional people, together with travel and other associated costs, will amount to approximately $300,000. However, the fiscal year 1970 estimate for materials and supplies is $200,000 less than the estimated fiscal year 1969 cost.

REDSTONE ARSENAL, ALA.

Mr. ANDREWS. At Redstone Arsenal, Ala., the contractor civilians decreased by 16 in fiscal year 1970 and contractor-operated facilities decreased $104,000. The civilian and military personnel will remain the same, yet your total obligations increase almost $1 million.

What is the explanation for this?

General BETTS. I will have to get the detail, Mr. Chairman. There are so many things that might account for it, it would be foolish for me to speculate. We will have to get the details.

(The information follows:)

The total obligations shown for Redstone Arsenal include, in addition to salary costs, provision for travel, contracts in support of the in-house effort, and the purchase of supplies and equipment. The increase shown for fiscal year 1970 is primarily for contracts in support of the in-house effort.

Mr. ANDREWS. Will you take the table on page 37 of the justification book and break it down to show the appropriate totals and amounts for the U.S. Army Missile Command, for the safeguard system command, and for the NIKE–X Development Office?

Provide this for the record.

(The information follows:)

REDSTONE ARSENAL

[Dollars in thousands]

	Fiscal year 1968, actual	Fiscal year 1969, estimated	Fiscal year 1970, estimated
A. Obligations:			
1. Research Development test and evaluation appropriation:			
(a) Army facilities operated by the Army (total)	$47,153	$50,633	$51,634
U.S. Army Missile Command	35,325	38,498	29,469
SAFEGUARD System Command	11,359	9,620	9,100
Nike-X Development Office	569	2,515	3,065
(b) Army facilities operated under contract: U.S. Army Missile Command (total)	3,724	3,504	3,400
2. Military Personnel Appropriations (total)	1,023	1,175	1,192
U.S. Army Missile Command	777	785	785
SAFEGUARD System Command	240	355	355
Nike-X Development Office	6	35	52
Total obligations	52,000	55,312	56,226
U.S. Army Missile Command	39,826	42,787	43,654
SAFEGUARD System Command	11,599	9,975	9,455
Nike-X Development Office	575	2,550	3,117
B. Personnel, Man-years:			
1. Government civilians paid out of research, development, test and evaluation funds (total)	1,792	1,738	1,738
U.S. Army Missile Command	1,534	1,454	1,431
SAFEGUARD System Command	229	197	205
Nike-X Development Office	29	87	102
2. Contractor civilians paid out of research, development, test and evaluation funds (total)	229	220	204
3. Military personnel in research, development, test and evaluation work and support thereof (total)	105	105	105
U.S. Army Missile Command	82	78	75
SAFEGUARD System Command	22	21	21
Nike-X Development Office	1	6	9
Total personnel	2,126	2,063	2,047
U.S. Army Missile Command	1,845	1,752	1,710
SAFEGUARD System Command	251	218	226
Nike-X Development Office	30	93	111

WHITE SANDS MISSILE RANGE, N. MEX.

Mr. ANDREWS. At White Sands Missile Range, there is a decrease of 65 contractor personnel for fiscal year 1970, the military and civilian personnel remain the same, yet the total obligations increase $3.5 million over the current fiscal year.

Will you explain the reason for this increase?

General BETTS. I believe it is instrumentation, but I will have to check that out.

We have been making some deliberate management changes at this range, but I would have to get detail on it. It is related to the range modernization program. I will have to pin down what the instrumentation is related to the shift in management.

Mr. ANDREWS. Do you think maybe some of that increase is due to hardware or construction?

General BETTS. There is a note here the increase in fiscal 1970 over 1969 is due to operating the Amrad radar for a full year at $1.1 million increase, labor costs at $2.4 million.

Mr. ANDREWS. Decrease in contract personnel?

General BETTS. In the contract effort. But we will have to check that out and make sure we show you the balance.

(The information follows:)

The increase of $3.5 million is due to:

(*a*) An increase in Army facilities operated by the Army as follows ($2.1 million): $0.600 million for increased pay to wage board employees; $0.400 million for procurement of special purpose equipment (examples: environmental test chamber, calibrations equipment, and frequency analyzer) to support Army test and evaluation activities at WSMR; and an estimated $1.1 million increase for common base support within the available manpower resources for Army activities at WSMR.

(*b*) A net increase ($0.765 million) in Army facilities operated under contract is due to operating the ARPA measurements radar (Amrad) for a full year instead of 7 months and a compensating reduction in other contractor personnel.

(*c*) The military personnel appropriation increase of July 1, 1968, was inadvertently left out of the fiscal year 1969 column, causing an apparent increase of $0.611 million in fiscal year 1970.

Mr. ANDREWS. Do you know what the radar is you mention?

General BETTS. The Amrad radar was one that had been in the ARPA program. It is an instrumentation radar in a sense, but also basically pointed at advancing radar technology. It was part of our agreement with ARPA to take over work that was very closely related to the advanced ballistic missile defense development program.

MISCELLANEOUS INSTALLATIONS

Mr. ANDREWS. For fiscal year 1970, total military and civilian employees at certain miscellaneous installations decrease. Actually, military personnel increased by 46 and civilian employees decrease by 51. The total obligations for miscellaneous installations increase $10.4 million in fiscal year 1970 over the current fiscal year.

What is the reason for this rather significant increase?

General BETTS. I can identify no single action that would account for this. This again is a setoff of one action against another, and I will have to get the details so we can show you how it balances.

I cannot answer that, Mr. Chairman. There was no deliberate program I can identify that would account for that.

Mr. ANDREWS. If you can find any, comment on them in the record.

General BETTS. We will do so.

(The information follows:)

The increase of $10.4 million in total obligations for miscellaneous installations is for the following:

[Thousands of dollars]

U.S. Army Advanced Materiel Concept Agency, Alexandria, Va. This agency was initiated in fiscal year 1968 with R.D.T. & E. funding of only $200,000. The fiscal year 1970 budget reflects a $3 million planned level, $1.4 million more than in fiscal year 1969	1,400
U.S. Army Security Agency Developments Activity, Arlington Hall Station, Va	8,293
Minor increases in seven medical research units	716
Total	10,409

The increase of 46 in military personnel is the result of the following planned changes:

Increases		*Decreases*	
Army test activities	42	U.S. Army Medical Research Laboratory, Fort Knox, Ky	−3
U.S. Army Materiel Command HQ, project managers	4	Medical research and nutrition laboratory, Fitzsimons Army Hospital, Denver, Colo	−5
Advanced Ballistic Missile Defense Agency	7	Engineer Strategic Studies Group, Army Map Service, Washington, D.C	−2
HQ, Aviation Materiel Command	3		

The reduction of 51 civilian man-years shown in fiscal year 1970 reflects the estimated effect of the Revenue and Expenditure Act. This reduction would be distributed across-the-board among the Army installations included in this category.

Mr. ANDREWS. For the record, will you provide for us a breakdown of the table appearing on page 45 of the justification book for each installation involved by fiscal year?

General BEITS. There are 56 installations involved and we are working up the figures to break it down for that entire collection of installations.

(The information follows:)

RESEARCH, DEVELOPMENT, TEST AND EVALUATION, ARMY—INSTALLATION ANALYSIS, MISCELLANEOUS INSTALLATIONS

[Dollar amounts in thousands; fiscal years]

	A. Obligations			B. Personnel (man-years)		
	R.D.T. & E.	MPA	Total obligations	Civilian government R.D.T. & E.	Military personnel in R.D.T. & E.	Total personnel
1. Headquarters, Army Materiel Command:						
(a) HQ, Army Materiel Command, (project managers) Washington, D.C.:						
1968	$3,075	$962	$4,037	240	73	313
1969	3,115	1,181	4,296	190	87	277
1970	2,875	1,238	4,113	180	91	271
(b) HQ, Army Materiel Command, Washington, D.C.:						
1968						
1969	4,176	826	5,002	150	65	215
1970	4,300	837	5,137	144	65	209
2. Advanced Ballistic Missile Defense Agency (ABMDA), Washington, D.C.:						
1968	50	5	55			
1969	1,100	138	1,238	27	9	36
1970	1,700	254	1,954	27	16	43
3. Construction Engineering Research Laboratory, Urbana, Ill.:						
1968	346		346	23		23
1969	2,425	16	2,441	13	1	14
1970	1,890	16	1,906	13	1	14
4. U.S. Army Cold Regions Research and Engineering Lab, Hanover, N.H.:						
1968	3,167	484	3,651	207	93	300
1969	3,236	510	3,746	161	90	251
1970	3,365	510	3,875	161	90	251
5. Army Aeronautical Research Lab, Moffett Field, Calif.:						
1968	2,361	15	2,376	50	1	51
1969	2,000	29	2,029	41	2	43
1970	2,000	29	2,029	41	2	43
6. HQ Aviation Materiel Command, St. Louis, Mo.:						
1968	1,963	135	2,098	99	9	108
1969	1,850	135	1,985	86	9	95
1970	1,850	180	2,030	86	12	98
7. U.S. Army Advanced Materiel Concept Agency, Alexandria, Va.:						
1968	200		200	14	1	15
1969	1,600	228	1,828	69	19	88
1970	3,000	228	3,228	69	19	88
8. Sentinel System Office, Alexandria, Va.:						
1968	270	106	376	9	10	19
1969						
1970						
MEDICAL ACTIVITIES						
9. U.S. Army Medical Research Laboratory, Fort Knox, Ky.:						
1968	1,797	944	2,741	120	87	207
1969	1,699	986	2,685	90	80	170
1970	1,717	1,042	2,759	85	77	162

RESEARCH, DEVELOPMENT, TEST AND EVALUATION, ARMY—INSTALLATION ANALYSIS, MISCELLANEOUS INSTALLATIONS—Continued

[Dollar amounts in thousands; fiscal years]

	A. Obligations			B. Personnel (man-years)		
	R.D.T. & E.	MPA	Total obligations	Civilian government R.D.T. & E.	Military personnel in R.D.T. & E.	Total personnel
MEDICAL ACTIVITIES—Continued						
10. Medical Research and Nutrition Laboratory, Fitzsimons Army Hospital, Denver, Colo.:						
1968	$2,012	$799	$2,811	100	102	202
1969	2,197	941	3,138	90	98	188
1970	2,312	990	3,302	85	93	178
11. Medical Equipment RLO Laboratory, Fort Totten, N.Y.:						
1968	656	125	781	40	13	53
1969	876	172	1,048	40	14	54
1970	1,127	189	1,316	40	14	54
12. Medical Research Unit, Kuala Lumpur, Malaysia:						
1968	146	70	216	.....	5	5
1969	144	94	238	.....	6	6
1970	145	103	248	.....	6	6
13. Surgical Research Unit, Brook Army Medical Center, Fort Sam Houston, Tex.:						
1968	814	917	1,731	70	105	175
1969	864	1,041	1,905	67	105	172
1970	868	1,145	2,013	67	105	172
14. U.S. Army Medical Research Unit, Europe, Landstuhl, Germany:						
1968	50	66	116	.....	6	6
1969	50	72	122	.....	7	7
1970	50	79	129	.....	7	7
15. U.S. Army Medical Research Unit, Panama Canal Zone:						
1968	82	73	155	7	6	13
1969	145	88	233	7	8	15
1970	145	96	241	7	8	15
16. HQ, U.S. Army Medical R. & D. Command, Washington, D.C.:						
1968	1,546	1,153	2,699	97	93	190
1969	1,635	1,335	2,970	90	89	179
1970	1,676	1,501	3,177	85	89	174
17. U.S. Army Medical Research Unit, Presidio of San Francisco:						
1968	415	343	758	16	32	48
1969	429	406	835	16	35	51
1970	459	447	906	16	35	51
ARMY SECURITY AGENCY ACTIVITIES[1]						
ENGINEER ACTIVITIES		[deleted]				
25. Engineer Nuclear Cratering Group, Los Angeles, Calif.:						
1968	98	20	118	3	6	9
1969	50	23	73	2	6	8
1970	170	24	194	6	6	12
26. U.S. Army District Engineers, Omaha, Nebr.:						
1968	100	.....	100	7	.....	7
1969	198	.....	198	7	.....	7
1970	135	.....	135	7	.....	7
27. U.S. Army District Engineers, Los Angeles, Calif.:						
1968	290	.....	290	.....		
1969	115	.....	115	.....		
1970	233	.....	233	.....		
28. Engineer Strategic Studies Group, Army Map Service, Washington, D.C.:						
1968	425	16	441	4	1	5
1969	200	33	233	2	2	4
1970	.....	.....	.....	.....	.....	.....
29. Office, Chief of Engineers, Washington, D.C.:						
1968	532	.....	532	39	.....	39
1969	560	.....	560	34	.....	34
1970	553	.....	553	32	.....	32

RESEARCH, DEVELOPMENT, TEST AND EVALUATION, ARMY—INSTALLATION ANALYSIS, MISCELLANEOUS INSTALLATIONS—Continued

[Dollar amounts in thousands; fiscal years]

	A. Obligations			B. Personnel (man-years)		
	R.D.T. & E.	MPA	Total obligations	Civilian government R.D.T. & E.	Military personnel in R.D.T. & E.	Total personnel
ARMY SECURITY AGENCY ACTIVITIES—Continued						
ENGINEER ACTIVITIES—Continued						
30. Two Rock Ranch Station, Petaluma, Calif.:						
1968	$2	$60	$62	.....	11	11
1969	.....	61	61	.....	11	11
1970	.....	62	62	.....	11	11
TEST ACTIVITIES						
31. U.S. Army General Equipment Test Activity, Fort Lee, Va.:						
1968	2,487	477	2,964	125	291	416
1969	2,513	1,074	3,587	88	331	419
1970	2,530	924	3,454	88	331	419
32. U.S. Army Artillery Board, Fort Sill, Okla.:						
1968	860	430	1,290	29	262	291
1969	793	968	1,761	23	298	321
1970	897	832	1,729	23	298	321
33. U.S. Army Armor and Engineering Board, Fort Knox, Ky.:						
1968	1,668	750	2,418	95	457	552
1969	1,655	1,810	3,465	77	557	634
1970	1,612	1,556	3,168	77	557	634
34. Infantry Board, Fort Benning, Ga.:						
1968	889	184	1,073	46	112	158
1969	924	435	1,359	37	134	171
1970	924	413	1,337	37	148	185
35. Air Defense Board, Fort Bliss, Tex.:						
1968	2,957	535	3,492	130	326	456
1969	2,900	1,300	4,200	124	400	524
1970	2,960	1,195	4,155	104	428	532
36. Airborne and Electronic Special Warfare Board, Fort Bragg, N.C.:						
1968	972	435	1,407	48	265	313
1969	1,119	1,033	2,152	36	318	354
1970	1,123	887	2,010	36	318	354
37. Arctic Test Center, Fort Greely, Alaska:						
1968	2,762	615	3,377	23	375	398
1969	2,836	1,462	4,298	19	450	469
1970	2,857	1,256	4,113	19	450	469
38. Tropic Test Center, Panama Canal Zone:						
1968	2,021	175	2,196	92	107	199
1969	2,500	562	3,062	67	173	240
1970	2,551	483	3,034	67	173	240
39. Aviation Test Activity, Edwards Air Force Base, Calif.:						
1968	1,575	131	1,706	109	80	189
1969	1,900	314	2,214	90	96	186
1970	2,000	268	2,268	90	96	186
OVERSEAS RESEARCH OFFICES						
40. European Research Office, Frankfurt, Germany						
1968	155	100	255	5	7	12
1969	160	100	260	4	7	11
1960	160	100	260	4	7	11
41. Latin American Research Office, Rio de Janeiro, Brazil:						
1968	57	16	73	2	1	3
1969	70	16	86	2	1	3
1970	70	16	86	2	1	3
42. Far East Research Office, Tokyo, Japan:						
1968	53	16	69	3	1	4
1969	58	16	74	3	1	4
1970	58	16	74	3	1	4

RESEARCH, DEVELOPMENT, TEST AND EVALUATION, ARMY—INSTALLATION ANALYSIS, MISCELLANEOUS INSTALLATIONS—Continued

[Dollar amounts in thousands; fiscal years]

	A. Obligations			B. Personnel (man-years)		
	R.D.T. & E.	MPA	Total obligations	Civilian government personnel in R.D.T. & E.	Military personnel in R.D.T. & E.	Total personnel
U.S. ARMY STANDARDIZATION GROUPS						
43. Australia:						
1968	$6	$58	$64	----------	4	4
1969	6	58	64	----------	4	4
1970	6	58	64	----------	4	4
44. Ottawa, Canada:						
1968	14	164	178	----------	10	10
1969	14	164	178	----------	10	10
1970	14	164	178	----------	10	10
45. London, England:						
1968	75	255	330	----------	16	16
1969	75	255	330	----------	16	16
1970	75	255	330	----------	16	16
HUMAN RESOURCES RESEARCH OFFICE UNITS						
46 Fort Rucker, Ala.:						
1968	59	96	155	----------	13	13
1969	61	96	157	----------	13	13
1970	61	96	157	----------	13	3
47. Fort Bliss, Tex.:						
1968	35	75	110	----------	14	14
1969	40	75	115	----------	14	14
1970	40	75	115	----------	14	14
48. Fort Knox, Ky.:						
1968	19	98	117	----------	16	16
1969	25	98	123	----------	16	16
1970	25	98	123	----------	16	16
49. Fort Benning, Ga.:						
1968	41	113	154	----------	18	18
1969	41	113	154	----------	18	18
1970	41	113	154	----------	18	18
50. Presidio, Monterey, Calif.:						
1968	23	69	92	----------	14	14
1969	23	69	92	----------	14	14
1970	23	69	92	----------	14	14
LIAISON OFFICES AND FIELD OFFICES						
51. U.S. Army Liaison Detachment, Wright-Patterson Air Force Base, Ohio:						
1968	4	----------	4	----------	----------	----------
1969	4	----------	4	----------	----------	----------
1970	4	----------	4	----------	----------	----------
52. Liaison Office, China Lake, Calif.:						
1968	6	----------	6	----------	----------	----------
1969	6	----------	6	----------	----------	----------
1970	6	----------	6	----------	----------	----------
53. Liaison Office, El Centro, Calif:						
1968	3	----------	3	1	----------	1
1969	3	----------	3	1	----------	1
1970	3	----------	3	1	----------	1
54. Army Pictorial Center, Long Island, N.Y.:						
1968	220	----------	220	----------	----------	----------
1969	220	----------	220	----------	----------	----------
1970	220	----------	220	----------	----------	----------
55. U.S. Army Field Office, Space and Missile System Organization, Los Angeles, Calif.:						
1968	34	----------	34	2	----------	2
1969	34	----------	34	2	----------	2
1970	34	----------	34	2	----------	2
56. Army Field Office, Andrews Air Force Base, Washington, D.C.:						
1968	27	32	59	3	5	8
1969	33	42	75	2	5	7
1970	33	42	75	2	5	7
Total miscellaneous installations:						
1968	42,598	12,175	54,773	1,955	3,179	5,134
1969	57,667	19,792	77,459	1,836	3,809	5,645
1970	68,518	19,350	87,868	1,785	3,855	5,640

[1] Information is classified and was supplied to the committee.

REVIEW OF INSTALLATION PROGRAMS

Mr. ANDREWS. How closely are these installation programs reviewed as to the increase and decrease in personnel and increases in programs? Do they get a close scrutiny at the Army staff level?

General BETTS. Not at the Army staff level; no.

Our control rests in project control at each installation. Each of these installations we have been talking about would be controlled by the commodity command under which they operate, and at that level there is a greater detail of control than here, although the primary control is a funding control.

Although, as you recognize, they do have an authorized limitation within their authority with respect to how many civilian employees they can have, and the average grade levels are established as a control point. So that if the individual unit commander or installation commander wanted to increase all of his people to higher grade levels, he immediately would get in trouble with his average grade level.

So there are some check points that do keep a control on installation level and at the same time I must insist we try to avoid making these controls so tight the commander has no flexibility.

Mr. ANDREWS. Do you have a limitation on the personnel?

General BETTS. That is the tight control. He has so much money and he is limited.

Mr. ANDREWS. Within those limitations he can make certain decisions that affect only his installations?

General BETTS. He has some flexibility.

Mr. ANDREWS. What new Army R.D.T. & E. facilities were opened in fiscal year 1969? Do you know of any?

Mr. POOR. I do not know of any.

General BETTS. I do not know of any. I will check that out in detail.

Mr. ANDREWS. Are any proposed in fiscal year 1970?

General BETTS. None I know of.

CLOSURE OF FRANKFORD ARSENAL R. & D. WORK

Mr. ANDREWS. What Army R.D.T. & E. facilities have been closed or ordered closed in fiscal year 1969?

General BETTS. We have made the decision to close Frankford Arsenal research and development activity, distributing it to several different installations in order to enhance the effectiveness of our management of the total research and development program. We do not yet have authority for additional facilities at the installations to which these people would move. The moves will not happen in fiscal 1970.

Mr. ANDREWS. It would not happen in fiscal 1970?

General BETTS. No.

The first of the requested facilities is in the fiscal year 1970 budget. Obviously we could not move any of these people until those facilities had been made available.

Mr. ANDREWS. Will you continue to carry on in fiscal 1970 at about the same level of operation as 1968 and 1969?

General BETTS. At Frankford we would, and in fiscal 1970 and 1971, as far as that is concerned.

Mr. ANDREWS. I wish you would enumerate in the record the reasons why you have decided to close the Frankford Arsenal.

General BETTS. I will expand on it in some detail, but the overall goal is to take the rather disparate elements of effort at Frankford and associate them more closely with similar work.

For example, there is ammunition work, powder work at Frankford that would be much more effective if it were used to augment the work now being done at Picatinny where there is a considerably greater effort.

Mr. ANDREWS. How much do you estimate you would save by closing this arsenal?

General BETTS. About $11.8 million a year once the work had been completed, is our estimate.

Mr. ANDREWS. How many people are involved working there at this time?

General BETTS. This action would require the transfer of 743 spaces to Picatinny Arsenal, 94 to Watertown Arsenal, and 417 spaces to other establishments that have not yet been firmly fixed.

Mr. ANDREWS. That is how many people?

General BETTS. We start with 743 plus 94 plus 417. That is 1,254 people.

Mr. ANDREWS. What is the total employment there now?

General BETTS. 5,700.

The major activity at Frankford is production. And we are now talking about the research and development activity.

Mr. ANDREWS. And you plan to move the R. & D. people?

General BETTS. This presently planned move relates only to the R. & D. activities.

(Off the record.)

MILITARY CONSTRUCTION PROGRAM FOR R. & D. FACILITIES

Mr. SIKES. What sums are included in the fiscal 1970 budget for facilities to be closed during the fiscal year?

General BETTS. We have in the fiscal year 1970 MCA budget money for additional facilities at Watertown. Part of them are related to this Frankford closing, but the closure would not take place during this fiscal year. We have no planned closures that would take place during this fiscal year.

Mr. SIKES. What major expansions or improvements of Army R.D.T. & E. are planned in fiscal 1970?

Provide it for the record and tell us what was done in fiscal 1969 in this regard.

(The information follows:)

Fiscal year 1969 RDTE MCA program authorized by Congress

[Dollars in thousands]

Description:	Cost
Calibration shop, Ft. Belvoir	178
Maintenance evaluation facility, Ft. Benning	71
Medical biological research laboratory, Ft. Detrick	6,433
Airfield improvements, dugaway Proving Grounds	1,787
Environ antenna facility, Ft. Huachuca	476
Maintenance evaluation facility, Ft. Knox	172
Air-condition transient quarters, Kwajalein	168
Cine-sextant facilities, Kwajalein	2,677
Modify 1,000-man barracks, Kwajalein	480
Range operations building addition, Kwajalein	600
Modify laboratory, Picatinny Arsenal	337
Advanced concepts facility, Redstone Arsenal	2,880
Improve Instrument Test Area 1, Redstone Arsenal	375
Maintenance evaluation facility, Ft. Sill	72
Research facility, Walter Reed Army Institute of Research	2,856
Range facilities, phase IV, White Sands Missile Range	1,435
Inert loading plant, Yuma Proving Grounds	211
Hanger w/apron-washrack, Yuma Proving Grounds	525
Total	21,733

Fiscal year 1970 RDTE MCA program submitted to Congress

[Dollars in thousands]

Description:	Cost
Coating and Chemical Laboratory, Ft. Belvoir	1,837
Physical Security Laboratory, Ft. Belvoir	183
Technical operations support facility, Ft. Clayton	816
Vehicle Track and Suspension Laboratory, Detroit Arsenal	3,300
Instrumentation building addition, Dugway Proving Grounds	307
Sampler processing building, Dugway Proving Grounds	113
Research animal isolation facility, Edgewood Arsenal	3,770
Relocate labs, phase 1, Harry Diamond Laboratories	12,781
Add communication center and terminal, Kwajalein	695
Civilian dorm, Roi Namur, Kwajalein	1,710
Live explosive storage facility, Kwajalein	156
Marine repair facility, Kwajalein	712
Canine holding facility, Ft. Meade	1,111
Electronic Warfare Laboratory, Ft. Monmouth	1,509
AMMRC Structural Material and Mechanical Laboratory, Watertown Arsenal	4,902
SAM-D facilities, White Sands Missile Range	1,281
Range facilities, phase V, White Sands Missile Range	1,937
High explosive facility, Yuma Proving Grounds	231
Sewage lagoon, Yuma	503
Total	37,854

MODIFICATIONS BUDGETED IN PROCUREMENT ACCOUNTS

Mr. SIKES. In discussing the funding of the Army procurement appropriations, note was taken of the very large sums requested for the various modification efforts. To what extent are the modifications due to a failure or partial failure in the development program, or due to the failure of the contractor to meet the specifications?

We are modifying weapons systems which have been in inventory only a very short period of time. I would like to know why.

General BETTS. I would have to go through that on a case-by-case basis. I do not know of any really significant problem that we ran into that would meet this definition. But in modification, thinking in terms of facility modification——

Mr. SIKES. We are talking about weapons, not facilities.

General BETTS. I am sorry. I thought we were on facilities.

Mr. SIKES. We were, but we left it.

General BETTS. You are well aware that we are working on modifications of the Sheridan vehicle that were revealed in the process of the test and evaluation in Southeast Asia.

Mr. SIKES. Let me be sure you understand the question.

There have been large sums requested for modification. I want to know to what extent modifications are due to failure of partial failure in the development program and to what extent they are due to the failure of the contractor to meet specifications.

Do you want to research that and provide it for the record?

General BETTS. Yes, Mr. Chairman. It would become very involved. I do not know if I could give you a quick answer on any one of the major programs.

Mr. SIKES. Do you want to answer that, Mr. Secretary?

Mr. POOR. I do not want to answer the question, but I could comment on it.

There is one class of modification which I assume you would want included. Let me give you an example.

In the case of the Shillelagh missile, sir, the system is performing according to specifications in a very satisfactory fashion, we believe.

During the 2 or 3 years we have conducted an elaborate program to determine whether there is any conceivable way the guidance and control system for the Shillelagh can be frustrated by countermeasures. Out of our countermeasures program then comes a realization that the ———. This then results in a program which will be included in the 1970 budget for exploration of what fixes could be applied to the Shillelagh for this purpose.

———.

———. We may do that. So I think your list would turn out to be very long, but we will do the best we can.

BASIS FOR MODIFICATION REQUESTS

Mr. SIKES. I think you could almost take any major weapon system of aircraft missiles. For example, the Pershing has been modified time and time again, and it has been in inventory a long time. A recent one involved the Cobra, in this instance asking for funds to move the tail rotor from one side to the other because of the stabilization problem. This is the sort of thing we had in mind.

Where does R.D.T. & E. fail in properly developing these items and testing them to find out whether these things do happen without having to determine this in the field?

Mr. POOR. My example of the Shillelagh was intended to suggest it is not always failure in R.D.T. & E., but rather the march of technology opening new possibilities. In the case of the tail rotor problem on the Huey, I think that was a recognized minor deficiency at the time it was deployed.

There are a number of helicopters with limited tail rotor authority. The Bell people came to us with a proposal for what they hoped would be an inexpensive modification to improve the handling qualities. It is certainly prudent to accept that improvement.

Mr. SIKES. Answer for the record what you wish.

(The information follows:)

Exhibit P–1, DA supporting data for fiscal year 1970 budget estimate, the President's budget (revised April 11, 1969), shows that 23 procurement line items involved modifications with funds for fiscal year 1970. Total value of these 23 items is $115 million. These 23 line items represent 109 different modifications. Modifications per line item vary from one to 26. In some cases, modifications to a line item will cross the spectrum of reasons for the modifications.

The analysis performed on these 109 modifications indicated that all could be classed in one of two groups. Group 1 includes those modifications to materiel due to changing threats and other requirements based on extensive field use in Southeast Asia and other areas where military materiel is located (for example Europe and Alaska). As our equipment is used over the years we find defects. Army efforts to eliminate modifications due to long field use would not be in the best national interest because we would have to add 3 to 5 years to our development cycle. This would be required to give materiel the exhaustive testing equivalent to years of use. This group also includes modifications to major items for incorporation of new improved components such as aircraft electronic subsystems. The second group includes modifications due to materiel failure or improper design. In many cases the metal or design has failed after extensive hard field use. Philosophically, it could be said that all failures of this nature could be attributed to failure or partial failure in the development program, but we must realize that these defects have only become visible after years of use in the field. With respect to failure of the contractor to meet specifications, it is difficult to lay the blame on a contractor because these items are all in production—having successfully completed testing and evaluation and having been accepted by the Army years ago. We regard acceptance by the Army as prima facie evidence that the contractor has, in fact, met the item specifications. Thus, there are no failures in this category. The results of the analysis are:

Modifications due to:

[In percent]

	Changed requirements	Materiel or design failure
Totals:		
109 projects	70	30
$115,000,000	93	7

TIME VERSUS MONEY IN CONCURRENT DEVELOPMENT

Mr. SIKES. Could significant sums be saved if we initiated the policy of having less concurrency in development and production of new weapons systems? It would take more time, but it could save money. Which is more important, time or money?

General BETTS. The savings that can be gained by that approach are very often lost in the fact that with the extended testing program that would otherwise be involved you carry forward engineering and overhead costs for a far longer period.

Our solution to the kind of problem that has resulted from trying to have a maximum concurrency inherent in total package procurement—not necessarily inherent, but inherent in the way we went about, for example, the Cheyenne program—is to do more exploration of subsystems and test beds in a competitive environment and then to have test hardware in a competitive environment, and select from that competition for the final development effort. Then the final development effort can be much more rigidly planned and controlled because hardware would have been demonstrated. People must recognize that in something like the Cheyenne program the development began on nothing but a paper design and of course experience with the XH–51 rigid rotor helicopters that explored the technical approach.

If we had an unlimited technical vision we would have discovered things in the XH–51 test that would have raised red flags with respect to the design of the Cheyenne that we just did not see.

With 20–20 hindsight we can see information that should have led us into more testing and research of the test bed. I would say that the clean-cut answer to the question is that there is no simple way to guarantee that you can save both cost and the problems of getting into trouble in the development program where there is a lot of complexity, because it is inherent in R. & D. that you are trying to advance into new things.

If you wait for a long period of testing, it is inevitable that you must get rid of the engineering team that designed the item in question. You cannot carry them forever. If you can carry them on into production engineering using their knowledge gained from the testing program to correct the production defects, you have as good a chance as any other of coming out with the best answer.

Mr. RHODES. What happened with the Cheyenne? Is it a matter of not evaluating the test properly?

General BETTS. Both Government and Lockheed failed to be so brilliant that they saw everything about the technology. There was rotor instability that appeared in the testing of the XH–51 that was corrected by the modification to the rotor; both the Government and Lockheed assumed those corrections took care of the problem.

Now with 20–20 hindsight, we realize we should have pushed that exploration further.

Mr. RHODES. Is there anything in the Cheyenne experience that may keep us from repeating it on some other type craft?

General BETTS. Yes, sir; just the one I said, that we should do more actual hardware testing of the full-scale prototypes in a competitive environment before we kick off a final hard development program.

EVALUATION OF TEST RESULTS

Mr. RHODES. Is that the only answer?

Do you not need to evaluate your results better? You said if the results had been evaluated properly that there were indicators to point out the defects. And to me this points to a lack of skill in evaluating your own results.

General BETTS. It is a matter of judgment. I do not think I would use the word "properly." I would like to turn it over to Mr. Poor, who has been deeply involved in this effort.

Mr. POOR. I have seen prior examples of where, going back to early test data and examining it very closely, you can find indication of future trouble. Early in the missile program in this country I was associated with most of the supersonic testing of most of the missiles and supersonic aircraft that were built. And in several cases we had the experience of finding in flight an unsatisfactory condition, then going back to test data taken on models in wind tunnels and finding one little point off the curve off in a corner somewhere that was not really noticed.

In the Cheyenne something very like that happened. In the XH–51 program there was a small indication of an instability under very limited conditions at very high speed. That class of instability turned out to be what caused the difficulty with the rigid rotor on the

Cheyenne. While it would be nice to point a finger of blame at somebody for failing to notice it, I cannot find it really possible under the circumstances.

MATHEMATICAL MODEL TESTING

Mr. RHODES. Before you leave this, could we explore the process just a little bit further?

Is it possible that some advantages could be gained by using automatic electronic processing means in evaluating your tests?

General BETTS. Yes. As we look back at the Cheyenne program, if we had attempted very early in that program to develop a mathematical model on computers that would simulate the full spectrum of degrees of freedom of the rotor, we might have found the problem that we are talking about at an earlier point in the development cycle.

After we had gotten into trouble with the particular rotor instability I am discussing, Lockheed did go through a mathematical model simulation. It is pretty clear now that we can duplicate on the computer the actions as they actually happened in flight.

Mr. RHODES. That is what I was in hopes you might have learned.

General BETTS. We certainly have. We have learned a great deal.

PROTOTYPE TESTING OF COMPONENTS

Mr. POOR. Mr. Rhodes, I think it is just learning again something that we really knew. It is for that reason that I am urging the Army and Dr. Foster is urging all three services to make more use of prototype testing, not of the complete system necessarily, that can be extremely expensive, but of those elements that appear critical to the success of the program.

Now in the case of the AH–56, I think collectively we did make an error in judgment. The rigid rotor had worked so well by all obvious indication that we did not regard it as a really high-risk component of the program, and we spent a great deal of time and effort on the armament which we thought was high risk. The armament system has proven very successful. But it certainly makes sense on anything that is a substantial step forward to test the critical pieces.

We did it in the program that resulted in the TOW weapon system many years ago in 1956 and 1958, tested various contenders for the guidance system all by themselves without building the complete system, and that program has turned out I think for that reason to be technically very successful.

We are going to try to do it more from here on in.

MILITARY SCIENCES

Mr. SIKES. For budget activity 1, military sciences, you are requesting $182.4 million for fiscal year 1970. This compares with $171.8 million for fiscal year 1969 and an actual amount of $162.5 million for fiscal year 1968.

What Army programs would be adversely affected if the Congress held the appropriation for military science to the fiscal year 1968 amount?

General BETTS. It would reduce our support of basic research and some of the exploratory effort that we feel is important to the future technology.

I might point out that we can rather firmly document that our costs of doing R. & D. is going up at about 5 to 6 percent per year. So that although there is an apparent increase in these numbers, in terms of level of effort there really is no increase.

Mr. SIKES. If reductions were required, where would you make them?

General BETTS. I would distribute these reductions through the major disciplines that we support in the 6.1 and 6.2 area.

I might ask Colonel Snead to expand on that answer.

Colonel SNEAD. We would follow the regular course in our input looking to see across all of the disciplines how the reduction would be distributed. There are some that are by nature not as reducible as others in that they are either a package or they are not a package. So in those cases you have to consider whether you can afford to stretch them out without reducing the validity of the research you are undertaking.

We would look across all of the disciplines.

Mr. ANDREWS. You would not want to make a statement until this had been done?

Colonel SNEAD. Correct.

General BETTS. What I am saying is we would have to go right through the physical sciences and social sciences and take something out of each. I do not know of any of these areas that are so sacrosanct we would not reduce them at all. We would just have to distribute the reduction.

Mr. ANDREWS. You would have to set up some priorities.

General BETTS. We do have some priorities of interest within the research support and that would influence the choice of line items we would reduce.

Mr. ANDREWS. It is reported in the papers today that the Senate Armed Services Committee clipped the authorization for procurement and research by a billion dollars. The inference from the story I read hastily was that most of that billion is coming from R. & D.

General BETTS. We understand that to be the case and we are now, for Dr. Foster, analyzing what the impact on our program would be. We have not yet completed that analysis.

Mr. POOR. If I may, I would like to simply say that I think it would be a very unfortunate thing for the Nation if this proposed cut were to hold. Yesterday I think I mentioned the concern we have about the level of effort of Russian R. & D., the fact that their military R. & D. is expanding at a rate which may well bring them substantially ahead of us. A cut as large as a billion dollars out of the $8 billion DOD budget would reduce our level of effort by about 12 percent.

The rate at which the Russian effort is now growing is about 12 percent per year. I submit that this is a very risky business, making it virtually impossible for us to guarantee that the program will present the options we must have for later procurement of new weapon systems based on new technology.

I feel very hopeful that this cut will not stand.

STATUS OF OBLIGATIONS, 1969

Mr. ANDREWS. How accurate is the $171.8 million estimate of fiscal year 1969 obligations? Fiscal year 1969 is now over. Athough I am

aware that your reporting system would not give you actual figures at this point in time, as of your last reporting date, how accurate did the $171.8 million estimate appear to be?

GENERAL BETTS. Our last really firm checkpoint on obligations against projection was back at the end of April so it is hard to be precise. But if one goes back to past experience in the support of the research, we usually manage to come out fairly close to the projection because this is largely made up of a series of many, many small contractual or grant efforts. Consequently, it is not normal for this to be left with a large carryover at the end of the year.

Mr. ANDREWS. I wish you would put in the record what your unobligated balance was as of the 1st of April, then at the close of the year and what your rate of expenditure was monthly for the last 3 months.

General BETTS. All right.

You mean expenditure or obligation?

Mr. ANDREWS. Obligation.

General BETTS. We will be pleased to supply that.

(The information follows:)

Fiscal year 1969 military sciences program

[In thousands of dollars]

Program reflected in the fiscal year 1970 budget	171,849
Less:	
Statistical distribution of facilities and installation support costs	—11,397
Reprograming subsequent to submission of the budget	—3,115
Currently approved fiscal year 1969 military sciences program	157,337

OBLIGATION STATUS

Unobligated balance June 30, 1968	15,323
Currently approved fiscal year 1969 program	157,337
Total availability in fiscal year 1969	172,660
Obligations as of Mar. 31, 1969	119,742
Unobligated balance Mar. 31, 1969	52,918
April obligations	8,929
May obligations	8,688
Estimate June obligations	15,000
Estimated unobligated balance as of June 30, 1969	[1] 20,301

[1] The unobligated balance is greater than expected due to release of $10,000,000 in the last quarter of the fiscal year.

UNCLASSIFIED BASIC RESEARCH

Mr. ANDREWS. How many of the various grants and projects with colleges and universities deal with unclassified research and development?

Colonel SNEAD. All of the grants are unclassified, all of the basic research, 6.1 is unclassified.

Mr. ANDREWS. What is your estimate in this area for fiscal year 1970, estimate of grants and projects for universities dealing with unclassified research and development?

General BETTS. Again all of the basic research will be unclassified and that means all of the grants will be unclassified.

Mr. ANDREWS. What we want to know is are you increasing the portion of your program that is unclassified?

General BETTS. I cannot identify a significant trend, but I will look at the projection with the ARO office in Durham and see if I can get it.

Mr. ANDREWS. What is your program for fiscal year 1969 and what was your actual experience in fiscal year 1968 in this area?

General BETTS. I will have to give you those numbers for the record.

(The information follows:)

The Army is making every effort to increase the unclassified portion of its research program with academic institutions. In fiscal year 1968 all Army activities were directed to insure that all basic research with academic institutions was unclassified. In fiscal year 1969, out of a total program of approximately 880 contracts and grants for research and exploratory development at academic institutions, only 46 classified contracts (none of which were in basic research) were identified.

The Army is maintaining a continued effort in fiscal year 1970 to make certain that only that work at academic institutions that must be classified is classified, and that generally work is held to an unclassified status, if at all possible.

CONTINUED FUNDING OF RESEARCHERS

Mr. ANDREWS. To what extent do you continue to fund researchers at selected colleges and universities on a continuing basis?

Colonel SNEAD. The support is renewed on a product-delivered or research-proposal-offered basis, there are no automatic renewals, sir.

General BETTS. By and large, we have a high percentage of renewals.

Colonel SNEAD. Yes. We will have to provide that for the record.

General BETTS. We do have a great many renewals, but I will have to supply the precise percentage for the record.

(The information follows:)

Because of careful initial selection the rate of renewals of contracts and grants over the past 5 years has been approximately 80 percent.

Mr. ANDREWS. What part of your program is tied to individual researchers who are supported on a continuing basis without regard to the subject matter involved?

Mr. POOR. None of them at all.

Mr. ANDREWS. They are not hooked in?

Mr. POOR. No.

Mr. ANDREWS. They have to come back each year?

Mr. POOR. Absolutely. There may be some cases where the contract runs for 2 years to completion or something of that sort.

Mr. ANDREWS. That is not what we are talking about.

Mr. POOR. There is no case I know of.

Mr. ANDREWS. Who makes the proposal in these relations you have with colleges? Do they come to you or do you go to them?

General BETTS. There is some of each, but most of it comes to us from the individual investigators who propose a program for our support. Occasionally we go out to an individual if we have something particularly that we want him to pursue.

Mr. ANDREWS. What did you come up with last year or 1968 that you can put your teeth in which you felt was worth the money you spent?

CONTRIBUTIONS OF INDIVIDUAL RESEARCHERS

General BETTS. I would submit that we have a broad advance in technology, but I can, if you wish, pull out some specifics.

Mr. ANDREWS. Put them in the record.

We are going to be asked that question.

General BETTS. We will be happy to.

Mr. ANDREWS. We have spent a lot of money in this area. Put some of them in there that laymen can understand.

General BETTS. This is a publication we put out once a year from ARO Durham that spells out things they consider to be significant scientific accomplishments of that fiscal year. That is fiscal 1968.

Mr. ANDREWS. That is what we want.

General BETTS. For example, they cite the work of W. E. Baker of Southwest Research Institute on a comparison of air and internal damping of the thin beams. This is of interest because it relates to helicopter rotors. The over-all assessment is to the effect that it is expected that the results of this study will have important implications for helicopter rotor design, their fatigue life and noise generation.

One would have to go into the details of the program, but——

Mr. ANDREWS. Has that project been completed or is it still under study?

General BETTS. This is reporting results. I would have to check whether this man is still under contract with us or not.

(The information requested follows:)

Dr. W. E. Baker of Southwest Research Institute is still under contract to the Army and is continuing his work on the comparison of air and internal damping of thin beams.

Mr. ANDREWS. They study some worthwhile projects and never come up with anything you can put your teeth in. That is what we want.

General BETTS. We are reporting here specific technology results that are directly applicable to helicopter rotor design.

Mr. ANDREWS. We want to get some examples of the finished product. You start out and find something, you pay money to have it researched.

General BETTS. I speak of Mr. Baker in just that context.

Mr. ANDREWS. We want to answer questions that are asked every year, what are you getting for this money?

Now I could not tell them a thing.

General BETTS. It is rare that any one of these individual investigators comes up with something that changes the whole course of that technology, but each one makes his contribution to pushing forward the state of the art. What we have done in this document, and I would be glad to submit all of these items for the record, is to pick out those we consider that are really significant contributions to technology.

Mr. ANDREWS. That is what we want and we want a little statement as to why it is significant, what contribution it will be making to the overall picture. I know you cannot buy stuff off the shelf from that program. You give them something to work on, research.

General BETTS. We will go through and provide these for the record.

(The information follows:)

RESEARCH IN FLUORINE CHEMISTRY

(John L. Margrave, Rice University)

The use of solid lubricants to meet increasingly severe demands imposed by advancing technology has become commonplace in lubrication practice. Extremes in temperatures and pressure as well as unfamiliar and hostile environments are imposing new requirements for superior lubricants. The more commonplace solid lubricants, graphite and molybdenum disulfide, have been used to solve a number

of difficult lubrication problems. However, certain shortcomings are encountered in these materials, giving rise to an interest in modifications or new materials that will extend the utility of solid lubricants. For example, graphite films fail to lubricate at relatively low temperatures. The reason for this effect is thought to be involved with the evaporation of water absorbed on the surface of the graphite flakes.

A new technique for fluorination of solids has been developed under the sponsorship of ARO–D by Prof. John L. Margrave of Rice University. One of the materials that Professor Margrave has produced, using graphite as a starting material, is a white solid which he has named "perfluorographite." Because of the well-known stability of compounds containing carbon-fluorine bonds, it is possible that perfluorographite may be found to be an exceptionally temperature stable and insert solid lubricant. Evaluation of this material is now underway.

Electro-Optical Properties of Molecular Solids

(R. C. Jarnagin, University of North Carolina)

In this nuclear age where irradiation is of concern on many fronts ranging from exposure to radiation from nuclear explosions to X-ray and gamma irradiation of materials and foodstuffs, dosimetry (the measurement of the total quantity of radiation received per unit volume of an object) is of great importance. Modern technology has solved the problem of dose measurement for small doses. However, in cases where one needs to monitor high doses, there is at present no generally accepted dosimeter available.

In connection with their studies on radiation damage in molecular crystals, Professor Jarnagin and his colleagues have developed a dosimeter with a wide dose range for gamma or X-ray radiation. They have found that a single crystal of anthracene may be used in the determination of gamma or X-ray dose over a range from 100 to 100 million roentgens. This single crystal dosimeter has several unique and important advantages and especially in that the same crystal can be used to measure both low and high doses. Further, since this method is accurate at high doses it holds great promise of solving an old but important problem in dosimetry.

Heat-Stable Polymers

(J. K. Stille, University of Iowa)

The need for materials that will stand up to high temperatures is of great importance not only to the Department of Defense, but to the civilian economy as well. A variety of man-made polymeric materials has been developed during the past two decades and found widespread acceptance for both civilian and military use. Among these one shows the best thermal stability (decomposition point: 930° F.) to date.

In his ARO–D-sponsored research, Professor Stille has recently synthesized several polymers of ladder structure (i.e., composed of aromatic ring molecules joined along two sides of each ring, instead of the usual chain-like structure) which show unusual stability at high temperatures. One of these, a ladder "polyquinoxaline", was found to be stable up to 1,250° F. in the absence of oxygen. Thus, it appears that polymers containing such ladder structures may lead to new materials meeting the ever-present Army requirements for high-temperature service.

Investigation of Rocket Nozzle Phenomena

(K. J. Bell, Oklahoma State University)

This project has produced results which are expected to provide the basis for improved performance of certain rocket nozzles.

Extremely high temperature gases are produced in many high performance rocket engines. The high combustion temperatures present only a modest problem in the chamber where the high temperature region is generally surrounded by unburned fuel which acts as a heat shield to the structure. However, hot gases flow from the combustion chamber to the nozzle where there is no shielding provided by unburned fuel. High temperature, high velocity gases have a rapid deteriorating effect on the nozzle walls.

To prevent this, relatively exotic materials are used for nozzle construction, and in addition, rocket performance is sometimes compromised to control gas temperature. Another approach is to provide cooling to the rocket nozzle. The high temperature of a rocket nozzle coupled with its proximity to the high temperature

rocket exhaust gases make conventional approaches to cooling ineffective. Film cooling, however, is one method well suited for such an application, since it occurs when a surface is at a much higher temperature than the boiling temperature of a liquid in contact with it.

While this type of cooling mechanism has been generally known about for many years, the basic research of Dr. Bell, through the support of the Army Research Office, Durham, provided the scientific basis for an important application. The propulsion laboratory of the Army Missile Command is undertaking steps toward the fabrication of nozzles to be cooled by this means and they are sufficiently impressed with the possibilities of this concept that they have initiated patent action on behalf of the Government.

Design and Analysis of Experiments

(John W. Tukey, Princeton University)

During the fiscal year 1967, Dr. Tukey and his colleagues have continued to further investigate and exploit the techniques of so-called "fast Fourier analysis." Thus, if it took a computer 10 hours to carry out the operations needed in the standard Fourier analysis, the "fast Fourier analysis" would require only a fraction of the computer operations and the time would be cut from 10 hours to about 10 seconds. This saving in computer time enables one to handle many new applied problems.

A Study of Strain Hardening and Fracture in Iron-Based Alloys

(A. S. Tetelman, Stanford University)

The low fracture strength of many materials, as compared to their theoretical strength, is attributed to the presence of tiny cracks which are inadvertently introduced during the processing, fabrication, or loading of a structural part.

Tetelman is investigating the fracture behavior or iron-based alloys in which cracks are intentionally introduced. (He drives hydrogen into the alloy electrically until the metal threatens to burst.) He has found that high temperature heat treatment heals these hydrogen-induced cracks in iron containing 3 percent of silicon, significantly increasing the strength of the precracked material.

That improvement represented the recovery of 55 percent of the loss of strength due to the cracks. At room temperature, cracked samples stretch ductilely before fracture, and their mechanical properties are unaffected by the heat treatment.

The improvement in the low temperature strength and ductility of iron-3 percent silicon brought about by experimental heat treatment suggests that such treatment might also result in improvements in the properties of structural components processed for military applications.

Studies of the Attack of Metal Surfaces by Halogen Atoms

(D. E. Rosner, AeroChem Research Laboratories)

One might hope to predict the rate of chemical corrosion of a solid in a mixture of reactive gases from experimental knowledge of the behavior of the solid in each gas alone. Unfortunately, that sort of inference can lead to gross errors in the predicted rate of reaction.

The remarkable effect of mixing the corrosive gases has been demonstrated, for example, in the exposure of tungsten to a series of mixtures of chlorine and oxygen at surface temperatures above 1125° C, under controlled conditions. The accelerated rate of removal (ablation) of the tungsten, sometimes more than 10 times the rate predicted from the rates of reaction in the separate gases, is attributed to the formation of gaseous compounds of tungsten, oxygen, and chlorine. Because of the wide variety of metal-containing compounds that may exist as gaseous compounds, it is likely that many mixtures of gases will exhibit characteristic similar to those displayed by chlorine and oxygen in the above example, with important implications for the designer who, in the choice of materials, must consider corrosion and ablation.

DISTRIBUTION OF RESEARCH CONTRACTS AND GRANTS

Mr. Andrews. How widely spread are your research dollars among colleges and universities?

Colonel SNEAD. We have contracts with universities in approximately 46 States. I would have to check because it changes.

Mr. ANDREWS. What percentage of your total contract and grant program for research is with the 25 colleges and universities with which you have the greatest dollar amount of research effort?

Colonel SNEAD. I would have to research that and provide it for the record, sir.

(The information follows:)

In fiscal year 1969, of the total Army program for contracts and grants at academic institutions supported from the research and exploratory development categories, approximately 9 percent of this support was programed for the top 25 colleges and universities.

Mr. ANDREWS. Are the top 25 colleges and universities with which you have grants and contracts the same top 25 of 5 years ago?

General BETTS. I am sure they are not. We would have to check it out in detail.

Mr. ANDREWS. And put in the record a list of those in the top 25, 5 years ago, that are in the top 25 today.

General BETTS. Yes.

(The information follows:)

The following 19 universities were among the top 25 in fiscal year 1964 and remain among the top 25 in fiscal year 1969:

American University
University of California
University of Chicago
Columbia University
Duke University
George Washington University
Harvard University
University of Illinois
Johns Hopkins University
University of Maryland
Massachusetts Institute of Technology
University of Michigan
New Mexico State University
New York University, N.Y.
University of Oklahoma
Princeton University
Stanford University
University of Texas
University of Wisconsin

Mr. ANDREWS. What is the total number of institutions with which you have research grants and contracts? Did you say 46?

Colonel SNEAD. Forty-six States.

Mr. ANDREWS. How many colleges and institutions?

General BETTS. 254 universities or colleges.

Mr. ANDREWS. How many of these are domestic and how many are outside of the United States?

You can supply that for the record.

General BETTS. This is both domestic and foreign.

(The information follows:)

The Army has contracts or grants with 98 academic and research institutions outside the United States and has contracts or grants with 156 academic and research institutes within the United States.

Mr. ANDREWS. How many institutions listed above have held Army research grants or research grants for periods in excess of 5 years?

General BETTS. I would have to supply that.

(The information follows:)

The Army has supported research, through contracts and grants, at 151 of the 254 academic institutions referred to above for fiscal year 1969, for a total of more than 5 years.

DIRECT AND INDIRECT OVERHEAD COSTS

Mr. ANDREWS. What percentage of direct costs do you pay in overhead on contracts with colleges and universities?

General BETTS. It varies from contract to contract.

Mr. ANDREWS. Tell us the highest one.

General BETTS. I will have to supply that.

Mr. ANDREWS. Do you know of anyone you can tell us about?

The question is, what percentage of direct costs do you pay in overhead or on contracts with colleges and universities?

General BETTS. I do not know that I can identify a specific percentage.

Mr. ANDREWS. Do you have a limitation on the percentage of direct costs for overhead?

General BETTS. We have guidance in the procurement regulations that apply to all of our contracting officers.

Mr. ANDREWS. What are those guidelines?

General BETTS. I could not quote them in detail.

Mr. POOR. I think it would be reasonable to provide this detail for the record if it pleases the committee.

(The information follows:)

The highest overhead rate on a contract with a college or university is 90 percent, based upon overhead computed as a percentage of salaries and wages.

Army experience shows that overhead rates range from 20 to 40 percent when overhead is computed as a percentage of total direct costs, and 40 to 90 percent when computed as a percentage of salaries and wages.

Army contracting officers, based upon the guidance provided by part 3, section XV of the Armed Services Procurement Regulations, do not have a specific limitation on the overhead rate. However, the guidance does specify limitations on the type of costs which may be allowed in computing the overhead rate.

Mr. ANDREWS. We had a limitation on the overhead that could be charged or the percentage of the contract costs that could be charged by the college for overhead. If I remember correctly, it was one time 20 percent and again 25 percent, and those ceilings were removed.

General BETTS. I think those ceilings applied to grants rather than contracts.

Mr. ANDREWS. It went on grants only?

GUIDELINES ON SHARING OF OVERHEAD COST

General BETTS. Yes.

The important requirement we have from the Department of Defense on grants is there must be sharing of the cost of the research supported, and the experience indicates that on the average this sharing is for the university to pick up 10 percent of the costs.

Mr. ANDREWS. Spell that out now.

Suppose you had a million-dollar contract, or do they run that high?

General BETTS. No, we are talking about $30,000, $50,000, levels like that where there are one or two investigators involved.

Mr. ANDREWS. Let's say you have a contract with a college for $50,000. Tell us about the mechanics of the way the program operates as far as overhead.

General BETTS. This would mean when we went in to negotiate with them, we would insist, if this is to be a grant, that the university must

share in the support of that research. On the average that share for the university may be $5,000 with $45,000 furnished by the Army.

Mr. ANDREWS. Suppose you have a project that is going to cost $50,000. Under your rules the college must pick up the tab for 10 percent of it?

General BETTS. The rule is that they must pick up more than a token share and we negotiate with them. Ten percent is the average we have been experiencing.

Mr. ANDREWS. The college puts in $5,000 and the Army puts up $45,000?

General BETTS. That is the average of our experience.

Mr. ANDREWS. And the $50,000 is spent at the discretion of the college under guidelines you give them?

General BETTS. Under the guidelines agreed with us. They just do not spend it any way they please. We very carefully monitor that effort and we demand research results.

Mr. ANDREWS. Put something else in the record about it.

General BETTS. Yes.

(The information follows:)

Included in the terms of the grant to a college or university are guidelines based upon the project proposal previously submitted to, and approved by, the Army grantor. The grant funds are then spent in accordance with these guidelines. Departures from the approved proposal exceeding $500 must first be approved by the grantor.

COMPARISON OF GRANT AND CONTRACT PROGRAMS

Mr. ANDREWS. What part of your college and university program is under the grant procedure and what part is under contract, and how does this compare with the previous 3 fiscal years?

You can supply that for the record.

(The information follows:)

The college and university research program for fiscal year 1968 had 94.2 percent of its $54.1 million allocated to contracts and 5.8 percent to grants. In fiscal year 1967, 95.1 percent of the $58.1 million programed funds was for contracts and 4.9 percent for grants. In fiscal year 1966, 97.3 percent of the $80.2 million went to contracts, with 2.7 percent to grants.

Information concerning contracts to universities is compiled and distributed annually. Although this is not yet available for fiscal year 1969, the information available on grants indicates that the total dollar amount has decreased slightly compared with fiscal year 1968. It is estimated that grants will account for between 3 percent and 5 percent of the university program.

OVERHEAD COSTS IN CONTRACTS

Mr. ANDREWS. Let's have you explain what the procedure is under a contract you make with the college about overhead, and so forth.

General BETTS. Before negotiating with a college or university on a contract basis——

Mr. ANDREWS. Let's talk again about a contract for $50,000.

General BETTS. We work from their specifically submitted proposal and if we feel that the items they want to charge us in the overhead part of the contract are not reasonable, then we either just do not award the contract or we negotiate with them to reduce the costs to what we feel are reasonable allocation.

Mr. ANDREWS. Let's say you are talking with them about a $50,000 contract. What percentage of that would you consider reasonable for overhead expenses?

General BETTS. We would not approach it on a percentage basis, Mr. Andrews. We would approach it on the basis of rates established by the Government audit.

For example, if the contract demands a lot of support from a good technical library and the university supplies that library and builds up some cost for it, we would look specifically at the rates and decide, in our judgment, whether it is a reasonable charge.

If there are administrative expenses in terms of travel, furnishing support, janitorial services, and that kind of thing, we would look at the reasonableness of the charge included in the proposal.

It is a judgment matter. These will vary from contract to contract, depending upon the kind of support that the university proposes to furnish to the effort.

Mr. ANDREWS. You want to pay them, but you want to be reasonable.

General BETTS. We want to be sure that we are getting an adequate return and that it is related to the contract in a specific way.

Mr. ANDREWS. You determine the reasonableness of their charges or their proposed charges under the contract.

General BETTS. Yes. There is guidance in the armed services procurement regulations to tell the contracting officers what they are able to do.

Mr. ANDREWS. Normally, what part of a fiscal year's funds in this area are committed within the first 6 months of the fiscal year? A heavy commitment during the first 6 months would indicate that this program is basically used for sustaining research.

General BETTS. It is about 40 percent.

The problem with its not being a higher percentage is that we are well into a new fiscal year before we know what our program can be. A continuing resolution does not tell us enough about what our budget will be.

CANCELLATIONS, COMPLETIONS, AND TERMINATIONS

Mr. ANDREWS. As a result of your field trips and reports relative to research contracts at colleges and universities, in the past year how many efforts have been found to be progressing unsatisfactorily and have been canceled?

General BETTS. I would have to furnish that.

Mr. ANDREWS. Have you canceled any?

General BETTS. Yes, sir.

Our procedure is to analyze the proposal with respect to whether or not we will continue it for another fiscal year. So, terminating at the conclusion of 1 year is the more normal procedure. It is very rare that we will stop a research program in the middle of a fiscal year and cancel it out, simply because the kind of analysis one has to make of research does not permit nice, clean, go-no-go decisions.

Mr. ANDREWS. Has any contract been canceled because of campus unrest?

General BETTS. No; I do not know of any that have been affected in any significant way by campus unrest.

Mr. ANDREWS. How many contracts and grants at individual universities have been completed or terminated in the past year?

General Betts. I would have to furnish that, Mr. Chairman.
(The information follows:)

Approximately 170 have been either completed or terminated during the past year as reported July 1, 1968, through June 30, 1969.

IN-HOUSE LABORATORY INDEPENDENT RESEARCH

Mr. Andrews. Now we will talk about in-house laboratory independent research. You are requesting $11.6 million in fiscal year 1970 for in-house laboratory independent research. This compares with $11,580,000 programed for fiscal year 1969, and $11,818,000 for fiscal year 1968.

How is this effort managed? Do you require reports from the in-house laboratories on their efforts in the independent research program?

Mr. Poor. We manage the in-house independent laboratory work out of my office. Each year the program accomplishments during the prior year are reviewed by a group of peer judges as nearly as we can provide them.

Mr. Andrews. Peer judges?

Mr. Poor. People who are experts in the various fields of activity, who are respected by the laboratory directors who, after all, are given this money to do work that they consider important and promising for the Army.

This review takes place on a set of reports submitted by each of the laboratories through General Betts to my office.

The committee that evaluated it this year consisted of: Dr. Emerson from our office. Dean Ralph Fadum, who is the No. 2 man on the Army Scientific Advisory Panel, the Deputy Chairman of it, and dean of engineering at North Carolina State. Dr. Thomas, who was then Director of Laboratories of AMC, Army Materiel Command. Dr. Quarles, who is Chief Scientist of the Corps of Engineers. Colonel Snead's predecessor, General Ostrom, Director of Army Research in OCRD. Colonel Plough, who was Deputy Commander of the Army Medical Service, R. & D. Command. And Dr. Tyrone Huber, who was from the Federated American Society of Experimental Biology.

We asked the review committee to recommend what level of funding should be allowed to each of these independent laboratory directors for the subsequent year. The funds are reallocated on the basis of those recommendations.

The general level of effort has been held constant because it was the concept in the beginning that we should have money available to allow the laboratory directors to undertake projects which seemed to be promising.

Mr. Andrews. The total has been constant?

Mr. Poor. The total has been essentially constant.

Mr. Andrews. Are the levels at each individual laboratory held constant?

SIGNIFICANT IN-HOUSE LABORATORY RESULTS

Mr. Poor. They are not. They are changed each year, depending on the results of the evaluation of the prior year and on the quality of their proposals for next year.

During the course of this program, we have gotten several really very significant kinds of advances, we think.

Mr. ANDREWS. I wish you would put some of them in the record.

Mr. POOR. I would be very happy to.

(The information follows:)

SIGNIFICANT ADVANCES FROM RESEARCH SUPPORTED BY THE ARMY IN-HOUSE LABORATORY INDEPENDENT RESEARCH PROGRAM

Laboratory name.—Harry Diamond Laboratory.

Project title.—Inductive proximity sensor.

Accomplishment.—A sensor responding to proximate metallic objects but not to poor conductors such as soil, foliage, and water was developed. The work resulted in a new method for near surface burst fusing of rounds in defeat of armor. Engineering development of the system will be carried out under a regularly funded development program. H. W. Kohler, the principal investigator received an outstanding achievement award at the 1968 Army Science Conference for this work.

Laboratory name.—Electronics Components Laboratory.

Project title.—Microwave materials for reciprocal phased arrays.

Accomplishment.—Requirements for reciprocal phase shifters operating at X-band are dependent upon temperature stable materials of specific critical characteristics and composition to improve device switching properties and losses. A titania-manganese substituted lithium ferrite composition has been prepared which meets all required properties. Samples are being prepared in the geometry necessary for actual device testing at X-band frequencies. This material represents a significant advance over materials now available. Reciprocal phase shifters are a key component in phased-array radar systems now under active development.

Laboratory name.—U.S. Army Tank Automotive Command—Physical Science Laboratory.

Project title.—Thin films research laser countermeasure.

Accomplishment.—A mirror system has been designed that will protect the human eye against laser radiation with the minimum restriction to the normal use of the vision device. This system uses all dielectric Fabrey-Perot type interference filters for the mirror element. The net effect of the mirror system is to mass all light except the laser wavelength. A computer program is presently in use to determine the optimum design in the filter elements for best system performance. Upon completion of the mirror element design, an experimental filter will be fabricated and tested.

Laboratory name.—Benet Research and Engineering Laboratories.

Project title.—Study of a technique for assessing accumulative fatigue damage.

Accomplishment.—Initial results of this investigation yielded an approximate fracture toughness calibration for the crack in a gun tube including the effects of the nominal stress state as well as the effects of gas pressure in the crack, utilising the fracture toughness distribution curve from as received tubes a life distribution curve was predicted which agreed well with experimental distribution curves. The theory also predicts the influence of test temperature on the distribution curve as well as the effects of yield strength of the material as both fracture toughness and yield strength are temperature dependent. Two important parameters (fracture toughness and yield strength) have been correlated with test temperature and tempering temperature. The latter being related metallurgically to the properties of the material. Through the efforts of a numerical program sponsored by this project the optimum regions for reduced crack propagation rates were determined and displayed automatically in a 3-D display. Thus the best mechanical properties for a given alloy to resist crack propagation can be readily and quickly determined once the effects of operating temperature and tempering temperature are known. This study has also been coordinated with Lehigh University and Case Western Reserve on a cooperative basis. The latter laboratories being interested in the experimental results and predictions of the Benet Research and Engineering Laboratories and the extensions of their theoretical studies through the utilization of the experimental results. One investigator is cooperating on the plastic zone effects at crack tips while the other is concerned with fracture toughness calibration from a theoretical viewpoint.

Mr. ANDREWS. It sounds as if you keep a pretty close check on them. Have you canceled out any because of inefficiency or slippage or any fault on the part of the researcher?

Mr. POOR. We have withdrawn money from individual laboratories and given it to other laboratories because of lack of promise of the work done at one laboratory and more promising work done at another. It is a reallocation.

Mr. ANDREWS. You try to reward efficiency?

Mr. POOR. Yes, sir.

Among the kinds of things that have come out that might interest you—and we will add detail for the record—are, for example, the design of a mirror system that can protect the eye against laser radiation, and an analysis which shows it is possible to build a 155-millimeter howitzer weighing as little as 8,000 pounds and still have it stable when it shoots, against the roughly 13,000 pounds of the current howitzer.

Mr. ANDREWS. That is most interesting.

I would like a statement for the record about what has come out of your college program.

(The matter referred to appears at page 135.)

Mr. POOR. Under the medical program in the in-house independent laboratory work, there was the development of a prophylactic paste which, when applied to young soldiers under 25 years of age, would arrest 80 percent of the tooth cavity lesions that could be expected and prevent approximately 60 percent of all cavities.

This is a significant thing because it can be applied to the young man in service and very substantially reduce the dental problems.

Mr. ANDREWS. Are you implementing any of those suggestions?

Mr. POOR. I believe at the Weapons Command, work is now being done to demonstrate the feasibility of this gun. It is very promising.

ALLOCATION OF FUNDS TO LABORATORIES

Mr. ANDREWS. How are these funds allocated? How was the $11,580,000 distributed in fiscal year 1969?

Mr. POOR. I would have to provide for the record the amounts given to each of the several laboratories. The method was to have this review committee recommend levels of funding for each of the laboratories based on their proposals and based on their last year's accomplishment.

(The information follows:)

Army in-house laboratory independent research program funding allocation for fiscal year 1969

Army materiel command	*1969 allocation*
Aviation Command: Aeronautical Research Laboratory	$45,000
Central laboratories:	
Ballistics Research Laboratories	800,000
Coating & Chemical Laboratory	20,000
Harry Diamond Laboratories	800,000
Human Engineering Laboratories	105,000
Materials and Mechanics Research Center	400,000
Natick Laboratories	380,000
Nuclear Defense Laboratory	100,000

Army in-house laboratory independent research program funding allocation for fiscal year 1969—Continued

Army materiel command	*1969 allocations*
Electronics command laboratories:	
Atmospheric Sciences Laboratory	$180,000
Avionics Laboratory	40,000
CS, NV, and TA Laboratories	185,000
Communications and ADPS Laboratory	136,000
Electronics Components Laboratory	250,000
Electronic Warfare Laboratory	10,000
Institute for Exploratory Research	295,000
Missile Command: R. & D. Laboratories	900,000
Mobility Equipment Command: Mobility Equipment R. & D. Center	90,000
Munitions Command:	
Picatinny Arsenal:	
Ammunition D. & E. Laboratory	60,000
Feltman Research Laboratory	470,000
Nuclear Engineering Laboratory	100,000
Frankford Arsenal:	
Ammunition D. & E. Laboratory	132,000
Fire Control D. & E. Laboratory	40,000
Pitman-Dunn Laboratory	195,000
Edgewood Arsenal: R. & D. laboratories	525,000
Biological Center: R. & D. laboratories	525,000
Tank and Automotive Command: R. & D. Laboratories	250,000
Test and Evaluation Command:	
Deseret Test Center	62,000
Tropic Test Center	35,000
White Sands Missile Range	95,000
Weapons Command:	
Benet R. & D. laboratories	800,000
Rock Island Arsenal laboratories	70,000
Chief of Engineers:	
Topographical Laboratory	90,000
Waterways Experiment Station	170,000
Terrestrial Sciences Center	80,000
Chief of research and development	
Behavioral Sciences Research Laboratory	95,000
Medical R. & D. Command:	
Aeromedical research unit	6,000
Institute of Dental Research	10,000
Biomedical Research Laboratory	44,000
Equipment and Development Laboratory	8,000
Research Laboratory (Ft. Knox)	14,000
Research and Nutrition Laboratory	73,000
Research Institute of Environmental Medicine	100,000
Surgical research unit	5,000
Walter Reed Army Institute of Research	1,180,000
Total	10,060,000

NOTE.—The difference of $1,520,000 between the total of $10,060,000 shown above and the $11,580,000 referred to in the testimony represents a statistical adjustment of Facilities and Installation Support money that was spread through the benefiting projects. No increase in the actual level of effort resulted from this statistical adjustment.

DISTRIBUTION OF ESTIMATE FOR INSTALLATION SUPPORT

Mr. ANDREWS. In the fiscal year 1969 budget, you requested $10,060,000 for in-house laboratory independent research. Through what reprograming process did you increase this amount to the $11,580,000 now shown?

Colonel JOY. That is nothing more than a statistical spread of the money that was originially in what we call, "Facilities and installa-

tions support," that was spread through the benefiting projects.

At this point in time, it is just an accounting procedure of what the money was originally for.

Mr. ANDREWS. You did not supplement that $10,060,000 that you got?

Colonel JOY. No, sir. In all military sciences there was an increase of approximately $11.4 million. It was a statistical adjustment of the money to installations.

Mr. ANDREWS. Does the $11.6 million requested for fiscal 1970 represent all of this in-house independent laboratory research set out in the justification book, or is it something else?

Colonel JOY. That would be for the work going on in the laboratories, and includes the pay of the personnel, which was originally carried before under "Facilities and installations support."

Mr. PRESTON. You changed the category definition in fiscal year 1970 and readjusted the prior year figures so they could be comparable?

Colonel JOY. Yes, sir; to make 1968 and 1969 comparable to 1970.

Mr. POOR. There is no requested increase in this budget.

Mr. ANDREWS. In the fiscal year 1969 justifications, you show an estimate for fiscal year 1968 in this area of $10,340,000. This year's justification shows actual amount for fiscal year 1968 to be $11,818,000. Describe the reprograming process by which this program was increased by $1.5 million, or more than 10 percent.

Colonel JOY. That is the same statistical adjustment, to make all 3 years comparable with 1970, sir.

SIGNIFICANT ADVANCES IN IN-HOUSE LABORATORY RESEARCH

Mr. ANDREWS. What technology developed under the in-house laboratory independent research program has been applied to Army weapons systems or equipment developments in the past year?

General BETTS. Mr. Poor spoke about that in speaking of the artillery weapons design item. That is one of the things that came out of the in-house laboratory effort.

The mirror approach to protecting the eye from laser was another.

Mr. ANDREWS. You may add some more. This is very interesting and useful.

(The information follows:)

SIGNIFICANT ADVANCES FROM RESEARCH SUPPORTED BY THE ARMY IN-HOUSE LABORATORY INDEPENDENT RESEARCH PROGRAM

Laboratory name.—Research and Engineering Directorate, Rock Island Arsenal.

Project title.—Study of an ultra lightweight 155 mm. Howitzer.

Accomplishment.—Sufficient analysis was conducted to verify the apparent technical feasibility of a stable 5,000 pound 155 mm. Howitzer. The current 155 mm. Howitzer weighs approximately 12,000 pounds. Work is now being done at the Army Weapons Command to actually demonstrate this feasibility.

Laboratory name.—Waterways Experiment Station.

Project title.—Study of an experimental wheel in the development and an analytical approach to ground mobility.

Accomplishment.—An experimental wheel was used to demonstrate that controlling pressure distribution in a pneumatic tire so as to make it favorable, i.e., increase from the leading edge toward the trailing edge of the contact area when running on deep, dry, sand, would yield 35 percent more pulling force than an unfavorable pressure distribution. These experiments indicate that it may be

possible to design a better wheel; one that would increase wheeled mobility by one-third, assuming that mobility is measured by amount of pull.

Laboratory name.—Institute of Dental Research.

Project title.—Effectiveness of zirconium silicate and tin zirconium hexafluoride.

Accomplishment.—Application of zirconium silicate-tin zirconium hexafluoride prophylaxis paste to Army personnel under 25 years has resulted in:

1. Arresting 80 percent of tooth cavities in development.
2. Preventing approximately 60 percent of tooth cavities that would result.

Laboratory name.—U.S. Army Medical Research Laboratory.

Project title.—The mechanism of erythrocyte aging.

Accomplishment.—A major step has been taken on prolonging the shelf life of blood banked for transfusion purposes in that the addition of trace quantities of Adenine, a naturally occurring substance in the human, will improve the quality, transportability, and shelf-life by factors approaching 100 percent. Adenine preserved blood is now being introduced into Vietnam.

DEFENSE RESEARCH SCIENCES

Mr. ANDREWS. You are requesting $85.5 million for fiscal year 1970 for Defense Research Sciences. This compares with $81.5 million programed in fiscal year 1969, and to $72 million in fiscal year 1968.

What is your justification for this approximately $4 million increase?

General BETTS. The cost of living, Mr. Chairman. That is actually less than what we consider to be the inflation factor in the cost of doing research. It represents no significant change in the level of effort.

ATMOSPHERIC SCIENCES

Mr. ANDREWS. Under Defense Research Sciences, you are requesting $4,780,000 for atmospheric sciences. What are the peculiar problems of the Army in this area? What are the objectives of your research in atmospheric sciences program?

Mr. POOR. There are several kinds of work in atmospheric sciences that are peculiar to the Army.

In meteorology, there is the matter of predicting the winds at very low levels in the region through which an artillery shell may fly in order to predict the effects of the winds on the shell flight path.

In the matter of command and control and steering of guided missiles, fire control devices, we are very much concerned with the behavior of light rays passing very close to the surface.

Differences in temperature and differences in wind structure can distort the light ray path.

We are much interested in propagation of light waves through the low-level atmosphere.

We are also concerned about obscuration, the effects of moisture, and this sort of thing, on the optically controlled devices.

We have a special interest in this area not well covered by the work of the weather bureau and other agencies that do work on atmospheric sciences in general.

Furthermore, for the dissemination of smoke and things like the incapacitating agents, one is very much concerned about the details of low-level wind patterns and how they change.

So, much of our work is in this kind of area.

General BETTS. An additional problem that all of the services face is that virtually all of our outdoor testing demands extensive instru-

mentation so one can relate from one test to the next in a precise way. Consequently, we do have interests in that aspect of the atmospheric sciences that relate to micrometeorology and the kind of instrumentation that one would need on the test range.

Mr. ANDREWS. What part of the atmospheric sciences research involves weather prediction?

General BETTS. We are not in the weather prediction business, Mr. Chairman. We do have a very direct interest in weather prediction, but we depend on work of the Air Force and the work of the Environmental Sciences Services Administration to supply it.

We are interested in the output from meteorological satellites. We have a representative who works in the joint office on the meteorological satellite program.

So, the Army's interest in this kind of technology is voiced, and we can draw from it as requirements may dictate.

Mr. ANDREWS. Where do you get your weather reports in South Vietnam?

General BETTS. I would have to confirm this, but I believe we get them from the Air Force weather central setup that they have within the theater. We have teams for special purposes, but the broad weather prediction functions, we look to the Air Force for that service.

We have some weapons systems that demand precise atmospheric observations right there at the firing point, like HONEST JOHN, for example, and for that kind of application we do have our own local observing capability.

LOCAL WEATHER PREDICTION NEEDS

Mr. ANDREWS. The descriptive summary describes one of the programs in atmospheric sciences as "prediction of local rainfall affecting trafficability and tactical operations." Of course, the weather bureau, the Air Force, the FAA, and a number of other Government agencies are involved in research in weather prediction. Why must the Army spend money in this area? What is unique about the Army's research in the area of weather prediction?

General BETTS. The Army is particularly sensitive to local weather conditions that affect mobility and specific operations. Research is directed to methods of observing atmospheric conditions in a local area or on a small scale not available from weather forecasting services such as the Air Force.

One Army research effort has been directed to the local measurement of rainfall with weather radar developed by the Army.

Mr. POOR. We certainly do not duplicate the Air Force.

As far as trafficability goes, the Army has the principal capability for the Nation in the business of the behavior of soils when they are wet by rain and disturbed by vehicles traveling over them.

I am not fully informed on the program you mentioned.

Mr. ANDREWS. What type of research are you doing under this program? Can you be a little more specific about it?

General BETTS. In the total program of atmospheric sciences, Mr. Chairman, or specifically with respect to the weather question?

Mr. ANDREWS. Atmospheric sciences.

General BETTS. I would go back to the opening remarks by Mr. Poor, that we must recognize that everything we do in the Army has some

problem with respect to the atmosphere, whether it be operations or the question of trafficability, whether it be local meteorological conditions that we have to take into account when we fire artillery or when we fire a rocket, or when we plan an air movement, we have to have an interest in this question.

We do not set up or try to duplicate the broad area weather prediction capability that is furnished to us as a service by the Air Force.

We do have studies that relate to small-scale meteorological phenomena, and here we are interested in what the experts call micrometeorology, where we are more concerned with immediate local weather questions, and not broad area weather questions.

The dynamic motion of the weather patterns in the immediate vicinity of an Army activity is of interest to us; forecasting in the sense that for military operations, Army operations, we have to interpret and apply locally the broad area predictions that we get from the Air Force.

We are interested in the atmospheric measurement techniques because they have to be applied at all of our test centers related to any outdoor testing that we do.

So, we are interested in instrumentation. We do not necessarily develop that kind of instrumentation ourselves, but we would need to buy it wisely if it is available that way, or go to our sister services for it if it is available there.

So, while this is a relatively small program, we have a clear and continuing interest in the climatological problems that apply to our field activities.

Let me give you an example of the sort of problem we get into. The Limited War Laboratory was given a requirement to find some means of extending the range of the jungle patrol radio that would not burden the poor man on patrol with additional weight. One of the solutions that they came up with was a balloon that would raise an auxiliary antenna up above the jungle. That seemed like a great idea. But the program actually floundered on our lack of knowledge within the Limited War Laboratory of the kind of meteorological conditions that one finds in the jungle.

We had assumed that this is rather dense foliage, not likely to be much in the way of surface winds, not likely to be much of a local meteorological problem. But it turned out there was.

Mr. ANDREWS. You have some unique problems in Southeast Asia. I do not think any of your sister services nor the Weather Bureau would be of any help to you. What you do down there you have to do yourself.

General BETTS. That is just the point.

ATMOSPHERIC SCIENCES LABORATORY

Mr. ANDREWS. How many personnel are involved in the Atmospheric Sciences Laboratory of the Army?

General BETTS. I would have to supply that, Mr. Chairman.

Mr. ANDREWS. How many military personnel are assigned there?

General BETTS. I would have to supply that.

Mr. ANDREWS. How many civilian personnel are employed? How many contractor personnel are associated with this laboratory?

Supply that for the record.
(The information follows:)

PERSONNEL AT THE ATMOSPHERIC SCIENCES LABORATORY

The Atmospheric Sciences Laboratory includes two elements of authorized personnel, those conducting the atmospheric R. & D. program and those providing specialized meteorological team support to R.D.T. & E. program throughout the Army.

ATMOSPHERIC SCIENCES PERSONNEL (INCLUDING ON HAND)

	Officer	Warrant Officer	Enlisted men	Civilian	Contract
Research and development:					
Authorized	7	1	26	163	(1)
On hand (July 1)	6	0	35	160	0
Team:					
Authorized	14	6	493	82	(1)
On hand (July 1)	8	5	370	82	65

[1] Not applicable to contract personnel.

ATMOSPHERIC MODIFICATION

Mr. ANDREWS. What part of the requested $4.8 million will be spent on "new approaches to atmospheric modification" which is listed in the descriptive summary on page 24 as a part of your fiscal year 1970 planned program?

General BETTS. I would have to supply that, Mr. Chairman.
(The information follows:)

It is planned to spend $300,000 for new approaches to atmospheric modification in fiscal year 1970. Techniques for modifying clouds at temperatures below freezing are known. Some work is required to develop methods of operation for a mobile Army.

The most important problem of interest to all military services in the interest of visibility is that of modifying warm clouds at temperatures above freezing. A major portion of this work is being performed jointly with the Air Force and the Navy utilizing know-how and facilities of each. Two approaches are being investigated:

a. A search for new materials that would stimulate clearing of a warm cloud.

b. Development of mechanical methods for disbursing a warm cloud such as the Army's idea of blowing it away with the downwash from a helicopter.

From Army applications, the operational methods used must be effective without the necessity for a fixed station installation.

FACILITIES INVOLVED IN ATMOSPHERIC SCIENCES RESEARCH

Mr. ANDREWS. How much of the research in atmospheric sciences will be done inhouse?

General BETTS. I have that number in front of me. It is about 50-percent in-house, and 50-percent contractual.

Mr. ANDREWS. Where will the atmospheric sciences research be performed?

General BETTS. As indicated, in-house and with industry and universities.

Mr. ANDREWS. List the major in-house facilities and the principal colleges and universities and contractors involved in this effort.
(The information follows:)

Atmospheric research under the defense research sciences program is principally performed by the Atmospheric Sciences Laboratory. Elements are located at Fort Monmouth, N.J.; Fort Huachuca, Ariz.; and White Sands Missile Range, N. Mex. In addition, one part of the program, Aeronomy, is accomplished at the Ballistics Research Laboratory, Aberdeen Proving Ground, Md., and another part, missile climatology, is performed by the Missile Command, Redstone Arsenal, Ala. A branch of the Army Research Office at Durham, N.C., supervises a small contract effort.

The principal colleges or universities and contractors involved in this program are:

College/University	*Contractor*
University of Delaware	Sperry Rand, Inc.
University of Maryland	Travelers Research
University of Wisconsin	Stanford Research Institute
University of Wisconsin	Aracoon
University of St. Thomas	
University of Washington	
University of Illinois	
New York University	
University of Miami	
Texas A&M University	
Columbia University	

In addition facilities of the Department of Agriculture, National Bureau of Standards, and the Environmental Science Services Administration are utilized through the direct transfer of funds.

BIOLOGICAL AND MEDICAL SCIENCES

Mr. ANDREWS. You are requesting $22.4 million for research in biological and medical sciences.

In past years we have discussed the program directed at finding a preventive medicine for resistant strains of malaria which had been encountered in Southeast Asia. It is understood that for the most part, this effort has been a success.

Was the effort in this area funded through this program or through your exploratory development program in the same area?

Colonel SNEAD. The malaria program was in the advanced development, the 6.3 program element.

Mr. ANDREWS. And not through this program?

Colonel SNEAD. Not through this program.

FACILITIES ENGAGED IN RESEARCH

Mr. ANDREWS. With how many colleges and universities do you fund grants or contracts in this area?

General BETTS. We have 155 contractors involved. I would have to dig out which are universities.

Mr. ANDREWS. Put something in the record about it.

General BETTS. All right, sir.

Mr. ANDREWS. Are most of these contracts with medical schools?

General BETTS. I would have to supply that.

Mr. POOR. With medical schools, drug companies. It is not all medical schools, by any means.

Mr. ANDREWS. Drug companies?

Mr. POOR. Yes. Business firms such as Pfizer, Parke, Davis, and so on, for work on various kinds of chemotherapy.

(The information follows:)

The following universities, colleges, nonprofit organizations, and commercial laboratories are involved in malaria research:

Academic

Columbia University, New York, N.Y.
Georgia State College, Atlanta, Ga.
Hebrew University, Jerusalem, Israel
Indiana University Foundation, Bloomington, Ind.
Instituto Brasileiro De Tropicologia Medica, Rio de Janeiro, Brazil
Liverpool School of Tropical Medicine, Liverpool, England
Medical College of South Carolina, Charleston, S.C.
Michigan State University, East Lansing, Mich.
New York University Medical Center, New York, N.Y.
Ohio State University, Columbus, Ohio
Old Dominion College, Norfolk, Va.
Princeton University, Princeton, N.J.
Reed College, Portland, Oreg.
Stanford University, Palo Alto, Calif.
Texas A & M University, College Station, Tex.
The Research Institute of Temple University, Philadelphia, Pa.
University of Alabama, Birmingham, Ala.
University of Arizona, Tucson, Ariz.
University of California, Riverside, Calif.
University of Chicago, Cincinnati, Ohio
University of Colorado, Boulder, Colo.
University of Florida, Gainesville, Fla.
University of Georgia, Athens, Ga.
University of Maryland, College Park, Md.
University of Manila, Philippine Islands, Philippines
University of Miami, Coral Gables, Fla.
University of Michigan, Ann Harbor, Mich.
University of Minnesota, Minneapolis, Minn.
University of Missouri, Columbia, Mo.
University of the Pacific, San Francisco, Calif.
University of Pennsylvania, Philadelphia, Pa.
University of Rhode Island, Kingston, R.I.
University of Tennessee, Memphis, Tenn.
University of Texas, Austin, Tex.
University of Virginia, Charlottesville, Va.
Vanderbilt University, Nashville, Tenn.
Virginia Polytechnic Institute, Blacksburg, Va.
West Virginia University, Morgantown, W. Va.

Other:

Advanced Computor Techniques Corp., Arlington, Va.
Aerojet-General Corp., Sacramento, Calif.
Aldrich Chemical Co., Inc., Milwaukee, Wis.
Aldridge and Associates & Co., Inc., Washington, D.C.
Arthur D. Little, Inc., Cambridge, Mass.
Ash Stevens, Inc., Detroit, Mich.
Beth Israel Hospital, BIMC, New York, N.Y.
Bionetics Research Laboratories, Inc., Falls Church, Va.
Childrens Cancer Research Foundation, Inc., Boston, Mass.
Colgate-Palmolive Co., Inc., Piscataway, N.J.
Collaborative Research, Inc., Waltham, Mass.
Computer Research, Rockville, Md.
Computer Usage Development Corp., Washington, D.C.
Dow Chemical Co., Midland, Mich.
Eltra Corp., Brooklyn, N.Y.
Esso Research & Engineering Co., Linden, N.J.
Food & Drug Research Laboratories, Inc., Maspeth, N.Y.
Gorgas Memorial Institute, Washington, D.C.
Gulf South Research Institute, New Orleans, La.
Hazelton, Laboratories, Inc., Falls Church, Va.
Herner & Co., Bethesda, Md.
Huntington Research Center, Inc., Baltimore, Md.
Hynes Chemical Research Corp., Durham, N.C.
IIT Research Institute, Chicago, Ill.

Insect Control & Research, Inc., Baltimore, Md.
Institute of Drug Design, Inc., Sierra Madre, Calif.
International Minerals & Chemical Corp., Libertyville, Ill.
Medical Pathology, Institute of Genoa, Italy
Midwest Research Institute, Kansas City, Mo.
Monsanto Research Corp., Everett, Mass.
Mount Zion Hospital & Medical Center, San Francisco, Calif.
New England Nuclear Corp., Boston, Mass.
Parke, Davis & Co., Ann Harbor, Mich.
Pfizer & Co., Inc, New York, N.Y.
Philco-Ford Corp., Newport Beach, Calif.
Research Triangle Institute, Durham, N.C.
Research Triangle Institute, Triangle Park, N.C.
Service Bureau Corp., Wheaton, Md.
Southern Research Institute, Birmingham, Ala.
Southwest Research Institute, San Antonio, Tex.
Standard Pharmacol Corp., Elgin, Ill.
Starks Associates, Inc., Buffalo, N.Y.
Stanford Research Institute, Birmingham, Ala.
Sterling-Winthrop Research Institute, Rennsalaer, N.J.
Virginia Institute for Science Research, Richmond, Va.

Mr. ANDREWS. To what extent is this basic research effort general, and to what extent Army oriented?

General BETTS. I think it is medical activity that we can specifically relate to Army problems in detail, but as is generally true of all medical problems, it has direct relevance to the civilian economy, although one must say in this country, while we put a great deal of emphasis on malaria, that does not return very heavily in the continental United States. It certainly does for people who contract malaria.

Mr. ANDREWS. If you can do anything to alleviate the malaria problem over in South Vietnam and help these young men who are over there in those jungles, it is the finest money you can spend.

General BETTS. I think the record of malaria cases in Vietnam applies to the kind of program we have here. In 1967 among army troops, there were 9,100, with 11 deaths.

In 1968, 8,600, with 15 deaths.

Through the first half of calendar year 1969 3,100 cases with 2 deaths have been reported.

That shows we are making some progress. We still have a long way to go.

Mr. ANDREWS. What about these young men who go over there and contract malaria, who think it is arrested, and then they come back over here and have a relapse?

General BETTS. The numbers I have here with respect to malaria cases initially diagnosed in U.S. hospitals from Vietnam returnees, are that in 1967 we had 2,000 such cases, and in 1968 that had dropped to 1,600. Even there, we are making some progress from these liimted statistics.

Mr. SIKES. How much of the $22.4 million that you are requesting for biological and medical sciences will be spent in Army medical laboratories?

General BETTS. A little more than half, Mr. Chairman, $12.9 million out of a total of $22 million.

Mr. POOR. I would like to say that the Army in-house laboratories in this case control in detail the spending of all the money. The medical program is a beautiful self-organizing program. The Army Medi-

cal Service is made up of competent professionals who can stand in any medical faculty anywhere in the world. They control the program in detail. We are extremely proud of their management of this program. I think we can be well pleased with it.

One area we did not cover very much is the epidemiological work, in the tropics in particular, which the Army medical service has been sponsoring. It is not just malaria. It includes diseases like hemorrhagic fever, filariasis in Thailand, and work of this sort. The work has been something of which I think we should be very proud over the years, and we hope next year's will be just as good.

Mr. SIKES. You certainly have some outstanding accomplishments, and the committee commends those responsible for it.

Do you attempt to attain a level annual effort in this area at participating Army research and development facilities?

General BETTS. We try to hold a fairly constant level of effort, although, as you recall, when we got into the malaria problem a few years ago, we made a rather significant increase in that particular activity.

BEHAVIORAL AND SOCIAL SCIENCES

Mr. SIKES. Under behavioral and social sciences, you are requesting $1.7 million. This compares with $1.4 million allocated in fiscal year 1969, and $1 million in fiscal year 1968. Why should there be an increase at this time?

General BETTS. In general, our total program in the behavioral and social sciences, if we add all of the effort in the several categories of the program, has been fairly constant, but there has been some increase in the recent past.

As in all of our programs, we are faced with about a 5- or 6-percent cost growth per technical man-year.

I would like to exand that for the record, if I may, to identify this particular change from $1.4 milion to $1.7 million.

(The information follows:)

The increase is an attempt to strengthen and augment the basic behavioral sciences research supporting technology necessary for more effective applied research on military problems. $260,000 of the increase is for strengthening in-house capabilities. The remainder will go to contract effort. The increase is consistent with the increase in requirements for exploratory and advance development.

REDUCED FUNDS ALLOCATION IN 1969

Mr. SIKES. The fiscal year 1969 estimate for behavioral sciences was $2.1 million, but only $1.4 million was actually allocated. What effort was eliminated by the fund reduction?

Colonel SNEAD. This actually resulted primarily in the redistribution of the money and a stretchout of the work.

Mr. SIKES. What was the effect of the stretchout?

Colonel SNEAD. Specific knowledge in some of the areas of behavioral science that we had hoped to have to feed into our training programs and selection programs is not as complete at this time as we had programed for under the original submission.

No major items were cut out of the program. It was a stretchout.

Mr. SIKES. Would you detail in what programs specifically the reductions were made?

Colonel SNEAD. I can do that for the record.
(The information follows:)

In behavioral science research, the following efforts were carried out in fiscal year 1969 at an effort below that planned when the $2.1 million was requested: (*a*) Applicability of social and behavioral science research to U.S. Army activities in the developing countries, (*b*) intercultural communication.

In other areas, the basic research on psychological responses as indicators of impending changes in human performance conducted by the U.S. Army Behavioral Science Research Laboratory was not accelerated as planned because of this reduction.

Planned increase could not be made in the research on the prediction of psychological stress effects carried out by the U.S. Army human engineering laboratories. Several proposed new investigations on human capabilities were not initiated at those laboratories.

At the U.S. Army Natick laboratories, the proposed expansion of basic research on taste, flavor, and sensory and metabolic factors influencing food and water consumption was dropped.

CONTINUING OF DELAYED PROJECTS

Mr. SIKES. To what extent have programs which were delayed or deleted from the fiscal year 1969 program been carried forward into fiscal year 1970, and to what extent will you expect to catch up on the delays?

Colonel SNEAD. I will provide that for the record.

General BETTS. I think we will have to supply that.

(The information follows:)

The research on the prediction of psychological stress and the research on basic sensory factors influencing food and water consumption are both important subjects with high potential payoff. These will both be accelerated in fiscal year 1970. We have lost approximately 1 year in each program. The two behavioral science research efforts mentioned above were carried out in fiscal year 1969 at approximately two-thirds the level of effort originally desired. It is now planned to continue them into fiscal year 1970 at a reduced rate. In essence, we will not be able to catch up. They will be completed at a later date than the requesting agencies desire.

FUNDING PROGRAM FOR 1970

Mr. SIKES. What new contracts are proposed in this area in fiscal year 1970?

General BETTS. There are no major new efforts. I would have to supply the full detail.

Mr. SIKES. Please submit for the record at this point a list of the studies in the area of behavioral and social sciences which are planned for fiscal year 1970, the fiscal year 1970 cost of each program, and the level of funding of each in the previous 2 fiscal years.

(The information follows:)

The studies and the cost of the programs planned for fiscal year 1970 and the funding for fiscal year 1968 and 1969 are as follows:

BEHAVIORAL SCIENCE (HUMAN FACTORS) BASIC RESEARCH PROGRAM

Research in taste, flavor, and food acceptance.
Research on factors influencing human capabilities.
Research on human performance.
Research in learning.

Funds	*Thousands*
Fiscal year 1968	468
Fiscal year 1969	859
Fiscal year 1970	1,076

SOCIAL SCIENCE BASIC RESEARCH PROGRAM

Research on analysis of subversive warfare.
Research on PSYOPS and civil affairs functions.
Research on foreign military environments.

Funds	*Thousands*
Fiscal year 1968	270
Fiscal year 1969	550
Fiscal year 1970	624

TASTE, FLAVOR, AND FOOD ACCEPTANCE RESEARCH

Mr. SIKES. You have a continuing program of basic research in "Taste, Flavor, and Food Acceptance." This is an in-house program. What knowledge do you consider has been gained from this effort in the past year?

General BETTS. That effort is designed primarily to provide us the kind of capability we need on a continuing basis as we come up with new food ideas, to check them out very early in the cycle before they are put into larger tests.

I do not know of any great advances that I could identify from this effort, but it is a necessary part of food development.

Mr. SIKES. Do you think the program is worthy of continuation?

General BETTS. Yes, sir. We do need the capability so we can apply in a disciplined way the expertise to the question of taste and acceptance.

Mr. SIKES. There is an increase in this area. Why is that necessary? Provide a breakdown on that for the record.

General BETTS. All right, sir. I will have to supply that.

Mr. SIKES. Also show for the record how the fiscal year 1970 effort compares with that of the previous 2 fiscal years.

(The infomation follows:)

The program is a relatively new one and has already shown promise of interesting new discoveries. For example, preliminary work has shown that saccharine, previously thought to affect nothing but taste, may produce metabolic changes usually associated with eating of actual food. Other preliminary results have shown the possibility of salt-sensitive nerve endings in the liver of some animals; if this should be confirmed in humans, our entire thinking about the mechanisms regulating food intake will change sharply. This small research effort is breaking new ground; it is discovering promising new knowledge in an area where knowledge is meager. We need to exploit this initial success in an area having important potential consequences for the extensive DOD food program. The following is a listing showing how fiscal year 1970 effort compares with that of the previous 2 fiscal years.

Research work unit	Fiscal year 1968	Fiscal year 1969	Fiscal year 1970
Sensory and metabolic interactions regulating food and water intake	$7,000	$18,000	$35,000
Chemoreceptors in appetite regulation	8,000	18,000	25,000
Human psychophysical response to chemical taste stimuli	5,000	16,000	20,000
Basic mechanism regulating human appetite and hunger		10,000	20,000
Total	20,000	62,000	100,000

BEHAVIORAL SCIENCE RESEARCH LABORATORY, ARLINGTON, VA.

Mr. SIKES. Describe the U.S. Army Behavioral Science Research Laboratory in Arlington. Where in Arlington is it located?

General BETTS. It has its offices in a building in Rosslyn. It was over in a temporary building just outside of Fort McNair until the recent past.

Mr. SIKES. How many military personnel and how many civilian personnel are associated with it?

General BETTS. We have 10 military total, of which four are officers and six are enlisted. We have 107 civilians. Sixty-nine are professionals.

Mr. SIKES. What contractor personnel are associated with this laboratory?

General BETTS. These are all in-house people, and they do very little contracting from the Behavioral Science Laboratory as such, other than contracting to support their in-house programs. It is not a center for the management of contracts.

Mr. SIKES. What is the annual operating cost?

General BETTS. It was $2.66 million in fiscal year 1969, and $2.8 million is programed for fiscal year 1970.

Mr. SIKES. How long has the laboratory been in existence?

General BETTS. In one form or another, since right after World War II.

Mr. SIKES. Describe the work done there.

General BETTS. If I might correct that, I am told in its basic form it goes all the way back to World War I. You recall yesterday I said that this is the center for analysis of the testing program for soldiers.

(Off the record.)

(The information follows:)

The work done there is in three categories as follows:

Selection Research includes personnel selection, classification, behavior evaluation involving unusual demands on individuals, groups, systems; personnel systems research relating factors such as manpower requirements, individual differences, to systems effectiveness.

Human Performance Research in command information processing systems, monitor performance, controller performance, night operations, computerized manpower systems, manpower operations.

Surveillance Systems, Image Interpretation Research studies factors influencing image interpreter performance, tactical image interpretation teams. Supports Army, DOD efforts to develop practicable tactical image interpretation system.

UNIVERSITY PROGRAM

PROJECT THEMIS

Mr. SIKES. Under the university program, there is a request for $12.2 million for fiscal year 1970. The justifications indicate that $10,579,000 was allocated in fiscal year 1969. In the conference report on the Defense Appropriation Act of 1969, the conferees were in agreement, and so stated in the report, that not to exceed $8,809,000 should be available to the Army for Project THEMIS. It is my understanding you allocated $10,569,000. Why was that, in view of the limitation?

Dr. HERSHNER. More than THEMIS is included under university programs in 1969.

Mr. SIKES. How much is included for THEMIS?

Dr. HERSHNER. THEMIS was funded at a level of $8,809,000.

Mr. SIKES. How much of the $12.2 million for fiscal year 1970 is for the THEMIS program?

Dr. HERSHNER. $10.2 million.

Mr. SIKES. How many active THEMIS projects did the Army have in fiscal year 1968?

General BETTS. In 1968, sir, we had 15 renewals, one from ARPA that we took over and renewed, and 13 new Army projects.

Mr. SIKES. How many in fiscal 1969?

General BETTS. In 1969, we had 27 renewals and eight new ones.

Mr. SIKES: And how many are proposed in fiscal year 1970?

General BETTS. We would expect to add eight new projects or reach a total of 43 over a 4-year period.

Mr. SIKES. At this point in time, can the Army demonstrate any tangible use in Army weapons systems or equipments, of technology from the THEMIS program?

Colonel SNEAD. Yes, sir; we can.

Mr. SIKES. What are they?

Colonel Snead. Two specific examples

The Stevens Institute of Technology work on cryogenics or extreme low temperature has provided information that permitted the modification of a nuclear reactor at the Army Materiel and Mechanics Research Center that allowed an increase in the neutron flux. This materially reduced the time necessary to examine the effects of such radiation on structural materials.

This, of course, is an indirect contribution to Army materiel, but a very important one.

The University of Missouri had done some very important work in the interactions of what is described as polyatomic molecules. This has been applied very usefully in analyzing the reactions that take place in rocket propulsion engines, and it is expected to play a very important role in optimizing the design of rocket engines.

We can provide others for the record.

(The matter referred to appears on p. 111.)

In general, on Themis, and particularly for those that started in the first and second year, the 1967 and 1968 starts, the evaluators have rated 137 of the papers and technical reports that have come out of this as being highly significant and relevant to Army requirements.

SIGNIFICANT RESULTS OF THEMIS PROGRAM

Mr. SIKES. 137 out of how many?

Colonel SNEAD. I do not have the total, sir. There is a large number of interim reports. These are reports that would present substantive findings or conclusions.

Mr. SIKES. That is the only kind that you can justify.

The question is: Are you getting your money's worth out of the program? I do not have the total number, but if the percentage is low of usable and useful ones, then it is hard to say the project is justifiable.

Colonel SNEAD. This is 137 judged as highly significant out of 29 contracts for those 2 years.

Mr. SIKES. I want the total number of papers and reports, et cetera, that were submitted.

General BETTS. We will supply that, Mr. Chairman.

(The information follows:)

Total number of presentations or publications by universities with Themis contracts starting in 1967 are listed below by category:

Papers presented at meetings, seminars	156
Journal papers published	71
Journal papers accepted for publication	45
Technical reports/memorandums published	119
Total, 1967	391

Total number of presentations or publications by universities with Themis contracts starting in 1968 are listed below by category:

Papers presented at meetings/seminars	26
Journal papers published	9
Journal papers accepted for publication	9
Technical reports/memorandums published	19
Total, 1968	63
Two-year total of papers and reports	454

Mr. SIKES. And any comments you want to add on the usefulness and value of the program.

General BETTS. Our overall assessment of the Themis program is that it supports research effort of a quality comparable to that of the general program for support of research.

Mr. SIKES. I have felt it is a useful program. I am not criticizing or condemning the program. But I would feel better if I had significant justification which I trust you can supply.

(The information follows:)

Project Themis is intended to provide new opportunities for defense-related research programs at universities that were not heavily engaged in research relevant to the Department of Defense. At the time this program was initiated, funds for support of the program were diverted from other Army research efforts.

Through this program the Army has been provided an opportunity to broaden its scientific base through the use of university talent and ideas. The program therefore provides balance and must be retained in order not to jeopardize our technological base.

Our management of the Themis program is designed to put the technical administration at the Army laboratory level. This assures the speedy transfer of scientific information and guidance by knowledgeable experts to these new centers of excellence. We believe that the Army has a special competency to accelerate a significant buildup in the development of more universiity centers of excellence with subsequent national advantages beyond Army needs.

The Army has obtained some significant benefits in the form of expert consultants, bringing an awareness to graduate students of Army problems, and a number of reports that have enhanced our overall technological base. The momentum of this program should be maintained if the Army's investment in funds and technical manpower in Project Themis is to show significant dividends.

JOINT SERVICES ELECTRONICS PROGRAM

Mr. SIKES. I would like to have a discussion of the joint services electronic program, which is also included under the university program. In other words, what is it, what are its objectives, and what are some of the results?

Mr. POOR. Dr. Hershner can report on that.

Dr. HERSHNER. The general objective of this program, sir, is to provide a broad base in the scientific area of electronics.

More specifically, in the 1970 program we plan research in solid state electronics and materials, quantum electronics and optics; microwave, plasma and ionized gas dynamic phenomena, communica-

tions and information theory and processing; and electronic networks and systems techniques and theory.

Anticipating a question, I have selected three accomplishments from last year that I would like to put into the record.

Mr. SIKES. We will be glad to have them.

Dr. HERSHNER. In prior years, as you know, we have had some very significant accomplishments. In fact, the laser concept came out of this program in the early days.

More specifically, for last year we have constructed the first visible, tunable, continuous wave optical parametic oscillator using an argon laser and a lithium niobate crystal in the oscillator, which is important to military laser communications and surveillance R. & D.

The second accomplishment: A semiconductor device of cobalt, gold, and zinc compensated silicon that may result in new infrared detectors capable of operating at room temperature was developed.

The third one: The University of Illinois developed a plasma display panel which was selected as one of the outstanding inventions in the area of electronics in the past year by the magazine Industrial Research.

Mr. SIKES. Thank you very much.

Supply additional information for the record, if you wish.

General BETTS. We do not mean to try to confuse you with too much technology.

Mr. ANDREWS. You are.

General BETTS. That is why I spoke up. The real contribution of laser to communications has yet to be realized, but when we get up into the frequencies that are involved with lasers, it is apparent that we have a wide band of frequencies available that will permit many channels to be applied on these communication links far beyond anything we can do in the much lower frequencies that are associated with the present communications spectrum. That is an important contribution.

If you look at some of our infrared detectors that we use now in the growing program of night vision, one of the most difficult things to do is to cool down the elements to the temperatures where it will operate effectively. If this new technology will permit that to be done at room temperature, it will make a major contribution to reducing complexity and costs.

These are significant steps forward.

(Off the record.)

CONTINUATION OF CONTRACTS AND COSTS—THEMIS PROJECT

Mr. SIKES. How much money would be required for the university program for fiscal year 1970 if no new agreements were entered into under Project Themis? How much money would be required to continue the ongoing Themis projects? Provide that for the record.

(The information follows:)

The university program includes Project Themis and the joint services electronics program. Funds planned to support these two in fiscal year 1970, if no new starts were entered into under Project Themis, are $9,210,000.

Funds required to continue the present ongoing Army monitored Themis projects are $7,210,000.

Mr. SIKES. Spell out for the record any adverse effects which you anticipate on the military capabilities of the Army if the plan of expension toward 43 Army-monitored Themis projects should be reduced to the 27 contracts now in being.

(The information follows:)

The Army presently has 35 assigned Themis projects. Failure to provide for eight Project Themis new starts, unless the research is obtained through other means in defense research sciences, would reduce the Army basic research program balance. The impact would not be as much in the immediate loss of new technology as in the long-range effect.

NEW THEMIS STARTS

Mr. SIKES. It was proposed that new starts in fiscal year 1969 Themis projects would be signed by June 30, 1969. What new start Themis projects were signed as of that date? Do you have that?

Colonel SNEAD. I do not have that.

Mr. SIKES. Provide it for the record.

(The information follows:)

The Army has eight new start Themis projects. Contracts signed on or before June 30, 1969, are as follows: University of Rhode Island, "Photo-Electronic Imaging"; University of Kentucky, "Electrochemical Processes"; Rensselaer Polytechnic Institute, "Digital Signal Processing"; Virginia Polytechnic Institute, "Mechanics in Vehicular Structures"; Illinois Institute of Technology, "Sensitivity of Structural Metals"; William Marsh Rice University, "Remote Sensing of Gamma-Ray Signature."

One new start at the University of Hawaii School of Medicine, "Vector-Borne Diseases," is expected to be signed on or about July 15, 1969.

One new start at the University of Missouri, Rolla, "Mechanisms of Rock Response," is expected to be signed on or about July 15, 1969.

Mr. SIKES. Very well, gentlemen. Thank you very much.

The committee will resume its discussions at 10 o'clock Monday.

MONDAY, JULY 7, 1969.

Mr. MAHON. Mr. Secretary, other responsibilities in connection with the Appropriations Committee have kept me out of the hearing room some of the time during your appearance here.

Mr. POOR. I appreciate that.

Mr. MAHON. So I am not thoroughly familiar with all of the testimony which you and General Betts and the other witnesses have given. We will now discuss exploratory development.

EXPLORATORY DEVELOPMENT

INCREASED FUNDING FOR AUTOMATIC DATA PROCESSING RESEARCH

I note in fiscal 1968 the figure for "Exploratory development, information processing" was $2,970,000. The estimate went up about a million in fiscal 1969. Your estimate for fiscal 1970 is up another million. Why the escalation of a million dollars a year in this program?

General BETTS. This program is made up of many small items, Mr. Chairman, and each of these has experienced an increase as we project them forward. For example, the project for study of techniques in automatic data processing proposes an increase of $130,000, and that is due to a change in the accounting procedures for overhead costs, and also to accommodate partially the 1969 civilian pay increase. The net effect of that is that although we show a dollar-increase there will

really be no increase in level of effort. All of this work is in-house.

Mr. MAHON. We have before us a list of the various projects, and you have mentioned the automatic data processing techniques. Our records show what the trend has been. I see here under information data exchange the trend has been downward. How do you explain that: $390,000, $230,000, $160,000. Who is qualified to speak to that?

General BETTS. I have worked up the information on increases, Mr. Chairman. I do not have the information immediately available on that decrease.

Mr. MAHON. What about the Colonel behind the Secretary?

Colonel SNEAD. Sir, this does represent a tapering down in that particular part of the program.

Mr. MAHON. I have already pointed that out. It represents a tapering down in the actual work, done specifically under information data exchange. You will note that the engineering data information systems has had an increase so that the totals represent a fairly consistent level of effort.

General BETTS. It represents a change of our priority, Mr. Chairman.

Mr. MAHON. Is any of the research work done under the information processing program performed at posts other than Fort Monmouth?

General BETTS. Yes, sir. There is no question about it.

Mr. MAHON. Where is it performed? What is the relationship there?

General BETTS. I would have to research that, sir. I do not have a ready response here.

Mr. MAHON. Can you place that in the record?

General BETTS. Yes, sir.

(The information follows:)

The information processing program element 6.21.01.A consists of eight projects. The major effort for each project is conducted at the indicated Army installations or contractor plants:

Project No.	Project	Contractors
A327	ADP techniques	Fort Monmouth, N.J
A720	Technical information functions and activities	Jonkers Business Machines, Inc., Gaithersburg, Md.; Applied Data Research, Inc., Arlington, Va.
A726	Engineering data storage and retrieval	Picatinny Arsenal, N.J.
A727	Chemical information and data systems	Edgewood Arsenal, Md.; University of Pennsylvania, Pa.
A728	Technical information support activities	Savannah District Engineer, Georgia; Library of Congress, Washington, D.C.; Waterways Experimental Station, Vicksburg, Miss.; Edgewood Arsenal, Md.; Redstone Arsenal, Huntsville, Ala.; System Development Corp., Santa Monica, Calif.; Saunders & Associates, Long Island, N.Y.; Office of Education, HEW, Washington, D.C.; University of Indiana, Bloomington, Ind.
A729	Symposia, conferences, and meetings	Distributed throughout the United States.
A730	Information and data exchange	Frankford Arsenal, Pa.; University of Pennsylvania, Pennsylvania; Walter Reed Army Institute of Research, Washington, D.C.
A960	ADPS future armies	Fort Belvior, Va.; Fort Leavenworth, Kans.

In regard to the relationship between these performing activities and the nature of the project, those installations and activities with the technical capability were selected to meet Army requirements in a reasonable time frame.

Mr. MAHON. How much of the $4.8 million requested would be expended on contracts?

Mr. POOR. May we provide that for the record?
(The information follows:)

$2.2 million of the $4.8 million in the information processing program element would be expended on contracts.

(Clerk's note: Subsequent to the hearing, General Betts submitted the following statement for the record.)

The project on information data exchange includes the design, construction, and installation of a scientific and technical information network to serve as a test bed for experimentation in the exchange of data in support of the Army R. & D. program. The overall level of effort has been reduced in order to concontrate on the solution of the problems of interfacing communication networks with terminals and mechanized source data files through network programing, in other words, query, search, response, and handling routines. When these problems are resolved this fiscal year the information data exchange project will initiate the experimental exchange program, drawing on the engineering data system, the chemical data system and other mechanized technical data files at technical libraries and technical information analysis centers.

NEED FOR ADP INFORMATION SYSTEM

Mr. MAHON. Explain the need for development of the "Army Research and Development Information System (ARDIS)." How much has been spent on this effort to date and what is the total estimated cost of the ARDIS project?

General BETTS. To date the fund expenditure for ARDIS has been $1.396 million, of which about $800,000 has been for development and testing. The balance has been for the operation and maintenance of the system. The need for this system is explained more by the availability of modern data processing techniques than by any consideration that we have not always wanted to have a ready means of assembling the massive information from the data available to us in the total R. & D. program.

What we hope to get from this approach is a better management capability at our level of Government to pull information out from the working level on the details of R. & D. projects. We would expect to spend about $500,000 in the further development of this effort in the next 2 years, and we see the continuing operation and maintenance of the system to cost about $1.1 million per year.

Mr. MAHON. I wish you would elaborate for the record on the objectives of this effort.

(The information follows:)

The four major objectives of the Army research and development information system are to provide consistent guidance and the means for subordinate commands and agencies to submit information needed for R. & D. control at Department of the Army and higher levels; to provide Army scientists and engineers with ready access to the technical information required to support their work; to provide a mechanism for interface and exchange of data and information between the research and development program and other Department of Defense programs; to provide timely, relevant, accurate, and comprehensive information required by the Department of the Army Staff in managing Army R. & D. This system will assist Army R. & D. managers to assess alternatives, determine the impact of program changes, measure program cost/effectiveness, and provide a variety of information for their use.

INFORMATION PROCESSING SYMPOSIA

Mr. MAHON. Explain item A–729, "Symposia-conferences" for which you are requesting $190,000. Is the Army sponsoring symposia and conferences in the area of information processing?

General BETTS. We sponsor scientific and technical conferences involving the Army scientists and engineers in all fields of activity. In this case we would certainly have an interest in the exchange of technical information in this general field as well as we would with others; $150,000 of the total $190,000 is required to support annual symposia that we call the junior science and humanities symposia. These are several symposia. As a matter of fact, for example, in the last 6-month period, 16 of these regional junior science and humanities symposia were held in 13 widely separated States where students presented scientific papers in competition for the national symposia. I think this program has been very effective in encouraging young people in the general field of science, but more importantly, it has presented to them an image of the Army's interest in young people and their advancement in science.

Mr. MAHON. That does not have anything to do with the war in Vietnam?

General BETTS. No, sir; not directly. It has to do with our determination to continue a broad support of science that is related to ultimate military requirements. We also have a balance of $40,000 that is used to support scientific conferences such as the International Geographical Union Conference, other conferences on specific scientific topics of interest to the Army, laser development, materials development, across a whole spectrum of interest to the Army.

LACK OF INFORMATION ON PROGRAM

Mr. MAHON. What activities are funded with the $175,000 allocated for this purpose in fiscal year 1968 and the $180,000 in fiscal year 1969?

General BETTS. I would have to research that and provide it in detail, Mr. Chairman. But it is in general the kind of activity I have just described. The bulk of it goes for the junior science and humanities symposia. This has been a continuing program.

Mr. MAHON. General, you are painting here with a rather broad brush. Who knows very specifically and in intimate detail about these programs? Who administers these programs?

General BETTS. I have a scientist on the staff of the Director of Army Research who handles the details of the program. But the Director of Army Research is responsible for the general plan of support of the Junior Science and Humanities Symposia.

Mr. MAHON. What is the name of the scientist involved here?

General BETTS. I might ask Colonel Snead.

Colonel SNEAD. Dr. John W. Dawson is the principal one for the Junior Sciences and Humanities Symposia. Dr. John C. Hayes of the Army Research Office handles the overall program.

General BETTS. Dr. Dawson is in the ARO, Durham office.

SURFACE MOBILITY STUDIES

Mr. MAHON. With respect to Surface Mobility Studies, you are requesting $1.6 million. In the fiscal year 1969 budget, $2.6 million

was requested. The fiscal year 1970 justifications show that only $1,570,000 was actually programed in this area. What work which you had planned to carry out in this area was deleted from the program? Dr. Dawson might know. I doubt that you know.

CANCELLATION OF PREVIOUS YEAR'S PROGRAM

General BETTS. There was a major Combat Developments Command study that is a prerequisite to establishing what we call a Qualitative Material Development Objective, as well as the follow-on Qualitative Material Requirements, that dealt with mobility items for the future Army. That effort was not funded, and we did not do work in that general field. The contract work ceased under the project Vehicle Mobility Under Adverse Conditions, by the Army Tank and Automotive Command and the traffic mobility research under the Army Waterways and Experiment Station, except for a small program that we were able to continue at less cost than some of the in-house work that had been on-going. There was also a general slowdown on all facets of in-house work supported by this program element except for those that were related to Southeast Asia.

Mr. MAHON. These are rather low-priority programs and if you have to cut somewhere you reduce them, I assume.

General BETTS. You are well aware of the fact that as we go through the year and new requirements are placed on us, particularly as a result of our activities in Southeast Asia, the only place we have to turn to for funds is the kind of effort that is long term in nature, doesn't have early payoff, and therefore is of lower priority interest than some of the more immediate problems. Since we have no contingency moneys to turn to, we have to reprogram from these lower priority items.

FUNDING CUSHION BUILT INTO R. & D. FUNDING

Mr. MAHON. Is it sort of anticipated that when you make up the budget you put in sufficient funds for low-priority items to give you a cushion in the event of fiscal strain.

General BETTS. In effect, that is the way we do it. We structure our program in the best way we know how, and then call out the priorities so as the year goes on and we need money for higher priority items we take it from those.

TESTING OF VEHICLES

Mr. MAHON. Are any new off-road vehicles to be tested under surface mobility studies in fiscal 1970?

Supply that for the record.

(The information follows:)

This program element will support studies to improve the accuracy and reliability of procedures for predicting and evaluating off-road vehicle performance and experiments with thin airfield and road surfacing materials. Only one vehicle, the Lockheed Twister, will be subjected to military potential tests.

NUCLEAR INVESTIGATIONS

Mr. MAHON. With respect to nuclear investigations, you are requesting ——— million, in fiscal year 1970 as compared with $5,482,000

in fiscal year 1969. Do you propose to initiate any new projects in this area in fiscal year 1970?

General BETTS. The program element entitled nuclear investigation consists of nine separate projects divided between the Army Materiel Command and Corps of Engineers. Included within each of these projects are several tasks. This effort is continuing exploratory development and as such, new ideas are constantly being pursued and/or old ones displaced as they move to advanced development or are dropped. No new formal projects are planned for initiation; however, several new concepts such as amorphous semiconductors, fluidics, explosive logic, hybrid connectors, and penetration sensors, that have promising potential will be pursued.

Mr. MAHON. The fiscal year 1969 budget requested $8.5 million for nuclear investigations. As just mentioned, $5.5 million was actually allocated. What planned programs were deleted? Supply that information for the record.

(The information follows:)

Limited funding restricted technical support on the vulnerability of the ——— fire control system to the electromagnetic pulse (EMP) threat from nuclear detonations. Planned efforts to develop the data needed to guide the design of these systems so that they could be hardened to the EMP environment were deferred.

The development of techniques for hardening Army systems against the long range damaging effects of electromagnetic radiation was greatly impaired. Specifically, work on a transportable biconic antenna and associated instrumentation being developed for field simulation of EMP phenomena associated with high altitude nuclear bursts was delayed.

The study of the vulnerability of atomic demolition munition hardware to nuclear weapons effects was suspended.

Studies involving nuclear weapon command and control concepts such as the command arming device was deferred.

Funding levels in radiation detection and equipment were reduced to the point where meaningful progress in this area was not possible.

Applied research on radiation hardened components and subsystems was severely curtailed. Specifically, efforts on amorphous semiconductors, fluidics and explosive logic, techniques which have shown promise as being reliable, compact, and cheap alternatives to radiation-sensitive electronic components, were affected.

Purchase of critical components for the Tamden Van de Graaff facility being installed at Edgewood Arsenal, Md., were deferred, thus delaying the full-time operation of this multimillion dollar facility by over 8 months.

RESEARCH IN NUCLEAR POWER

Mr. MAHON. With all of the funds the Atomic Energy Commission is spending in the area of nuclear power, why must the Army maintain a $1,500,000 program in the area of "Exploratory research in nuclear power"?

General BETTS. The AEC has primary responsibility for research and development of the nuclear components in Department of Defense land-based nuclear powerplants whereas the Army is responsible for the development of all other parts of these plants such as heat exchangers, power conversion equipment, instrumentation, and so forth. Since its inception in 1954 this program has been a cooperative effort between the AEC and the Army. Funds in the Army program are also used to investigate the feasibility of applying the unique properties of nuclear power to specific service requirements. Examples are reactors

for remote locations (SM–1A in Alaska and PM–3A in Antarctica) and floating nuclear powerplants (MH–1A in Panama) for contingency operations worldwide. Consistent with Army requirements, exploratory research and investigation in land-based nuclear power is concentrated in the 1 to 100,000 kilowatt range. There is no other known Government agency or civilian concern with an interest in land-based nuclear powerplants in this power range. Consequently, the Army has developed a unique expertise in this area.

EXPLORATORY MATERIAL DEVELOPMENT

Mr. MAHON. Under "Materials," you are requesting $14.2 million for exploratory development in materials. What is the total amount budgeted for fiscal year 1970 in the Army R.D.T. & E. for materials research and development in all budget categories?

General BETTS. $23.8 million will cover the three items of 6.1 and 6.2 research effort. These apply to basic research in structural electronic materials, as well as fundamental propellants effort. They also will provide for work in conceptual and exploratory development in the following materials field: Metals, organic materials, ceramics, electronic materials, fuels, lubricants, materials degradation and technology, design coupling, mechanics, and test and evaluation methods to support those efforts.

Mr. MAHON. The budget for fiscal year 1969 requested $13,050,000 for exploratory development in materials. The fiscal year 1970 budget indicates that $14,872,000 was allocated to this area. Explain the $1.8 million increase above the amount budgeted. What was the purpose of this reprograming? Describe the reprograming procedure by which these funds were reallocated. Will you do that for the record, please.

(The information follows:)

The increases were in the areas of liquid hydrocarbon fuels and metallic materials. In the former case, postcrash aircraft fires have been a major source of casualties in Vietnam. Research in crash safety techniques have indicated that emulsified fuels hold promise in preventing the spread of aircraft fires. To evaluate more completely the possibility of using emulsification on specific fuels, $490,000 was transferred from the flight safety project to the liquid hydrocarbon fuel project.

Significant improvements in propellants have reduced wear and extended the life of gun tubes to a point where they may no longer fail from wear but from metal fatigue. Such failures have been reported in testing and there is one proven case of such a failure in Vietnam.

The metals research for material project was increased by $1,330,000 to determine metallurgical features which would provide clues to incipient failure and improved metals for gun tubes. As a result, a magnetic boroscope has been developed which gives early warning of failures in gun tubes. A new method of processing steel into gun tube forgings has been perfected which improves metal toughness. These developments not only prevent loss of life from catastrophic failures but they also allow extension of criteria for gun tube condemnation which materially reduce the logistics problem and the costs for replacement tubes. These funds were transferred in relatively small amounts from many lower priority tasks in order to attack these urgent Southeast Asia problems.

Mr. MAHON. Tell us for the record what part of the materials effort in exploratory development is done in-house and what part on contract?

(The information follows:)

This effort is 80 percent in-house; 20 percent by contract.

Mr. MAHON. Tell us for the record some of the recent achievements under your project entitled "Lubricants, friction, and wear" for which you are requesting $860,000? Where is the work under this heading carried out?

(The information follows:)

Examples of achievements under the lubrication, friction, and wear project include:

Development of a thickened lubricant with special antiwear additives now used for the M–16 rifle in Southeast Asia, and for use on the Vulcan gun;

Development of a fully florinated lubricant useful over a wide temperature range for liquid fuel rocket engines;

Establishment of a fundamental relationship between the surface viscosity of gear oils and their tendency to foam, with consequent reduced lubrication under service conditions; will lead to better ways to reduce gear oil foaming and thereby provide better lubrication;

A number of commercial polymers consist of chemically bonded together organic chemicals (hydrocarbons) with other hydrocarbon groups attached as "side chains" much like the feet of a centipede. Solid lubricants of this polymer type have been shown to possess increased lubrication properties when these "side chains" are of comparably greater length. This knowledge will allow for a much more scientific approach to "tailor-making" solid lubricants for specific Army application.

This effort is carried out at: U.S. Army Coating and Chemical Laboratory, Aberdeen Proving Ground, Md.; U.S. Army Fuels and Lubricants Research Laboratory, Southwest Research Institute, San Antonio, Tex.; Rock Island Arsenal, Rock Island, Ill.; Frankford Arsenal, Philadelphia, Pa.; and U.S. Army Tank Automotive Command, Warren, Mich.

MILITARY PERSONNEL PERFORMANCE STUDIES

Mr. MAHON. Under "Military personnel performance," you are requesting $2.9 million in fiscal year 1970. Describe this program and its objectives to the committee. Is this an in-house effort?

General BETTS. The military personnel performance program supports a broad group of Army operation and personnel requirements. We do this work in three Army in-house laboratories. The Human Engineering Laboratories at Aberdeen, Md., the second one is the Division of the U.S. Army Natick Laboratories at Natick, Mass., and the third is the Behavioral Science Research Laboratory located in Arlington, Va.

NIGHT OPERATIONS STUDIES

Mr. MAHON. What specific studies are you performing in the area of night operations?

General BETTS. I think you will recall last year we talked broadly about a program we called Sea-Niteops, or Southeast Asia Night Operations.

This is a very large effort that involves hardware development, basic research on the technology of night vision devices and a very broad study of what we can do operationally with not only optical night vision equipment but all of the other sensors that help us in night operations, such as radar, or the seismic sensors that have come available in the recent past. The military personnel performance research is one part of this total effort. It is designed to provide answers, for example, about the number of a given type of device needed by a given unit, such as a rifle company. It also is aimed at determining the best search techniques for the equipment operator to use. In fiscal

year 1968 before the Southeast Asia Night Operations (Sea-Niteops) Program really got underway, we did some preliminary work on this that assisted us in planning the work in support of the Sea-Niteops program.

Mr. MAHON. You can elaborate that for the record.

(The information follows:)

The objective of this work was to identify the things that influence operator performance with these devices. Knowledge was needed as to how target size, shape, and distance from the observer influenced finding the target with these night vision devices, and the effect of differing degrees of light, such as full moonlight versus only starlight. In addition to collecting data in this area, the field research also served to develop techniques, methodology and instrumentation procedures for doing future experimentation with this equipment.

OTHER PERSONNEL OPERATIONS STUDIES

Mr. MAHON. What else do you do under military personnel performance? I am not quite clear how you will spend this $2.9 million. You make reference to Southeast Asia. That is interesting. What else do you do? What is the objective here?

General BETTS. The primary objective is to put ourselves in the position of having a broad technical capability in the general field of man-machined interfaces. For example, before we firm up the configuration of any new item of equipment, the Human Engineering Laboratories are brought into the picture to study the general layout of the subsystems within the equipment, the question of space for the crew in which to operate.

Mr. MAHON. I have heard it said, General, that in some cases the engineering in this field has been quite inadequate, and the relationship of man to beast is not too good.

General BETTS. I would characterize it this way: We do have people who devote their entire careers to this business, and they develop a very considerable capability in terms of the understanding of man's reaction to the equipment placed in front of him his limitations with respect to its maintainability, whether or not the question of claustrophobia is important such as in a tight space such as one finds in an armored vehicle. I would challenge the people who say the engineering in this area is not good. I believe our engineering people are contributing significantly in this area.

Mr. MAHON. You can elaborate for the record.

(The information follows:)

Army human factors engineers are brought in during the earliest phase of system development. They work side by side with project people to study how best to combine man and machine to make the most effective system. They help make decisions on what should be automated in the system and what should be manually controlled. They help determine how large a crew is needed, what the crew tasks are, how much space is needed, and how the equipment should be arranged for maximum effectiveness.

In short, these human factors people look at the total complex of men, their skills, their training their capabilities and limitations in relation to the equipment that they will operate and maintain. This is done from the earliest phases of development right on through the testing and evaluation of the system.

The problem here is much the same as in other areas; the Army does not have resources enough to fully cover each and every system. But increasing success is being demonstrated in applying human factors engineering to improve effectiveness, reduce training, simplify maintenance, and better protect the soldier.

Mr. POOR. Mr. Chairman, if I might elaborate just one moment on that: I have looked into the work of the Human Engineering Laboratories at Aberdeen, and on those systems where they have been able to work the results have been outstandingly good. They get spread awfully thin because we have so many different kinds of things being built, so it is not always possible to assure that the human engineering inputs are put in early enough. Where they are I think it has been successful. Where they have not been applied, I think we have had difficulties.

MILITARY LEADERSHIP TRAINING

Mr. MAHON. You are requesting $3.4 million in fiscal 1970 for military training leadership. In fiscal year 1969 you requested $3.4 million for this program, but the fiscal year 1970 justifications indicate that $3,577,000 was allocated. What was the reason for the increase?

General BETTS. The element increase in fiscal 1969 is to provide specifically for research in human factors aspects of this question of continuous military operations. The very real question of whether or not one can continue effectively with troop units around the clock. In other words, as we develop night operations capability through new sensor technology, there is a very real question the Army has to answer as to whether or not we create night fighting units and day fighting units, or give the night fighting capability to all our units. Frankly, we do not have the answers on this subject as yet. We need a great deal more research and test applied to it in order to determine just that. Actually in fiscal 1969, $500,000 of our requested dollars was deferred by the Office of the Secretary of Defense. We do have our differences with that office on some of these programs and we were not able to persuade them to release those funds to us until late in the fiscal year.

Mr. MAHON. In fiscal 1969?

General BETTS. In fiscal 1969.

Mr. MAHON. How much has been released for this program in fiscal 1969?

General BETTS. $3.4 million.

Mr. MAHON. Does this mean that throughout this justification book this does not indicate what has been released for these efforts by OSD, but merely what the Army has requested.

General BETTS. It indicates our best estimate of what we would have available at the time we submitted the book to you. Obviously most of this has been released in the interim.

WISDOM OF RESEARCH IN NIGHT FIGHTING TECHNIQUES

Mr. RHODES. May I ask a question there?

General, are you saying that the Army is contemplating using the new night fighting techniques by actually having units that employ them and other units that do not, so when retreat sounds the one unit falls back to the bivouac and you have a passage of lines and you bring up the night fighters.

General BETTS. No, sir; I am saying that both ways of operating have been postulated as answering certain of the problems inherent in trying to fight both day and night.

We are in the process of exploring the advantages and disadvantages of the two approaches. No, we do not have a solid answer that says we are contemplating that kind of an operation.

Mr. RHODES. You are undoubtedly not going to do that, because I do not think in the modern field you can cut it quit that cleanly.

General BETTS. I think there will be some kind of compromise worked out that will say under certain circumstances you will have troops that are particularly effective in a night environment where the tactical situation demands that kind of capability.

Mr. RHODES. You are undoubtedly going to have certain specialized forces to conduct certain sophisticated types of night maneuvers. But all of your units would have to have a certain amount of capability around the clock.

General BETTS. I agree, Mr. Rhodes. You remember I said we have structured this large very deliberate test effort we call Sea-Niteops. That will take us 2 or 3 years to do properly, mostly because the sensor equipment we would like to test out is not readily available. It will take some time to get it, some time to train the troops on it, make them thoroughly familiar with its capabilities and limitations, and then structure the adequate tactical testing to come up with the kind of answers we need.

Mr. RHODES. As I understand this item, however, this is testing new concepts of leadership.

General BETTS. This is just a piece of the effort that would feed into that program and into training programs.

Mr. RHODES. It is a pretty good size piece, $3.4 million. It strikes me as a rather ambiguous type of research program for one very small segment of this problem which really does not seem to me to be so tough.

General BETTS. I did not mean to mislead you. It is within this item that we would handle the training and leadership part that feeds into the total Army training program. This training and leadership program element does other things. For example, the development of testing and analysis leading to whether or not we can effectively use the lower mental category personnel, project 100,000, rather scientific work that feeds into that program which is within this total category. There are other things in here that I named.

Mr. RHODES. Is this being performed in-house or do you have a contract?

General BETTS. Much of this effort is done in the Human Resources Research Office, these field units we have in each of our major combat arms centers.

Mr. RHODES. Would you expand on that for the record and give us a more detailed analysis of who is doing what?

General BETTS. I would be pleased to.

Mr. RHODES. Thank you.

(The information follows:)

Most of the work in the military training and leadership element is performed by a contractor, the Human Resources Research Office, of George Washington University, which has units at the following locations: Alexandria, Va.; Fort Knox, Ky.; Presidio of Monterey, Calif.; Fort Benning, Ga.; Fort Bliss, Tex.; and Fort Rucker, Ala. The scientists at these Army installations work side-by-side with Army personnel. Research is performed in the general categories of individual training and performance; unit training and performance; training

for leadership, command and control; language and area training; training technology; and training management. Further, this element supports research related to continuous military operations that will be performed by an independent contractor other than the Human Resources Research Office. In fiscal year 1970 this element also provides for the establishment of an Army in-house training research laboratory that will reduce our dependence on the Human Resources Research Office for training research. The in-house program will be related to, but not duplicate, the research performed by the Human Resources Research Office. It will also perform work aimed at developing utilization technology to assist Army users in applying research results.

Mr. ANDREWS. General, what training do you plan to give a man for night fighting under this program that he would not get under the ranger program?

General BETTS. The important missing element at the moment is a good concept for the use of all of the sensor equipment that is coming available in this time frame. There are so many possibilities that apply to night fighting that it is incumbent upon us in the military to look at what we should integrate into the fighting team and what we should just put aside. There are many more capabilities available from technology than it would make sense to try to use simultaneously. Men have to learn the capabilities and limitations of the seismic sensors, acoustic sensors, magnetic sensors, and radar. There is a whole family of these things that have come available just within the last few years. I think we must have a testing job with man in the loop to come up with good answers in this field.

LIST OF LEADERSHIP STUDIES MADE

Mr. MAHON. In elaboration of Mr. Rhodes' request, as a part of your submission, could you list for the committee those tasks performed in this area in fiscal year 1969, the amount for the individual task, and an indication of where and who is performing the task.

(The information follows:)

BUDGET PROGRAM ELEMENT: MILITARY TRAINING AND LEADERSHIP ($3,400,000)

Title of research	Fiscal year 1969 cost	Location	Research agency
Research for improvement of Infantry stability operations training.	$39,200	Fort Benning (the Infantry center)	HumRRO
Development of concepts and techniques for area training.	18,600	Alexandria, Va	Do.
Analysis of the Army training center system	117,600	Fort Ord (an individual training center)	Do.
Development of a generalized method for preparing self-instructional foreign language courses.	98,000	Alexandria, Va	Do.
Knowledges, skills, and thought processes of the battalion commander and primary staff.	78,400	Fort Benning (the Infantry center)	Do.
A program of instruction for the development of cultural self-awareness.	98,000	Alexandria, Va	Do.
Feasibility study of a system for debriefing MAAG advisers.	40,000	Bangkok, Thailand	Do.
Tank crew performance during periods of extended combat.	137,000	Fort Knox (the armor center)	Do.
Factors in organizational effectiveness	98,000	Fort Benning (the Infantry center)	Do.
Small-group instructional methods	18,600	do	Do.
Proficiency measurement techniques	39,200	Fort Knox (the armor center)	Do.
Development of training for improving the combat skills of leaders in small infantry units.	18,600	Fort Benning (the Infantry center)	Do.
Determination of performance capabilities and training requirements for manual command and control functions of the safeguard weapons system.	78,400	Fort Bliss (the air defense center)	Do.
Human information-processing requirements in manned aerial reconnaissance and surveillance tasks.	39,200	Fort Rucker (the aviation center)	Do.
Training guidelines for the US/FRG main battle tank.	137,000	Fort Knox (the armor center)	Do.
Training techniques for passive night vision devices.	157,000	do	Do.

BUDGET PROGRAM ELEMENT: MILITARY TRAINING AND LEADERSHIP ($3,400,000)—Continued

Title of research	Fiscal year 1969 cost	Location	Research agency
Longitudinal analysis of aviator performance	117,600	Fort Rucker (the aviation center)	HumRRO
Implementation and modification of the USMACTHAI adviser debriefing program.	18,600	Alexandria, Va	Do.
Factors influencing effectiveness of adviser-counterpart interactions.	59,000	do	Do.
Curriculum engineering to enhance the soldier's resistance to stress in combat and hazardous job situations.	18,600	Fort Ord (an individual training center)	Do.
Training methods for forward area air defense weapons.	157,000	Fort Bliss (the air defense center)	Do
Overseas military posts and communities	78,400	Alexandria, Va	Do.
Development of efficient training across all aptitude levels.	157,000	Fort Ord (an individual training center)	Do.
Aircraft recognition training	137,000	do	Do.
Development of training management procedures for heterogeneous ability groups.	98,000	Alexandria, Va	Do.
Development of improved training for combat support duties.	18,600	Fort Ord (an individual training center)	Do.
Modernization of synthetic training in army aviation	117,600	Fort Rucker (the aviation center)	
Improving aviation maintenance training through task and instructional analysis.	117,600	do	
Human performance degradation	78,400	Fort Bliss (the air defense center)	
Manual format	59,000	Alexandria, Va	
Troop information	78,400	Fort Benning (the infantry center)	
Logistics systems	78,400	Alexandria, Va	
United States-Thai security guard	28,600	Bangkok, Thailand	
Technical advisory service	270,000	Consultive assistance provided in the field of training, motivation, and leadership at 6 major installations.	
HumRRO subtotal	2,900,600		
Continuous military operations	500,000	Unknown	(1).
Military training and leadership program, total.	3,400,000		
FUNDS PROVIDED BY THE OFFICE OF THE SECRETARY OF DEFENSE FOR RESEARCH IN SUPPORT OF PROJECT ($305,000)	100,000		
Training strategies appropriate to aptitude level for selected training courses (APSTRAT).	$105,000	Fort Ord (an individual training center)	HumRRO.
Determination of reading, listening, and artithmetic skills required for major military occupational specialities (REALISTIC).	150,000	do	Do.
Study of men in lower mental categories: Job performance and the identification of potentially successful and potentially unsuccessful men (UTILITY).	50,000	do	Do.
Secretary of Defense, total	305,000		

[1] Contract not yet awarded.

RELATIONSHIP BETWEEN PERSONNEL RESEARCH PROGRAMS

Mr. MAHON. How is this program on military training leadership related to the previous program we discussed, military personnel performance? They seemed to be very much alike. You mentioned night fighting.

General BETTS. They are certainly related. Perhaps we tend to tie ourselves up in our own nomenclature, but the only way I could break this out would be to do it by showing representative tasks that would describe it. I think you can pull it out from looking at the specifics of the kind of things we do under the personnel performance program. For example, one of the things that worries people about night vision equipment is the fact that when a man keeps his eyes glued to one of these starlight scopes for hours at a time in a surveillance mode, there is a very real question whether or not his performance degrades be-

cause he is in a night environment, yet one eye is being exposed to a high level of light. We need deliberate, carefully instrumented, planned test efforts to determine whether we are taking the right approach, both operationally and with respect to the instrument light levels, to this kind of a problem. We would do that sort of thing in the behavioral sciences research laboratory.

We would do it under the personnel performance program rather than under this military training and leadership effort that is related but is different in the nature of the task we would attempt to perform.

Mr. POOR. I think the distinction is fairly simple. In the military personnel performance program we learn the sort of mechanical limitations of man to perform jobs. We try to adjust the machines so that they fit the man properly. We also try to improve our classification and selection program so we can characterize new people as they come in.

The military training and leadership program is aimed primarily at learning how to best train the people after they have come abroad, to get the most effectiveness out of them. Thus it develops improved curriculum for the training of men after they get in the Army. It seeks to improve methods of training for such important skills as rotary and fixed wing aviators. So the separation is quite clear. The first is to characterize the man as a machine interacting with other machines. Military training and leadership is to try to help him to do that job as well as we can through proper modern methods of training.

Mr. MAHON. What is the status of the Army's relationship with the Human Resources Research Office of the George Washington University? They worked with the Army in this area for many years.

ARMY RELATIONSHIP WITH GEORGE WASHINGTON UNIVERSITY

General BETTS. I think I remarked the other day that George Washington University has asked that we agree to their plan to sever this laboratory from George Washington University. George Washington University has a contract with us to supply certain services, and it is conceivable that we could be hard nosed and hold them to the contract. Yet I believe it is to our mutual advantage to go along with their plan, if indeed we can find a proper and adequate contract structure that will take over the responsibility for the continuing human resources research activity.

Mr. MAHON. Is your plan to accomplish this change in fiscal 1970?

General BETTS. It is our plan to make this change as quickly as possible. As a matter of fact, it may well turn out that the best approach to this whole problem is to create a nonprofit agency within the District of Columbia that itself is the human resources research office and not relate that office to any other contract structure. Dr. Crawford of that office is trying to work out this sort of arrangement. The important thing is that we keep the capability and keep the high competency of the people in that organization working for our various combat arms centers as they are doing now.

CREATION OF ARMY TRAINING RESEARCH LABORATORY

Mr. MAHON. Will you describe the project entitled "Army Training Research," for which you are requesting $794,000?

General BETTS. This is for the establishment of an Army in-house training research lab in order to reduce our total dependence on the Federal Contract Research Center that we were just discussing, the Human Resources Research Office. We would still do training research related to but not duplicating that which is supported under the Human Resources Research Office.

Our program would cover training methods, techniques, motivation, leadership, that kind of thing, but the important goal is to give us a greater in-house competency in this field so that we can do a better job of directing and monitoring the work to be done under contract.

Mr. MAHON. The justification book shows nothing for fiscal 1968, nothing for fiscal 1969, which indicates that you are starting a new $794,000 Army training research program.

General BETTS. That is correct, Mr. Chairman. We would have gotten this program underway during fiscal 1969 except for the arbitrary manpower restrictions on the Department of Defense that you will recall resulted in limitations on the numbers of people we could hire as related to the numbers of people we lost by attrition. It was our judgment that to have expended our limited manpower resources to get this program underway in fiscal 1969 would have had too severe an impact on other things in the Army R. D. & E. program. So although we wanted to go ahead with this program we did not do so.

Mr. MAHON. How many people are you requesting here?

General BETTS. We would plan to build to about 40, but I would not expect to have that many on board in fiscal 1970.

Mr. MAHON. Where would they be? Where are you going to establish this laboratory?

General BETTS. We have looked at several places, one of which would be to put it at Fort Monroe near the Continental Army Command Headquarters, since much of their general field of interest would relate to the kind of activity that would take place at the In-House Training Laboratory. At the moment there is no room or facility there that could handle these professionals.

Mr. MAHON. Do you want to put it in an existing Army facility?

General BETTS. Either at an existing Army facility, or somewhere where it could be closely related to one. What we have been loking at in the immediate past is the possibility of putting it at Fort Lee, Va. or Fort Monmouth, N.J.

Mr. MAHON. The Army has gotten along without this office for many, many decades.

General BETTS. Yes. I might add to that that the Director of Defense Research and Engineering has been very strong in his urging us to get this program started, to the extent that he has refused to release funds in this category of effort to use until he could see signs of the effort underway. I might go off the record for a minute.

(CLERK'S NOTE: The following additional information was supplied subsequent to the above testimony:)

We are trying to develop an in-house training research capability so as to reduce our dependence on a Federal contract research center. I believe this action to be in accord with Congress' desire.

(Discussion off the record.)

TRAINING AND UTILIZATION OF MEN IN LOWER MENTAL CATEGORIES

Mr. MAHON. How much of the effort under this heading is related to the utilization of men in lower mental categories? Who knows about that? Is there anybody that can discuss that?

General BETTS. The Army has a part of the effort that you will recall as Project 100,000. In fiscal 1970 we would propose to spend $350,000 on research in support of that general area. Of this $150,000 would be work done at the Behavioral Sciences Research Laboratory under the work unit entitled "The Optimum Mental Distribution"; $200,000 would go for the rest of this general effort in the program to learn how to use the less mentally capable people. That means testing to see what we can do in improved training programs that would help them to identify with the job and feel confident of their ability to do a job that they had never done before.

There has been some success in this general area. I would not say that it has been 100-percent successful. It is perfectly clear that they cannot be trained to really skilled jobs or even what I would call semiskilled jobs. But they can be trained to do things that are fairly mechanical and do not require a really high level of mental capacity. But it does take a lot of study of individual jobs and a lot of testing of the kind of people we are dealing with.

What I am saying is that our training centers—in order to handle people of this category need a lot of help from professionals who are thoroughly familiar with the capabilities and limitations of this level of mental capacity.

Mr. MAHON. Is this a field in which the Army should project itself, General?

General BETTS. I feel it would be a waste of potential manpower, in a situation where we are drafting people, to limit ourselves to drafting only those of high mental capacity.

Mr. MAHON. I am not talking about high mental capacity. We are talking about average.

General BETTS. I understand. I mean higher level capacity than we are talking about. If it is possible to train these people adequately to do jobs that the average mental capacity person does not like to do, or conversely to put him in that sort of a skill level when there are more skillful things to which he could apply his talents.

I do think it is a sensible thing for the Army to be doing, and one that is profitable in the long pull for the country because we give these people some sort of skill capability they can apply when they get out of the Army.

Mr. ANDREWS. You are talking about the old category 4 types.

General BETTS. They are people that in the old system we might have never taken in in the first place.

Mr. ANDREWS. When you take them in you take them in for 2-year training.

General BETTS. We take them for the 2-year draft.

Mr. ANDREWS. How long does it take to train them before they can do useful work? How many months?

General BETTS. It takes longer than the basic training but not appreciably; a few more months.

Mr. ANDREWS. Do they just take this special training?

General BETTS. No, sir. It precedes their entry into regular basic training. To be specific, I am talking about the remedial reading training given to men who read below the 5th grade level. These men are given remedial reading training and some military training concurrently. They are quartered together and move to and from classes together. At the end of this training, these men enter regular basic training right along with all the other men.

Mr. MAHON. Do you have anybody in the room who works directly with this?

General BETTS. No, sir; I do not.

I can get such an individual to talk to this much more deeply.

(Discussion off the record.)

General BETTS. I do not have at my fingertips the statistics of what we have done with these people, but I can assure you that by and large the program of bringing in these lower skilled people has been successful and we have made fine soldiers of them.

Under the old circumstances we would never have let them come in the Army.

Mr. LIPSCOMB. I would suggest before you make these statements that you get a hold of the studies already made by the people in Military Personnel administration and read them.

General BETTS. Yes, sir.

Mr. LIPSCOMB. You will find they have had great difficulty in the operation of Project 100,000. I think you ought to check that out before you start making a lot of statements about how successful the project has been. A lot of information is contained in the hearings on military personnel that have already been printed by the committee. There is a lot more in the Operation and Maintenance hearings. I think you ought to review those hearings before making such glowing statements.

General BETTS. Yes, sir. They have had difficulties.

Mr. LIPSCOMB. You are correct. They have had a lot of difficulty. You had just said it has been a successful program.

General BETTS. That was my understanding.

Mr. LIPSCOMB. If it has been successful, why are you spending a lot of money on research? The Army has been in existence for about 175 years. This program has been in effect for over 3 years, and if you have not found out how to utilize these lower mental category personnel by this time you have been wasting your time. I think before you get into great testimony on programs that are not familiar to you, you just ought to say you will look it up. All these problems are of record. The Army has made numerous studies on Project 100,000 since its inception.

General BETTS. I am aware of that, but I am stating what my impressions were of the information that I have within the staff. My specific concern if with the research side of Project 100,000. Research on utilization of these personnel could not begin 3 years ago. We had to wait until these people completed basic training, were assigned specific duties and were on the job for awhile. Only then could we obtain information through research about their performance effectiveness. We have just recently completed collecting the information.

I will be pleased to get somebody over here who is more expert on the subject.

(Discussion off the record.)

BASES AT WHICH RESEARCH CONDUCTED

Mr. MAHON. Where is this training done? Do we do this kind of work for the lower mental categories in all our training bases or just in some of them? How does that work out?

General BETTS. This kind of effort in the R. & D. program is done by the Behavioral Sciences Research Laboratory and the Human Resources Research Office. Where they go for their specific experiments I would have to supply for the record.

Mr. MAHON. Supply it for the record.

(The information follows:)

The Office of the Chief of Research and Development conducts the four research efforts UTILITY, REALISTIC, APSTRAT, and Optimum Mental Distribution. The efforts comprise the research described to the committee in earlier testimony by representatives of the Deputy Chief of Staff for Personnel. The objective of this research is to provide knowledge that will help to achieve optimum training and utilization of Project 100,000 personnel.

The Army probably has a greater interest than the other services in men of lower mental ability because it has the greatest bulk manpower requirement and gets most of them. This research, therefore, will benefit the Army now and in any future mobilization.

Experimental work and data collection for the Army research in support of Project 100,000 have been carried out at the following locations:

U.S. Army Europe
Fort Benning, Ga.
Fort Bragg, N.C.
Fort Carson, Colo.
Fort Dix, N.J.
Fort Gordon, Ga.
Fort Jackson, S.C.
Fort Knox, Ky.
Fort Leonard Wood, Mo.
Fort Meade, Md.
Fort Monmouth, N.J.
Fort Ord, Calif.
Fort Polk, La.
Fort Sill, Okla.
Letterman General Hospital, Calif.

Research related to Project 100,000 addresses several specific topics. Research unit UTILITY will determine how men in mental category IV and men in other mental categories compare both in performance on the job and in their overall suitability for military service, and will determine what measures are useful in predicting successful military performance. Data collection is complete and the data are being analyzed. Preliminary results will be available in September. This research could not be accomplished until men completed basic and advanced training, were assigned to a unit, and had an opportunity to perform on the job for a reasonable period.

Research entitled "REALISTIC" is directed at determining the reading, listening, and arithmetic skills required for military jobs, and a matching of this against the skills of Project 100,000 personnel on these subjects. Data collection is in progress. Preliminary results are expected in September. This work will provide a skill profile of Army jobs. Training can then be tailored to meet the needs of the man as well as the job.

The APSTRAT research seeks to formulate a new strategy of instruction for more effective advanced individual training for men of widely varying aptitudes. This will permit more efficient training of Project 100,000 personnel. This work will be carried out as an experimental course of instruction for Army wiremen that will be evaluated in fiscal year 1970.

The Optimum Mental Distribution research seeks to assess the impact on unit effectiveness of varying mixes of aptitude level personnel within the unit. Data have been collected on rifle squads and are now being collected on vehicle maintenance units. This type of information is totally unavailable at the initiation of a program such as Project 100,000. The data can be obtained only after a period of experience with these people actually in the operating units. Preliminary results should be available in fiscal year 1970.

Some information already obtained by research has been applied to existing courses. The supplyman course taught at Fort Lee, Va., and the signal terminal

already been revised with special reference to the characteristics of Project operator's course taught at Fort Gordon, Ga., are two specific courses that have 100,000 personnel.

Research in Social Analyses

INCREASE FUNDING

Mr. Mahon. With respect to Defense Operations Social Analyses, you are requesting $2 million, a nice round figure—relatively small. You had $2.5 million last year. I guess the job is approaching completion and you can get along on less next year. What is the situation?

General Betts. No, sir; this is a continuing program that we carry in the Center for Research in Social Sciences and two other contractors. The best thing I can say about it is that it does get extensive use on the part of the Army General Staff and other agencies that look to this center for help. For example, during calendar 1968, and that is the last time I ran a numerical analysis on this, the CINFAC portion of CRESS had received requests for information and research from 65 different organizations and staffing agencies and they produced some six technical reports—full reports—some 73 analyses that were of a lesser stature and received various levels of distribution. I might give representative responses to give you some idea of the fields in which they are asked for information. One of them is the military considerations related to jungles around the world. In other words, as we have found in military problems related to our jungle activities in Southeast Asia, these people were asked to research the question more broadly to see if there is any fundamental difference in other places around the world where we might expect to have a different military situation. In another case they were asked to collect information on communism in Sub-Saharan Africa. This was a bibliographic approach, presumably because some staff element was making further plans for the future.

Mr. Lipscomb. Mr. Chairman, may I ask a question at this point? General, would you tell us who laid on that request?

General Betts. I do not have that information with me but I would be pleased to.

Mr. Lipscomb. Who would you think would request it?

General Betts. I suspect the planners in either the Army General Staff or the planners in STRIKE Command.

Mr. Lipscomb. In the Sub-Sahara?

General Betts. In Sub-Saharan Africa.

Mr. Mahon. Below the Sahara.

General Betts. Yes, sir. In still another case they were asked to create an annotative bibliography on civil affairs. This is a fairly routine research job—library research—but nevertheless it was useful to the civil affairs people. They also were asked to build a bibliography on Cuban guerrilla training centers and Radio Havana. I presume that was related to the general pattern of communism in South America. The Cinfac portion of the center is really what I would call library research. It is the kind of capability that is available to you in the Library of Congress on some general subject that you want information on. You can turn to the Library of Congress and ask them for this CINFAC is a much narrower subject in that the capability is there and we can turn to it when we want information dug out of the files.

USE OF THE LIBRARY OF CONGRESS

Mr. ANDREWS. I was going to ask, why didn't you get the information from the Library of Congress? You could do it much cheaper than in-house.

General BETTS. We are not privileged to ask the Library of Congress to go to work on this kind of thing. As a matter of fact, we have recently had conversations with the Library of Congress because they came to us seeking fiscal support in a field that they felt was related to our military interests, where they thought they could produce this kind of study for us. Upon analysis it turned out that they did not have a sufficient number of the right kind of professional people to conduct the sort of research we needed.

Mr. ANDREWS. They do a lot of work for the Air Force.

General BETTS. I am aware of that.

Mr. ANDREWS. In fact, the Air Force make a contribution, If I remember, of around $2.5 million a year.

General BETTS. It was that particular group that came to talk to us because the Air Force was planning to cut back their support.

Mr. ANDREWS. I thought the people over here in the Library of Congress could come up with anything.

General BETTS. In our analysis of the particular subject in question, we did not find enough of the right kind of professionals to prepare the sort of report we wanted.

Mr. ANDREWS. Do your professionals use the facilities of the Library of Congress in making reports for you?

General BETTS. I am sure that we do when it is necessary; yes, sir.

I might turn to Colonel Snead who is closer to this.

Mr. ANDREWS. Colonel, how do your professionals come up with these reports that the Libary of Congress can't produce?

Colonel SNEAD. I can't answer the specific questions as to how they relate it to the ones that the Library of Congress cannot produce, sir. I do know that one of the strengths of a CRESS type of an organization, one that is principally oriented to our specific areas of interest, is that they maintain a knowledge as to the location of information in a wide variety of sources including that of their own files. And in this regard, I am sure that they would use the total facilities, as appropriate, of the Library of Congress, it having an available and very complete reference of published material.

Mr. ANDREWS. That is all, Mr. Chairman.

CULTURAL INFORMATION ANALYSIS CENTER FOR CRESS

CONTRACT WITH AMERICAN UNIVERSITY FOR CRESS

Mr. MAHON. Where is the Cultural Information Analysis Center located?

General BETTS. It is a part of CRESS here in Washington in space that was rented by the American University. This is presently carried under contract with the American University. We are now studying ways of severing that contract from the American University at their request, but we would plan to continue this kind of activity.

Mr. MAHON. You wouldn't associate it with American University?

General BETTS. American University has asked that we let them disassociate themselves. They are under contract to us to provide this service, so that one could hold them to it, but it is not to our mutual advantage to do so if we can work out other arrangements.

Mr. MAHON. Is there something odd just about the Army from the standpoint of the American University?

General BETTS. No, sir; the American University put together a faculty-student committee related to their recent disturbances, as well as to take a long look at whether or not the university was in the right kind of activity and it was their committee judgment that they shouldn't be in this sort of activity unless it was very closely coupled to the on-going educational mission of the university. Since the Center for Research in Social Systems is an entity that is not integrated into university activities—and properly so because some of the material is classified—the committee of the university recommended that there would not be an appropriate long-term application for the university.

Mr. MAHON. How many military, Government civilian, and contractor personnel are assigned to the center? Would you put that in the record?

General BETTS. I will submit it.

(The information follows:)

The Center for Research in Social Systems (CRESS) presently employs 143 people, 26 of whom are part-time employees. This total includes 60 professional researchers, 26 in the Cultural Information Analysis Center and 34 in the Social Science Research Institute of CRESS. There are no military or Government civilian personnel assigned to or working at CRESS.

Mr. MAHON. Are the people who do this work retired Army officers?

General BETTS. We have a few retired Army officers who have been employed but when they were so employed it was because of their professional education as psychologists, or some other professional background. By and large, we use the kind of people from the social sciences that one would expect; historians, sociologists, psychologists, and political scientists.

NEW RESEARCH STUDY IN PSYCHOLOGICAL OPERATIONS

Mr. MAHON. You are requesting $100,000 to initiate a new program entitled "Psychological Operations." How would you spend this money?

General BETTS. The Department of Defense directed the Army to establish an in-house capability, as I remarked before, to avoid the total dependence on the Federal contract research centers for foreign area sensitive research. It is our belief that some of the Army's overseas psychological operations requirements that should be conducted in-country, and that are sensitive, would be among a number of things better done by an in-house laboratory.

The moneys requested here would establish the laboratory and begin to fund its initial efforts.

Mr. MAHON. General Betts, you were discussing the fact that American University desires to sever its relationship with the Center for Research in Social Systems. Has a reorganization of CRESS taken place? What are your future plans for CRESS? Will it become an independent, nonprofit corporation?

General BETTS. We think it is likely that it will be absorbed by some nonprofit organization that now exists. Several have been negotiating with the American University and with CRESS to take over the contract effort. At least initially it would not result in any significant restructuring of the center itself, but it undoubtedly would, over time, depending on the work being done by the organization that takes it over. The two most likely organizations are the American Institute for Research or the Midwest Research Institute. Both have expressed an interest in taking over the responsibility for this contract.

CRESS RESEARCH STUDIES

Mr. MAHON. What tasks are currently assigned to CRESS? Put that in the record.

(The information follows:)

Fiscal year 1970 research program of the Center for Research in Social Systems at the American University

Cultural information analysis center	$750,000
Research to improve capability to work effectively with foreign military:	
Improving relations between military units and local communities	55,000
Intercultural communications	150,000
Research to improve Army doctrine and procedures to deal with "subversive" warfare:	
Characteristics of selected societies to U.S. military interests (U)	130,000
Roles and mission of military police in internal defense and internal development	95,000
Strategic and tactical factors underlying internal defense and internal development	110,000
Research to improve the conduct of PSYOPS and military civil affairs:	
Civil affairs functions in insurgent environments	88,000
Criteria for selection and assessment of military civic action programs	35,000
A systematic framework for psychological operations	130,000
Communication data on Korean audiences	67,000
ROKA civic action in Korea	55,000
Improving communication through the associative group analysis technique	33,000
Research on selected civic action programs	90,000
Criteria for evaluating U.S. military assistance programs	70,000
Research with unique specificity:	
Applicability of social and behavioral science research to U.S. Army activities in the developing countries	37,000
Village reconstruction program of the Republic of Korea Army (U)	100,000
Institutional research	105,000
Total	2,100,000

COMPARISON OF SOCIAL ANALYSIS STUDIES IN VIETMAN

Mr. MAHON. In what ways is your program in Vietnam in social analysis different from the social analysis in ARPA's project, Project Agile?

General BETTS. They are complementary in that we are aware of what Agile supports and they are aware of what we support. ARPA tends to move into areas that are of general interest to all three services rather than the specific interest of one service. Consequently, there are

some essential differences. I might point out that the largest part of Agile has employed operations research and systems analysis on many facets of materiel, logistical, and tactical problems of combating insurgency. The Army has been very careful not to duplicate the effort that they have done and I don't think we are directly competitive in the social science areas that they support, but we have been complementary in our approach to this problem.

STUDY OF AFRICAN GROUPS

Mr. MAHON. What is the status of your fiscal year 1969 program described as "A study of African groups"?

General BETTS. This research was recently terminated, but it focused on the independent countries of black Africa. The primary objective was to provide information to U.S. Strike Command who, from a worldwide point of view, is responsible for U.S. military interests in that area of the world.

The research studied the social-political structures, leadership resources and attitudes in those countries.

Mr. MAHON. Why was it terminated?

General BETTS. Just due to limited funding resources. There were other things of higher priority. However, one report has been published and a second one is being reviewed.

Mr. MAHON. Did you learn anything from it before it was terminated.

General BETTS. I am sure we did. I would prefer to give you an answer from the Strike Command on that subject since we did it at their request.

Mr. MAHON. Yes; and also provide us with information of a specific nature as to what Army mission this project supported, and what they spent on it.

General BETTS. All right, sir; I will give you the total expenditures and Strike Command's assessments of the import to them.

(The information follows:)

The research on African groups focused on the independent countries of black Africa. The primary objective was to provide information to U.S. Strike Command and concerned the sociopolitical structures and dynamics as well as those aspects of leadership resources that would be of significance to military operations. The first report has been delivered to the command while a second report is in the process of final review. The funding for the research is given below:

Fiscal year 1967	$65,000
Fiscal year 1968	92,000
Fiscal year 1969	34,000

Further research in this area has been terminated because of higher priority requirements.

The U.S. Strike Command has advised that the report is valuable for their contingency planning. The command stated the report is an excellent, detailed, sociological analysis. Although it is of limited present use except for planning purposes, it is their judgment that if the need ever arises for substantial U.S. military presence in these countries the information contained in the document will be of great value.

CRESS STUDIES RELATING TO VIETNAM

Mr. MAHON. General Betts will you list for the record the 50 CRESS studies concerning Vietnam which are referred to on page 14 of your

statement. Maybe you better read a few of them and put the rest in the record?

General BETTS. Minority groups in the Republic of Vietnam. Then there is a series of ethnographic studies relating to these different tribal groups in Vietnam.

Mr. MAHON. Put it in the record.

(The information follows:)

The following is a list of 56 reports dealing with militarily relevant aspects of Vietnam that were prepared by the Center for Research in Social Systems (CRESS). Prepared in response to military requirements, these documents provide a valuable introduction to a very complex situation. The titles indicate the scope of the research efforts. Among the 56 documents are 24 substantive technical reports, 24 information responses, and eight bibliographies.

An example of the latter category is item 51, "Bibliography on Witchcraft, Sorcery, Magic and Other Psychological Phenomena in Southeast Asia." This eight-page bibliography illustrates the quick-response capability of the CRESS Cultural Information Analysis Center (CINFAC). It took 53 manhours, at a cost of $383.26, to prepare this document in response to an ARPA requirement. Eleven subsequent requests for similar material were satisfied by this document without additional cost. Information of this type is often critical in understanding the reasons for unusual foreign behavior that affects U.S. military operations.

ETHNOGRAPHY AND CULTURE

1. *Ethnographic Study Series: Minority Groups in the Republic of Vietnam.*—AD 649-980. Joann L. Schrock et al., February 1966 (unclassified). Published as Department of Army Pamphlet No. 550-105, 1, 63 pp., extensive bibl., 26 maps, index.
2. *Ethnographic Study Series: The Nung of Vietnam (U).*—Compiled by Elaine M. Murphy, April 8, 1966 (Secret). CRESS/CINFAC R-0422, 51 pp., bibl.
3. *Ethnographic Study Series: Notes on Tribal Groups in the Viet Bac Autonomous Region: The Nung.*—Elaine M. Murphy and Dennis E. Gosier (December 1967) (Unclassified). CRESS/CINFAC R-1088. iv+43 pp., bibl., map.

Ethnographic Study Series. Notes on Tribal Groups in the Viet Bac Autonomous Region: The Yao.—Patricia L. Stegeman (December 1967) (Unclassified). CRESS/CINFAC R-1089. iv+95 pp., bibl., map.

Ethnographic Study Series. Notes on Tribal Groups in the Viet Bac Autonomous Region: The Meo.—Raymond W. Meyers (December 1967) (Unclassified). CRESS/CINFAC R-1090. iv+126 pp., bibl., map.

Ethnographic Study Series. Notes on Tribal Groups in the Viet Bac Autonomous Region: The Tho.—Dennis E. Gosier and Joann L. Schrock (February 1968) (Unclassified). CRESS/CINFAC R-1092. iv+56 pp., bibl., map.

Ethnographic Study Series. Notes on Tribal Groups in the Viet Bac Autonomous Region: The Nhang.—Joann L. Schrock (February 1968) (Unclassified). CRESS/CINFAC R-1093. iii+10 pp., bibl., map.

Ethnographic Study Series. Notes on Tribal Groups in the Viet Bac Autonomous Region: The Lati.—Joann L. Schrock (February 1968) (Unclassified. CRESS/CINFAC R-1094. iv+8 pp., bibl., map.

Ethnographic Study Series. Notes on Tribal Groups in the Viet Bac Autonomous Region: The Laqua.—Joann L. Schrock (February 1968) (Unclassified). CRESS/CINFAC R-1095. iv+5 pp., bibl., map.

4. *General Information on the Viet Bac Autonomous Region (U).*—Walton C. Manee, December 1967 (Secret). CRESS/CINFAC R-1087. v+22 pages, bibliography, map.
5. *Customs and Taboos of Selected Tribes Residing Along the Western Border of the Republic of Vietnam.*—AD 649-981, Skaidrite (Maliks) Fallah, February 1967 (Unclassified). vi+50 pages, bibliography, maps.
6. *Modes of Transportation and Dress of Selected Tribes Residing Along the Western Border of the Republic of Vietnam.*—Skaidrite (Maliks) Fallah, February 1966 (Unclassified). CRESS/CINFAC R-0325. 47 pages, bibliography, maps.
7. *Ethnographic Study Series: Brief Notes on the Tahoi, Pacoh, and Phuong of the Republic of Vietnam.*—AD 648-509. Marilou Fromme, December 1966 (Unclassified). v+24 pages, 1 figure, bibliography.

8. *A United States-Vietnamese Calendar of Holidays and Celebrations in Vietnam.*—AD 454–030. Joann L. Schrock, October 1964 (Unclassified). 175 pages, 1 figure, tables, bibliography, appendix, index.
9. *A United States-Vietnamese Calendar of Holidays and Celebrations in Vietnam: 1965–67 Supplement.*—Joann L. Schrock, Februaoy 1967 (Unclassified). CRESS/CINFAC R–0805. 35 pages, tables.
10. *Propitious and Unpropitious Days in Vietnam, 1954–68.*—Joann L. Schrock, February 1967 (Unclassified). CRESS/CINFAC R–0808. 7 pages.

POLITICAL FACTORS

11. *Research Notes on the Vietnamese Village Council.*—AD 464–904. Compiled by Arthur S. Abbott, assisted by Skaldrite (Maliks) Fallah, January 1965 (Unclassified). 52 pages, 4 tables, bibliography, appendix.
12. *Charting of Roles and Groups in Vietnamese Society.*—Arthur S. Abbott, December 1965 (Unclassified). CRESS/CINFAC R–0264. 10 pages, bibliography, appendixes, including 2 charts.

PSYCHOLOGICAL OPERATIONS FACTORS

13. *Intercultural Communications Guide for the Republic of Vietnam (U).*—AD 384–693L. Frederick P. Munson *et al.*, September 1967 (Confidential). x+290 pages, bibliography, appendix, maps.
14. *Notes on the Impact of Radio and Television in Vietnam.*—Barbara A. Wilson, assisted by Elaine M. Murphy, June 1967 (Unclassified). CRESS/CINFAC R–0940. 22 pages, appendix.
15. *Attitudes of Selected Audiences in the Republic of Vietnam (U)*—Walton C. Manee *et al.*, February 1966 (Secret). CRESS/CINFAC R–0217–0227. 348 pages, bibliography, map.
16. *Republic of Vietnam: Selected Vulnerabilities and Propaganda Opportunities (U).*—Andrew D. Sens and Joseph M. Macrum, May 1965 (Secret). CRESS/CINFAC R–0064. 124 pages, bibliography, appendixes, map.
17. *A Short Guide to Psychological Operations in the Republic of Vietnam—1965 (U).*—AD 362–100. Jeanne S. Mintz *et al.*, June 1965 (Confidential). viii+163 pages, Annexes A and B, bibliography; Annex C: Province-Specific Data (U). AD 362–808. Jeanne S. Mintz and Herbert M. Silerburg, July 1965 (Secret). vii+182 pages.
18. *Felt Needs of the Rural Population: Republic of Vietnam (U).*—Norman A. LaCharite *et al.*, April 1966 (Secret). CRESS/CINFAC R–0339. 65 pages, bibliography, appendix.
19. *Persuasion Overseas (Republic of Vietnam Emphasis) (U).*—AD 464–963. Lorand Szalay *et al.*, June 1965 (For official use only). vii+154 pages, bibliography.
20. *Working With Peoples in Developing Areas—One Task of the American Soldier Overseas (U).*—AD 374–755. John L. Houk, June 1966 (Confidential). xi+284 pages, 17 figures, bibliography, appendix.
21. *Notes on Psychological Opportunities in the Republic of Vietnam (U).*—AD 465–558L. Andrew D. Sens and Joseph M. Macrum, 30 June 1965 (For official use only). iii, 88 pages, bibliographies.
22. *The North Vietnamese Regime: Institutions and Problems.*—Charles N. Spinks *et al.*, June 1968 (in review process).

MILITARY AND PARAMILITARY ACTIVITIES

23. *Vietnam: A Survey of Military and Non-Military Activities (U).*—AD 368–092L. Jeanne S. Mintz, April 1965 (Secret). ix, 64 pages, bibliographies, appendicies, notes.
24. *The U.S. Special Forces CIDG Mission in Vietnam: A Preliminary Case Study in Counterpart and Civil-Military Relationships (U).*—Frederick H. Stires, November 1964 (Secret). xvii, 121 pages, 2 figures, appendices, gloss.
25. *Giving Credit to the Republic of Vietnam (U).*—AD 304–315. Richard H. Moore and James R. Price, March 1964 (Confidential). v, 59 pages, appendicies.
26. *Experiences of United States Army Special Forces in South Vietnam Applicable to Thailand (U).*—Sandford S. Silverburg, September 1967 (Secret). CRESS/CINFAC R–1004. v, 61 pages, bibliographies, map.

27. *A Review of U.S. Military Counterinsurgency Activities with Selected Minority Groups in South Vietnam (U).*—AD 381-804L. Donald S. Bloch, May 1967 (Secret). v, 48 pages, map, bibliographies.
28. *Characteristics of Selected Societies Relevant to U.S. Military Interests: North Vietnam, Part I (U).*—AD 383-932L. Charles N. Spinks et al., September 1967 (Secret). viii, 132 pages, maps, charts, appendicies, bibliographies. *Part II (U)*, June 1968 (Secret). viii, 82 pages, maps, charts, bibliographies.
29. *Ethnographic Study Series: Cultural and Biological Effluents of Ethnic Groups in Southeast Asia.*—Skaidrite (Maliks) Fallah, June 1968 (unclassified). iii, 45 pages, bibliographies; and *Supplement to Cultural and Biological Effluents of Ethnic Groups in Southeast Asia (U).* CRESS/CINFAC R-1129 (confidential). 6 pages.
30. *Father Augustin Nguyen Lac Hoa and His "Sea Swallows."* Arthur S. Abbott, March 1967 (unclassified). CRESS/CINFAC R-0829. 7 pages.

ECONOMIC FACTORS

31. *Economic Data on South Vietnam.* Skaidrite (Maliks) Fallah and John H. Stowell, September 1965 (unclassified). CRESS/CINFAC R-0178. 65 pages, bibliographies, appendicies.
32. *A Partial Inventory of Ongoing Private Aid Programs in the Republic of Vietnam.* Compiled by William F. Stockton, Jr. (unclassified). 98 pages; *A Partial Inventory of Ongoing Public Aid Programs in the Republic of Vietnam (U).*—Compiled by John H. Stowell, assisted by Skaidrite Maliks Fallah, February 1966 (for official use only). CRESS/CINFAC R-0336. 52 pages.
33. *Inland Waterways of the Mekong Delta, Republic of Vietnam (U).*—Albert A. Marchant, Jr., February 1966 (confidential). CRESS/CINFAC R-0352. 24 pages, bibliographies, map, tables.

EDUCATION

34. *Education and Communication Data on the Republic of Vietnam.*—Skaidrite (Maliks) and John H. Stowell, August 1965 (unclassified). CRESS/CINFAC R-0164. 14 pages.
35. *A Brief History of Ethnically Oriented Schools Within Vietnam's Educacational System.*—Compiled by Skaidrite (Maliks) Fallah and John H. Stowell, October 1965 (unclassified). CRESS/CINFAC R-0198. 9 pages.

HISTORY

36. *Research Notes on Hue as a Traditional City of Vietnam.*—AD 615-854. Skaidrite (Maliks) Fallah, December 1964 (unclassified). 14 pages, bibliography, appendix.
37. *Tuy Hoa, Capital of Phu Yen Province.*—Arthur S. Abbott, February 1967 (unclassified). CRESS/CINFAC R-0822. 2 pages.
38. *Conflict Between Vietnam and Foreign Forces—111 B.C. to 1885 A.D.*—John H. Stowell and Skaidrite (Maliks) Fallah, November 1965 (unclassified). CRESS/CINFAC R-0233. Chart, produced in spreadsheet form.
39. "Indochina (1946-1954)." Bernard B. Fall. Chapter 9 in *Challenge and Response in Internal Conflict: The Experience in Asia,* Volume I. AD. 666-747. D. M. Condit and B. H. Cooper, Jr., editors, February 1968 (unclassified). Pages 237-269.
40. *Indochina Conflict: Key Personalities 1940-1968.*—Asia and Pacific Branch, CINFAC, March 1968 (unclassified). CRESS/CINFAC R-1109. 241 pages.

THE VIET CONG

41. *The Communist Insurgent Infrastructure in South Vietnam: A Study of Organization and strategy.*—AD 655-506 and AD 655-507. Michael Charles Conley, July 1967 (unclassified). Published as Department of Army Pamphlet No. 550-106. Volume I, xii+215 pages, bibliography, maps, and volume II, vi+354 pages.
42. *Duration of Military Service for the North Vietnamese and the Viet Cong (U).*—Arthur S. Abbott, May 1967 (confidential). CRESS/CINFAC R-0914. iv+38 pages, bibliography, appendix.

43. *Viet Cong Truces To Suspend Hostilities, January 1964–February 1967.*—Skaldrite (Maliks) Fallah, February 1967 (unclassified). CRESS/CINFAC R–0806. 4 pages.
44. *Human Factors Considerations of Undergrounds in Insurgencies.*—AD 645–518. Andrew R. Molnar et al., December 1966 (unclassified). Published as Department of Army Pamphlet No. 550–104. xxix+377 pages, illustrated, appendix.

CASE STUDIES

45. *Casebook on Insurgency and Revolutionary Warfare: 23 Summary Accounts.*— AD 416–553. Paul A. Jureidini et al., December 1962 (unclassified). ix+607 pages, 22 figures, index.
46. *Case Studies in Insurgency and Revolutionary Warfare: Vietnam 1941–1954.*—AD 436–429. Bert Cooper et al., January 1964 (unclassified). x+159 pages, 17 figures, bibliography, appendix, index.
47. "South Vietnam (1956–1963)." Bernard B. Fall. Chapter 12 in *Challenge and Response in Internal Conflict: The Experience in Asia.* Volume I. AD 666–747. D. M. Condit and B. H. Cooper, Jr., editors, February 1968 (unclassified). Pages 331–375.
48. *Internal Defense Against Insurgency: Six Cases.*—AD 645–939. Adrian H. Jones and Andrew R. Molnar, December 1966 (unclassified). v+144 pages, 10 figures.

BIBLIOGRAPHIES

49. *The Land and People of Vietnam: A Selected Bibliography.*—Skaldrite (Maliks) Fallah, October 1966 (unclassified). CRESS/CINFAC R–0683, 38 pages.
50. *Bibliography of Materials on Selected Groups in the Republic of Vietnam.*—AD 643–989. Asia Branch, CINFAC, December 1966 (unclassified). ii+30 pages.
51. *Bibliography on Witchcraft, Sorcery, Magic and Other Psychological Phenomena in Southeast Asia.*—Skaldrite (Maliks) Fallah, October 1965 (unclassified). CRESS/CINFAC R–0214. 8 pages.
52. *Selected Sources of Demographic Information: Republic of Vietnam.*—Compiled by Norman A. LaCharite, May 1966 (unclassified). CRESS/CINFAC R–0503. 19 pages.
53. *A Selected Bibliography on the Internal Defense and Internal Development Operations in the Republic of Vietnam.* Skaldrite (Maliks) Fallah, July 1966 (unclassified). CRESS/CINFAC R–0589. 28 pages.
54. "Vietnam," in *A Bibliography of Internal Defense Electives.*—Skaldrite (Maliks) Fallah, January 1967 (unclassified). CRESS/CINFAC R–0738. 30 pages.
55. *Suggested Sources for Research on Viet Cong Logistics (U).*—Walton C. Manee, June 1966 (For official use only). CRESS/CINFAC R–0549. 8 pages.
56. *A Selected Bibliography Dealing With the Relationships Between American Advisors and Their Vietnamese and Thai Counterparts.*—Skaldrite (Maliks) Fallah, October 1966 (unclassified). CRESS/CINFAC R–0680. 38 pages; enclosure I, "Classified CRESS Studies Dealing With the Relationships Between American Advisors and Their Vietnamese and Thai Counterparts (U)" (for official use only). 4 pages.

STATUS OF CONTRACT WITH AMERICAN UNIVERSITY FOR CRESS

Mr. LIPSCOMB. General Betts, when do you have to firm up this CRESS contract, or contractual relationship? You have been told to depart the American University campus by now, haven't you?

General BETTS. No. You see, the rented facility is not on the campus, Mr. Lipscomb, and that hasn't been a direct problem once the university announced that they do plan to sever the contract.

Mr. LIPSCOMB. Perhaps I phrased it incorrectly. Are your relationships with American University at an end?

General BETTS. Not completely. They still have a contractual responsibility to us.

Mr. LIPSCOMB. Up until what date?

General BETTS. Long before that contractual responsibility runs out, we will have accomplished the change and we will move just as fast as we can find an adequate contractor and come to an agreement on contract terms.

Mr. LIPSCOMB. Suppose the Congress didn't agree with the idea that CRESS ought to continue? Can you cancel it off in any fiscal year?

General BETTS. It is provided in the contract that if the Government wishes to terminate for its convenience we can always do so. We pick up certain termination costs to do so.

TRANSFER OF CRESS PERSONNEL TO ANOTHER CONTRACTOR

Mr. LIPSCOMB. Is it your intent right now to take the whole staff of CRESS and just move it to another contractual relationship?

General BETTS. Yes, sir.

Mr. LIPSCOMB. And the only thing that you are going to change is the management by American University of the CRESS contract?

General BETTS. That would be the only immediate change; depending on the institution that took over the contract. I would expect to see changes internally in the CRESS structure because the research institutes that have expressed interest have comparable capability and I would expect to see internal changes.

Mr. LIPSCOMB. Why don't you just cancel out CRESS?

General BETTS. Because it is a very important capability to the Army, Mr. Lipscomb.

Mr. LIPSCOMB. You changed the name once. What was its name before?

General BETTS. It used to be called the Special Operations Research Office.

Mr. LIPSCOMB. And it got in trouble at that time?

General BETTS. It got in trouble in the Camelot program.

Mr. LIPSCOMB. So you changed the name?

General BETTS. Since that time we have a new director. The particular person who gave us the problem in Camelot, the one particular scientist who used less than prudent judgment in Chile and got us in trouble in the Camelot operation was never a member of the CRESS staff and was used only as a consultant. I believe that at the very low level of effort at which we support this program it is a very useful adjunct to Army staff and planning activities. Witness the fact that we are called on by Army agencies and staff elements for far more research and reports than CRESS can possibly do in any fiscal year, so that we are constantly in the problem of sorting out the priorities of effort to satisfy the people who ask for help from CRESS.

Mr. LIPSCOMB. Have we already asked for the accomplishments of CRESS for fiscal year 1969 to be put in the record?

General BETTS. We asked for the list of studies, but I would be glad to expand on it and pick out the accomplishments specifically.

STUDY OF COMMUNIST CHINESE MILITARY PERSONNEL

Mr. LIPSCOMB. Did you complete a study entitled "Beliefs and Habits of the Communist Chinese Military Personnel"?

General BETTS. I would have to check that out, Mr. Lipscomb. If it was on our prior listing, I suspect that we did.

Mr. LIPSCOMB. Would you put in all the details on that particular study?

General BETTS. Yes, sir.

(The information requested follows:)

The research effort entitled "Beliefs and Habits of Certain Foreign Populations of Significance for Psychological Operations," classified "confidential" was initiated in August 1967. Data collection and report writing stages of this effort have been completed and a final report is expected to be submitted to the Army in November. Total cost of the project is $89,000.

The objective of this project was to describe the ———.

The research information was gathered solely from various academic and Government sources and the experiences of the principal investigator. Documents have been interpreted and results presented in a form useful for the military audience.

Army psychological operations programs must be based on a thorough understanding of the target audience. ———.

VARIOUS CRESS STUDIES

Mr. LIPSCOMB. Do you know about this proposed study, "Phases of Behavioral Change in Foreign Populations During Situations of National Crisis?"

General BETTS. I don't know the details of the requirement, no, but I would be glad to furnish that.

(The information requested follows:)

The research effort "Phases of Behavioral Change in Foreign Populations During Situations of National Crisis" was begun in 1967 in response to a requirement from the U.S. Continental Army Command. The research was completed at the end of fiscal year 1968 with a report titled "Psychological Operations: A Method of Effecting Behavioral Change." Although the report provides a review of previous theory on the subject and provides reference material, it was judged not to be of sufficient use Army-wide to justify formal publication and distribution. The cost of this research was $23,080.

Mr. LIPSCOMB. When you mentioned that this "Studies of African Groups" was canceled because of higher priority requirements, do you know to what higher priority requirements the funds were reprogramed?

General BETTS. I would have to research that, Mr. Lipscomb.

(The information requested follows:)

In fiscal year 1970 the funds available after the termination of the African research will be devoted to priority problems associated with ———. The results will be followed closely by the appropriate Department of Army staff agency.

Mr. LIPSCOMB. Do you still maintain an office down at Fort Bragg for CRESS?

General BETTS. Yes, we do.

ACCOMPLISHMENTS OF CRESS GROUP AT FORT BRAGG

Mr. LIPSCOMB. What do you think the representative down at Fort Bragg accomplished this past fiscal year?

General BETTS. I would have to research that to give you a good answer.

Mr. LIPSCOMB. Is there anybody here who knows what CRESS did last year?

General Betts. In a general sense; yes, sir.

Mr. Lipscomb. Did they do anything?

Colonel Snead. Yes, sir. They continued to be responsive to specific requests from the Army staff and the Army commands for research or information required by those commands in their complete contingency planning effort. They provided information that was useful in the school training program, for example, in the advisory schools, or the programs preparing officers to serve in an advisory capacity, making inputs to better prepare them to understand the nature of the people, the thought processes of the people where they were going to be assigned.

(Staff note: The following additional information was supplied by Colonel Snead for the record.)

The Center for Research in Social Systems (CRESS) representative at Fort Bragg maintained a continuous liaison between CRESS scientists and operating military personnel at the Special Warfare School, Civil Affairs School, Military Police School, three field agencies of the Combat Developments Command, three special forces groups, one psychological operations group, and one civil affairs group.

This is a two-way operation. He assisted the military personnel at the installations in conveying their research needs to the research scientists and, at the same time, was instrumental in insuring that the research scientists were more responsive to these research requirements. Since authors of Army field manuals, classroom instructors, commanders, and staff officers of the schools and operational groups have extensive need for CRESS research products he was able to furnish guidance to them on the use that they could make of CRESS products.

He assisted research scientists in developing research plans to insure that data collected in the field would be pertinent and useful. He made arrangements with the military organizations for data collection and actually assisted the research scientists.

FUNDING OF CRESS OPERATIONS

Mr. Lipscomb. Colonel, are you the one in direct contact with Cress?

Colonel Snead. It is in my total program area. We have within the Army staff those who monitor the program in detail directly, sir.

Mr. Lipscomb. What is the total fiscal funding for Cress for fiscal year 1969?

Colonel Snead. For 1969, $1,960,000, I believe, sir.

Mr. Lipscomb. The whole amount?

Colonel Snead. Yes, sir.

Mr. Lipscomb. What is the sum scheduled for Cress for fiscal year 1970?

Colonel Snead. $2.1 million.

Mr. Lipscomb. How many personnel does this program have planned for 1970?

Colonel Snead. I haven't that right before me. I can provide that for the record.

General Betts. I have it, sir. Thirty-four professional researchers in the Social Science Research Institute and 26 professional staff in the Cultural Information Analysis Center.

I could expand on the accomplishment question by a summary statement that is prepared by the staff. It says that over 150 technical reports were published, 28 of which were completed during fiscal year 1968—and I don't have the number of completions during 1969. Over half of these had direct relevance to Southeast Asia. Fifty-six dealt specifically with Vietnam and the conflict in there. Over 30 reports

were on topics of insurgency and internal defense developments such as the Communist insurgent infrastructure in South Vietnam. Challenge and response in internal conflict; internal defense against insurgency. There were over 70 reports on psychological operations, foreign cultural evaluations, such as inter-cultural communications guides, Vietnam and Korea; cultural meanings assessed by associated group analysis.

The important thing to me is that so many elements of government call on them for help. They served over one thousand specific responses in the past 3 years, some of them from DOD, some of them from the Joint Staff, Army, Navy, Air Force, State Department, as well as——

UNREIMBURSED CRESS STUDIES

Mr. LIPSCOMB. Is this on a reimbursable basis?

General BETTS. Within government, it wouldn't be on a reimbursable basis, no, sir.

Mr. LIPSCOMB. Why not? Why wouldn't State pay for their share?

General BETTS. Well, our feeling is that if the information is readily available and we can serve other elements of government, the bookkeeping would probably cost more than we would collect from them.

Mr. LIPSCOMB. You know, General, that lots of work is done on a reimbursable basis.

General BETTS. We do. We do. We do a great deal.

Mr. LIPSCOMB. You know, General, that, if the State Department has a requirement for something Cress has to offer, then the State Department can pay for it?

General BETTS. Yes, sir.

Mr. LIPSCOMB. But the fact is that the Department of Defense is so flush with money that they can do all these studies for all of Government. I suppose that is the reason. There is just so much money in the Defense Department—particularly the Army—that it can work for any Government agency.

General BETTS. I think our response has been that we felt we had the information——

Mr. LIPSCOMB. You didn't have the information if they asked for it. Didn't they lay out the requirements?

General BETTS. I am sure they did.

Mr. LIPSCOMB. You mean you had the staff and the capability to get the information?

General BETTS. And the library and the expertise in that particular field that presumably was not available to them somewhere else.

TERMINATION OF CRESS PROGRAM

Mr. LIPSCOMB. It is time to start cutting down some of this some place and Cress is a very worthwhile candidate for cutting as far as I am concerned. It has been for years.

General BETTS. You and I have had to differ on that over the years, Mr. Lipscomb.

Mr. LIPSCOMB. Now is a good time to knock it out completely.

General BETTS. I just have a contract agency to support those elements of the Army who have asked for this kind of service and

I assure you that the Army has asked me for more of this kind of help than the resources available to me to supply it.

Mr. LIPSCOMB. We have other places to put $2.1 million now.

General BETTS. But we have no place to turn to to get this kind of help if we cut it off.

Mr. LIPSCOMB. Turn to the Air Force or ARPA with its Project Agile or some of the other places. Check on duplication of effort.

General BETTS. Agile does not do this sort of thing.

Mr. LIPSCOMB. Ask Rand.

General BETTS. I think Rand does not do this sort of thing. The experts are at Cress and the library is there.

Mr. LIPSCOMB. There is a wealth of such information available around here and we can get by without a $2.1 million operation at Cress at this time.

General BETTS. I don't believe we can, sir.

STATUS OF OTHER ARMY RESEARCH CONTRACTS WITH AMERICAN UNIVERSITY

Mr. RHODES. General, how many other research contracts does the Army have with American University that come under your purview?

General BETTS. I would have to look at that. I don't have it ready and available, Mr. Rhodes.

Mr. RHODES. Furnish it for the record, will you please?

General BETTS. Nothing like this that I know of.

(The information follows:)

The Army has one other contract with the American University that falls under the purview of the Chief of Research and Development. It is contract number DA44009AMC1386(T), "High Energy Chemical Electro Storage Research." It was initiated in November 1965 and total cost to date is $158,340.

Mr. RHODES. Were all of these contracts reviewed by the same board of faculty and students who decided that CRESS should no longer be in the American University span of endeavor?

General BETTS. In a policy sense they are reporting to the university on what they felt should be the university policy with respect to supportive research. In that context, their report applied to all supported research across the board. I don't think that they went through the contract structure looking at each individual contract, but they may have. I would have to furnish that.

Mr. RHODES. American University has decided to ask for release from all Army research contracts?

General BETTS. No, sir.

Mr. RHODES. Now, I am confused.

General BETTS. Remember my comment earlier. What this committee recommended was that the university should not be mixed up in the supportive research that did not relate to their basic mission, which is to teach. Most of their individual investigators who are supported either by the Army or National Science Foundation, or whatever, do have a relationship to the teaching program and the kind of research they do is related to their ability to teach.

Mr. RHODES. Who decided that CRESS did not? Was it the committee or was it the administration of American University?

General BETTS. The administration of the university looking at the policy recommendation of the committee.

Mr. RHODES. How many other contracts have received a similar decision insofar as American University is concerned?

General BETTS. I don't know. I would have to ask American University. No other Army contracts that I know of.

Mr. RHODES. You ask somebody and put it in the record. I am talking about the contracts in your purview. I am not talking about anybody else's contracts.

General BETTS. As I say, none that I know of within the Army. This was the only one brought to my attention at that time.

Mr. RHODES. If you find that the answer is different, please correct the record.

(The information follows:)

The other Army research contract with the American University within the purview of the Chief of Research and Development—"High Energy Chemical Electro Storage Research"—is still active. This contract, unlike the one for the operation of CRESS, involves no classified work and is not in opposition to university guidelines for sponsored research. This contract will continue until the work has been completed.

BIOLOGICAL-MEDICAL INVESTIGATIONS

TOTAL FUNDING FOR MEDICAL RESEARCH IN 1970

Mr. MAHON. The Army is requesting a program element under exploratory development in the area of "Biological-Medical Investigations" to be funded at the level of $24.1 million in fiscal year 1970. We just discussed "Biological-Medical Sciences" under research for which you are requesting $22.4 million. Tell us for the record the total sum requested in R.D.T. & E., Army, for medical programs?

(The information requested follows:)

The total sum requested for Biological-Medical programs in R.D.T. & E., Army, for fiscal year 1970 is $66,940,000.

INCREASED FUNDING FOR BIOLOGICAL-MEDICAL INVESTIGATION

Mr. MAHON. Biological-Medical Investigations was funded at $20.6 million in fiscal year 1968, $22.9 million in fiscal 1969, and you are requesting $24.1 million for 1970. This is approximately a 10-percent increase each year. Why is an annual increase of this magnitude required?

General BETTS. The increase for fiscal year 1969 resulted from the need for continued investigation of the many tropical diseases associated with military operations in Southeast Asia. Emphasis on the field evaluations of vaccines and continued investigation of other military preventive medicine problems as well as studies to improve surgery under field conditions and the associated studies on trauma and shock accounted also in part for the increase. Studies to extend the storage time of whole blood and laser research to determine the extent of damage to tissues and the establishment of safety standards and a modest cost of living increase are other examples explaining the rise in funding from fiscal year 1968 to fiscal year 1969. The increase from fiscal year 1969 to fiscal year 1970 is required for the modest

cost of living increases, and continued investigation of medical problems of military importance. Increased funds are required for investigation of tropical diseases and medical problems associated with tactical operations of helicopters in Southeast Asia. For example, knowledge is needed in the role of disorientation in helicopter accidents. Increased funding is necessary to conduct clinical research within Army hospitals in the medical residency program. Research to improve management of mouth, jaw and face war injuries requires additional funding.

Mr. MAHON. How much of the $24.1 million requested is directly related to medical problems in Southeast Asia?

General BETTS. Of the $24.1 million requested, about $10 million is related to medical problems in Southeast Asia?

Mr. MAHON. What part of this program is accomplished within the Army?

General BETTS. Of the total of $24.1 million requested in fiscal year 1970 for this program, $13,850,000 or approximately 58 percent is accomplished within the Army.

Mr. MAHON. For the record tell us how many organizations are performing research in this area for the Army in fiscal year 1969? How many contractors are academic institutions? Nonprofit organizations? Industrial?

(The information requested follows:)

Within Biological-Medical Investigations, a total of 112 organizations are performing research. Of these organizations, 60 are academic institutions, 34 are nonprofit organizations and 18 are industrial.

PRESERVATION OF FOODS BY RADIATION

Mr. MAHON. What are the objectives of your research effort in the area of radiation preservation of foods? What questions have the Public Health Service raised with respect to radiated foods?

General BETTS. The objective of this project is to establish the technical feasibility of preserving food of Army interest by means of ionizing radiation. The ultimate goal is to provide troops everywhere with wholesome, highly acceptable, stable, fresh-like foods which require no refrigeration or special preparation prior to serving.

The Food and Drug Administration has questioned the Army's wholesomeness data on irradiated ham and bacon. This question can only be answered by additional animal feeding studies to resolve doubts on:

Adverse effects on rat and dog reproduction.

Adverse effects on mortality, body weight, and red blood cell count.

Suggested higher incidence of tumor and eye cataracts in some animal-fed irradiation diets.

Suggested production of an antivitamin or some antagonist to essential nutrients in diets treated with irradiation.

Mr. MAHON. How much has the Army spent in research on radiation preservation of food?

General BETTS. The Army has spent $23,596,000 on irradiated food research through fiscal year 1969.

Mr. MAHON. The fiscal 1969 budget requested $21,060,000 for biological-medical investigations. This justification book indicates that $22.9

million was allocated. What was the reason for this increase of almost $2 million, and what was the source of the increased funds?

General BETTS. The increase of $1.8 million represents the statistical allowance of $1.6 million for facilities and installation support which in previous years was carried under a separate line item. In fiscal year 1969, facilities and installation support funds were redistributed from the management and support category into the biological-medical investigations programs. The remaining 0.2 million was a reprograming action in the combat surgery project of the biological-medical investigation subelement.

ATMOSPHERIC INVESTIGATIONS

FISCAL YEAR 1969 FUNDING

Mr. MAHON. With respect to atmospheric investigations, you are requesting $5.1 million in fiscal year 1970 as compared to $5.9 million in fiscal year 1969, and $5.7 million in fiscal year 1968. Last year this effort was included under "Environment."

What changes were made in the classification of these projects? Will you give us some feeling for why the changes were made?

General BETTS. I will have to furnish that for the record, Mr. Chairman. I don't remember, or know what the change related to.

Mr. MAHON. Will you do that, please.

(The information follows:)

The previous environmental sciences exploratory development program included both atmospheric and terrestrial investigations. Terrestrial investigations has now been established as a separate program element and includes projects in support of the Chief of Engineers Military Construction R. & D. mission. Atmospheric investigations has also been established as a separate program element for all previous environmental sciences 6.2 projects assigned to the Army Materiel Command. These changes were made to provide increased visibility and relevance within these programs and facilitate reporting and coordination procedures with separate Federal committees.

METEOROLOGICAL ROCKET PROGRAM

Mr. MAHON. The fiscal year 1969 budget requested $465,000 for "Meteorological rocket program." The fiscal year 1970 budget indicates that the $742,000 was programed in this project in fiscal year 1969 and that $885,000 is requested in fiscal 1970. What is the reason for the increases in this area?

General BETTS. At the time of the fiscal year 1969 request, the meteorolgical rocket program was reduced from the fiscal year 1967 and fiscal year 1968 levels to provide part of the funds for continuation of the personnel detection project initiated in fiscal year 1968 with Office, Secretary of Defense Emergency Funds. During fiscal year 1969, it was necessary to reprogram from other projects to provide a total of the $742,000 required for the Department of the Army to meet its commitment to a joint meteorological rcoket program with Canada. The increase to $885,000 in the fiscal year 1970 request includes amounts for management costs and increased costs of living. The level of effort has not increased and is consistent with the priority for Army meteorological rocket requirements.

Mr. MAHON. The fiscal 1969 budget requested $750,000 for "Meteorological equipment and techniques development." The fiscal 1970 budget indicates that $1.3 million was allocated to "Meteorological equipment techniques" in fiscal 1969 and that $1.7 million is requested in fiscal year 1970. Are these the same programs and why the large increase in this area?

General BETTS. These are the same projects. The increase from the $750,000 requested for fiscal year 1969 to the $1.3 million allocated in fiscal year 1969 is attributed to two causes. Part of this increase resulted from the statistical redistribution to specific projects of program management support funds. The remainder resulted from a reprograming action initiating efforts on an automatic meteorological system to support Army weapons systems.

Mr. MAHON. You are not requesting funds in fiscal 1970 for the project entitled "Personnel detection." What was gained from this effort?

General BETTS. A 2-year program at a total cost of $3.345 million over fiscal years 1968 and 1969 was undertaken to investigate two problems arising with a new item of equipment to detect the presence of insurgents ———. Two problems were investigated: What was the ———. The determinations described above led to equipment simplification and weight reduction. Consequently, later models procured to support operations cost less.

Mr. MAHON. Why must the Army continue to spend funds to test meteorological rockets? Why couldn't you use rockets developed by the Air Force, Weather Bureau, NASA, or others?

General BETTS. The development, testing, and use of meteorlogical rockets is closely coordinated among Federal agencies. One rocket developed by the Navy and Air Force, though in general use, was not completely satisfactory and very expensive. An Army tactical rocket was modified during production and adopted as an expedient solution to satisfy the need for a meteorological rocket.

The current Army project was initiated to develop a consumable meteorological rocket for use outside of established missile ranges. Two separate rockets are desired: one to reach an altitude of 32 kilometers as a part of the new Army sounding equipment to support artillery; and one for research and range support programs to go to an altitude of 100 kilometers. If these objectives cannot be fully achieved at an acceptable cost, the project will still produce a meteorological rocket that will represent a major reduction cost per item. This program is coordinated among all interested agencies.

The Weather Bureau does not attempt to develop meteorological rockets. National Aeronautics and Space Administration has shared the costs of hazard and design studies. At present, nonconsumable rockets are being designed and flight-tested jointly with Canada. Canada is assuming more than half the contract costs. The Air Force has agreed to procure rockets developed by the Army, if the tests prove successful, and will provide a portion of the test costs.

Mr. MAHON. What is your requirement for the development of automatic weather stations? What other efforts in this area are carried out within the Government?

General Betts. The requirement is for a small equipment package for air drop into inaccessible areas to automatically sense the meteorological conditions and telemeter the information over short distances. The data will provide measurements needed for direct support-type operations; in other words, artillery fire, surveillance activities, or logistical air drops. This will be in addition to the general weather forecast information obtainable from the Air Force in the tactical area concerned.

PROJECT OBJECTIVES

Mr. Mahon. Is there someone here who can tell us generally in a sentence or two what is being done under these atmospheric investigation projects? Can you do that, Colonel Snead?

Colonel Snead. I can give part of it, sir.

The Army's direct interest in atmospheric sciences and that part that is separate from the other programs, the other national programs and the other service programs, are those parts that generally are characterized by being close-in to Army operations in the field. There are several examples, such as the very precise meteorological data required for precise artillery prediction. This is the type of information that must be available, current, and accurate, to the artillery system in the field at all times. So that in addition to the larger range meteorological information that comes from the other prediction, or weather forecasting services such as the Air Force, the Army requires that some precise data for its own operation.

Similarly in the operations in the field, and particularly with the growing number of Army helicopters, and the question of weather influence on helicopter landings and helicopter visibility becomes extremely important. The Army is involved on a cooperative basis with the other services on those research aspects that are unique to Army helicopter operations, such as when the weather conditions close in on landing zones on a very short period of prediction. What can be done locally to modify the visibility with materiel that is appropriate and supportable in the field?

Mr. Mahon. Did you learn anything about that?

Colonel Snead. The Army has had some interesting results in tailoring, or proper positioning of helicopters so that the down-wash from the helicopter can, by build-up, slowly clear the immediate landing zone and give visibility of the landing zone once the approaching helicopters get into the area, cleared by the down wash. This is just starting. We feel that there is potential there for much more, and part of our research is oriented in that direction.

In addition, the Army has meteorological and atmospheric science requirements in its test programs. During the conduct of tests it is important that we are able to describe exactly what the weather conditions were during the period of test so that we are able to properly evaluate how much weather the equipment was actually exposed to. If it were not sufficiently exposed to give a true, valid determination as to its ability to operate in such weather, then it becomes necessary to include or add this period of testing back into the test program.

Corollary to that, of course, is the necessity that the Army be familiar in detail with the type of weather conditions that will pertain in potential areas of operation so that we can describe these to the

test commands and we can make sure the equipment is tested against this weather.

A final—and one that does in fact use a great deal of our atmospheric sciences staff—is our responsibility for the support of the national ranges, specifically the White Sands Missile Range, in which the Army has responsibility for meteorological support that would cover that facility.

Terrestrial Investigations

INVESTIGATION OF NEW MATERIALS FOR CONSTRUCTION

Mr. Mahon. With respect to terrestrial investigations, you want $4 million for fiscal year 1970. You had a smaller sum last year, and a smaller sum the prior year. What is involved in the new program entitled "Military Engineer Design Expedient Construction?" What is that all about?

Colonel Snead. Sir, this represents an organized approach to an old problem. For example, in Vietnam at the time of the buildup, it became necessary to quickly construct—because there were no adequate facilities there—the essential expedient-type construction to house and support the U.S. forces.

The purpose of this program is to look carefully into new approaches that might make better use of either new materials or indigenous materials, and to attempt to reduce the hammer and saw and cement approach where possible; to hopefully reduce the need by better identification of what local materials might be adapted to reduce the need for the necessary importation of construction materials in areas where they are not available.

Mr. Mahon. Is this highly theoretical?

Colonel Snead. No, sir; it is directly practical, and that the program is designed to look into practical applications of either new materials or the modification of existing materials in-country.

For example, are there ways of using building materials in-country that will do the same thing as cement, if it is only for a temporary period, to provide a hard stand and how to insure that that information is available to the engineer on the scene so that he can make his judgments and select the local materials.

EVALUATION OF GEOGRAPHIC AREAS

Mr. Mahon. What do you mean when you make reference to "Military evaluation of geographic areas" for which you are requesting $450,000?

Colonel Snead. I can speak to this, sir, with several examples. There is a continuing need to insure that as Army and other service materiel changes that we maintain pace with our knowledge of the particular geographical conditions in which it may operate. For example, cold weather operations. If the Army, with its mission to provide airfield construction technology support to the Air Force, must know precisely what the geographical considerations are in cold regions and other regions, as pertain to the changes in Air Force aircraft——

Mr. Mahon. You can expand on that for the record.

(The information follows:)

The project, Military Evaluation of Geographic Areas, is concerned with the development of analytical models for analyzing the effectiveness of materiel and/or military activities in operational environments. Mathematical models are used to predict the performance of off-road vehicles, rate of cross-country movement of infantry on foot, behavior of a projectile impacting on soil, and performance of large-yield conventional munitions as a means to rapidly construct emergency helicopter landing zones. Analytical models are used to relate vegetation to terrain conditions.

The project seeks methods for acquiring, storing, retrieving and processing environmental data for terrain analysis and for constructing parametric (or synthetic) terrains for use as scenarios in operations analysis. In this connection, automatic recording instruments (cone penetrometer, meteorological sensors, digital recorder, laser theodolite) are developed for rapid acquisition of environmental data in the field.

PERMANENT CONSTRUCTION MATERIALS TECHNIQUES

Mr. MAHON. What is the objective of "Permanent Construction Materials Techniques" for which $400,000 is requested?

Colonel SNEAD. There is the corollary in the permanent construction to the expedient-construction program.

Mr. MAHON. You can elaborate on that.

(The information follows:)

The objective of the permanent construction materials and techniques is to provide new knowledge essential for permanent construction to support fixed weapon systems, improved communication centers, logistical support systems, and hardened installations. Research is conducted to reduce construction time, effort, and costs, improve materials and techniques to enhance reliability, maintainability, and reduce life-cycle costs of future contract constructed military facilities.

Studies are conducted on sealants for waterproofing structures, use of bamboo and other locally available material for reinforcing concrete, and techniques for extruding construction components. Theoretical studies are conducted on the response of soil and structures to dynamic ground motions. Shock spectra criteria are developed for assessing weapon-induced ground shock damage to critical military structures. Procedures are developed for management control of engineering design, construction, and maintenance. New techniques are developed for nondestructive testing, determining electromagnetic effects on materials, and seismic wave propagation in earth materials to determine geophysical properties. Methods are developed for obtaining, storing, analyzing, and updating technical data for Army construction of facilities.

ENGINEERING RESEARCH LABORATORY

Mr. MAHON. Discuss the "U.S. Army Construction Engineering Research Laboratory" which is scheduled to be completed this month. What will be the annual cost of this facility? Is it a Government-owned facility? How many personnel will be involved?

General BETTS. In the recent past the Chief of Engineers has established a research center for construction research and development under contract with the University of Illinois. As far as I am concerned, in the whole construction business, that is probably the most significant single step we have taken in years because traditionally we have left the whole business of research up to the materials suppliers and to the architects and engineers to create new techniques for building a building. But there has never been any centralized approach to research and development related to the whole question of construction and that has been a real lack.

Now, this is just beginning, but I predict in time we will be able to apply modern system-oriented analysis to the construction that we have been applying for years to major weapons systems.

COORDINATION OF HOUSING RESEARCH EFFORT WITH HUD

Mr. MAHON. Mr. Romney, the Secretary of Housing and Urban Development, as I understand it, is interested in considerable research in the field of construction. Is there any relationship between what is being done by the military and what is being done by Housing and Urban Development?

General BETTS. It is my understanding that they are working very closely together in their mutual planning of the future research and development efforts.

Mr. MAHON. Is there anybody here who foresees any dramatic breakthrough?

General BETTS. I think it is too early in terms of what the Chief of Engineers has started doing. I would have to leave it up to HUD to decide what they have to say on the subject.

Mr. RHODES. What type construction are you talking about? You are not talking about civil functions of the Corps of Engineers in the construction of dams and the like, are you?

General BETTS. I am talking to the general problem of construction that is faced by the Chief of Engineers. It goes all the way from housing to major buildings.

Mr. MAHON. I would assume it might relate to some extent to dams.

Mr. POOR. It is my understanding that it does not relate to dams at all. It is primarily concerned with application of current technology to the inexpensive construction of buildings of all sorts.

Mr. MAHON. Temporary and permanent?

Mr. POOR. Temporary and permanent. It deals particularly with new plastics and new materials that don't fit easily into the current building trades environment and makes use of such things as plastics and prefabricated components, building block construction. I think it is an extremely promising thing which ultimately may have a real application in the civil community, with the proviso we can make these techniques also acceptable to the labor unions. It has been really a serious problem in the building trades.

Mr. MAHON. Will you check this testimony and confer, if necessary, with the Army Engineers and clarify the record as to this program so that we can have a comprehensive understanding of what you propose?

Mr. POOR. Mr. Chairman, I will be happy to.

(The information requested follows:)

The U.S. Army Construction Engineering Research Laboratory is a class II activity under the Chief of Engineers. The laboratory will develop, through investigations and analytical study, methods of advancing concepts and technology for the planning, design, construction, operation and maintenance of fixed weapon, communication and logistic facilities. The laboratory will advance and disseminate knowledge of new and improved construction materials and techniques in the interest of national defense and the conservation of national resources. Studies will be conducted on the advantages of industrialized construction, off-site prefabrication and optimum scheduling of deliveries and module erection.

The laboratory building will be leased from the Interstate Research Park in cooperation with the University of Illinois. The laboratory will be staffed by Government personnel and all equipment will be Government owned. By December 1969, the staff is expected to consist of two officers and 150 civilians. Fiscal year 1970 budget is $2.6 million. It is planned to expand this laboratory as qualified people and additional funds become available.

USE OF QUONSET HUTS

Mr. ANDREWS. What happened to the old World War II quonset huts? Have you used them in Vietnam? Why would they not be very suitable to that country?

General BETTS. We have used them in appropriate circumstances.

Mr. ANDREWS. You had the Pacific full of them during World War II. I can't conceive of a cheaper type of construction than a quonset hut. You can throw them up overnight. They can be as big as you want or as small as you want.

General BETTS. Except it has to be hauled away from the United States, all the way to Vietnam and what we are seeking in some of this temporary construction is a technique for using local materials that will save that shipping.

Mr. ANDREWS. Just what do they have down there, General?

General BETTS. They have lumber in quantities; they have local materials; gravel, sand.

Colonel SNEAD. Mr. Chairman, I might add something at this point. This is in the exploratory development program. One of the very important benefits that the Army gets from participating in this type of program is, it couples our own laboratory people very closely to current technology in this area. It prepares them to better meet their responsibilities in describing precisely the specifications for the construction of military buildings.

HARDENED ANTIBALLISTIC MISSILE MATERIALS

Mr. MAHON. With respect to hardened antiballistic missile materials, you apparently are requesting ———. That appears to be a new program, yet we have been working on the hardening of various types of missile sites over a number of years.

What problems associated with ABM materials do you seek to overcome?

General BETTS. ———.

Mr. MAHON. Haven't you been working on this problem heretofore?

General BETTS. Yes, sir; we have.

We created it as a new program element to give visibility to the effort because we considered it so important.

COMPUTERIZED INSTRUCTION FOR DEFENSE LANGUAGE INSTITUTE

Mr. MAHON. You are requesting $1.4 million in fiscal year 1970 for "Education and training development" as compared with $850,000 in fiscal year 1969 and $495,000 in fiscal year 1968. What is your justification for such a large increase in this program?

General BETTS. In fiscal year 1968 this element supported the computer administered instruction program. In fiscal year 1969 this element was increased to provide for an additional program directed toward curriculum modernization and improved tests and measurements in the Defense Language Institute. In fiscal year 1970 both of these programs are increased to provide for progressive phases planned in both programs.

Mr. MAHON. For the record tell us the urgency of this program. You budgeted $1.2 million in this area in fiscal year 1969 and only allocated $850,000. Could much of this program be further deferred without serious consequences?

General BETTS. A deferral in this program will have serious consequences. This is a development program rather than research. It is through this program that we develop and apply to Army training the advances that Army research, industrial, and educational research have made available. As I explained, the two efforts within this program are relatively new. We feel this program is very important and have emphasized the new applications in Defense language instruction program because of the progress that can be realized there. We are trying to bring that effort up to a level where the progress will occur within a reasonable period of time and not be unduly protracted. In our computer administered instruction effort, the staff, the hardware, the computer programs, and the instructional materials have been gradually integrated into a system for test and evaluation. The preliminaries are now complete. We must increase our level of funding in fiscal year 1970 in order to operate the system for test and evaluation purposes.

Mr. MAHON. For the record describe the "Computer assisted instruction" project for which you are requesting $800,000.

General BETTS. Research outside the Army has demonstrated the potential utility of the computer as an educational tool. The purpose of the Army effort is to assess the feasibility of using computer administered instruction (CAI) in Army training. We are developing a prototype system for test and evaluation. This will give us the basis for deciding when and how to use CAI and for specifying the optimum CAI system. Existing computers are used. We are developing the computer programs, the instructional methods, and the instructional materials and integrating these into a functional military CAI system. The evaluation phase was initiated in June 1969.

STUDIES AND ANALYSES

EFFECT OF CANCELLATION OF PROGRAM

Mr. MAHON. You are requesting $10 million for "Studies and analyses" as compared to $9.6 in fiscal year 1969. What kind of studies and analyses? What would happen if you abandoned this program and didn't have the $10 million?

General BETTS. Our structure for total life cycle of any new item of equipment or weapons system demands that during the formative stages we are interested in what technology can do to supply answers to problems we see within the military. That structure demands an extensive series of both design studies with respect to equipment and operational analysis studies with respect to how one might use that equipment.

Mr. MAHON. Would studies of this kind do any good on a project like the Cheyenne helicopter or the main battle tank, and so forth?

General BETTS. It certainly would and studies of this sort were very important to the beginnings of, say, the main battle tank and the Cheyenne. As a matter of fact, every major system. Furthermore, they

continue through the life cycle of the system. As we know more about the details of systems capability and limitation, as well as costs. For example, one very important factor in the Army approach to the question of whether or not we should continue the Cheyenne production contract was an analysis of whether or not a very much more expensive aircraft could pay its way as a gunship. So we went through some very important operational effectiveness studies related to cost to help the Army staff make up its mind as to whether or not we could accept cost growth in this aircraft and still find it a prudent purchase for the Army.

Now, actually those studies indicated that we could accept some cost growth. The real question yet to be decided, since we canceled that production contract, is what the cost growth will be once we have solved the present R. & D. programs. If we can get that aircraft for a reasonable price, there is no doubt whatsoever about its cost effectiveness. If the cost growth is more than I now think it will be, the answer will be pretty clear that we just shouldn't try to afford it, but we do need to do the analysis.

Mr. MAHON. You are requesting $10 million for "Studies and analyses" as compared with $9.6 million in fiscal year 1969. For the record, tell us why you require an increase in this area.

(The information requested follows:)

This amount represents a modest cost-of-living increase. Technical man-year effort remains constant.

LIST OF STUDIES

Mr. MAHON. Submit a tabulation of the fiscal year 1969 program in "Studies and analyses" showing the name of each study, the name of the organization performing the study, the total estimated cost of the study, the fiscal year 1969 funding, and the anticipated completion date of the study. Can you also supply similar data on the fiscal year 1970 program?

(The information requested follows:)

TABULATION OF THE FISCAL YEAR 1969 STUDIES AND ANALYSES PROGRAM

Study	Contractor	Total estimated cost (thousands)	Funding (thousands)	Anticipated completion date
FOREWON (automated force planning system)	Research Analysis Corp.	$3,905	$1,665	August 1970.
Gaming support for the Department of the Army	do	(1)	178	(1).
Research support in gaming	do	191	69	August 1969.
Simulation and gaming methods for analysis of logistics (SIGMALOG)	do	395	193	Do.
Analyses of integrated supply and maintenance systems.	do	93	93	Do.
Nike X in nuclear exchange	do	954	321	August 1970.
Force and system planning cost-information system	do	74	74	August 1969.
Personnel inventory analysis techniques (PIA)	do	194	194	Do.
Force cost model development	do	93	93	Do.
Counterinsurgency costing	do	63	63	Do.
Operations analysis and evaluation of SAM-D and related defense systems technology.	do	239	239	Do.
RACFOE (RAC field office Europe)	do	(1)	257	(1).
Simulation of personnel operations (SIMPO)	U.S. Army Behavioral Science Research Laboratory, Arlington, Va.	720	180	August 1970.
Intelligence analysis by machine	do	75	75	March 1970.
Force Portfolio (FORPORT)	Planning Research Corp.	95	95	(2).

See footnotes at end of table, p. 205.

TABULATION OF THE FISCAL YEAR 1969 STUDIES AND ANALYSES PROGRAM—Continued

Study	Contractor	Total estimated cost (thousands)	Funding (thousands)	Anticipated completion date
Ad hoc requirements, institutional research, miscellaneous.	Research Analysis Corp.	(2)	$183	(2).
Strategic analysis of Europe	do	$122	122	Aug. 31, 1969.
Strategic analysis of Northeast Asia	do	122	122	Do.
Strategic analysis of Southeast Asia	do	124	124	Do.
Strategic analysis of North Africa, Middle East, and South Asia.	do	95	95	Do.
Strategic analysis of Latin America	do	94	94	Do.
Strategic analysis of sub-Saharan Africa	do	71	71	Do.
Army's potential role in space	do	22	22	Do.
Latin American nuclear free zone (LANFZ)	do	29	29	Do.
Minor contingencies, their roles and their demands	do	26	26	Do.
U.S. and regional collective security arrangements (COLSEC)	do	75	75	Aug. 31, 1969.
Long-range environmental (LORE) studies, East Europe.	do	48	48	Do.
Science and technological support	do	(1)	269	(1).
Southeast Asia night operations equipment system development plan (SEA NITEOPS SDP).	do	29	29	July 1970.
Aggregate cost model for Southeast Asia night operations multiple systems analysis.	Resource Management Corp.	100	100	Do.
Project High Gear troop test	Technical Operations, Inc.	(1)	23	(1).
War game support (Cheyenne)	Research Analysis Corp.	(1)	250	(1).
Nonnuclear ammunition rates	Eyler Associates, Inc.	(1)	198	(1).
Evaluation of barrier systems	Technical Operations, Inc.	38	38	May 1969.
Tank, antitank/assault weapons system study (TATAWS) division war game.	do	164	164	(2).
Support of airmobile operation through destruction of enemy air defense system (SAMODEAD 75).	Booz-Allen Applied Research, Inc.	214	214	(2).
Terrestrial target analysis methodology for nuclear weapons.	Braddock, Dunn & McDonald.	75	75	(2).
Bulk petroleum facilities and systems	Technical Operations, Inc.	247	125	June 1969.
Combat operations loss and expenditure date—Vietnam (COLED-V).	Research Analysis Corp.	752	352	July 1969.
Airmobility in the mid-high-intensity, phase III war game.	do	480	80	February 1970.
Short takeoff and landing (STOL) utility fixed-wing airplane study.	Resource Management Corp.	100	100	December 1969.
Nuclear warfare operations	Institute of Combined Arms and support—research office.	916	916	November 1969.
Theater Army replacement system (TARS) evaluation and implementation tactical reconnaissance and surveillance.	Institute of Combined Arms and Support—Research Office.	201	39	(2).
Methodology for Army-85	do	130	130	November 1969.
Combat operations frequency Study (COF)	Technical Operations, Inc.	130	90	May 1969.
Field evaluation, mission effectiveness in a toxic environment (METOXE).	do	100	25	June 1969.
Target arrays—Threat 75	do	107	107	(1).
Standard target arrays	do	100	100	(1).
Optimum mix of artillery units (legal mix IV)	do	437	69	March 1971.
Preferential analysis methodology formulation and refinement land combat system 90.	Resource Manage Corp.	(1)	116	(1).
Family of aircraft study (FAAS-85)	Research Analysis Corp.	190	40	September 1970.
Tactical fire table data base	Oklahoma University Research Institute.	(1)	33	(1).
Probable Communist Tactics (Operational Behavior) for Takeover of Developing Countries post-Vietnam through 1985.	Research Analysis Corp.	130	42	August 1970.
Development of improved tactical war game model, DIVTAG II.	Institute of Combined Arms and Support-Research Office.	368	45	June 1969.
Comparison of airmobile and mechanized division level operations in a low-intensity type I environment (CAMDIV).	do	146	146	November 1969.
Logistic data base associated with the FM-101-10 series.	do	(3)	143	(1).
Development of a division level computerized simulation model for evaluation of combat developments doctrine (DIVSMO) (DIVTAG I).	do	120	120	January 1969.

See footnotes at end of table, p. 205.

TABULATION OF THE FISCAL YEAR 1969 STUDIES AND ANALYSES PROGRAM—Continued

Study	Contractor	Total estimated cost (thousands)	Funding (thousands)	Anticipated completion date
Air defense agency computer simulation capabilities and analysis of war game results.	Braddock Dunn, and McDonald.	140	140	January 1969.
Analysis of test experimental and other data pertaining to artillery effectiveness.	Oklahoma University Research Institute.	(1)	67	(1).
Development and analysis of alternative air defense systems for the Army (80-85).	Braddock Dunn, and McDonald.	150	150	June 1969.
Identification of dental diseases and conditions reducing combat effectiveness.	Technical Operations Inc.	195	195	(2).
Troop test mixed tank platoon	do	8	8	April 1969.
Troop test armor battalion light	do	4	4	Do.
Institutional research miscellaneous	do	(1)	72	(1).
Preparation for preferential analysis support—War games and simulations (manual war gaming) land combat system 90.	do	(1)	36	(1).
Automated force planning system—FOREWON	Research Analysis Corp.	3,905	600	August 1970.
Combat, combat support, combat service support. tradeoffs (CST).	do	150	150	September 1970.
Force mix of Army aircraft capable of instrument flight rules flight and of instrument flight rules formation flight.	do	250	250	August 1970.
Force unit cost information system	do	75	75	Do.
Cost factor development for use in estimating U.S. Army funds in support of the Republic of Vietnam Army, regional forces, and popular forces.	do	50	50	July 1970.
Cost data development	do	50	50	August 1970.
Developing cost factors for estimating equipment operating costs.	do	150	100	Do.
Personnel analysis system (PAS)	do	300	300	Do.
Simulation model of personnel operations (SIMPO II).	Behavioral Science Research Laboratory.	720	180	July 1970.
Reserve component personnel projection model (RCP^2M).	Research Analysis Corp.	200	200	August 1970.
Military logistic and mobilization bases of Warsaw Pact forces	do	35	35	September 1970.
Warsaw Pact security force trends	do	35	35	Do.
Methodology for force requirement determination (MEFORD)	do	200	200	August 1970.
Strategic analysis of North Africa, the Middle East, and South Asia.	do	105	105	July 1970.
Strategic analysis of Northeast Asia	do	70	70	January 1970.
Strategic analysis of Europe	do	70	70	August 1970.
Force interface study (FINS)	do	70	70	Do.
Asia defensive postures (AD POST)	do	70	70	Do
Alternatives to mobilization (ALT MOB)	do	52	52	Do.
Communications role in national development—including political, economic, and military considerations.	do	52	52	June 1970.
A strategic study of manpower resources in the Pacific area.	do	35	35	October 1970.
Model of the U.S Army worldwide logistic system (MAWLOGS).	do	550	350	August 1970.
Simulation and gaming methods for analysis of logistics—II (SIGMALOG II).	do	200	200	Do.
Model for integration of supply and maintenance operations in tactical support systems.	do	200	100	Do.
Expansion of prescribed load list (PLL)—multi-echelon stockage models to include essentiality, weight, and cube.	do	150	150	Do.
Technological alternatives and mixes for 1975-85 Army fire support systems.	do	350	350	February 1970.
Impact of projected employment of tactical communications satellites on the electronic environment of the field Army.	do	400	200	July 1971.
Roles of Nike X in nuclear exchange	do	546	225	August 1970.
Gaming support for Department of the Army	do	(1)	200	(1).
Ad hoc requirements, institutional research	do	(1)	160	(1).
Science and technological support	(3)	(1)	178	(1).
Target arrays—threat 85	Technical Operations, Inc.	200	116	(2).
Army avionics program	(4)	165	145	July 1973.
SAM-D firing doctrine study	(3)	125	125	(2).
Infantry battalion as a combat system	(3)	366	366	(3).
Nonnuclear ammunition rates	Eyler Associates, Inc.	200	160	April 1970.

See footnotes at end of table, p. 00.

TABULATION OF THE FISCAL YEAR 1969 STUDIES AND ANALYSES PROGRAM—Continued

Study	Contractor	Total estimated cost (thousands)	Funding (thousands)	Anticipated completion date
Operations research support for Army-75	Institute for Combined Arms and Support-Research Office.	(1)	180	(2).
Operations research support for combat arms and support-85.	....do	(1)	70	(2).
Hostile observation satellite systems (HOSS)	Technical operations, Inc.	450	450	July 1970.
Examination of the feasibility of developing a stability operations system (SOS).	....do	50	25	(2).
Design of the methodology for conceptual force gaming in support of land combat systems-90s preferential analysis.	(3)	(1)	280	(2).
TACFIRE table data base	Oklahoma University Research Institute.	232	33	July 1973.
Probable Communist tactics (operational behavior) for takeover of developing countries—post-Vietnam through 1985.	Research Analysis Corp.	130	90	August 1970.
Family of Army aircraft study 1970-85 (FAAS-85) follow-on studies.	....do	150	150	(2).
Functional area descriptions (FAD's) for Institute of Strategic and Stability Operations.	Technical Operations, Inc.	185	120	May 1970.
Airmobile test program	(3)	(3)	50	(2).
Optimum mix of artillery units (LEGAL MIX IV)	Booz-Allen Applied Research, Inc.	(3)	316	(2).
The police role in internal defense and development	Research Analysis Corp.	(3)	45	(2).
Family of combined arms computerized simulation models (OPMOR).	(3)	(3)	375	(2).
Field Army airspace utilization study (FAAUS II)	Communications & Systems, Inc.	(3)	674	September 1970.
Army-75 evaluation war game	(3)	(3)	674	(2).
Airmobile concepts-combat arms-85	(3)	(3)	200	(2).
Identification of dental diseases and conditions reducing combat effectiveness.	Technical Operations, Inc.	432	200	January 1974.
Forecast of resources availability	(3)	(3)	75	(2).
Analysis of test experimental and other data pertaining to artillery effectiveness.	Oklahoma University Research Institute.	368	67	July 1973.
Paramilitary organizations for social and economic benefit.	(3)	(3)	36	(2).
A study of survey accuracy requirements for artillery weapons: Army -1975.	(3)	(3)	80	(2).
U.S. Armed Forces relations with governments: In-exile.	(3)	(3)	36	(2).

[1] Continuing requirement.
[2] Undetermined.
[3] Unknown.

Wind Tunnel Study

USE OF NASA WIND TUNNEL

Mr. Mahon. A university research program on wind tunnel testing is referred to on page 16 of your statement, General Betts. Does the Army own one tunnel for the testing of helicopters and V/STOL aircraft? Both NASA and the Air Force have a number of wind tunnels. What is the situation with respect to wind tunnels?

Mr. Poor. The Army uses a wind tunnel facility at the NASA Ames Research Center, which is maintained and operated by Army personnel in cooperation with Ames Laboratory people.

Now, to put it in perspective, the Air Force, the Navy, and NASA all have wind tunnels for testing V/STOL class aircraft, but a wind tunnel is in a very real sense just one of the tools of the trade and it is important that we have these facilities available to our own people for their use.

The actual ownership of the wind tunnel we use for aircraft and helicopter research at the Army Aeronautical Research Laboratory is

NASA owned and leased at no cost to us for our purposes. We have several other wind tunnels for special purposes, such as the supersonic wind tunnel complex at Aberdeen Proving Ground, which is used for ballistic research.

ARMY RELATIONSHIP WITH ARNOLD ENGINEERING CENTER

Mr. MAHON. What relationship does the Army have to the Arnold Engineering Center at Tullahoma, Tenn.?

Mr. POOR. I believe the fair characterization is that we are an interested bystander. Tullahoma was primarily built for work on very high performance fixed-wing aircraft. It was established a number of years ago. I was a member of the committee that started it in being. It has facilities for testing very large jet engines, transconic aircraft, supersonic aircraft, and guided missiles. While we don't have any use for all those articles, we have a great deal of use for the aeronautical design results that come out of Tullahoma.

General BETTS. And we have, upon occasion, in some of our test programs, used those facilities on a reinbursable basis.

Mr. MAHON. How many wind tunnels does the Army operate and at what annual cost? For the record.

(The information follows:)

The Army operates 14 wind tunnels at an approximate annual operating cost of $2,015,000.

BODY ARMOR

Mr. MAHON. Is the study of polyolefin films for body armor a part of your research effort under "Materials"?

General BETTS. Yes, sir.

Mr. MAHON. What is that material, polyolefin?

General BETTS. It is a tough plastic which promises a very considerable return in the protection-to-weight ratio for body armor.

DEFECTIVE ARMOR SENT TO VIETNAM

Mr. MAHON. There has been recent discussion of cracks in body armor sent to Vietnam. Do you have any R. & D. effort directed toward overcoming this problem and actually what is the situation in regard to the armor utilized in Vietnam?

General BETTS. We do have work on improving body armor but may I say that in connection with the recent publicized problems with body armor, that during the development cycle we do establish a set of joint characteristics. That relates to the human-engineering question, the fit question, the weight, and that sort of thing.

The physical properties that are selected for body armor don't apply to a specific size of individual, but they do apply to the ability to get in and get out of them quickly because there are circumstances under which a crew member of an aircraft, or a GI in certain circumstances may be particularly anxious to get out of his armor quickly.

The background I have just given relates to the fact that this whole impact on the logistics problems related to body armor, the tailoring of body armor for individual requirements, and what we have done is

try to compromise between the many desires of the user and what we feel is practical from the point of view of mass production of body armor that is applicable to all size individuals and under all circumstances of use.

We don't try to create body armor for an infantry soldier that will protect him against all battlefield threats simply because it is impractical from the point of view of the penetration of a bullet as opposed to the penetration problem with respect to mortar fragments, or shell fragments.

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

(The information follows:)

The battlefield threats to personnel and hardware include fragments from explosive shells, armor piercing projectiles from small arms to artillery sizes, blast from exploding shells and mines, shaped charges, and possibly various forms of radiation. The main battle tank is designed for major protection against all. Other hardware items such as personnel carriers, aircraft, trucks, and boats can afford only enough weight penalty for armor to protect them against a portion of the entire threat spectra. Personnel armor is intended primarily to defeat shell fragments.

Current fibrous organic armor materials (nylon, duron, and similar materials) in armor vest form at weights up to about 6 pounds can give protection from these shell fragments. The material used weighs about 20 ounces per square foot. Vests using more layers of material and weighing up to about 12 pounds are competitive with metal armor and superior to ceramic armor.

When greater weight can be carried, as for example, by truck, aircraft or boat crewmen, use of metals or ceramics backed up with bonded organic fibrous structures or bonded glass fiber structures begin to show advantages over single materials of any type.

Different fragmentation munitions generate a wide variety of fragment weights and velocities, and thus different armors have varying capacities to absorb energy depending on the fragment characteristics. For example, armor composed of titanium plates backed up by nylon fabric, a combination weighing about 6 pounds for the standard body armor vest, was selected to emphasize protection against low-weight, high-velocity fragments from high explosives. If it is less important to provide protection from fragments than from small arms fire (e.g., caliber .30 and .50 ammunition), heavier composite armor consisting of a ceramic body such as alumina, or silicon carbide or boron carbide backed up by a glass reinformed plastic will be used.

Determination of the type of armor to be used is therefore dependent upon the ballistic threat, and the weight that can be carried.

IMPROPER CHECK OF MATERIAL

Mr. MAHON. It has been alleged that the faulty armor sent to Vietnam hadn't been properly checked. I wish you would comment specifically in regard to this.

General BEITS. I will have to put that in the record. I don't have information on the specific charges.

Mr. MAHON. All right, let us have the facts from the standpoint of the Army.

(The information follows:)

The allegation that faulty body armor had been shipped to Vietnam was made by Representative Margaret M. Heckler, Republican, of Massachusetts, in a letter to the Secretary of Defense, dated June 26, 1969. The body armor referred to in this letter is the ceramic body armor for ground troops providing protection against caliber .30 ball ammunition. In May 1968, Department of the Army approved a request for 40,000 sets of ceramic body armor for use in Vietnam. The Defense Supply Agency is procuring that body armor from the Carborundum Co. of Niagara Falls, N.Y. Delivery of the armor began in December 1968 and is scheduled for completion in December 1969.

Through March 31, 1969, a total of 7,524 sets of armor were delivered to Vietnam. No shipments were made in April 1969 as it was discovered that some of the armor in lot 4 contained cracks. At this point, representatives of Defense Supply Agency, Natick Laboratories and Carborundum Co. met to determine necessary corrective action. It is reported that the contractor changed his manufacturing process starting with lot 5. Lots 5, 6, and 7 have been subjected to a 4 percent sampling X-ray test. These tests have so far revealed that lots 5, 6, and 7 are satisfactory. There is no evidence that armor sets from lots 1, 2, and 3 are defective, but efforts are underway to locate the sets from these lots. Through June 2, 1969, 10,948 vests had been shipped to Vietnam.

Thirty-two sets of armor from lot 4 were X-rayed at the Army Materiels and Mechanics Research Center, Watertown, Mass. Thirteen of these contained cracks that would cause rejection. The effect these cracks may have on ballistic protection has not yet been determined. However, 1,166 sets of armor from lot 4 have been located and are being returned from Vietnam.

AVAILABILITY OF BODY ARMOR

Mr. MAHON. We have been discussing these various programs. Before going into aircraft and related equipment, are there any questions?

General BETTS. I would like to add to that armor item and we will for the record, so everyone can question us on it. We simply do not want to so burden a man on patrol by giving him armor that will stop everything that we make certain compromises. Unfortunately, the soldier in the field doesn't always understand that the armor is not supposed to stop everything. Consequently, we are faced with those very unhappy circumstances. A bullet will penetrate the body armor.

Mr. ANDREWS. What percentage of our soldiers, General, have body armor?

General BETTS. It is available to all of the soldiers who go out on patrol. It is available to them when they go into combat. There are many circumstances under very high heat conditions where the local commander would prefer not to use them because the heat prostration question is more real than the question of protection.

PROTECTION OFFERED BY ARMOR

Mr. ANDREWS. Describe one of the issues given to a soldier if you want to. What part of the body is covered?

General BETTS. It covers the chest and back. It is a vest.

Now, for crewmen who are not so concerned about mobility, we have chest, back, legs, a much more complete coverage.

Mr. ANDREWS. What is the biggest bullet or fragment that they are developed to protect against?

General BETTS. The design of the standard armor handles a 17-grain fragment moving at 1,250 feet per second. Now, that is less than the bullet of any rifle unless it is a fairly spent bullet.

Mr. ANDREWS. After all, it is not too much protection?

General BETTS. It is tremendous against mortar fragments and shell fragments, and those are by far the largest percentage of killings now.

IMPROPER CHECK OF MATERIAL

Mr. LIPSCOMB. General, the further specific allegation is that some of the body armor being sent to Vietnam is defective and has cracks in it causing danger to the man wearing it.

General BETTS. I have heard of the allegation. I just don't have any answer to it.

Mr. LIPSCOMB. The allegation also is that the manufacturer of this body armor sells armor on the commercial market to sheriffs and local police. The manufacturer X-rays the body armor purchased by the sheriffs' departments and local police so they can tell where the cracks exist in the armor. It appears that the Defense Department chose to purchase this armor from this manufacturer, without having it X-rayed and therefore it is being sent to Vietnam with cracks in it.

Now, the Secretary of Defense has already told Mrs. Heckler that he was going to have an investigation made immediately. You haven't heard about the investigation; maybe the problem doesn't come under your jurisdiction. I think, however, that we ought to be sure that the record is clear here that Mrs. Heckler's allegations are serious enough to already have warranted some attention and consideration.

General BETTS. I have heard about the allegations. I don't have an answer to it. It is not in my area of responsibility, but for this record I will give you a complete answer.

(The information follows:)

Investigations to date indicate that the alleged faulty ceramic body armor is confined to lot 4 produced by Carborundum Co. The Army has been evaluating samples of ceramic body armor taken from lot 4, to include radiological tests and ballistic tests. Although some decrease in ballistic protection may occur as a result of the cracked armor extensive tests will be required to determine the actual degradation of protection. To date the decrease in ballistic protection, if any, has not been determined. Army Materiels and Mechanics Research Center X-ray specialists have visited the contractor's plant and confirmed that samples selected from Lots 5, 6, and 7 are satisfactory based on X-ray tests.

In response to Representative Heckler's letter to the Secretary of Defense, a DOD staff team departed on June 30, 1969, to visit Army Materiels and Mechanics Research Center, Natick Laboratories, the Carborundum Co. and Defense Personnel Support Center, Defense Supply Agency. This team of specialists in quality control and engineering will review all thte facts and circumstances surrounding the procurement, testing, and inspection of this body armor. The Secretary of Defense has notified Representative Heckler that he will advise her of the outcome of the review and of actions taken prior to July 15, 1969.

Mr. MAHON. We will return, gentlemen, at 2 o'clock.

AFTERNOON SESSION

AIRCRAFT AND RELATED EQUIPMENT

PROGRAM FUNDING

Mr. ANDREWS. The committee will come to order. This afternoon we will take up "Aircraft and related equipment."

Mr. Lipscomb, did you have further questions on the subject that was under discussion before we adjourned at noon?

Mr. LIPSCOMB. No; Mr. Chairman.

REPROGRAMING INCREASED IN 1969 FUNDS

Mr. ANDREWS. General Betts, you are requesting $127.1 million in fiscal year 1970 for aircraft and related equipment. This request is $10 million more than the 1969 program. Was $117.1 million the amount appropriated by Congress for fiscal 1969?

General Betts. Yes; $123 was appropriated but we reprogramed some of those funds to other activities.

I will have to research where that other money went.

(Staff note: Subsequent to the hearings General Betts corrected his answer to read: No; $98.5 million was appropriated but through reprograming we increased this to $117.1 million.)

Mr. Andrews. Why was this budget activity increased and what programs were decreased as a result of this reprograming action.

General Betts. The reprograming budget was related to 1969. The increase in 1970 is related to the additional effort that would be involved in going ahead with the heavy lift copter, and concurrent with that we would like to get underway with the utility tactical transport aircraft system.

(Discussion off the record.)

Mr. Andrews. Has the subcommittee of the other body taken action on the authorization for the R. & D. program for the Army with reference to the heavy lift chopper?

Genreal Betts. Yes, sir. The Senate Armed Services Committee in marking up the 1970 budget have recommended deletion of the $20 million we had allocated for the heavy lift chopper.

Mr. Andrews. Do you have a request for $20 million for that project before us in this budget request?

General Betts. We do. It is included in the submission to you. My mistake, it is $15 million for fiscal 1970. It has been reduced. It was originally $20 million and had been reduced when we readjusted the fiscal 1970 budget.

Mr. Andrews. Is this correct? Your appropriation for 1969 was $98 plus million.

General Betts. That is correct.

Mr. Andrews. Then by reprograming actions you increased that to $117.1 million.

General Betts. That is correct.

Mr. Andrews. Now as against $117.1 million, which is the total amount of money you obtained by appropriation and reprograming for fiscal 1969, you are requesting approximately a $10 million increase for 1970.

General Betts. That is correct.

Mr. Andrews. Part of that $127.1 million, you stated, was for the heavy lift helicopter.

General Betts. Yes; and the utility tactical aircraft system, UTTAS.

Mr. Andrews. Can you tell us how much was involved for that particular project?

General Betts. The heavy lift helicopter for fiscal 1970 is programed at $15 million.

Mr. Andrews. And that item has been deleted by the committee in the other body from the authorization?

General Betts. Yes, sir: that has been deleted from the authorization by the Senate Armed Services Committee.

PROGRAMS AFFECTED AS A RESULT OF REPROGRAMING

Mr. Andrews. Now back to the amount of your 1969 funding, what programs were decreased as the result of your reprograming action?

General Betts. I would have to research that and supply it for the record.

Our paperwork supports the increase in this area. I would have to go research this.

(The information follows:)

[In millions of dollars]

Aircraft and related equipment	Program base	Reprogram changes	Plus or minus
Advanced aerial fire support system	25,380	38,041	+12,661
Aircraft weaponization (exploratory development)	1,050	930	— 120
Avionics (exploratory development)	2,780	2,330	— 450
Air mobility	15,960	13,460	— 2,500
Aeronautical research	4,260	4,140	— 120
Demonstrator engines	6,000	6,250	+ 250
Operational evaluation V/STOL	1,000	290	— 710
Heavy-lift helicopter	-----	1,000	+ 1,000
Research helicopter	4,000	4,500	+ 500
New surveillance helicopter	640	6,959	+ 6,319
Aircraft weaponization (advanced development)	3,760	1,971	— 1,789
Avionics (advanced development)	4,180	4,930	+ 750
Avionics systems (engineering development)	2,880	2,380	— 500
Aircraft weaponization (engineering development)	20,130	22,900	+ 2,770
Aircraft engines	1,800	140	— 1,660
Supporting development air mobility	4,670	4,160	— 510
Subtotal	98,490	114,381	+15,889
Distribution of overhead costs to mission activities	.....	+2,704	.....
Total	98,490	117,085	+18,595

Mr. Andrews. Are there nay questions on this section, "Aircraft and related equipment"?

Mr. Lipscomb. No, Mr. Chairman.

Cheyenne Helicopter Development

EXPLORATORY DEVELOPMENT OF AVIONICS

Mr. Rhodes. Mr. Chairman, I note that in the general heading "Avionics," you have a total of ——— million in exploratory development, advance development and engineering development. Does this refer to one avionics system, or is it several? If it is the latter, what are you doing?

General Betts. No; that relates to the whole package of avionics development. It may apply to the Cheyenne, it may apply to our broad technology effort for some future aircraft. It would be everything we have under avionics.

Mr. Andrews. Why do you still refer to the AH-56A Cheyenne helicopter as the advanced aerial fire support system?

General Betts. That is a generic term. The more popular name we have given it is the Cheyenne. Its model is the AH-56A.

FUNDING FOR CHEYENNE DEVELOPMENT

Mr. Andrews. Page 72 of the justification book indicates your fiscal year 1970 program for the advanced aerial fire support system is $16.5 million. Secretary Resor's letter of June 27, 1969, indicates it is $22.5 million. Is the $6 million difference in the TOW subactivity?

General BETTS. That is correct, Mr. Andrews.

In the aircraft weaponization line item the $6 million to do the R. & D. work is to apply the total missile system to the Cheyenne.

Mr. ANDREWS. Just exactly how will the $22,500,000 be used, General?

General BETTS. We had intended that to be the total effort in the Cheyenne at the time this budget was submitted. You are aware that as a result of having canceled the production contract we have been compelled to go back to the contractor and readjust the R. & D. program in order to take out the direct and immediate orientation toward early production.

I suspect that these numbers will have to be changed as we negotiate with the contractor and come up with a new R. & D. program. Mr. Resor wrote you on the subject directing attention to the problem with the Cheyenne is that we needed more money than was indicated here for the TOW integration, we needed money for the night vision integration.

The R. & D. problems raised by the difficulties reflected in the termination of production would require more money in R. & D.

Mr. ANDREWS. We will touch on that later. The fiscal year 1968 budget request estimated the total development cost of this helicopter to be $141.1 million. In the fiscal year 1969 budget request it was estimated to be $186.5 million. And in the fiscal year 1970 budget request it is estimated to be ——— million. What was the original estimate and why have your cost esitmates increased so rapidly each year?

General BETTS. I will have to research briefly for the original estimate.

Mr. ANDREWS. Somebody ought to know the original estimate.

General BETTS. $125.9 million.

Mr. ANDREWS. Colonel, when was that estimate made?

Colonel GILBERT. It was made January 1966, prior to the award of the contract.

Mr. ANDREWS. That was in the 1967 budget request, then.

Colonel GILBERT. No, sir. This decision was made on January 24, 1966, after the 1967 budget had been submitted, sir.

Mr. ANDREWS. So the cost has overrun on this Cheyenne program from $125.9 million in January 1966, to ——— million as reflected in this budget request.

General BETTS. That is correct, except I do not like the use of the word "overrun," because the cost growth in this program in some measure represents deliberate decisions taken by the Army to increase the capability of this aircraft. For example, in the original program we did not have the night vision capability that we now see for this aircraft.

In the original program we underestimated the extent to which the user in the present time scale feels it is necessary to test this aircraft in order to prove to himself that it is acceptable to him as a user.

Part of that problem is related to the difficulties we had with some other development programs over the past couple of years. There have also been changes that had added to the cost that were related to the Government-furnished material and the instrumentation for the aircraft and the test facilities, because of our technical difficulties and the fact that the program is taking longer and we have to con-

continue to support our in-house management capability. That adds to the cost. We have damaged a couple of these aircraft. That adds to the cost.

In addition to that there have been some engineering changes that we have requested that were not in the original contract and those added to the cost.

ENGINEERING CHANGES AND COST TO GOVERNMENT

Mr. ANDREWS. I wish you would tell us all the engineering changes and the other requests of the Government and what they amounted to.

General BETTS. I would be pleased to.

(The information follows:)

Engineering change proposal	Date approved	Amount	Purpose
ECP-5	Nov. 16, 1967	$3,334	In SWP for ECM warning system.
ECP-6	Feb. 13, 1967	2,907	Gunfire detect SWP, deletion.
ECP-7	do	(1)	Fuel hose changes.
ECP-8	do	(1)	Kit armament.
ECP-10	Feb. 10, 1967	(1)	Exterior lift description.
ECP-12	May 17, 1967	(1)	Transmittal of anticollision light drawings.
ECP-13	May 16, 1967	$25,110	Engine inlet duct.
ECP-14	July 7, 1967	(1)	Multipurpose crane.
ECP-15	July 20, 1961	(1)	Flyaway support kit, revision.
ECP-16	do	(1)	Set, component sling.
ECP-17	June 19, 1968	[2] 4,180	Revision of mooring kit decision.
ECP-18RI	Nov. 16, 1967	(1)	HF antenna coupler.
ECP-22	June 26, 1967	(1)	Skid system weight classification correction.
ECP-24	do	(1)	Pilot helmet sight weight revision.
ECP-25	Nov. 3, 1967	8,750	ADF loop antenna.
ECP-27	Jan. 31, 1968	(1)	Deletion of bar, towing and steering.
ECP-29	Nov. 3, 1967	9,550	Substitution of AS-1304 for AS-24.
ECP-30	Nov. 20, 1967	(1)	Flyaway support kit description.
ECP-31	Dec. 4, 1967	(1)	Deletion of extended range station keeping.
ECP-34	May 7, 1968	188,180	GMR/RMR line driver/receivers hardware modification.
ECP-35	Jan. 3, 1968	(1)	Incorporation of MIL-W-81381/3 wire.
ECP-38	July 15, 1968	(1)	XM-134 gun with modification extractor.
ECP-39	June 12, 1968	(1)	Battery installation requirement and deviation.
ECP-40	Dec. 12, 1968	(1)	Revision to development description of fire control components.
ECP-41	Oct. 31, 1968	(1)	Incorporation of updated changes by development decision.
ECP-43	Dec. 19, 1968	(1)	Deviation from MIL-L-6503D searchlight installation.
ECP-45	May 5, 1969	(1)	Revision of flaws.
ECP-49	Apr. 2, 1969	(1)	Cockpit canopy redesign.
ECP-51	July 10, 1969	135,140	XM-51 turret modification (XM-140).
ECP-52	May 21, 1969	(1)	Doppler/HARS decision revision.
64A-7	Apr. 3, 1969	590.17	Front frame bearing support.
64B-10	Feb. 20, 1969		
64E-21	do	8,417.05	RA 14th stage line manifold improvement.
64E-23	Apr. 16, 1969	7,779.92	Improved carbon seals.
64N-5	Apr. 24, 1969	8,437.18	Ignitor plus bushing.
64R-6	Apr. 10, 1969	417,667.56	CODEP coding stage 2 nozzle particlan stage 1 and 2 buckets.
64T-12	Feb. 20, 1969		Lube pump increased flow capacity.
64U-3	Apr. 25, 1969	(1)	Engine vibration limits (HI).

[1] No cost.
[2] Credit.

CURRENT ESTIMATE OF DEVELOPMENT COST

Mr. ANDREWS. Do you have a more recent estimate of cost than this ——— million?

General BETTS. Our most recent estimate is ——— million.

Mr. ANDREWS. It gets worse.

General BETTS. That ——— is before the current negotiation that is restructuring or proposing to restructure the research and development contract.

Mr. ANDREWS. It could make it higher.

General BETTS. It could make it higher, it could make it lower. I would not predict.

Mr. ANDREWS. Was your most recent estimate ——— million or ——— million?

General BETTS. ———.

Mr. ANDREWS. Is that the current total estimated cost of completing development of the Cheyenne?

General BETTS. That is the best estimate we have until we complete the negotiations with the contractor.

Mr. ANDREWS. What does your justification book show as the total cost estimated through fiscal year 1971?

General BETTS. At the time we made that estimate we did not have all of the information that has been generated as the result of this complete review of the Cheyenne program. We won't have it until we complete these negotiations with the contractor. The estimate that was in Mr. Resor's letter represents the best information we have to that time, and nothing has changed since that date.

SECRETARY OF ARMY LETTER ON CHEYENNE

Mr. ANDREWS. General Betts, I wish you would place a copy of that letter in the record at this point.

(The letter follows:)

DEPARTMENT OF THE ARMY,
Washington, D.C., June 27, 1969.

Hon. GEORGE H. MAHON,
Chairman, Committee on Appropriations,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: On May 19, 1969, I wrote to inform you that the Army had terminated the AH-56A Cheyenne production contract with the Lockheed Aircraft Corp. for default. In that letter I stated that a substitute procurement on an interim basis for another armed helicopter would probably be required and that the Army desired to continue developmental efforts on the Cheyenne. The purpose of this letter is to provide you with information on the funds required for the substitute procurement and continuing R.D.T. & E. effort as currently approved by the Secretary of Defense.

The Army proposes to procure with fiscal year 1970 funds ——— AH-1G gunship aircraft to meet estimated SEA gunship attrition in the fiscal year 1970 funded delivery period and ——— AH-1J helicopters for troop test. The estimated cost of these aircraft is ——— million which should remain in the fiscal year 1970 PEMA appropriation. Since the President's budget presently includes $420 million for procurement of AAFSS, ——— million may be deleted therefrom to accommodate other needs and still permit procurement of the substitute aircraft.

The continuing development effort will require ——— million funding for R.D.T. & E. in addition to the $22.5 million contained in the fiscal year 1970 President's budget. Of this amount, ——— million is needed for AAFSS and TOW/AAFSS development; ——— million is needed for development of TOW missile, night vision and 20/30-millimeter gun subsystems for COBRA; ——— million for advanced development of an electronic rotor control system; ——— million for automatic test equipment and a data storage and retrieval system applicable to gunships.

Since the requirements in fiscal year 1970 for the PEMA and R.D.T. & E., A appropriations require both authorization and appropriation, your early consideration will be appreciated. Army representatives are on call at your convenience to provide details on the proposed changes in funding outlined above.

Sincerely,

STANLEY R. RESOR.

TOTAL COST INCREASE FOR CHEYENNE

Mr. ANDREWS. What has been the total cost increase in the development of the Cheyenne and the reasons therefor?

General BETTS. There are the ones I just went through that led to the change in cost you cited.

Mr. ANDREWS. In the record I wish you would give more detail.

General BETTS. Yes, sir.

(The information follows:)

The total increase in the Cheyenne development program totals ——— million dollars through March 1969. These increases resulted primarily from increased Government testing; incorporation of night vision; integration of the TOW missile; and increased cost of Government-furnished material such as engines and weapons.

DEVELOPMENT AREAS REQUIRING INCREASED FUNDING

Mr. ANDREWS. The fiscal year 1969 program was increased $12.7 million, to a total of $38 million, by a reprograming action. Will you describe the reasons for this reprograming?

General BETTS. There were three things that we did during that fiscal year that account for practically all of it. First, the increase in the estimated cost of night vision. This increase is related to a change in the technological approach to night vision that should provide a very considerable increase in capability over what we had previously planned. The second is that we found it necessary to commit more funds to range instrumentation and familities. That was to go to the Yuma Test Station for an adequate testing environment in which to test this aircraft.

Mr. ANDREWS. What do you mean by changing the approach of night vision?

General BETTS. Within the very recent past it has become apparent that the best technique for night vision, other things being equal, is to use thermal imaging.

Mr. ANDREWS. Will you explain that?

General BETTS. That means that you use a matrix of detectors that detect the difference in temperature of elements of the target that are scanned by the system. It can detect differences of a fraction of a degree. This kind of thing is absolutely beyond the ability of the enemy to do anything about. The old image intensification, he can give problems to that by bursts of light that tend to make the thing bloom, as we say. Radar, he can jam with electronic countermeasures. But we do not know of any way that he can give us fits with this approach to night vision.

Mr. ANDREWS. Did you know of that approach when you first conceived the idea of Cheyenne?

General BETTS. No, sir; it was certainly not ready.

Mr. ANDREWS. Is it ready today?

General BETTS. It is flying. I would assume that Mr. Poor has something to add to that. Yes, it has been demonstrated.

Mr. ANDREWS. Mr. Secretary, do you want to add to that?

Mr. POOR. Yes, it might be helpful to explain these thermal imaging things work in a simpler and briefer way. They consist of a camera-like device with a heat sensor inside the camera. They scan the world,

look at it and form a picture like a television camera, which is displayed to the operator. This picture, as General Betts indicated, shows small temperature differences between different parts of "the world," with a very high resolution. I flew a helicopter containing one of those things some months ago over Aberdeen Proving Grounds and they were so sensitive and so fine in their detailed resolution that you could see the horns on deer and tell the difference between a male deer and a female deer at quite long ranges. You could detect people very easily because they are warmer than the surrounding.

Mr. ANDREWS. Do you get a picture of the deer and people on the screen?

Mr. POOR. You get a picture of people.

Mr. ANDREWS. Picked up by the heat?

Mr. POOR. By the heat of the objects themselves. You can see buildings because their temperature is a little different than the surrounding ground. So it is a very powerful way of seeing very well at night.

Its greatest weakness is that it is much more expensive than the older night image intensification that we had been pursuing and still are, in things like the Starlight Scope.

Mr. ANDREWS. Just the heat of a human would put a picture on the television?

Mr. POOR. Yes; it is a dramatic advance. This technology has been developed by some three or four companies. We have a moderately competitive environment. I am hopeful that the price of these devices will come way down given time. At the moment they are expensive, like a quarter of a million dollars apiece. We are very hopeful that with time they will come down substantially. While the R. & D. models are very costly we are hopeful that in production they will be very substantially less. The capability offered is so dramatic that we do not feel we can ignore it.

Mr. ANDREWS. That came into the picture after you started on Cheyenne.

Mr. POOR. That is correct.

Mr. ANDREWS. That is one reason why the price of the Cheyenne has skyrocketed.

General BETTS. It is one contributing factor. There is one other in the ——— million I had not mentioned. Earlier I said that the user asked for much more extensive testing than we had previously planned. That will also require that the contractor's support be continued for a longer period. That in turn has added to the cost.

Mr. POOR. I might say in passing that the basic R. & D. contract with Lockheed has held at the price originally agreed upon with the exception of the very few engineering changes associated with things like the change in night vision and we will provide details in the record.

Mr. ANDREWS. I have asked the general to put in the record what the specification changes amounted to.

Now, back to this heat picture system. Have you got a name for it?

Mr. POOR. It is called the FLIR, the forward looking IR.

General BETTS. The IR is for infrared.

Infrared is just the heat as it comes from the bottom. It is in a spectrum of radiation associated with infrared.

Mr. ANDREWS. Are other services interested in this?

General BETTS. Yes, sir; all of the services are.

Mr. POOR. The other services are very interested.

Mr. ANDREWS. It is the Army's brainchild.

General BETTS. I would go so far as to say we started the effort but as it proved to be an effective instrument—we started it about 15 years ago—and where it looked attractive in technology everyone began to pursue it with vigor.

UNCOMMITTED FUND BALANCE

Mr. ANDREWS. According to the information supplied to the committee by the Army of the total program of $168 million through fiscal year 1969, only $145.2 million has been obligated and only $122.5 million has been expended; is that correct?

General BETTS. I would have to check that.

(The information follows:)

The figures are correct.

Mr. ANDREWS. As a result of the cancellation of the production contract and the grounding of the aircraft, how much of these uncommitted funds will not be obligated and expended during fiscal 1970?

You can supply that for the record.

General BETTS. I will have to research that, Mr. Andrews.

(The information follows:)

It is hoped that most of these uncommitted funds can be obligated and expended during fiscal year 1970. This depends on how soon we can complete restructuring of the development program.

UNCOMPLETED DEVELOPMENT OBJECTIVES

Mr. ANDREWS. Were you able to complete all of the planned fiscal 1969 development objectives?

General BETTS. No, sir; we were not.

Mr. ANDREWS. If not, what fiscal 1969 development objectives will not be met?

General BETTS. Most importantly we had to cease the weapons and subsystem testing which we had been engaged in. We wanted to get on with the TOW integration, the testing of the 30-millimeter cannon, rocket firing, the grenade weapon, the 7.62-millimeter gun in the nose. We had to bobtail the testing effort of all of those subsystem testings.

Mr. ANDREWS. How far will the development program slip?

General BETTS. I really cannot answer that until we solve the problem of rotor instability that was the reason for the accident this past winter.

Once we know that, we can handle that problem.

Mr. ANDREWS. Rotor instability.

General BETTS. It had vibrations in it.

Mr. ANDREWS. Whose fault was that?

General BETTS. It is basically the fault of a very involved technology that people do not understand very well. Both the Army and Lockheed participated in a program that created some flying prototypes, a compound helicopter we call the XH-51. That used a rigid rotor and used the same basic control system that is now on the Cheyenne. We saw rotor instabilities in the testing of that test-bed aircraft, but with modifications to the rotor we were able to push those instabilities

outside of the desired performance envelope of the aircraft. Consequently, when we decided to go into the full-blown development of Cheyenne, both the Army, a full evaluation board, and the contractor were confident that we had licked the problems of rotor control, for that aircraft. As we went on and pushed the performance envelope to higher and higher speeds, and varied flight conditions related to the different speeds of the rotor and into different gusting conditions in flight, we discovered aspects of ths rotor instability that we thought we had previously licked. So this is just a technical judgment. The only one you can blame is mother nature for not making us smarter.

Mr. ANDREWS. Did you change the rotor design in any way after the contractor went into production of these test ships?

ROTOR INSTABILITY

Mr. POOR. Yes, there have been a number of changes in detail, but not in principle in the design of the rotors on the test ships that were built.

Mr. ANDREWS. I believe you said you lost one.

General BETTS. We lost one in a flying accident. We lost a couple of them on the ground, or at least we damaged a couple on the ground.

Mr. ANDREWS. Did the rotor instability have anything to do with the three accidents, one of which was a complete loss?

Mr. POOR. Yes.

General BETTS. Yes.

Mr. POOR. It is a little more complicated in that there were two kinds of rotor instabilities that caused difficulty. The kind that resulted in the loss of one aircraft on the ground and one aircraft just after an emergency landing was relatively quickly understood and has been essentially corrected. This was an instability that occurred at low speeds with very large control forces put on the rotor, which could really only happen with the machine on the ground. The second kind of instability is a highspeed forward flight thing that occurs at about 186 knots in the present configuration. That results in a fairly rapid growth of as oscillation in the blades which, if carried too far, will result in the blades striking the fuselage and that is what happened in the crash.

DESIGN SPEED

Mr. ANDREWS. What is the design speed of the Cheyenne?

Mr. POOR. The design top speed is about 220 knots or something of that sort. So this is below the design speed.

Mr. ANDREWS. Have you had it to the maximum speed?

Mr. POOR. The machine had been flown at a maximum speed of 223 knots. This speed was achieved at full power while flying at a significant angle of dissent.

Mr. ANDREWS. Did you notice any rotor instability at that speed?

Mr. POOR. In that test there was no rotor instability noticed. However, it was incipiently there. Later experiments were conducted with different rotors resulting in the accident we described. Since then an extensive program of analysis, using simulators, has indicated there is a very good promise that by some small changes in the rotor con-

trol design it may be possible to extend the speed for no instability up to about 280 knots which should be safely outside the normal flight envelope. Under the current contract with Lockheed prior to any amendment they are still required to demonstrate that performance.

NEED FOR INCREASED FUNDING IN 1970

Mr. ANDREWS. If you are unable to complete the fiscal year 1969 objectives and the development program has slipped, why do you require ——— million in addition to the $22.5 million current fiscal year 1970 estimate?

Mr. POOR. There are a number of reasons. One of the reasons is that we feel it would be prudent at this time to undertake the development of an alternative rotor control system to make sure that we can build a machine that is safe to fly and easy to control over the total speed range. We have had proposals and suggestions from experts that we called in to review the program that indicated a high degree of certainty that with certain modifications to the rotor control system, the rigid rotor can be made unambiguously safe to fly. In the ——— million is included approximately ——— million for this purpose.

The balance has to do with Cobra, the machine which we are using as an interim armed helicopter, to provide TOW installation and night vision equipment for that interim backup machine, and certain moneys for the TOW Cheyenne, and certain moneys for test equipment. I can provide the detailed breakout of that for the record.

(The information follows:)

[In millions of dollars]

Install night vision on Cobra	———
Install TOW on Cobra	———
Install 30-milliammeter gun on Cobra	———
Continue Cheyenne development	———
Install TOW on Cheyenne	———
Develop automatic test equipment	———
Develop data storage and retrieval equipment	———
Develop advanced rotor control system	———
Total	———

NEED FOR INCREASED TOW FUNDS

Mr. ANDREWS. Now we would like to discuss the details relative to the ——— million required over and above the $22.5 million current 1970 program, as mentioned in Secretary Resor's letter of June 27, 1969. Why do you require ——— million for AAFSS and TOW/AAFSS development, and how will these funds be used?

Colonel GILBERT. The ——— million breaks down into two pieces in the budget documents. There is a ——— million for the Cheyenne line item for the basic Cheyenne development which will be in addition to the $16.5 in the budget. The remaining ——— of the ——— million is for the TOW development for the Cheyenne which comes under the aircraft weaponization line item, in the 6.4 element. Taking first the Cheyenne portion of that ——— million, of the total effort, it is really a part of the total estimate that General Betts referred to earlier of what we think may be required, although that number is soft at this point until we complete the contractual negotiations with Lockheed.

As regards the TOW development, there has been some increase in the total cost of the TOW development for Cheyenne and the additional ——— million is to accommodate that increased requirement.

Mr. ANDREWS. Colonel, how are you going to use these funds? What is wrong with TOW/AAFSS that needs additional work? You told us where they are going to be spent. What is it going to spent on?

Colonel GILBERT. The moneys for the TOW will be to carry on the TOW/Cheyenne development initiated in prior year money to phase B, which will be the procurement of four TOW subsystems that go on Cheyenne prototype aircraft for further testing.

General BETTS. The problem is that it is not just a simple question of hanging the TOW on the aircraft and going out and testing it. One has to test fire that missile in virtually every configuration within the performance envelope that we think is important to the tactical capability.

We have to worry where the blastback of the rocket goes. We have to worry about whether or not the wire stays intact. This is a wire-guided missile. Also, whether our stabilization system under all conditions of maneuver will in fact perform with the accuracy necessary to make that missile effective. This just takes time and money and a lot of different test flights and different operational situations.

Mr. ANDREWS. Why a guided missile?

General BETTS. The TOW is a wire-guided missile.

Mr. ANDREWS. I saw those fired 10 years ago.

General BETTS. That is correct.

Mr. ANDREWS. Is there any difference between the ones you have today and the ones you had then? If I remember they were developed by the French.

General BETTS. That is a French development you are thinking about, the original SS–9, ultimately the SS–11. This is a far superior missile in our judgemnt.

Mr. ANDREWS. More accurate?

General BETTS. It is much more accurate and it does not take anything like the operator's skill to make it work properly.

Mr. ANDREWS. It only has a daylight capability, does it not?

General BETTS. If one can see the target, he can fire, day or night. The problem is what kind of night vision capability is available to the gunner. With night vision capability he can fire in day or night.

Mr. ANDREWS. Would this enter into the picture?

General BETTS. The FLIR would enter into this. It is our ultimate goal to have the Cheyenne aircraft fire the missile at night in an antitank role and come out of the darkness in surprise and kill the tank.

Mr. ANDREWS. It would be a surprise.

General BETTS. It is going to work that way.

EFFECTIVENESS OF CHEYENNE WEAPONS

Mr. ANDREWS. Page 18 of your statement indicates that all of the five weapons on the Cheyenne have been fired successfully. Why then is additional TOW/AAFSS work necessary?

General BETTS. It is the question of effectiveness under all flight conditions.

Mr. ANDREWS. Did you have a problem with the TOW/AAFSS work?

General BETTS. None discovered yet, but we have not tested it in all conditions of flight.

Mr. POOR. Mr. Chairman, I think the situation is something like this. All of the weapnos systems have been demonstrated in flight. That is quite a long way from very precise measurements of the accuracy that you can expect. The tests so far just say there is a very high prospect they will all work and all work successfully if sufficiently developed. As an example, the sight stabilization system on which the performance of the TOW very critically depends, has been measured in flight with the current rotor system, current vibration levels, and current performance level of the GE-developed stabilized sight. It is quite clear that the sight line wiggles in flight are too big to fully exploit the accuracy of the TOW system. Fixing it so it can fully exploit the accuracy of the missile takes a good deal of time and a good deal of careful development to make sure the vibration levels are appropriate, and the gyro system that controls the stabilized sight is working properly and the whole system ties together and plays right. That has not been done. What has been done in the test program so far is to show us that the systems are capable of working, that the computer which controls the whole fire control system is capable of working.

Mr. ANDREWS. With the limited test you are satisfied you will have to go in depth?

Mr. POOR. The limited test says it is a very promising system. The kinds of tests we need to assess its value have yet to be done.

Mr. ANDREWS. What assists the gunner when he is working a wire? Does he have any gadgets to indicate how the wire should be turned or twisted on the target?

Mr. POOR. Let me try to describe the system simply. The gunner looks through a sight system which presents to him a view of the target. There is a crosshair in the middle of his sight which he steers with a control to put it on the target. Once it is on the target, that sight line is so stabilized that as the aircraft maneuvers it stays on the target with very high accuracy. A number like one- or two-tenths of a mil, one or two-tenths of a yard at a thousand yards. So his task is simply to keep the crosshairs on the target. The missile is then launched and an automatic tracker which is looking out through the same sight follows the missile in its flight—the missile has a little flare on the back which tells the tracker where the missile is—and automatically the tracker sends signals down the wire to the missile to tell it to steer up, down, right or left to follow right into the target.

This is the same general control system as the ground TOW. It also has an automatic tracker. The ground gunner keeps the sight on the target. The difference between the air and ground environment is that the ground sight is still so that the tracking task for the gunner on the ground is very easy. The tracking task from the air with the helicopter hopping around would be very difficult if it were not for the automatic stabilization system to help keep the sight line on the target at all times.

It is getting all of this to work together well that is the technical challenge. Once it is done, this should be an extremely valuable weapon

to us. We have had a demonstration in a UH–1 helicopter with a system developed by Hughes. I have flown it and it is very easy to aim, retain the sight line and get target hits.

Mr. ANDREWS. I saw a sergeant once from a stationary chopper, which was in the air, and as stable as a chopper could be, get five hits out of five shots.

Mr. POOR. With TOW?

Mr. ANDREWS. With one of these wire-guided missiles.

Mr. POOR. That perhaps was the TOW. It has been very successful indeed in the UH–1.

NEED FOR INCREASED TOW FUNDS

Mr. ANDREWS. General Betts, I do not believe the committee has yet received an answer to the question why do you require the ——— million for AAFSS and TOW/AAFSS over your original 1970 budget estimate? Either you have run into some unforeseen development problems with the TOW/AAFSS, or you have fully underestimated the 1970 budget with TOW/AAFSS, one of the two.

General BETTS. We did underestimate what was going to occur in 1968 in terms of the difficulties we got ourselves into technically speaking. The additional effort is reflected in these dollars. Part of it is just that. Part of it is that you get into difficulties and things stretch out, you have to carry your engineering team that much longer and its costs more money to do it.

Mr. ANDREWS. Are you experiencing unforeseen difficulties with the TOW/AAFSS?

General BETTS. We were grounded for a period where we were not able to pursue the testing program that had been laid out. I could not identify any specific technical difficulties that we are experiencing. I may have a little more information on that ——— million, though.

Mr. POOR. I think in the early planning of the TOW/AAFSS there is very little question that we substantially underestimated the costs that would be incurred in integrating the TOW into the Cheyenne system.

It was at first assumed, and assumed incorrectly, that all that would be required would be to take the guidance system that had already been developed by the Hughes Co., for the UH–1 and simply plug it into the AAFSS. That ignored the necessity for integrating the system into the fire control system for the guns. You will remember that one swiveling gunner's station controls all of the armament on the system. It was a long time before we succeeded in negotiating a contract to handle this interface problem which was not planned for properly in the original contractual arrangement with Lockheed. There have been substantial cost increases as a result of putting together a proper team using the Hughes people and the missile command people to make sure the interface is properly managed.

How much of the increase in fiscal 1970 is a result of the definitization of those contracts I do not know, but we would like to provide it for the record. It is just one of the pieces of the program, a program of which I am generally quite proud, in which I think we did a much less than good job in initial planning. So there was a serious under estimation in initial planning, some cost stretchout, but most of it I think was the first cost.

General BETTS. I could add with respect to the ——— million a big piece of that is a ——— million effort for a copilot's night vision capability that was not a requirement earlier and represents an additional requirement for this aircraft.

DEVELOPMENT OF HUEYCOBRA GUN SYSTEM

Mr. ANDREWS. The Secretary's letter indicates that an additional —— million is needed for development of TOW missile, night vision, and 20/30 millimeter gun subsystem for the HueyCobra. Why are these funds being requested under the Cheyenne program and how will they be used?

General BETTS. Within our budget structure we will put them under appropriate line items. The reason they come into the Cheyenne question is that as a result of having terminated the Cheyenne production program, we asked the Secretary of Defense for approval of applying the production moneys we saved to the procurement of some additional aircraft, the HueyCobras. This is just a numerical replacement of the aircraft capability we lost through the loss of the Cheyenne production contract. At the present time the HueyCobra does not have either TOW or 30 millimeter capability.

Mr. ANDREWS. Can they be installed on the Cobra?

General BETTS. Those can be carried on that aircraft. What we are asking for here is the R. & D. money to go through the engineering and testing programs to adapt them to the Cobra.

Mr. ANDREWS. You plan to do it and equip the Cobra.

General BETTS. We would propose to do that. There is one very real advantage to this. At some point in time we are going to have to face up to the question of the cost of procuring the Cheyenne. As I remarked earlier the Lockheed people in their analysis and cost proposal, when the right time comes to ask for it, if they ask for more money than we think it is worth, we will not produce that aircraft. If there is a reasonably comparable—and I use that word very carefully because the TOW and 30 millimeter do not make the Cobra into a Cheyenne by a factor of about three—nevertheless, if there is some fall-back combat capability that is reasonably competitive with the Cheyenne, we believe that we have a much better chance of getting a hard rock bottom price quotation out of Lockheed at the time the Cheyenne is ready for production. I think it is very important that we get this capability. Furthermore, it is even more important if we are never able to produce the Cheyenne. This ends up being a tank killer. If it ends up being a tank killer, it gives us one more leg up in the very unbalanced situation that faces us in Western Europe between ourselves and the Warsaw Pact.

USE OF CHEYENNE WEAPONS ON HUEYCOBRA

Mr. RHODES. Did I understand you correctly that the Cheyenne has a capability of maneuvering after the TOW missile has been set in flight?

General BETTS. Yes; it has a stabilized sighting system so it is possible to keep the crosshairs on the target.

Mr. RHODES. Are you saying that this system could be installed on the Cobra?

General BETTS. Not completely, not the same system.

Mr. RHODES. But with that capability?

Mr. POOR. A different system in detail but similar in principle can be carried in the Cobra which will give it equivalent accuracy and delivery range on the Tow missile to that which we could get with the Cheyenne.

The Cobra is severely payload limited. It is a much smaller machine. Therefore, we could not expect without very serious performance degredation to put anything like the same number of Tow's on one Cobra, nor could we carry anything like the number of rounds of gun ammunition. However, it would still be a very useful interim capability, and looks as if it may be virtually the only way we can get an interim tank killing capability in a helicopter.

Mr. RHODES. Is the TOW guided by manual operation of the wires, or do the wires act as a transmitter of electronic impulses?

Mr. POOR. The wires are simply signal carriers. They carry the error signals generated by the automatic trackers. The automatic tracker looks along the line of sight to the target and says the missile is up or to the left and would send commands back, go down or to the right, and bring it back onto that line of sight continuously by electric signals transmitted down the wires.

That part of the system unambiguously works extremly well.

Mr. RHODES. Don't wires clutter up the battlefield very badly?

Mr. POOR. They are very fine wires, a few thousandths of an inch in diameter.

They are very strong wires, which they have to be, to stand the pull off the spools on the missile. I do not think they would be a severe battlefield clutter upper, because they are so fine they can easily be burned or broken by vehicles running over them. I do not think they would be much trouble.

Mr. RHODES. Thank you, Mr. Chairman.

COST OF CHEYENNE WEAPON FOR COBRA

Mr. ANDREWS. What is the total estimated cost of providing the Cobra with the Cheyenne weapon subsystems?

Mr. POOR. I do not think I can answer that, Mr. Chairman, because we do not propose to do that. The Cobra cannot carry the full Cheyenne equipment. We do have figures, I believe, of the cost to provide this interim capability and General Betts can answer that.

General BETTS. The capability we are proposing here, about ——— million total in one and a half to two and a half years, which will be required to give the Cobra all three, TOW, night vision and 30 millimeter capability.

Mr. ANDREWS. At what cost?

General BETTS. ——— million.

Mr. ANDREWS. Break that ——— million down.

You can supply it for the record.

General BETTS. Yes, sir; we have it if you wish it.

Mr. ANDREWS. Very well.

General BETTS. That is ——— million for the 30 millimeter gun subsystem, ——— million each for TOW and night vision.

Mr. ANDREWS. That is R. & D.

General BETTS. That is correct.

Mr. ANDREWS. When you got down to the hardware, how much would that cost?

General BETTS. If we produce it?

Mr. ANDREWS. What would it cost to equip each Cobra with a TOW missile, the night vision and the 20/30 millimeter gun?

Mr. POOR. The current class of Cobras cost about ——— apiece. The estimated cost of buying the AH–1G Cobra with the add-on items is ——— apiece.

Should we decide to buy the AH–1J, which is a twin-engine version the Marines are now buying, that cost would go to ——— a copy.

Mr. ANDREWS. You have a great need for the Cheyenne. You are in an unusual situation as far as the Cheyenne is concerned at this time.

General BETTS. Yes, sir.

Mr. ANDREWS. What would a souped up HueyCobra with the systems we have mentioned add to your capability?

General BETTS. It would turn that aircraft into one that had a hunter-killer capability, one that could go out and hunt trucks, armored vehicles, and kill them on sight.

Mr. ANDREWS. Then you would get something which you had hoped to get out of the Cheyenne from this modified HueyCobra.

General BETTS. That is correct. We would get some part of the capability we hope to have from the Cheyenne.

Mr. ANDREWS. At a much less cost?

General BETTS. At a much less cost, that is correct.

ARMY SUPPORT OF NEW BELL HELICOPTER

Mr. RHODES. Who makes the HueyCobra?

General BETTS. Bell Aircraft.

Mr. ANDREWS. Bell advertised they had a helicopter that would go 314 miles an hour. Do you know about that?

General BETTS. That is right. That is a research aircraft.

Colonel NIXON. That is research. It is a prototype aircraft and it has a jet engine mounted on one of the wings of the aircraft. It is a modified C model Bell.

Mr. ANDREWS. Is the Army interested?

Colonel NIXON. That is our program.

General BETTS. We are sponsoring it as a technology development effort.

Mr. ANDREWS. Are you providing any of the R. & D. money?

General BETTS. We are under our research helicopter program.

Mr. ANDREWS. Put something in the record about what you are furnishing in the R. & D. effort for the 314-mile-an-hour chopper.

(The information follows:)

Under this program, the Army has established an unofficial world's record speed for a helicopter by flying the UH–1 research compound helicopter 316 miles per hour. The program is managed by the U.S. Army aviation materiel laboratories and has been accomplished by the Bell Helicopter Co. at its Fort Worth, Tex., facility. The program is part of a continuing effort to conduct analytical and

experimental investigations of pure helicopter, unloaded lifting rotor systems, and slowed rotor systems for possible application to a wide range of helicopters. The information derived from this program is being injected into the helicopter industry and the military services helicopter design information systems.

This specific high performance helicopter project uses a modified YH–40 Bell helicopter that has a standard UH–1D (Huey) rotor hub and modified UH–1B rotor blades. The test aircraft has also been modified by installation of two Pratt-Whitney JT12–A3 engines on the short stubby wings. The wings provide auxiliary lift and the jet engines provide auxiliary forward thrust permitting the high speeds attained. The pilot flying the aircraft during its speed runs described the ride to be comparable to that experienced in a UH–1D flying at 135 miles per hour.

Prior year funding of this project is $2,074,701 since 1961. These moneys have funded the aircraft modifications, engineering support, and purchase of necessary parts and equipment.

PRODUCTION OF COBRA HELICOPTERS

Mr. ANDREWS. What is the top speed of the Cobra?

Colonel GILBERT. The cruise speed of the current Cobra is 130 knots and a top speed of about 150 knots.

Mr. ANDREWS. I am talking about the HueyCobra we are discussing about modifying.

Colonel GILBERT. It is the same one. It will be the same speed. However, with the total armament installed, it would have a reduced cruise speed because of the increased drag.

Mr. ANDREWS. What is the speed of the AH–1J?

General BETTS. It will be somewhat faster.

Colonel GILBERT. About 170 knots.

Mr. ANDREWS. Is it in service?

General BETTS. Not yet. It is in the late stages of production for the Marines and it should be off the line very shortly.

Mr. ANDREWS. Have you considered putting the various equipment on that chopper?

General BETTS. Yes, we would put it on that aircraft and we believe the work we are doing in connection with the AH–1G is directly transferable to the AH–1J.

Mr. ANDREWS. So then you should have two choppers with the missile, night vision and the special gun?

Mr. POOR. The AH–1G and the AH–1J are essentially the same machine. The difference is, in the Marine model they have twin engines rather than the single engine for the AH–1G. Whatever we do would be applicable to either the twin engine or single engine of the Cobra.

Mr. ANDREWS. The Cobra has been in production for some time?

General BETTS. Yes, it has.

Mr. ANDREWS. Put something in the record about the rate of production and the inventory that we have. How many do we have?

General BETTS. I don't know this number.

(The information follows:)

The present Cobra inventory is ———. The current production rate is ——— the last month of presently approved production. The total Cobra buy to date is for ——— aircraft.

NUMBER OF HUEYCOBRA TO BE EQUIPPED

Mr. ANDREWS. Would you want to equip all of them with these missiles, the night vision, and the 20–30 mm. gun systems?

General BETTS. I am sure we would want to, Mr. Chairman. I think that will have to turn on our analysis of cost, once we have solved the R. & D. problems, and whether or not we feel we can afford it because it will be a retrofit question if we did it.

Mr. ANDREWS. It wouldn't be as expensive as getting the systems installed initially, would it?

General BETTS. No. Once we have done the R. & D., the business of putting it on each aircraft shouldn't be any more expensive for those that we go back and retrofit.

Mr. ANDREWS. You gave us some figures on the cost of the Cobra with these systems as against the cost without the system.

General BETTS. It was the difference between ——— thousand and ——— dollars. That is correct.

Mr. ANDREWS. It almost doubles the cost.

Mr. POOR. These capabilities are inherently very expensive. The technology that works the night vision equipment and the guidance and control system is a guided missiles kind of technology.

Mr. ANDREWS. Is this the same night vision as with the FLIR?

General BETTS. This would be the same technology.

Mr. ANDREWS. You said that would cost about a quarter of a million dollars?

General BETTS. Yes.

CAPABILITY OF HUEYCOBRA TO HANDLE HEAVIER WEAPONS

Mr. ANDREWS. Would the Cobra be big enough to handle this system?

Mr. POOR. Yes, it would. The equipment need not be terribly heavy. It weighs a little over 100 pounds per installation. The high cost is in the very complicated solid state devices that make up the sensor element and the expensive infrared optical system and the stabilization to go with it.

Mr. ANDREWS. How much speed will these three systems take from the Cobra's maximum speed?

Colonel GILBERT. The Cobra, when equipped, fully armed with the missiles would lower the speed approximately 20 knots.

Mr. ANDREWS. Down to 140?

Colonel GILBERT. Down to 140 or 150.

Mr. ANDREWS. Would that be fast enough to be safe over there where they are firing those shotguns and rockets and SAM missiles and everything else at our aircraft?

Mr. POOR. It is difficult to predict. Helicopters can improve their safety very substantially by flying very low so that very few enemy weapons can be brought to bear. Alternatively, if they are faster, they can fly a little higher and still be safe, so we are not sure.

Mr. ANDREWS. In order to take advantage of these three systems, they would have to fly low, wouldn't they?

General BETTS. In a direct-attack environment, our analysis says that during the time of the attack the aircraft gains—reduces its vulnerability if it slows down its speed to about 90 knots, so it can break away from the enemy at greater ranges than would be the case if it came in at maximum speed.

Mr. ANDREWS. Do you mean zigzagging?

General BETTS. It comes up and breaks away.

From the point of view of the attack itself, the top speed is not the criterion that is most important with respect to vulnerabiliy. The criterion is how close do you come to the enemy installation and its antiaircraft guns.

When they are flying to targets, then they fly right at treetop level and unquestionably increased speed would decrease vulnerability. The difference of 20 knots that we would have to pay for carrying this is unquestionably worth having that additional capability available.

Mr. ANDREWS. It is worth it?

General BETTS. Yes, sir.

TIME REQUIRED TO ADAPT CHEYENNE WEAPONS TO COBRA

Mr. ANDREWS. How long do you predict it will take to adapt these Cheyenne weapons systems to the Cobra?

General BETTS. One and a half to two and a half years, depending on the technical problems we encounter.

Mr. ANDREWS. You couldn't hope to have a Cobra operational, with the three systems, in less than a year and a half?

General BETTS. We would not expect to be able to; no, sir.

Mr. ANDREWS. And maybe longer than that?

General BETTS. And maybe longer.

Mr. ANDREWS. I believe you said you thought you had the bugs out of this night vision system. Mr. Secretary, you said you flew one over at Aberdeen.

Mr. POOR. The one that I flew certainly demonstrated that this class of equipment can give very high quality pictures of the ground. A dramatic new capability. I don't think I can say that I am sure we have the bugs out because until a number of copies of these equipments have been built and they are in mass production and have proven easy to maintain, I don't think it is prudent to state that the bugs are out.

Mr. ANDREWS. I wasn't asking about the maintenance. I would assume it is a very sensitive system.

Mr. POOR. The first few that were built were certainly extremely difficult to maintain. They had complicated cooling equipment which amounted to a little baby liquid air plant that had to fly along with the machine. In the competitive environment that now exists and with the new developments in solid state electronic technology, I think there is a very real promise that we will get production, forward-looking infrared equipment that is easy enough to maintain so we can expect to keep it working 80 or 90 percent of the time in the field.

Mr. ANDREWS. I would certainly hope before the Army went into production they would get all the bugs out and have something that really would be useful.

Mr. POOR. I couldn't agree more. That is, of course, one of the reasons that General Betts' estimates say it might take 2½ years to get this equipment to the state where we are prepared to put it into production in a different configuration on a Cobra.

COST OF COBRA WITH NEWER WEAPONS

Mr. ANDREWS. What is the estimated cost of the Cobra with this added firepower capability and how does this compare with the cost of the Cobra in its current gunship configuration?

(The information follows:)

The production cost of the present Cobra is ——— dollars. With TOW, night vision, and the 30-millimeter gun installed it is estimated that the AH–EG will cost ——— dollars and that the AH–1J will cost ——— dollars.

PROBABLE COST OF CHEYENNE PRODUCTION AIRCRAFT

Mr. ANDREWS. What is your best estimate as to the probable cost of Cheyenne production aircraft, assuming the development is successful?

General BETTS. At this point, Mr. Chairman, I would be very reluctant to estimate any cost on it. There are still many questions facing us.

Mr. ANDREWS. The record we have established here shows that you have gone up from $125 million to approximately ——— million.

Mr. POOR. That is correct.

Mr. ANDREWS. And the price has been rising every time you made a new estimate.

Mr. POOR. Each time we add new capability the cost will clearly go up. One of the difficult questions facing us now, if we ever decide to produce the Cheyenne, we will have to have a complete rebid of all the subcontractors and so on and until that effort is initiated I can't make any kind of prediction as to what the cost will be.

The decision whether to produce or not would first have to depend on the contractor's ability to show us that he can build a machine that really performs as we had hoped. We think technically there is every reason to believe that can be done. Even if it is successful, the price may be too high and in that case we would certainly not go into production.

Mr. ANDREWS. The HueyCobra was sold originally to Congress as an interim gunship requirement until the Cheyenne became available?

Mr. POOR. That is right.

Mr. ANDREWS. Are you in effect requesting Congress to fund two separate AAFSS developments simultaneously, giving the HueyCobra the Cheyenne firepower capability and at the same time continue with Cheyenne development?

Mr. POOR. I think what we are asking Congress for is to equip the Hueycobra, which was intended as an interim gunship, with those equipments that will make it a good interim gunship between now and the time we resolve the problems on the Cheyenne system. It is quite clear that we cannot possibly expect to have the Cheyenne system within even 2 years of our hoped-for production date, even if everything goes well in the further development program. Therefore, it does seem prudent to provide the Cobra interim gunship with better capabilities to let it handle the problems of tank killing and night fighting, neither of which capability it now has in its role as an interim gunship.

General BETTS. May I add to that, Mr. Chairman, we recognize that, try as we will to keep the Cheyenne costs down, even if we do get the price to where we believe it is a good buy and we do buy them, that we will not be able to afford the numbers that we think we ought to have, in which case the Cobra, as a gunship, will be in the system just as long as the aircraft will last.

Mr. ANDREWS. Let me reframe my question. If you get the Cobra with the three systems that we have discussed, it will dampen your enthusiasm for the Cheyenne?

General BETTS. Our total system effectiveness analysis that was done in the very recent past in connection with the Cheyenne review indicated that even with a very high cost allocated to the Cheyenne, at a number like ——— or even ——— an aircraft, it was still a better buy from a cost-effectiveness point of view than would be three Cobras.

Mr. ANDREWS. In other words, you are still saying if you had the Cheyenne and it met the dream that you had for it, you would rather have one Cheyenne than three Cobras, and you could get one at about the price of three Cobras?

General BETTS. That is correct, roughly speaking.

PROBABILITY OF CHEYENNE SUCCESSFUL DEVELOPMENT

Mr. ANDREWS. I would think after the experience you have had with the Cheyenne program you would be a little more cautious in the future about the program than you have been in the past.

General BETTS. I would like to amend that to say it has taught us very broadly that the concept that one can buy major weapons systems, so-called total package procurement, on the basis of a paper design competition, is just not a good sensible, feasible thing to do. You have to put in checkpoints and write them into the contract so that if the development program does not go the way it was planned, that the Government doesn't find itself tied to an agreed cost and an agreed schedule that doesn't recognize short fall in R. & D. success.

I would say from now on, if we can afford it, we will have our contract definition phase stretched out to a longer period and require during the competition there be hardware produced to give us a chance to evaluate hardware in a competitive environment before signing a full development production contract with one contractor.

Mr. ANDREWS. Would you say that the dream you had of the Cheyenne was an impossible dream?

General BETTS. No, sir. I would say it is much more complex than that.

May I give you a little of what I went through—and Mr. Poor did too—in hour upon hour on the Cheyenne Review Board where we went into that program in tremendous detail. It turns out that it has been a practice generally accepted in the aircraft industry that in order to determine the extent of the performance envelope of a new aircraft in development that one would send up a test pilot and he would deliberately program, either fluttering stabilities or rotoring stabilities—whatever difficulties he might choose in order to measure some part of the aircraft performance, and that would be one checkpoint on the test program.

Now, it was that kind of a procedure that killed the test pilot with the Cheyenne. Once that had happened, Lockheed changed its approach and went back to this math model on a computer to check out these points on the flight envelope.

The important breakthrough is that they were able to create a math model that we find with reasonable precision duplicated what they had been discovering in flight as to where the rotor instabilities occurred at different parts of the flight envelope.

Now, if that can be done as a matter of routine, then one can check out the entire performance of the aircraft in a much safer way and at less cost and with lots more surety than by the test pilot approach.

We are all learning in this business. The industry is learning and we in the military are learning.

Mr. ANDREWS. How far down the line do you see the Cheyenne that you have hoped for, for so many years?

General BETTS. I believe we will know within the next 2 months whether or not this math model is actually duplicated in wind tunnel testing and we have in fact, or Lockheed has in fact proved they have the ability to simulate on a computer just exactly what happens at all parts of the flight envelope. If they have done that and then again through wind tunnel testing of modifications to the control system and the rotors prove that they are in fact able to give us the flight envelope we have asked for, we would then be able to say that this is a feasible development effort. Until we have gone through that cycle, all we have now is confidence in the math model that has not yet been confirmed by final wind tunnel testing.

Mr. POOR. To answer your direct question, if the current control system can be fixed, we think the delay in the R. & D. part of the program will be somewhat of the order of a year. If it takes a backup system, advanced control system, to accomplish the full flight envelope, we think it may be about 2 years' delay. We should know which it is within 3 or 4 months and at that point I'd like to come back and tell you how long it will take. At this point I would be a little silly to predict.

FUNDING REQUIRED IF CHEYENNE AUTHORIZED

Mr. LIPSCOMB. Is that when you are going to come in and request your funding too?

Mr. POOR. We are asking for the funding right now.

Mr. LIPSCOMB. It is almost a moot question considering the action being taken by the other body.

Mr. POOR. The first point is, we still do have the contractor under contract.

Mr. ANDREWS. How long can you keep him if you haven't anything to pay him with?

Mr. POOR. A rather short time, I guess.

Mr. LIPSCOMB. You mean you have him under contract for R. & D.?

Mr. POOR. That is right. We are not talking about production at all.

Mr. ANDREWS. If you don't get any money—and there hasn't been any appropriation if there isn't an authorization.

Mr. POOR. Then we will be in great difficulty in carrying out the program we are recommending to you.

Mr. LIPSCOMB. Is $16.5 million the very minimum that you can go ahead on?

Mr. POOR. I think that $16.5 million, with that we would be able to accomplish a very minimal program which would still leave major uncertainties to the feasibility of this system.

Mr. LIPSCOMB. Would any less funding for R.D.T. & E. be worthless?

Mr. POOR. It is hard to say that less funding is ever worthless.

Mr. LIPSCOMB. If you say $16.5 million is the very minimum program you can go ahead with and if you can't get that much, then it would be better to cut the whole thing?

Mr. POOR. I would feel very uncomfortable in facing you in another year, having stopped a program that is technically as promising as this one is. You see, the major subsystems have worked.

Mr. ANDREWS. What do you mean by major subsystems?

Mr. POOR. The navigation system is a very advanced navigation system. The fire control system is a very advanced fire control system. The guns on this are significant steps forward.

Mr. ANDREWS. Are they the same systems we are talking about installing on the Cobra?

Mr. POOR. Not exactly, because the Cobra can't carry the weight. So the systems that would be installed on a Cobra would be somewhat less capable derivatives.

But the point I want to make is that we have had a serious unanticipated difficulty in the flight mechanics part of this machine only. We hope, and we really believe that the flight mechanics can be fixed. There are two routes. One, the control system, as proposed by Lockheed in the first place, and agreed to by us and, second, a backup control system based on autopilot techniques. If the backup control system is required, we believe it will take about 2 more years to demonstrate something that is a fit candidate for production. Meanwhile, a great deal of very successful development work is under our belt in the development of this advanced fire control and munitions system and navigations system that goes on the machine.

I would feel most unhappy if I had to tell our taxpayers that we were not able to persuade you that this capability should be carried through, at least to a demonstration so we can determine whether or not we were right in our assessment of the great value of these advances. They are almost in hand. The fact that we have had some eight of these aircraft flying, and have demonstrated most of the subsystems, is hardly justification for throwing the R. & D. baby out with the bath water.

There is no question at all that Lockheed was in default on the production contract and we had to stop it, but we would like to keep the option open should this machine prove successful in a military functional sense, as I believe it can, and that was really the basis of the case.

CAPABILITY OF MEETING ORIGINAL SPECIFICATIONS

Mr. ANDREWS. In view of the fact that you are requesting money for these systems to go on the Cobra, does this mean that you are not confident that the Cheyenne can be developed to meet the original specifications? You have discussed that?

General BETTS. I believe in time it can be brought to the original specifications.

Mr. ANDREWS. Has the Army provided Lockheed with a cure notice on the development contract? If not, why not?

General BETTS. We have not in the development contract, although we are or have asked them to sit down with us and discuss a restructured contract that reflects what happened with the production contract. I don't think it is appropriate to serve them a cure notice until we have analyzed what sort of a proposed restructuring they would suggest to us.

FUNDS FOR FURTHER DEVELOPMENT OF CHEYENNE SUBSYSTEM

Mr. ANDREWS. Why is an additional $16.9 million required for "Advanced development of an electronic rotor control system" and how will these funds be utilized?

General BETTS. I might say the preliminary look we have had at the various ideas manufacturers have had for the utility tactical transport aircraft system have all come in with a rigid rotor.

Now, the Lockheed control of the rigid rotor is proprietary with them but it is a very simple and effective control system and if, indeed, it can be made to work and made to work reliably, that is a good way to go. But if, in the next 3 to 4 months we satisfy ourselves that it can't be made to work effectively and really reliably, then it is prudent from the national point of view, with respect to the growth of helicopter capability, to, look at another means of controlling the rotor.

The best technical advice we can get from both our in-house experts and those that we have asked to help us from academic circles and from industry is that the next step in technology ought to be to an electronic system. What we are proposing here is a backup program that could salvage the Cheyenne if the Cheyenne got in trouble with its control system but, more importantly, could contribute to rigid rotor control for the entire helicopter industry.

Mr. ANDREWS. The Secretary has stated that another $6.8 million is required for "Automatic test equipment and data storage and retrieval system applicable to gunships." What does this mean and why are these additional funds required? Also, why is this funded under the Cheyenne program?

General BETTS. It would be funded under this line item because it applied to gunships in general. It is a requirement in our judgment because, as the whole technology of test and checkout systems has evolved, it is apparent that we can provide an automatic checkout system that will test out all of the complex equipment that is aboard a ship like the Cheyenne. Fire control, computers, that kind of thing.

APPLICABILITY OF NEW SUBSYSTEM TO COBRA

Mr. ANDREWS. Would this be applicable to Cobra?

General BETTS. It would be applicable to Cobra. It represents a new capability, and it is a step forward that was not in the original proposed program.

Mr. ANDREWS. In other words, I get the impression as a layman that you can take Cobra and fix it up and almost have the same capability you have with Cheyenne, except speed. Is that about right?

General BETTS. We can do the same kind of things, but I would liken it to the fact that you can move the same mound of dirt with a ton-and-a-half truck that you can move with a 10-ton truck, but there are efficiencies that are practical in the larger vehicle. In the Cheyenne, you can carry much more ammunition per mission than you can ever carry with the smaller Cobra.

Mr. LIPSCOMB. On paper?

General BETTS. No, you can carry it today.

Mr. LIPSCOMB. You can't even fly it.

General BETTS. We can fly it today, but you can't fly it at 200 miles an hour under all flight conditions. That is the problem. We are captive of the fact that we suddenly got into a difficult situation and it is not a no-go situation by any means. We are very confident that in a relatively few months we will see that airplane flying all over the flight performance envelope, but that's the point. It will carry a lot more ammunition; it will go faster.

Mr. LIPSCOMB. It is proposed to carry a lot more ammunition.

General BETTS. It will carry it today at lesser speed. The point is, it has the lift capability.

Mr. LIPSCOMB. Aren't the eight or nine you have grounded today——

General BETTS. No, they are flying in test right now.

Mr. LIPSCOMB. I thought they were grounded.

General BETTS. We did until we analyzed this far enough to be sure we wouldn't kill another test pilot. That is just prudence.

Mr. ANDREWS I can easily detect that you have a burning desire for the Cheyenne and I hope you have it some of these days. One that works.

General BETTS. So do we.

DIFFERENCE BETWEEN CHEYENNE AND COBRA AFTER MODIFICATION

Mr. ANDREWS. So I will get back to my original question that brought forth all this conversation: When you put these three systems we discussed in the Cobra, won't you have most of the capabilities you would have had with the Cheyenne except speed?

General BETTS. In a qualitative sense we will have most of the capabilities. In a quantative sense, we will have about one-third the capability in a Cobra that we have in Cheyenne.

Mr. ANDREWS. That is a good answer. You have stated repeatedly that the cost of the Cheyenne, if and when you ever get it, would be three times that of a Cobra, but you would rather have one Cheyenne than three Cobras?

General BETTS. That is correct. Actually, we are going to end up with a mix because we can't afford to scrap all the Cobras that will be in the system, and we will keep them in the system.

Mr. ANDREWS. With respect to the automatic test equipment referred to in the Secretary's letter, are you familiar with the Navy's VAST system, in the Air Force GPATS system?

General BETTS, No; I am not.

Mr. ANDREWS. It is automated systems to test out electronics-avionics systems in aircraft.

Will this system you are speaking of be similar to that? In other words, will this be a third automatic——

General BETTS. I would have to look at those systems in detail, Mr. Andrews. I will be glad to do that and give you an analyzed answer for the record.

I might go on to say that you are familiar with the fact that we have had a system that we developed ourselves called the land combat support system that in fact may end up being what it takes to do this by extension of the software of that system but we need some R. & D. and engineering talent and money therefor in order to explore that application, but I would be glad to look at these two systems and see if either of them could be applicable to this problem.

TRW—COMPUTERIZED PROGRAM MANAGEMENT SYSTEM FOR CHEYENNE

Mr. ANDREWS. We are intrigued by the phrase "data storage and retrieval system applicable to gunships." Does this mean that the $13 million spent on the TRW contract through fiscal year 1969 for the integrated technical data system will provide the Army with little more than a data storage and retrieval system?

Colonel GILBERT. The data storage and retrieval system is the TRW system which you just described, that we have had for the past few years in the Cheyenne program. The dollars indicated—the ——— million indicated was to continue that effort which would have been funded out of PEMA money, that being a major part of the Cheyenne program until recently. The ——— is a continuation of these past years' efforts with R. & D. paying the bill rather than PEMA.

Mr. ANDREWS. As I recall, we had some discussion of this contract during our Operation and Maintenance and PEMA hearings. I believe the Army indicated that this contract would not be funded further. You are now suggesting picking it up in the R. & D. area, is that correct?

Colonel GILBERT. Yes, sir. This program was initially funded under the R. & D. for the first couple of years and then as production came up the funding went to the appropriation carrying the bulk of the Cheyenne effort which meant PEMA.

With the cancellation of PEMA it falls back into R. & D. and these are dollars required to continue that effort.

TIME REQUIRED TO COMPLETE DEVELOPMENT

Mr. ANDREWS. What is your prediction as to the length of time it will take to successfully complete the Cheyenne development and the total cost thereof?

We have discussed that. You can mention it again in answer to this question for the record. How much of this work to be done with the additional ——— million would have been done under the production contract? In other words, this added requirement was the direct result of the production contract cancellation and it could be inferred that this added development work would have been done under the production contract had it not been cancelled.

General BETTS. Well, if we had gone through with the production contract, we would not have had any reason to upgrade the Cobra. So that the night vision and other moneys indicated for Cobra for the 30 and 31 millimeter gun would not have been required.

Mr. ANDREWS. Are we to understand then that the ——— million is nothing more than the Army funding the completion of development or correcting deficiencies in the Cheyenne which Lockheed failed to do under the current development contract?

General BETTS. No, sir. As was indicated in part of what Colonel Gilbert said, there has been work under the PEMA program. Since we now have no PEMA program, it will shift to R. & D. The Cobra work would not have been done at all so that is hardly Lockheed's responsibility.

The backup rotor control system—and that is one of the most important items that ends up in that ——— million—is a matter of prudence on the part of the Government to make sure that we do

have the best technology available for rotor control if the Lockheed approach fails.

The Government insisted on that. That is hardly Lockheed's basic responsibility since they are confident they can fix up the rotor with their present approach to the control system. The backup program is just our conservatism.

Mr. ANDREWS. If they fail to do it, it is a default, isn't it?

General BETTS. No, sir. The rotor control system was not part of the contract requirement at all.

Mr. ANDREWS. We are talking about the original contract.

General BETTS. I know that.

Mr. ANDREWS. If they are unable to correct this——

General BETTS. But we don't know that they are unable to correct it. As a matter of fact, they are confident that they can correct it.

Mr. ANDREWS. If it turns out they can't, what happens? Can't they be made to correct it?

General BETTS. I suspect they can, but the real question is where we would be in a development program if we wait until that point is reached, and then start a backup program. We would all have to sit on our hands while we waited for the backup program to get underway. Furthermore, as I remarked before, since the whole industry is now clearly interested in the capability of rigid rotors, it is very important to the military that we have the best possible control system for rigid rotors. Our technical experts have argued that, even if the Lockheed system works, they are convinced that an electronic control system would in the long run prove to be a better system.

Now, this is something that wasn't true even 2 or 3 years ago. It is a question of the available components, the confidence in electronics systems for that application.

Mr. ANDREWS. Did the Director of Defense Research and Engineering originally refuse to grant these additional funds because the Cheyenne development contract was considered to be sufficiently funded, at least through fiscal year 1970?

General BETTS. I know of no occasion when they turned to us and said, "We don't want you to continue this program and we don't want you to revise your R. & D."

Their interest was in making sure that we could in fact make a good aircraft out of the Cheyenne.

EFFECT OF DENIAL OF FUNDS

Mr. ANDREWS. What would be the effect of Congress denying the request for an additional ——— million?

General BETTS. It would deny us the Cobra capability.

Mr. ANDREWS. How much of the ——— million do you plan to spend on the Cobra effort?

General BETTS. ——— million; and it would also deny us the ability to carry forward a backup control system. It would also deny our applying funds to the automatic test equipment.

Mr. POOR. The automatic test equipment capability would be used with the Cobra as well as for gunships in general.

Mr. ANDREWS. Who would develop the automatic test equipment?

Colonel GILBERT. That is still to be determined.

General BETTS. We would have to compete that.

TOTAL PACKAGE PROCUREMENT

Mr. ANDREWS. In April 1968 Congres was told that—

The decision to begin production of the AH–56A in fiscal year 1969, before the flight tests are completed, involves a relatively small risk and allows us to take advantage of the favorable price * * *.

General Betts, you have recently been quoted as saying the Cheyenne is another casualty of total package procurement under which we thought we could make a decision based on a paper design that said all technical problems could be solved. You also reportedly indicated that total package procurement might be used successfully on smaller programs, but not for large complex weapons. Are these your views?

General BETTS. Those are my views, but I should expand a little bit. The phrase, "total package procurement" has to be defined. The kind of problem we had here was related to making a firm development and production program that was tied to a time schedule in the contract and not tied to the demonstration of certain technical milestones. Furthermore, one went into that contract on the basis of the paper design competition. As I remarked earlier, my view is that the design competition is to produce hardware, so that in a competitive environment we have the opportunity to see what industry can provide in a new capability, with enough hardware produced so that one has a solid basis for making the judgment with respect to whether or not the technology has advanced far enough that one can tie up a contractor in a firm development and production contract.

Mr. Andrews. Now, the Sheridan seemed to suffer from a similar fate. However, I do not wish to get into the Sheridan at this time. Nevertheless, the fiscal year 1970 PEMA budget contains requests for funds for the procurement of many items of equipment and weapons which have not completed their development and testing, and are not yet approved for service use. Why should Congress provide the procurement funds for these PEMA items under those circumstances?

General BETTS. The time cycle between the time we asked for the funds in the President's budget and the time that we would commit them is anywhere from 1 to 2 years. Consequently, we have to ask you for these funds before we pass the milestones that would indicate when they ought to be committed.

PROCUREMENT WITHOUT ADEQUATE DEVELOPMENT

Mr. ANDREWS. Aren't you going contrary to the advice of not buying until you "fly" when you go into programs like this?

General BETTS. I don't know what that means, Mr. Chairman, because——

Mr. ANDREWS. It is pretty well known in this committee. We have insisted on it for years. Unless you are sure it will fly, don't buy it.

General BETTS. If we had followed the philosophy literally that you are espousing, we would not have had one new aircraft available to this country in all World War II. All World War II. In other words, if there is any time urgency to the requirement, there has to be some judgment made at some point in the development cycle that says, "This item of equipment, this weapon, is ready to be released to production," because the lead time from that decision to the time when you first see production is very considerable. Up to 2 years in many cases.

In World War II we built aircraft that had never flown at all because we wanted them quickly. When they came off the end of the production line, they went to another production line. We called it a modification line if you will recall, and in the modification line we made up for the corrections we had found during the testing effort. Now that is an expensive way to do things and that is one extreme, but if we took something like the Cheyenne and said, "We will fly this and thoroughly test it before we make any release whatsoever to production," we will have lost the engineering team that did the original design when it comes time to pick up the changes that we discover in the course of testing.

Now, somebody has to translate those changes into the design for the production item. Now, if you have a completely new engineering team making the changes that are related to the production item, you are just as likely find all sorts of new technical problems when you get that production item off the line.

That is what happened to our M60A1E2 that is now sitting in storage waiting for us to solve the stabilization system. The design team that created the R. & D. stabilization system quit the contractor between the time they created the R. & D. design and the time we asked them to redesign the thing for production. So it was not a completely different, but a significantly different crew who designed the production item and we have had trouble with it ever since. So you can't just "fly before buying." It doesn't make good sense.

Mr. ANDREWS. You are talking about a matter now that will be argued effectively on both sides.

General BETTS. Yes, sir.

Mr. ANDREWS. What role do you play in the decision making process to initiate production of an item still under development?

General BETTS. I am one of many who are asked to advise my superiors on what we call—well, there are several points in the classification cycle. Classification for limited production means that we have not completed the testing to our satisfaction, but we feel it is appropriate to release to limited production pending the time when we have completed the testing cycle. Then at a later date we release to what we call cassification standard A, and that woud mean we have completed the testing to our satisfaction and it is released——

LESSON LEARNED BY BUYING BEFORE ADEQUATE RESEARCH COMPLETED

Mr. ANDREWS. What lessons have we learned from the Cheyenne, and Sheridan programs, as well as those of the other military services where decisions were made too early in the program to initiate production? What steps are being taken by the Army to move possibly more toward the "fly before buy" approach in weapons systems developments?

Mr. POOR. I think the most signficant lesson we have learned is that reliance on paper designs is an imprudent thing to do. It is not entirely a new lesson. The main consequence has been a policy decision, where possible, to have competitive development of the critical sub-elements of all new systems in hardware.

We did it a number of years ago in the development program that led to the TOW missile system. At that point we were seeking a new kind of high-precision guided missile to shoot at tanks on the ground

and what we did offers a lesson for today. We tested in the field the critical guidance components of each of some 10 different proposals. Each vendor wanted us to buy a whole missile system from him and we didn't do that.

We took the pieces out and tried them in the field. That is also why, in our proposal to you on the heavy-lift helicopter, we are planning a program of component development to test those critical parts where we can't predict what will happen, confidently, early enough in the program so the design will be meaningful. We have the full support of D.D.R. & E. I think we feel we have collectively learned a very important lesson, or relearned a very important lesson which is, understand all the pieces before you make an evaluation that the thing is worth putting under contract.

The point where you go into production partly depends on time urgency but I hope very much that we will be able in the future to say that we have not repeated the mistakes of requiring, to save time, so much concurrency that we get unenforceable contracts. I hope at the same time we don't swing the other way and get to such a tremendously stretched-out program of test before production that the things are obsolete before they go into production. We must strike a balance.

The key thing, I think, is being confident, through test, that those pieces that you cannot reasonably analyze on paper are well enough understood so the design really makes sense.

Mr. ANDREWS. General Betts, do you want to add anything?

General BETTS. I think that is a very good answer.

Mr. ANDREWS. An example this committee remembers and will never forget is those planes the Navy bought and couldn't get a one of them off the ground. They had to tow them away from a field in St. Louis, if I am correct.

General BETTS. There have been programs during the war, Mr. Chairman, that were outstandingly successful where release to production was made before the first flight.

Mr. ANDREWS. I know a good lawyer could argue effectively on either side of this question that we are talking about.

Those are all the questions we have on Cheyenne. Mr. Lipscomb?

Mr. LIPSCOMB. I have no further questions.

Mr. ANDREWS. Mr. Rhodes?

Mr. RHODES. I think we have covered the subject very adequately, to put it mildly.

Mr. ANDREWS. Mr. Davis?

Mr. DAVIS. No questions at this time, Mr. Chairman.

Mr. ANDREWS. Before we get into another subject, we will adjourn the committee until 10 o'clock tomorrow.

TUESDAY, JULY 8, 1969.

AIRCRAFT WEAPONIZATION

INCREASED FUNDING

Mr. ANDREWS. The committee will come to order.

This morning we will discuss exploratory development, aircraft weaponization.

You are requesting ——— million in fiscal year 1970 for aircraft weaponization, an increase of ——— million over fiscal year 1969.

What is the reason for this increase, General Betts? Before answering that question, would you tell us briefly for the record what is meant by exploratory development and aircraft weaponization?

General BETTS. The exploratory development is one category of the several different categories under which we program all our research and development effort. The exploratory development category is that which follows basic research and represents broad state-of-the-art advances, that type of activity.

So that within the aircraft weaponization program it would mean fairly fundamental work that could be applicable to many aircraft systems, not necessarily one specific one such as Cobra or Cheyenne.

Mr. ANDREWS. Tell us the reason for the increase of ——— million over the past fiscal year.

General BETTS. I do not have the data available immediately.

Colonel BONIFACIO. Continually for the last 3 years we have been requesting approximately ——— million per year for the aircraft weaponization exploratory development. In each case, however, we have been allotted only 50 percent or we have had to reprogram close to 50 percent of it for higher priority developments. Therefore we have applied approximately ——— each year to this effort.

ITEMS UNDER DEVELOPMENT

Mr. ANDREWS. What are some of the items you are working on in this area?

Colonel BONIFACIO. In this particular area because of the approximately 50-percent reduction we have reduced our study effort to those involved in the weapons effectiveness, those areas that tell us the effectiveness of our weapons systems, the kind of vibrations that can be expected on the structure of the aircraft, the effectiveness of certain kinds of rounds that attack targets. These kinds of studies assist us in making our final decisions as to whether or not we should go or not go, let's say, with a 20 millimeter, 30 millimeter, or 40 millimeter, or with the Tow.

Yesterday I think we addressed some areas of why we needed R. & D. for the TOW, 30-millimeter and night vision. In these areas we would take up the basic study and determine whether or not we should indeed go in that direction. Is it feasible to hang on certain weapons systems on aircraft already in being? These are the kinds of studies that we conduct in exploratory weaponization.

Mr. POOR. Mr. Chairman, since this program is an exploratory development program, it means that it is fairly early in the development cycle of new things. I think it would be useful, and perhaps helpful, to talk about some of the things that have come out of this line element in prior years. We have talked about the effectiveness of the TOW missile system as helicopter armament. The study that resulted in the choice of the TOW rather than the Shillelagh missile for incorporation in the helicopter armament systems came out of this element.

We are also, for example, very pleased with the successful development of the new 30-millimeter cannon originally intended for the Cheyenne system. We have developed under this line item new warheads for the 2.75-inch folding fin aerial rocket. We have developed

laser range finders and we have done exploratory work which has established the feasibility of airborne moving target radars, low light level TV equipment and image intensifier equipment for fire control systems. All of those systems came out of this program, had their beginnings in this program. It is a rather broad program.

Mr. ANDREWS. I wish you would put some more in the record, Mr. Secretary.

Mr. POOR. I would be happy to.

(The information follows:)

Some examples of exploratory work conducted in aircraft weaponization during fiscal year 1969 are:

1. Tracking and acquisition tests of the XM-26 stabilized sight.
2. Initiated a 4-month study on optimum Cobra armament and a 5-month study on follow-on sensors and armament for AH-56A.
3. Redeye investigations for aerial applications.
4. Evaluated 25 unsolicited proposals from contractors.
5. Study on a 20-grain flechette warhead.
6. Tests to identify and quantify error sources in delivering air launched or air dropped munitions.
7. Conducted off angle sled firing for rocket control ammunition.
8. Studies for the selective effects armament subsystem (SEAS) development.
9. Studies to include the design and feasibility of using submissile warheads, guided missiles, and multiple tank engagement mathematical models.
10. Lethal area studies of the XM-229 (17 pound) warhead and the 30-millimeter and 40-millimeter high-explosive, dual-purpose rounds.
11. Field flight tests were performed to obtain ballistic and target vulnerability data.
12. A contract was extended to obtain additional data on gun reaction forces and blast effects.

RESEARCH AND DEVELOPMENT CONTRIBUTIONS TO VIETNAM

Mr. ANDREWS. In the last 3 years this sub-element has been decreased through reprograming in favor of higher priority developments. Is this what will happen to half of this ——— million this year?

General BETTS. I can't say that it will or it will not, Mr. Chairman. It is true that throughout the exploratory development part of our program we have found it necessary to go back into that money as priority requirements from Southeast Asia have been identified. As I remarked earlier in our discussions, since we have no source of contingency money we must resort to the problem of reprograming from lower priority efforts. In this case we have done that with aircraft weaponization; as you are aware, we have done it with other programs. I would hope that we do not have to, but I find it hard to predict one way or the other.

Mr. ANDREWS. I assume that your requirements from Southeast Asia have a very top priority.

General BETTS. This is correct.

Mr. ANDREWS. That war has been with us now for 8 or 9 years. I wish you would place in the record at this point some of the outstanding contributions that R. & D., Army, have made to Southeast Asia, things that are actually in existence down there today.

General BETTS. We will be very happy to.

Mr. ANDREWS. I think it would be very helpful.

(The information follows:)

OUTSTANDING R. & D. CONTRIBUTIONS TO VIETNAM

A. CURRENTLY IN FULL TACTICAL USE

1. Air cushion vehicle.
2. Armor kits for vehicles
3. Airborne personnel detector.
4. Airmobile platform for M102 howitzer (105 mm.).
5. Aircrewman's body armor.
6. Aircrewman's fire resistant clothing.
7. Adjustable ranging telescope for M–14 rifle.
8. Fire retardant flight gloves for aircrews.
9. Helicopter armament subsystem, XM–28, 7.62 mm. machinegun and 40 mm. grenade launcher for AH–1G, Cobra.
10. Improved conventional munitions.
11. Airburst proximity fuze (40 mm.), XM–596.
12. Attack helicopter, AH–1G, COBRA.
13. AN/PPS–5 radar.
14. Light observation helicopter, OH–6A Cayuse.
15. Southeast Asia Mohawk revision (Seamore).
16. Miniscope.
17. Lightweight intrenching tool.
18. Lightweight combat clothing.
19. Long-range patrol rations.
20. Riot control canister cluster, CS, E158.
21. Collapsible water bag
22. Mask, riot control agent, XM 28
23. Squad radios, AN/PRT–4 and AN/PRR–9
24. FLASH, multishot portable flame weapon, XM191
25. Rome plow
26. Miniature colored smoke grenades, XM–166 thru XM–168
27. Sheridan armored reconnaissance/airborne assault vehicle
28. Two-quart collapsible canteen

B. PROGRAMED FOR FULL TACTICAL USE

1. Retransmission device for AN/PRC–25 radio
2. Landing zone directors signals for directing helicopters and aircraft
3. Integral smoke generator for helicopters and airboats
4. Aircraft armament pod, 7.62 mm. machinegun pod, M18E1 for AH–1G COBRA
5. Helicopter armament subsystem, 7.62 mm. machinegun, M27E1 for OH–6A Cayuse
6. Battlefield illumination system
7. Mine firing switch
8. Off-leash scout dogs
9. Portable radio frequency monitor set (AN/USQ–42)

FORECASTING WEAPON SYSTEMS

Mr. ANDREWS. What is meant by the statement on page 75 of your justifications book: "Perform parametric studies to aid in forecasting weapon systems effectiveness"?

General BETTS. In looking at the question of weapon systems effectiveness, it is desirable to optimize the combination of the weapon system and the aircraft that carries it. Now, the way to do this in a study environment is to assume a spectrum of capabilities for the aircraft in terms of speed, lift, stability, if that is a factor, and then a spectrum of capabilities for the weapons. So that as you vary these different capabilities in an overall effectiveness analysis you can eventually pick out an optimum combination of aircraft character-

istics and weapon characteristics for maximum total system effectiveness. Now, we refer to the different capabilities in each of these categories as parameters applying to the ultimate result. We call that a parametric analysis because we have not tried to assume any fixed set of characteristics, but rather a spread of characteristics in that sort of a system approach.

Mr. Poor. May I say, Mr. Chairman, this is jargon for doing a good job of design.

For example, in the gun-fire control system combination that was studied for the Cheyenne helicopter within this area one of the questions is clearly: How much should we spend on a very accurate fire control system to deliver the gun ammunition very precisely? You can use a whole range of things, a very inexpensive, simple sight to point the gun, and in that case it takes many rounds to defeat a target because it sprays around the landscape. At a much higher expense you can get a very precise delivery system that will give a very high assurance of a first-round hit.

Now, depending on what kind of targets you have to contend with, that extra expense may or may not prove to be worthwhile. So these studies are intended to try to get a handle on how much sophistication is worthwhile, what is the optimum size of the armament, this kind of thing. In old-fashioned words, it is nothing but good system design.

UTILIZATION OF 1970 FUNDS

Mr. Andrews. Mr. Secretary, do you have specific studies in mind that you plan to conduct this year on particular weapon systems?

Mr. Poor. I understand that the planned program includes design studies of this sort to assess the value of some of the improved moving target indicator radars, new fire control techniques, and daytime and nighttime fire control systems for application to helicopters. We would do exploratory work, for example, on improved armament systems for antitank, antitruck, antipersonnel weapon systems, so that we have in our budget of tricks reasonably well assessed new schemes for development in future years. It is the beginning, the preliminary design work in all of these areas.

Mr. Andrews. How will the 1970 fiscal year funds be utilized?

Mr. Poor. The prior answer was intended to cover that, Mr. Chairman.

Mr. Andrews. Do you have ——— million worth of work programed or will you wait and see?

General Betts. We have more than ——— million worth of work we would like to do. At the moment that is what we felt we could allocate to this.

LOW-PRIORITY AREA

Mr. Andrews. Mr. Lipscomb, do you have any questions on "Exploratory development, aircraft weaponization"?

Mr. Lipscomb. Yes, Mr. Chairman.

From your testimony I understand that this is basically a very low priority area of operation, General.

General Betts. I wouldn't pick out this one aspect of exploratory development, but the problem with priority, with respect to explora-

tory development, is that we cannot point to an immediate crisis need in these various or very preliminary efforts. Now, broadly speaking, we feel that exploratory development is very important. Yet when we have a firm hardware requirement from Southeast Asia——

Mr. LIPSCOMB. We are talking about an aircraft weaponization program that has been cut basically in half by reprograming over each of the past 2 or 3 years. In discussing this item earlier, you said that the reason that this has been reduced by reprograming is because it is a low priority item compared with others.

General BETTS. It is a low priority item compared with the other aspects of the development, 6.3, 6.4, that are much closer to hardware where the need can be more immediately identified. That is what I meant to indicate.

Mr. LIPSCOMB. So it is considered a low priority item? It has been in the past.

General BETTS. I consider aircraft weaponization, as such—I don't consider it as a low priority item. I consider that when we must meet an immediate requirement my only source of funds is the general capability represented by the money we have programed for exploratory development, and this is one of them.

Mr. LIPSCOMB. Would you say that all the discussion that we have here on justification is a useless exercise of your time and our time?

General BETTS. No. I think it is very helpful to you and to us to point out what we think are the fields of exploration that we ought to pursue if the resources are available and if higher priority immediate requirements from Southeast Asia do not appear during the year, we would in fact pursue them.

Mr. LIPSCOMB. Are items for Southeast Asia the only ones of higher priority that you can anticipate?

General BETTS. That is our highest priority. I wouldn't deny the importance of developments that are pointed toward strengthening NATO.

Mr. LIPSCOMB. Would you prefer for budgeting purposes to knock out all these low priority items but in their place set up a contingency fund?

CONTINGENCY FUNDING

General BETTS. I think we could do a better job of managing our program if a percentage of the total R. & D. budget was identified as contingencies but were programed during the year and then we came back and reported to you as we program them.

Mr. LIPSCOMB. Supposing you came into the committee before you programed, instead of after, and said that you had a use for the contingency fund?

General BETTS. I would be very happy to do it that way. I do think it would be a better way to manage the program.

Mr. LIPSCOMB. I think it is a waste of your time and our time to sit here day after day listening to you justify something that you don't even intend to go into or utilize. It is a waste of time over in the Defense Department to set up sheet after sheet of a scenario that makes it appear that you are going to do something which in reality you have no idea or no intent of doing.

General BETTS. I think you are absolutely right, Mr. Lipscomb. You know, in construction we have recognized this for years. We put in 10 percent for contingency.

Mr. POOR. Mr. Lipscomb, I can share your view with great enthusiasm. I had understood that the Congress, in general, has not looked with favor on contingency funds for R. & D. I think it is absolute nonsense. It would be enormously helpful to you and to us if we did not put together a budget which is so tight that it has inherent fictions built into it. The fact of the matter is that is what we now have to do.

Mr. LIPSCOMB. I don't want to mislead you. I do not believe in contingency funds either, because they have been misused and not handled with prudence. But I believe it perpetrates a fraud on the Congress to try to tell us that you are going to do something and have some plans and yet you have no intentions of ever doing it. This is true especially when you sit here and justify these figures in order to get some funds so that you can later reprogram them.

Now, I have sat on this committee for years and years, and I have realized that there has been reprograming going on but this is the first time that I have felt that it has been done with complete intent.

General BETTS. No, sir; no, sir; that is just not the case, that is just not the case. We know by experience——

Mr. LIPSCOMB. Isn't that the way it sounded?

General BETTS. We know by experience that there will be things that come up that we do not foresee before going into the budget year.

Mr. LIPSCOMB. We understand that.

General BETTS. Since we are not allowed any contingency funds we must emasculate a program that has been very carefully and deliberately planned and proposed. I don't want to change this program.

Mr. LIPSCOMB. Supplemental funds may be requested from the Congress. You would do 10 times better by being frank, candid, and clear with the Congress than trying to do otherwise—and I realize we are only talking about ——— million now.

General BETTS. I appreciate that, but it is a lot more than that through the course of the year, as you are well aware.

Mr. ANDREWS. If the gentleman will yield, do you get the feeling this is a cushion?

Mr. LIPSCOMB. Just a cushion, yes.

Mr. ANDREWS. Or a contingency under a different name.

Mr. LIPSCOMB. Yes. Then to sit here and try to justify what you mean by "perform parametric studies to aid in the forecasting of future weapon system effectiveness." In trying to justify that sentence; you waste the time of the shorthand reporter, the committee staff, and the committee members.

General BETTS. The sentence explains exactly what we propose to do if we had the money.

Mr. LIPSCOMB. If you had the money?

General BETTS. Yes.

Mr. LIPSCOMB. You know you are going to reprogram money out of that as fast as you can.

General BETTS. No, I don't.

Mr. POOR. I don't think that is the case. I think the 6.2 part of the program is quite clearly the most vulnerable part. When an urgent

requirement comes to put more money into a Southeast Asia-related program or one of our ongoing advanced development or operational system development programs we do have to find the money somewhere. But this item and every other line item in the 6.2 development program has been carefully reviewed by Dr. Foster's office as well as ours, and given that we do not have to reprogram out, we would indeed carry out this work. We do think it is important. I think it is important. I think the payoff in the past from this program has been well worthwhile.

FISCAL YEAR 1969 FUNDING

Mr. ANDREWS. What was the amount appropriated under this heading last year?

General BETTS. $1,050,000.

Mr. ANDREWS. $1,050,000?

General BETTS. Yes.

Mr. ANDREWS. How much of that, if any, was reprogramed?

Colonel BONIFACIO. Very little of the $1,050,000. The majority of $1,050,000 was spent in the exploratory development for aircraft weaponization.

General BETTS. What was actually appropriated: $1,050,000?

Colonel BONIFACIO. $1.9 million was in the President's budget, sir.

General BETTS. That was in the President's budget. We asked for $1.9 million and we got $1,050,000—according to the figures we have here—and of that $1,050,000 which was appropriated we reprogramed about 10 percent.

Mr. POOR. Which shows that we are serious about this program. We spent 90 percent of what we got last year, as I understand it.

Mr. ANDREWS. This report on page 75 shows that you were funded for 1969 at $900,000. You say $1,050,000. Explain that for the record, if you can.

(The information follows:)

The amount of money shown in the President's budget for this program in fiscal year 1969 was $1.9 million. The amount appropriated was $1.050 million—$0.120 million was reprogramed for the quiet aircraft (reprograming action fiscal year 69–3 (DOD F/69–11)). By reprograming authority of the developing agency, an additional $0.27 million was provided to this effort. As of June 30, 1969, a total of $0.957 million was allotted to conduct exploratory development in aircraft weaponization.

INVESTIGATION OF REDEYE MISSILE

Mr. ANDREWS. Any further questions?

Mr. LIPSCOMB. Yes, Mr. Chairman.

Could you explain the work that you are doing in your fiscal year 1969 program to investigate air-to-ground system, for example, Redeye missile for use against material targets? That is on page 74.

General BETTS. Yes, sir. We have explored the possibility that the Redeye heat-seeker might be adequate to seek out the infrared radiation from a tank or other very high powered vehicles. So far, these experiments have not been very promising. I doubt that we will pursue it further. In theory, it is a feasible technology but in practice one is limited by the amount of radiation you get from that type of source.

Redeye is not that sensitive. It is my understanding that there are a couple of additional experiments that we propose in this general area

to confirm or deny what we have learned so far, but at the moment it doesn't seem very promising.

Mr. LIPSCOMB. How much effort do you feel that you have expended on this particular investigation with the Redeye missile?

General BETTS. I would have to check that out, but in the order of a few hundred thousand dollars is my present guess. I would have to confirm that, Mr. Lipscomb.

Mr. LIPSCOMB. Would it be the idea that if it was feasible you could——

General BETTS. If it did work, it could be used as an antitank, or as an antivehicular, weapon.

Mr. LIPSCOMB. On a helicopter?

General BETTS. On a helicopter; yes, sir.

Mr. POOR. It is conceivable that the improved Redeye seeker, which will be somewhat more sensitive than the one we are now using, may have more capability against warm targets such as trucks and other military vehicles. So it would be prudent to find that out, but there are also a lot of hot things in a battlefield which could distract the weapon. So I think it is just one of those things that we ought to explore to make sure that the capability, if it is useful, is not overlooked.

Mr. LIPSCOMB. What about the TOW on a helicopter?

Mr. POOR. The TOW on the helicopter is, of course, a tremendously useful weapon. It is very big, relatively expensive. It is designed to kill tanks. Against lighter, more vulnerable targets it would be well if the Redeye does have a capability to use it because it would be a great deal less expensive.

General BETTS. If we had a seeker missile it would be a better way to go, operationally, because then the helicopter would have no requirement to continue to track the target after launching the missile. So at some point in time in the future we would hope to be able to develop an adequately effective and reliable seeker missile for this mission.

Mr. ANDREWS. Does a TOW missile cost more than the Redeye? The Secretary indicated that it did cost more.

Mr. POOR. The TOW installation in a helicopter is a very expensive device, as you know.

Mr. ANDREWS. I am talking about the missile.

Mr. POOR. I think the missiles are roughly comparable. The Redeye may cost a little more.

Mr. ANDREWS. How far have you gotten in your effort to have the Redeye adapted to the choppers?

General BETTS. As of the 7th of July, we had fired four rounds against trucks, but we augmented those trucks with a thermal output to check the system.

Mr. ANDREWS. You mean, you fired Redeye from choppers?

General BETTS. Four Redeye.

Mr. ANDREWS. So you can do it.

General BETTS. Three were hits, the fourth hit the ground. We do propose six to 10 more test flights.

Mr. ANDREWS. So you can do it.

General BETTS. We can do it under under the conditions of that experiment. Now, having done that, we will try to explore this further to see what the limitations of this system may be.

Mr. ANDREWS. Do you need special equipment on the chopper to use the Redeye?

General BETTS. Very little. I don't see a significant problem here.

Mr. ANDREWS. Mr. Lipscomb?

CONTINGENCY FUNDING

Mr. LIPSCOMB. Just to complete our contingency discussion: In your R.D.T. & E. budget, request presently pending before the Congress, how much contingency do you feel you have cranked into your request?

General BETTS. I don't have any amount that I have identified, Mr. Lipscomb. We built the program from the laboratory up and everything that is proposed are things that the Army really wants to do.

Mr. LIPSCOMB. By the rule of thumb, what do you think in the development of the budget you would put in—say, 10 percent?

General BETTS. We don't go about it that way.

Mr. LIPSCOMB. I know you are not supposed to but you indicated yesterday and again today that you have to reprogram for higher priority items because of contingencies.

General BETTS. That is right. The amount that we reprogram depends on the level of the higher priority things that occur during the year. So that the only good answer I can give you is to go back into the history of the last 2 or 3 years—say, for example, last year where the reprograming total was about 11 percent and the year before it was less than—about 9 percent. But we do not deliberately program a part of this effort to say, "Well, that is going to disappear."

Mr. POOR. Mr. Lipscomb, I think we are discussing a matter that has been of very serious concern to me, and I think Dr. Foster shares my concern. The present method of budgeting without any explicit contingency, building the budget on firm programs which we seriously intend to carry out, as you have indicated, is inherent nonsense. We know we are going to have to reprogram sometime, and each program that we cut in order to provide money for these unanticipated, important new R. & D. programs, simply has to suffer. It is a very painful process for us, because whenever we move out of a program of this sort—and we reprogramed about 10 percent out of this line item—something that we seriously thought was important and worth doing has to be stopped. If the Congress sees fit to put in a small reprogramable fund, identified as a contingency fund, it would make our life and yours, I think, a great deal simpler and I think we could do a great deal better job of planning our budget. We wouldn't have this yo-yoing up and down of some programs which are also important.

Mr. LIPSCOMB. Well, I haven't regained that confidence yet in the Congress giving you a contingency fund.

Mr. POOR. I understand that. I think it would be desirable.

Mr. LIPSCOMB. I am afraid that the funds would go to CRESS, the university program, Project THEMIS, and all of these kinds of things.

Mr. POOR. I think the record will show that the reprograming has largely been in the systems that are well along in development and into programs like Southeast Asia. I can give you full assurance that we could arrange matters so that a contingency fund would not be used in support of a preestablished level of study programs.

Mr. LIPSCOMB. Last year before this committee, Dr. Foster said about the last place he would make a reduction is in the THEMIS program. I hope he doesn't say it this year.

Mr. ANDREWS. And we have got a war going on.

Mr. LIPSCOMB. Yes.

Thank you, Mr. Chairman.

Mr. ANDREWS. Let me ask you off the record——

(Discussion off the record.)

SOUTHEAST ASIA REQUIREMENTS

Mr. ANDREWS. Do you know of anything that you need in Southeast Asia today that research and development could get for you?

General BETTS. We have treated our Southeast Asia requirements as of the highest priority——

Mr. ANDREWS. You told us that, and I think you should do so.

General BETTS (continuing). After the ballistic missile defense effort that is a national No. 1 priority also.

While I know that there are some additional efforts that we would like to apply for the Southeast Asia environment, it is our judgment that those needs that we have identified as critical are in fact adequately funded in the budget presented to you.

AVIONICS

DEVELOPMENT OF NAVIGATIONAL SYSTEM FOR HELICOPTERS

Mr. ANDREWS. We now take up Avionics.

You are programing———million for Avionics, an increase of——— million over fiscal year 1969. What is the reason for this increase?

General BETTS. I will have to supply that. I cannot identify the demand immediately for that increase and I would not like to speculate.

Mr. ANDREWS. How will the fiscal year 1970 funds be used?

General BETTS. A very important part of this effort is in the navigation capability we would like to have in our helicopters. We have an advance system planned for Cheyenne that we feel is too big and too complex for the smaller sized helicopters.

Mr. ANDREWS. You cannot use it on a Cobra?

General BETTS. I believe it is physically possible, but, nevertheless, it cuts down an already limited payload by too much.

Mr. ANDREWS. What type of navigational system is it, General Betts?

Mr. POOR. The system is a combination of a doppler radar device which measures velocity over the ground, and an inertial device which tells the doppler which way is up and which way is north.

Now, with these two pieces of information, the system can keep track of where the aircraft is as it moves over the ground. It works through the fire-control computer in the AH–56A and presents to the pilot his present location, the distance and direction to the place where he started from, and the distance and direction to a number of possible target areas.

Mr. ANDREWS. Do you have any present comparability?

Mr. POOR. We have no system presently flying that has the full capability of this system. The system includes also a laser rangefinder device which allows the machine to update its navigating system by ranging on known points. As a result, the navigational accuracy is sufficiently high so that the navigation system can be used to control the firings of our artillery weapons.

Mr. ANDREWS. Do other services have that capability today?

Mr. POOR. Not in exactly the same form. There are doppler navigators and pure inertial navigators in the other services which have precision nearly good enough for some kinds of bombings.

Mr. ANDREWS. Why couldn't you use those?

General BETTS. They tend to be larger and heavier because they are for fixed-wing aircraft.

Mr. POOR. The other difficulty is that they do not have the updating precision that the laser rangefinder computer combination gives this thing which, as I say, finally allows us to control the fires of our artillery weapons as well as a forward observer could do.

Mr. ANDREWS. How far along in development or research have you gone in connection with this navigational system?

Mr. POOR. The system has flown several navigational systems and has demonstrated essentially specification performance accuracy.

Mr. ANDREWS. In other words, you have it, you could get it today, but in order to use it on a Cobra you would have to scale it down and reduce the size and weight?

General BETTS. This is a very important goal of the exploratory effort.

Mr. ANDREWS. Can you do that? Are you working on that?

General BETT. With time, we believe we can.

Mr. ANDREWS. How much time? Years?

General BETTS. Certainly 1 or 2. It is not immediately available. That is why this effort is an exploratory development, it is very preliminary in nature.

Mr. ANDREWS. You are working on the system with a view to making it adaptable to the Cobra?

General BETTS. To the smaller aircraft; that is correct.

Mr. ANDREWS. After that discussion yesterday I would think that for the next few years you ought to concentrate on the Cobra.

General BETTS. Our goals are to try to get to a less expensive, less complex and lighter system. There are some new technologies becoming available, such as the laser gyro. That will be pursued under this effort. We hope it will provide a better capability for the aircraft that are either now in the inventory or coming into the inventory.

Mr. ANDREWS. What is the best navigational system you have today in use on the Cobra?

Colonel BONIFACIO. There is none in Cobra right now. That is, no kind of a navigation system. We just have the basic instruments, gyro, horizon, compass, that kind of thing. It is a daylight ship, VFR rules. That is how it was developed.

Mr. ANDREWS. Would this system you have discussed have all-weather and nighttime capability?

General BETTS. It would.

Mr. ANDREWS. I can see how it would be very useful for a chopper.

General BETTS. I think it is an important program to pursue, but it is developmental in nature. It is not near an end item as yet.

Mr. ANDREWS. You say you have some in use. Are they on the Cheyenne?

General BETTS. The system that is now being tested on the Cheyenne we think is a very good system.

COMPUTER ANALYSIS OF SYSTEM CONTROL

Mr. ANDREWS. How much will be spent to "continue computer analysis of the AH–56A to identify system control low limitations" and what does this mean?

General BETTS. I can't answer that. I will have to supply it. I do not identify the effort.

Mr. ANDREWS. It is on page 77. You state here, among other things, that you plan in 1970 "to continue computer analysis of the AH–56A to identify system control low limitations where improvement in man-machine system performance may be accomplished by software rather than hardware."

General BETTS. I would have to research that.

Mr. ANDREWS. Can anybody explain that?

General BETTS. I don't identify that effort.

Mr. ANDREWS. Off the record.

(Discussion off the record.)

Mr. ANDREWS. Put something in the record on that.

(The information follows:)

The Avionics System Simulation, located at the US Army Electronics Command, can be programmed to simulate the flight dynamics of the AH–56 as well as other Army helicopters with a man at the controls. The effort listed on page 77 of the Justification Book is to determine the limit or limits at which catastrophic or unsafe conditions will exist when the flight control or Avionics Systems either singularly or in combination are degraded or fail. This is beneficial in identifying critical subsystems prior to experiencing these conditions in a developmental aircraft. The programmed money for this effort is ——— for FY 70.

TACTICAL AIR GUIDANCE SYSTEM

Mr. ANDREWS. How much will be spent on the study of the "application of the fly-by-wire concept to the UTTAS and HLH aircraft," and what does this mean?

General BETTS. We have been carrying the program we call Tactical Air Guidance System, working with the instrumentation laboratory of MIT. As a colloquialism we call it the fly-by-wire, simply because it represents an approach to helicopter control that is sufficiently automatic that it is practically as simple as flying the helicopter as though it was on a wire. The point that I am asking is that it does for the pilot virtually everything that he would have to do by a carefully coordinated control of all of his flight controls.

Mr. ANDREWS. In other words, he can get in there, push a button, and away it would go; it would stay on course?

General BETTS. With a small joystick control he can go forward, backward, sideward, downward, by the very simplest of control applications. The system itself flies the machine.

Mr. ANDREWS. How far along are you with this system?

General BETTS. We have flown that for a good year or two in the test-bed aircraft. We are now working with the Boeing Vertol Co. to apply it to a more tactical configuration. I think we have proved the

technology. What we now need to do is work out the details of an installation in a tactical aircraft.

Mr. ANDREWS. How much hardware is involved?

General BETTS. It actually will permit us to reduce some of the controls now in the helicopter involved.

Mr. ANDREWS. That is on a new chopper where you will put the system in?

General BETTS. That is right.

Mr. ANDREWS. What would you do with a chopper that you have in service; could you modify it to put the system on it, and do you plan to do that?

Mr. POOR. I think we can discuss this logically under the 6.32 program, research helicopter, but it appears practical to incorporate this system into a machine like the CH–47, the Boeing twin-rotor helicopter, with some advantages. The advantage is far greater if it is put into a machine from the beginning in its initial design. The current demonstration system is not the kind of thing you could fly at all in any practical sense, because it uses for its inertial control system very large navigation equipment designed for a Navy submarine. The stuff is much too big and the computer is too big.

Mr. ANDREWS. What about the cost of the system?

Mr. POOR. The cost in that form is also prohibitively large. But we believe that we can, with further development, using the kinds of inertial elements that are used—for example, in the inertial navigation systems used now in airplanes like the 747 and some of the commercial aircraft—get this thing down to the point where the cost is reasonable.

Mr. ANDREWS. Is it a complicated system?

Mr. POOR. It is moderately complicated.

Mr. ANDREWS. Is it heavy?

Mr. POOR. It need not be very heavy.

Mr. ANDREWS. Would it put a limitation on the speed of the chopper?

General BETTS. No, sir.

Mr. POOR. It would relieve some of the limitations on the machine in this sense: that, by programing the computer properly, it can assure that the pilot will not by mistake fly into unsafe corners.

Mr. ANDREWS. Is that the chief advantage of the system?

Mr. POOR. The chief advantage, I think, would be simplification of the flying task. It will very substantially lower the amount of training required for a helicopter pilot if it proves successful.

Mr. ANDREWS. How many of those systems are in operation today?

Mr. POOR. I believe there is only one.

Colonel NIXON. One, sir; yes.

Mr. ANDREWS. Colonel Nixon.

Colonel NIXON. Yes, sir, Mr. Chairman?

General BETTS. Did you want to add anything, Colonel?

Mr. ANDREWS. There is one system in operation today, Colonel?

Colonel NIXON. Yes, sir.

COST OF SYSTEM

Mr. ANDREWS. What type chopper is it used on?

Colonel NIXON. It was demonstrated on the CH–46, which is a prototype of the Marine Corps troop-carrying aircraft. You asked the

question earlier about the cost involved in this specific effort in avionics. It is a very small fraction of ——— that was allotted to ECOM to do a total avionics study for requirements for new aircraft. This fly-by-wire was just one of the significant smaller parts of it.

Mr. ANDREWS. Do you know what the cost of the finished system would be, Colonel?

Colonel NIXON. Of the TAG system?

Mr. ANDREWS. Of the wire system.

Colonel NIXON. Fly-by-wire; yes, sir. Right now it looks like it is going to run ——— per aircraft. We believe that is too expensive. However, in the ensuing years in this development program, we believe that the state of the art will permit the cost to be reduced substantially. Now, what that cost will be, sir, we just do not know. The computer technology is moving so fast it is hard to predict 3 years from now what a computer is going to cost.

Mr. ANDREWS. In other words, the pilot is going to set his destination, his course, altitude, speed, and so forth, and turn it all over to the system to operate and get him there.

Mr. POOR. Yes. Essentially, that is right. He sets the velocity and direction in which he wants to fly by displacing a control system. It is called velocity vector control, in another phraseology. The aircraft then does whatever is appropriate to go in that direction at that speed. It will also hold the aircraft in a hover, at no speed, and control the rate of climb or rate of descent. It makes a helicopter extraordinarly easy to fly. I think General Betts has flown this thing. He is not checked out in a helicopter. I have flown it and I am not, either.

General BETTS. A 10-minute briefing is all that is needed in order to give you enough information to fly that helicopter, and I had never flown a helicopter before.

Mr. ANDREWS. Off the record.

(Discussion off the record.)

ACCOMPLISHMENTS WITH PRIOR-YEAR FUNDS

Mr. ANDREWS. What have you accomplished with the funds provided for avionics exploratory development in the last 2 fiscal years? Give us some concrete examples, things that have actually been accomplished and are in service today.

General BETTS. I think we can point to the completion of a simulation of an avionics fire-control system performance that applies to the OV–1B aircraft, the AH–1G, which is the Cobra, as well as to the AH–56A.

Mr. ANDREWS. Explain that, General Betts.

General BETTS. We have to fly the hardware in a flight environment. If it is possible to do so, it is well to simulate the capability of the fire control and weapon systems on the ground, using appropriate computer-assisted technology.

That kind of thing has been done and has given us a great deal of confidence that, when we get the aircraft in a flight environment, it will perform the way we predicted.

Mr. ANDREWS. That is the finished product?

General BETTS. The simulation effort for those aircraft named have been completed under this program.

Mr. ANDREWS. And they are in operation?

General BETTS. In each case, except only in a preliminary way, in the Cheyenne, and the AH-56A. You remember, we indicated that we have demonstrated all of the weapon systems but we have not thoroughly tested them.

Mr. ANDREWS. All right. Any others? I am talking about the last 2 years.

Mr. POOR. Much of this program does not result in operational flying hardware, you understand. This is the exploratory phase of the program. So much of it is involved in determining whether or not a given new technique is suitable for work under the 6.3 program, the next step. So it is difficult to point to very many things in that program that are in flight today.

Mr. ANDREWS. List some of the accomplishments for the record.

(The information follows:)

Virtually all of today's inservice equipment had its origin in exploratory (6.2) development. The normal development cycle is several years from 6.2 to hardware being placed in service.

It might be possible on very rare occasions, where there is no technical risk, the equipment is extremely simple, and intensified management practices are used, to place an item in service in 2 years.

The goal of the avionics exploratory development program (6.22.02.A) is to investigate new technology to determine its feasibility or possible application for future military uses and refine this technology so that it can be useful in future systems.

Some significant advances in technology have been made in the past 2 years. A few examples follow:

(*a*) Feasibility has been demonstrated for operating multiple radios off the same antenna.

(*b*) Feasibility for development of a broad-band antenna has been demonstrated; thus eliminating the need for an electromechanical tuning coupler within the antennna base.

(*c*) The rotor blade radar or helicopter multifunction systems (HELMS) completed exploratory development in May 1969, in a breadboard design, and is now ready to move into advanced development (6.3). Exploratory development work for this effort was initiated in fiscal year 1967.

Mr. ANDREWS. Questions on avionics?

Mr. LIPSCOMB. No, Mr. Chairman.

Mr. ANDREWS. Mr. Addabbo?

Mr. ADDABBO. No, Mr. Chairman.

AIR MOBILITY

FIRE RETARDATION EFFORT

Mr. ANDREWS. Your fiscal year 1970 request for "Air mobility" is ——— million, an increase of ——— million over fiscal year 1969. Why is this increase necessary?

General BETTS. We hope to expand efforts in the area of fire retardation, survivability, two very important programs.

Mr. ANDREWS. Explain those two programs briefly.

General BETTS. Let me give you some feeling for the kind of things we are doing, which we feel are very important.

Mr. ANDREWS. Yes.

General BETTS. One of these is to work with emulsified fuels. Now, it is apparent from our testing that if we can get the right combination of emulsification of the fuel with a fuel that will still operate

properly in our various engines, that when the aircraft crashes or if a fuel tank is punctured by a bullet, that any ensuing fire does not spread as rapidly as it would with ordinary fuel.

We have shown by experiment that this will work. What we need to do is to work out the emulsification so that in fact the engines can use the fuel with that material in them. Now, it takes a great deal of testing to establish confidence that that is indeed the case. We have run engines on the emulsified fuel we are talking about. We have done another thing that I think is important and will contribute to survivability and that is to develop a material for fuel tanks that is sufficiently tough as well as flexible that it can survive a severe crash environment.

Mr. ANDREWS. You have been working on that for several years, have you not?

General BETTS. Yes, sir; we have. I believe we are reaching the point now that we are about ready to commit putting production tanks into aircraft.

Mr. ANDREWS. Describe the tank you are working on and what you hope to get.

General BETTS. It is a material like rubber; it is not just rubber as such, it is fiber reinforced and designed in such a way that it can withstand very severe blows without puncturing. It is not bulletproof as such, but it will take a sharp impact, say a piece of the aircraft, something of that sort, in a crash environment.

Mr. ANDREWS. Is the whole tank to be made of that fiber?

General BETTS. The whole tank would be made of that material.

Mr. ANDREWS. Are you not working on some self-sealing tank?

SELF-SEALING TANKS

General BETTS. We have also worked on the self-sealing approach to tank survivability.

Mr. ANDREWS. Does that work come under this heading of Mobility?

General BETTS. Yes.

Mr. ANDREWS. Tell us a little about the self-sealing method you have worked on and what is the status of it.

Colonel NIXON. We have two ongoing efforts in this self-sealing lightweight fuel tank. The first is an immediate solution. We are now incorporating this into our production UH–1 aircraft. It is a little heavier than our long-range solution is. Both of them are self-sealing and both of them are designed to reduce the crash fire problem we have in the Army with our helicopters.

The immediate solution is a combination, as General Betts was referring to, of a rubber type tank that has some standard self-sealing features built into it of liquid which in contact with fuel immediately hardens into a gummy substance, which in turn closes the opening that has been made in the tank by shell fragment or structural members of the aircraft driven into the tank on crash.

The long-range solution is going to put this fluid into little dimples all throughout the tank so that this will in turn reduce the total weight of this individual tank material and enable us to use an even lighter weight nylon woven material which is even stronger than the ones we are using right now.

Mr. ANDREWS. What kind of tanks are you using now in Vietnam?

Colonel NIXON. They are using a standard type real heavy rubber-type material very similar to waders that your fishermen use, only much heavier than that. They weigh on the order of 150 to 200 pounds more than the lightweight material we are trying to get into our aircraft.

Mr. ANDREWS. Are those self-sealing tanks in use in Vietnam?

Colonel NIXON. Yes, sir.

Mr. ANDREWS. What happens if you get a direct hit on a tank and a hole is made in the tank?

Colonel NIXON. Your fuel leaks out, sir.

Mr. ANDREWS. I am talking about the self-sealing tanks.

Colonel NIXON. It depends on the size of the hole. The stuff we are developing now will seal a .50 caliber round, which is a pretty large hole, 6 inches in length and maybe an inch and a half in breadth. If it gets much larger than that, it is beyond our capability now.

USE OF SELF-SEALING TANK IN VIETNAM

Mr. ANDREWS. How long have you had those self-sealing tanks in use in Vietnam?

Colonel NIXON. Since the war started, sir. It is a limited self-sealing capability that we have right now, though, sir.

Mr. ANDREWS. And you hope to have a better product?

Colonel NIXON. Yes, sir, by all means.

Mr. ANDREWS. When?

Colonel NIXON. We have a better product right now, but it is heavier than we would like it to be. In the long run we will reduce as much as 200 pounds per aircraft.

Mr. ANDREWS. Do you have the newer type in service in Vietnam?

Colonel NIXON. They are starting those ——— with the next production line.

Mr. ANDREWS. What about the cost of them?

Colonel NIXON. The exact costs I am not familiar with, sir. I believe it is about $900 per aircraft.

Mr. ANDREWS. Do you hope to replace all the tanks in Vietnam with the new ones when they get into production?

Colonel NIXON. This is not an R. & D. question, sir, but based upon my contact with the PEMA side of the house, we hope so, but it is a very expensive proposition unless the aircraft is brought back to the depot and it is done during normal depot overhaul. And that is when we intend to do it. Whether that is going to be done during the course of the war or not, I doubt seriously.

Mr. ANDREWS. Thank you, Colonel.

COORDINATION OF RESEARCH EFFORT

In reading page 78 of the justification book, one receives the impression that Army work under Air Mobility might be highly duplicative of Navy and Air Force efforts in this area. Is this possible?

Mr. POOR. I think I can answer that.

The work in advanced flight control, crash resistant fuel cells, emulsified fuel development, air drop, aircraft propulsion systems, the flight safety work, work on airfield service equipment, all is very

closely coordinated with our sister services and also with similar work that goes on in the space agency.

I have attended meetings in the conference room across from my own office in which the programs in flight safety were discussed with representatives from all three services, the Marines, NASA, and the FAA, and I really think to the extent that there is any duplication, it is that desirable kind which results in competition for the development of a better idea. The information exchange is very complete.

Mr. ANDREWS. What use do you make of Navy and Air Force study efforts in this regard?

Mr. POOR. We make a good deal of use. I can think of examples in the development of new kinds of fuel lines. An example, the Vithane fuel line, was not an Army development. We have taken that up and are applying it in our own aircraft. So the work is extremely closely coordinated. If one of the other services develops a useful technique, we incorporate it, and vice versa.

USE OF 1970 FUNDS

Mr. ANDREWS. How will the ——— million be used in fiscal year 1970 for this project?

General BEITS. I mentioned we planned to expand our areas of survivability we were talking about. We would also be working in cargo handling for application to helicopters. Reduction in noise is a very important goal. We would like to improve the maintainability and this kind of exploratory effort will contribute to helicopters across the board.

We also have exploratory work in improving our methods of airdrop and the development effort to get a better airdrop capability.

We have talked about the emulsified fuels development. I would like to specifically identify the reliability of electrical, mechanical, and hydraulic connecters, sources of reliability failure in the helicopter environment. We are addressing particular attention to that effort.

Mr. ANDREWS. I wish you would break down the ——— million in the record.

General BEITS. Yes, sir.

(The information follows:)

The following is a breakout of the requested ——— million for fiscal year 1970 air mobility R. & D. (dollars in thousands).

Maintainability and reliability	———
Classified project ———	———
Aircraft applied research (flight control, fluidics)	———
High performance helicopter evaluation (high-speed compound helicopter)	———
Aircraft propulsion system (engine, transmissions, and propeller development	———
Ground effect phenomenon, Army aircraft (air cushion vehicles)	———
Reduction detection, aircraft (infrared supression, noise supression)	———
Reduction in vulnerability, Army aircraft (aircraft/aircrew armor, survivability design)	———
Airdrop equipment and systems (parachutes, support equipment)	———
Internal cargo handling (tiedown devices, load platforms)	———
Army aircraft field services equipment (maintenance stands diagnostic maintenance equipment)	———
Army aircraft support (cargo slings, external load criteria)	———
Flight safety research (emulsified fuels, crash resistant fuel cells)	———
Air mobility investigation (requirements studies for future aircraft)	———

OVERCOMING DUST PROBLEM IN VIETNAM

Mr. ANDREWS. If I remember correctly, when choppers first went to South Vietnam you had a dust problem over there.

General BETTS. We do.

Mr. ANDREWS. Did you correct that?

General BETTS. We still have a severe dust problem in Vietnam. Some measure of improvement has been accomplished through typical construction techniques, the material Peneprime is one that has been used extensively.

Mr. ANDREWS. What is that?

General BETTS. It is an asphalt-like material that penetrates into the soil and provides a binder to hold down the dust.

We have also used membranes where we did not have the time or where we felt that the environment was such that the Peneprime would not be satisfactory. The membrane is spread out over the ground to hold the dust down in particular areas.

Mr. ANDREWS. Let me ask this question and then you can continue.

The committee has been informed that damage due to injection of solid particles and other foreign objects into engines accounts for almost half of the premature engine removals from the Army UH–1 Huey and OV–1 Mohawk aircraft. Have you established a program to overcome this problem?

General BETTS. Yes, we have

That goes on into the area of filters and, more importantly, a new approach to this, a technology of preventing this problem using the centrifugal forces to throw the particles out of the airstream as taken into the engine.

I would like Colonel Nixon to expand on that.

Colonel NIXON. The immediate problems we face in Vietnam we came up with solutions for them. We had a severe problem when the C model Huey first came into use over there, which is a gunship version, prior to the Cobra. The dust was getting into the teflon bearings we had in the rotor hubs. We solved that with shields for the bearings to prevent the dust from getting to them.

The rotor-blade problem we are looking at constantly in our new development programs, developing new materials to prevent dirt erosion on the rotor-blade leading edges.

General Betts mentioned the centrifugal-force idea on injection of air into an aircraft engine. We have a large problem with foreign object damage in our aircraft engine and the immediate solution we have come up with is using an additional barrier filter on the inlet to our engines in Vietnam.

We are looking in our future engine development programs toward a very promising aspect of, as the air is brought into the engine, making it come around in a circle and then at the outer part of the circle at the intake manifold, we have a collection point where we collect the dust and dirt that is thrown out by centrifugal force.

Mr. ANDREWS. Have you extended the time that engines can be used?

Colonel NIXON. Yes, sir.

Mr. ANDREWS. With these processes?

Colonel NIXON. The barrier, in addition to other improvements, has increased the life of the T–33 engine 300 hours, from 1,200 to 1,500 hours before we have to overhaul it.

Mr. ANDREWS. What are your main problems now about maintenance of choppers?

General BETTS. The rotor damage and injection in the engine are the two most important.

Do you want to add to that?

Colonel NIXON. Yes, sir, that is it.

Mr. ANDREWS. Are you doing any work in R. & D. on those problems?

General BETTS. On both of those, as Colonel Nixon has remarked.

ARMOR FOR HELICOPTER CREWS

Mr. ANDREWS. In your development of lightweight armor for aircrews, are you duplicating research in body armor for the foot soldiers?

General BETTS. We are using the same basic materiel technology.

Mr. ANDREWS. You described that yesterday.

General BETTS. That is correct. But I would not call it duplicating in the sense that the configurations are different. We can afford to wrap a pilot up fairly well by arming his seat and then letting him wear the additional protection on his chest and legs. That sort of protection is much too heavy for a moving man, a man on foot patrol. But the basic term, the basic approach to armor protection is the same.

Mr. POOR. There is one significant difference, I think.

In the armoring of a man in a flying machine there is the possibility not only of putting armor right close to him, but also spacing out some distance from his local armor a thing called a tipping plate, another piece of armor that upsets the bullet on its way to the man and very much increases the safety of the man with a given weight of armor surrounding him.

Mr. ANDREWS. Do you have any information about actual cases where this new armor has saved lives of crewmen?

General BETTS. Yes, we have. I do not have numbers with me today, but we have literally at least tens of incidents that have been reported where it is clear that the armor saved the pilot's life.

Mr. ANDREWS. Put something in the record.

General BETTS. I can get specific numbers.

(The information follows:)

A statistical analysis indicates that during the period 1962–67, 125 men's lives were saved by protective body armor.

AIR CUSHION VEHICLE

Mr. ANDREWS. Question on air mobility?

Mr. RHODES. Do you get into the more or less far-out type of experiments such as the flying belts and the movement of platforms on air cushions and this sort of thing?

General BETTS. We are certainly interested in the air-cushion vehicle, in that we have several of them performing in Vietnam rather effectively.

Mr. RHODES. Is this on an experimental basis?

General BETTS. We sent them out on an evaluation basis. They proved to be so effective they were immediately operational.

Mr. RHODES. Would you describe them for us?

General BETTS. I could give the dimension as roughly 20 feet wide by 40 feet long. Of course, they are jet propelled by the downdrift.

Mr. RHODES. Are they platforms, or what is the configuration of them?

General BETTS. It looks like a boat.

Colonel LAMB. It is the Bell machine.

General BETTS. The Navy has also bought some of the Bell air-cushioned vehicles.

Colonel LAMB. It carries a crew of six to eight. It can carry a squad of men in addition, but generally we have abandoned the theory of using a squad of men with it. And it is an armed vehicle, it has two 7.62-millimeter machineguns and 50-caliber machineguns. It has grenade launchers; recoilless rifles can be fired from it. It goes quite well.

We have three of them operational in Vietnam. Hopefully, ——— more are being procured to join those three. The test was done with those three and also based on Navy experience. They had one that was not rigged for combat and did not have the machineguns, did not have the armor protection. Both the crew and the engine are protected against 30-caliber machinegun fire, and it can go in a rather hot area and has been very effective in the Delta.

Mr. RHODES. How far above the surface of the ground does it go?

General BETTS. Several inches.

Colonel LAMB. It can get over a 3½-foot dike. A canal the width of this room would give it a hard time because it would fall down in and have a little bit of trouble getting out. If it is a little bit narrower than this room, half of the room, there is no problem. If it is 50 to 100 feet wide, you have no problems; it gets down in the water and can come out on the other side.

Mr. RHODES. How fast does it go?

Colonel LAMB. It can attain speeds between 50 and 70 knots. It will not cross swamp grass 10 or 12 feet high at that speed, but will go that fast on the water. Forty to sixty knots, depending on the height of the grass over land. It has difficulty on side hills, tending to slide down the hill. In areas such as the Delta, it is highly effective because it is very flat terrain with a lot of water in small narrow canals.

General BETTS. It is special purpose for that reason.

Mr. RHODES. How long can it operate without refueling?

Colonel LAMB. This will be a guess, but a very close guess, 3 to 4 hours of continuous operation. It can stay out overnight. It can sit on the ground. It can be refueled there. If you do not have the engine running, it can stay out 2 or 3 days at a time. It floats, can park on the water or park on land.

USE OF FLYING BELTS

Mr. RHODES. I gather you have no interest in the flying belts.

General BETTS. We have had a corollary interest in that we are interested to know what can be accomplished in terms of size, weight, shape, cost, that sort of thing. But the end item application in a tactical sense has still not been determined. It is one of those things we frequently said it would be nice to have something like this, but, when we look at the hard facts of the cost and the weight of the hardware for what now appears in ARPA experiments to be about a 10-minute flight time, that is just not enough to be of serious interest to the foot soldier.

One can imagine special circumstances under which it might be useful, but that is hardly enough to justify it as a firm requirement.

Mr. RHODES. You would not relieve the guard around the bivouac with flying belts?

General BETTS. No.

Mr. RHODES. Thank you.

Mr. ANDREWS. Further questions on air mobility?

AIRDROP RESEARCH

Mr. LIPSCOMB. General Betts, you mentioned that you are doing some work in airdrop. Specifically, is it to look into what you are going to do with the use of the C–5A airdrop capability?

General BETTS. No. Our work there is coordinated with the Air Force.

We do have a requirement for an exploratory development of 50,000-pound capacity air drop and that would be applicable to the C–5A since nothing else could carry a weight like that.

We also have further developments in both personnel and equipment airdrop capability. I might say we are also very much interested in this development we call the Parawing that would permit precision dropping by air with the control on the ground dictating the point at which material is deposited.

Mr. LIPSCOMB. Did you say you were working on a 50,000-pound airdrop capability.

General BETTS. This would be a system in effect because it will take several chutes and a coordination of those chutes to be able to handle a weight that large.

Mr. LIPSCOMB. Is this a total Army responsibility?

General BETTS. We work with the Air Force on it, but I might ask Colonel Gilbert to expand on this.

Colonel GILBERT. With regard to the 50,000-pound airdrop system, there are prototypes in existence that are presently being tested in connection with the Air Force at El Centro. This airdrop system employs existing platforms and will use 135-foot diameter parachutes.

We estimate that possibly five of those large chutes will handle the 50,000-pound payload. When we start testing the C–5 at Fort Bragg in October of this year for a 1-year period it will include testing of this 50,000-pound airdrop system.

Mr. LIPSCOMB. Do you have any idea of why the 50,000-pound requirement was laid on?

Colonel GILBERT. Only to the extent that weight capacity will handle any Army equipment they will need to drop from the C–5.

Mr. LIPSCOMB. You are dropping how many pounds now?

Colonel GILBERT. The present system prior to 50,000 is a 25,000-pound system, which is useful in the C–141 and will be useful in the C–5 as well.

Mr. LIPSCOMB. Is the 50,000-pound drop feasible?

Colonel GILBERT. Indications of our tests thus far at El Centro indicate it is in fact feasible. Whether or not you would want to commit an expensive aircraft like the C–5 to go into an airdrop might be another question, but the airdrop system itself is feasible.

Mr. LIPSCOMB. What is the approximate expense of the equipment we get into with a 50,000-pound drop?

Colonel GILBERT. It really is not a high-cost system. We do have the 135-foot diameter parachute which will be one item we will have to see how they work during the tests. But we are using an existing platform like the one they use in the C–141 in an Air Force link system.

Mr. LIPSCOMB. How much do you think you are investing in doing the research on a 50,000-pound drop?

Colonel BONIFACIO. We have identified $697,000. That would be for the recovery of chutes and also to procure 80 chutes for the testing program. In that connection, the category 1, which is the contractor testing, and category 2, testing being Air Force and Army testing, has provided four or five volumes in various aspects of aerial delivery. That is parachute jumping, air landing operation, and the airdrop aspect.

The biggest problem we visualize is probably the long extraction line. If you consider the vast cargo compartments of the C–5 and extracting a 50,000-pound load, the extraction line within itself is considerable in size, maybe as much as 500 pounds. They do feel and have indicated this would be feasible.

Mr. LIPSCOMB. What kind of an aircraft are you flying in the drop experiment, a C–141?

Colonel BONIFACIO. The C–130 is what we are doing much of the work in preparation of the 50,000-pound system. We do not have too many loads, frankly, of 50,000 pounds.

Mr. LIPSCOMB. How do you load the C–130 with a 50,000-pound load?

Colonel BONIFACIO. It can be done, sir. You say how do you do it. They do a lot of stripping down of the system and they have dropped some gradually. I do not know if they have dropped exactly 50,000 pounds. They are using what they call the bathtub load, and gradually increasing from 25,000 to 30,000, and the concept is mostly used with C–130 and they will probably progress on to the system as it applies in the C–141.

Mr. RHODES. Will the gentleman yield?

Mr. LIPSCOMB. Yes.

TYPE OF EQUIPMENT TO BE AIR DROPPED

Mr. RHODES. What would be the content of a 50,000-pound air drop? Why would you drop that much?

Colonel BONIFACIO. The capacity is there and, of course, it could be a combination load, and I believe the Sheridan is 46,000. But when we consider the weight of parachutes and the paraphernalia that goes with it, the platform, the extraction line, it increases considerably to about 50,000 pounds.

Colonel LAMB. If I might expand on dropping the Sheridan, today we have to modify, take the cupola off and make a slight modification in order to drop it. We can drop it?

Mr. ANDREWS. Have you done it?

Colonel LAMB. Yes, sir, we have dropped the Sheridan.

Mr. ANDREWS. Do you put it in a crate of any kind or drop it as is?

Colonel LAMB. As is on a platform. It can be driven off in a matter of minutes after it lands. It pushes the state of the art on weight right now. With the C–5 it will be easy. The ammunition has to be

dropped separately. By increasing this to 50,000, we will be able to put the ammunition and the Sheridan all together, the crew can ride the same airplane and follow them out and they are in the same area ready to put the vehicle in operation.

(Off the record.)

REQUIREMENT FOR SPECIAL LOADER FOR C–5

Mr. LIPSCOMB. You know special loaders are being made for this 50,000-pound requirement you are putting on this C–5A and these loaders are costing about $400,000.

Colonel BONIFACIO. Is this the air transportable loading dock you are speaking of? That is for all applications, not only the airdrop aspects.

Mr. LIPSCOMB. The only justification they are giving for building it is that the Army has placed a 55,000-pound requirement on the Air Force and, therefore, they have to have all of this special equipment.

From where in the Army would the requirement like this originate?

General BETTS. It would originate in the Combat Development Command study concepts of future operations of the Army, and they are the ones responsible for creating justification bases for new requirements. It would come to the Army staff for review before being sent to the Air Force.

The requirement to be able to drop the Sheridan has existed and is inherent in the basic design of and the requirement for the Sheridan. But as Colonel Lamb indicated, until the C–5A was available there was no aircraft that could take that in a full configuration completely with drop platform.

Mr. ANDREWS. How many Sheridans could a C–5 handle?

General BETTS. The C–5A can handle four Sheridans for airdrop or six Sheridans for air transport.

Mr. ANDREWS. Are there other questions?

Mr. LIPSCOMB. No questions.

AERONAUTICAL RESEARCH

RESEARCH ON V/STOL AIRCRAFT

Mr. ANDREWS. The fiscal year 1970 request for "aeronautical research" is ——— million. The justification book indicates work will be continued on the V/STOL aircraft. What is the status of the Army on V/STOL aircraft?

General BETTS. I will ask Colonel Nixon to respond to that.

Colonel NIXON. Sir, may I just clear up one thing?

You mentioned aeronautical research and then V/STOL aircraft, and they are two separate program elements. I can handle the V/STOL aircraft question.

Mr. ANDREWS. That is the question.

Colonel NIXON. Yes, sir. The V/STOL aircraft work we are going to be doing during 1970 is virtually nil, sir. As a matter of fact, we have asked for nothing, but to participate with Canada in evaluation of their CL–84 tilt wing aircraft. The CL–84 has been an ongoing program sponsored by Canada for the past 3 years. They have just now gone into a prototype stage they hope to use in an operational

field environment to evaluate the concept of the tilt wing as it applies to the Canadian Army.

Since we in the Army are interested in all types of vertical rising aircraft, we are particularly interested in finding how the CL–84 operates in the environment. We are interested in determining the answer to two questions:

Can the CL–84 live in the field with the troops?

And the second question is: Can the troops live with the CL–84?

That is a particularly important question, Mr. Chairman, because we have found in V/STOL aircraft in the past that the high downwash velocities associated with these aircraft operating in a vertical mode pretty well preclude their operation in an Army environment from two standpoints.

No. 1, the downwash velocity digs a hole in the ground, creates all sorts of dust problems to the aircraft itself and the people around it. In addition to that, if it operates in close proximity to command post locations, it blows the tents over, the ammunition down the hill, the C–rations all over the place, and so it is important for us to find out if we can live with the CL–84.

Mr. ANDREWS. Do you have any of these V/STOL's in operation?

Colonel NIXON. Canada does, sir.

Mr. ANDREWS. You are continuing with Canada?

Colonel NIXON. Yes, sir.

V/STOL AIRCRAFT IN OPERATION

Mr. ANDREWS. Tell us about the ones that are in operation.

Colonel NIXON. They have three of them, sir. I am not sure whether the third has been rolled off the line yet, I know two of them have been.

This aircraft is a twin-engine aircraft, the engines are installed rigidly to the wing and the wing itself tilts to the upright position when they want to take off vertically, and then after they have lifted off the ground it rotates in horizontal position for forward flight. It cruises approximately 220 to 250 knots in the horizontal position and it hovers at zero air speed on the ground.

One problem with the aircraft, it is underpowered for our requirements. However, that is strictly an operational type test vehicle anyway so we are not too concerned about the power requirements.

Mr. ANDREWS. Do you think you have solved the problem and that you can come up with a V/STOL aircraft?

Colonel NIXON. Mr. Chairman, that is a difficult question to answer.

Mr. ANDREWS. You have been working on this a long time, spent a lot of money?

Colonel NIXON. Yes, sir.

Mr. ANDREWS. Once in cooperation, if I remember correctly, with the Germans. That was scratched, was it not?

General BETTS. This kind of capability has much more applicability to the Air Force and Navy where they can operate from paved airfields. Our participation has been more in the context as users we are very concerned about finding answers to the kind of questions Colonel Nixon mentioned.

Mr. ANDREWS. Dust among others?

General BETTS. Yes, sir.

I might point out as far as the numbers available to me are concerned, we have asked for no funds in fiscal 1970 under this program element. We have in the past had funds in there for evaluation work with the Navy and Air Force on this effort. In program 6.32.02A, my indication is we have asked for no funds in 1970.

Mr. ANDREWS. The justifications page 83 states this, General:

"For fiscal year 1970"——

Mr. POOR. We are talking about two different programs. I think I can clear it up.

Colonel Nixon was talking about the 6.3 program and the Chairman is talking about 6.2 category program. So we have gotten somewhat off the track.

The justification the Chairman refers to addresses our basic work in rotary wing aerodynamics and states that:

"For fiscal year 1970 and future years there will be a continued emphasis on low speed and V/STOL, including rotary wing, flight research as related to Army air mobility requirements. Particular emphasis will be given composite materials structures and aerodynamic-generated noise programs."

Are we back together now?

This program element, as I understand it, is that program element under which we do the basic aerodynamic research that underlies the design of helicopters, rotary winged aircraft, V/STOL of all sorts. It covers the work performed by the Army Aviation Materiel Laboratory at Fort Eustis and also the work done jointly with NASA at the Army Aeronautical Research Laboratory in Moffett Field we mentioned on the first day I think.

It also covers some contract work with universities and industry.

TERMINATION OF TRI-SERVICE V/STOL PROGRAM

Mr. ANDREWS. You are not requesting funds in fiscal year 1970 for the Tri-Service V/STOL program?

General BETTS. That is correct.

Mr. ANDREWS. Does this mean this program has been terminated and, if so, how much has been spent for this purpose through fiscal year 1969 by all of the services?

General BETTS. Through fiscal 1969 the Army has put in $37.8 million R.D.T. & E. I would have to get for the record the contributions from the other services.

Mr. ANDREWS. I wish you would and put the total in there.

(The information follows:)

The Air Force share of the V/STOL program has been approximately $113 million and the Navy share approximately $34 million through fiscal year 1969.

Mr. ANDREWS. Does this mean this program has been terminated?

General BETTS. It does.

Mr. ANDREWS. After expending these funds what has been accomplished in the way of developing a V/STOL aircraft?

General BETTS. I think mostly we have learned from the Army's point of view about the kind of problems that are associated with that sort of technology, the high downwash problems, high maintenance requirements, the cost, complexity that goes into that kind of an aircraft.

Mr. ANDREWS. You have learned you cannot get what you want?
General BETTS. We have learned we will not get what we want.
Mr. ANDREWS. After spending $37.8 million?
General BETTS. That is correct.
Mr. POOR. This, Mr. Chairman, does not mean that V/STOL technology has proved useless. For the other services where higher performance, higher speed is important, it still seems entirely possible that the machine will be very useful.
Mr. ANDREWS. And where they have a runway.
Mr. POOR. It is merely in the Army environment that we have become convinced that the lower disc loading properties of helicopters make them do our jobs very much better. I think it would be misleading if we reached the conclusion that moneys spent jointly in the development of V/STOL aircraft were moneys wasted.
The V/STOL technology still looks extremely interesting and promising for certain classes of fighter aircraft, higher performance machines of a type that the Army should not properly have.
Mr. ANDREWS. Are you telling us that the $37.8 million spent by the Army for V/STOL contributed to the other services?
Mr. POOR. Yes; I am.
Mr. ANDREWS. It has been an effort which resulted in the other services possibly getting V/STOL that they can use?
Mr. POOR. That is right.
Mr. ANDREWS. But you have learned that you cannot get an Army V/STOL that you can use?
General BETTS. We do not feel that this is the right approach for an Army aircraft in the Army environment.

HELICOPTERS VERSUS V/STOL AIRCRAFT FOR ARMY USE

Mr. ANDREWS. You are going to forget V/STOL and stick to choppers?
General BETTS. That is our present view of the state of the art. I would not predict that we might never change that point of view if things advance in the future.
Mr. ANDREWS. Let me get back to the book again on page 83.
For fiscal year 1970 and future years there will be a continued emphasis on low speed and V/STOL.
General BETTS. Perhaps we are tied up in nomenclature here. We are still interested in the kind of fixed wing aircraft performance that that is applicable to a field army environment.
Mr. ANDREWS. In other words, you would like to have one but you have not been able to get one yet?
General BETTS. But in the kind of technology exploration that we are continuing to have interest in, we would not be looking at these direct downwash aircraft like the CL-84.
Mr. RHODES. Would it be more accurate if you take the "V" out and just leave the "STOL"?
General BETTS. I think one has to recognize when you are looking at a general field of technology that you cannot so circumscribe it that you are foreclosed to look at other possibilities. We do not see the strong downwash aircraft when you get a straight vertical lift, but the helicopter is a V/STOL aircraft in a sense. So we are going to continue to look at applicable technology.

Mr. RHODES. That is what the chairman just said. You are wed to the chopper for the time being, and I think your answer properly was for fiscal 1970 this is true.

General BETTS. But I did not want to foreclose the fact we are still interested in and looking at some of these aircraft that are short takeoff and not vertical.

Mr. RHODES. That is what I tried to tell you. You take the "V" out and you have it made.

General BETTS. If we separated the two, I would agree.

Mr. ANDREWS. As far as the Army is concerned, you have stated this V/STOL tri-service program has terminated?

General BETTS. The cooperative tri-service V/STOL program has been terminated as far as the Army interest is concerned.

Mr. ANDREWS. Finally, let me ask you this: You still have a desire for V/STOL type aircraft but you have not been able to find one that the Army could use?

General BETTS. That is correct.

Mr. POOR. The most likely kind would be a machine with a very low disc loading, like the helicopter, that might change configuration in flight.

For example, there are some tilt propeller design studies with very large propellered machines to take off like a helicopter and then change by tipping the propeller forward in flight. Another scheme to get better high-speed performance and better efficiency in carrying loads over fairly long distances is a scheme which would involve folding the blades of the helicopter and then flying on a wing during cruise and landing again by unfolding the blades.

Mr. ANDREWS. You may get one some day.

Mr. POOR. Some day we may get one and under this relatively low exploratory program such things as test of wind tunnel models and configurations of that sort might be undertaken as a prelude to something like the UTTAS or follow-on machine.

CONTRACT FOR EVALUATING V/STOL PERFORMANCE

Mr. ANDREWS. It has been reported the Army Aviation Materiel Laboratory awarded a contract to Convair for a 12-month study to generate methods of evaluating the effects of various high-lift devices and combinations of high-lift devices on V/STOL aircraft performance, stability, and control, and handling qualities.

AVLABS noted that there exists at this time a large amount of experimental data on particular high-lift configurations, but no effort has been made to compile and correlate these data with existing analytical methods. What is the cost of this contract and why is this compilation and correlation not done in-house by the Army?

General BETTS. The cost of the contract was $77,000. We did not have adequate manpower available at the AVLABS to do this effort and they, therefore, turned to a contractor who had done extensive work in this general area.

As a matter of fact, they also had access to computer capability that was not available at AVLABS.

QUIET HELICOPTER PROGRAM

Mr. ANDREWS. The committee understands the Army has a contract with Kaman Aircraft to obtain maximum noise reductions on the HH-43 Huskie helicopter. The contract is part of the ARPA-sponsored quiet helicopter program. What is the total cost of this effort and what has been accomplished?

General BETTS. What we were trying to do with this program was to modify an existing aircraft, using what we now know of noise reduction technology. For obvious reasons we would like to reduce the noise of helicopters if it is possible to do so.

This program was funded by ARPA who designated the Army as executive agency. As you are aware, ARPA usually places its contract effort through the service that has the directly relevant activity of their own that is similar to that which ARPA wants to do. In this case there was a significant noise reduction, if 2 decibels can be called significant, and I think it is measurable. We certainly accomplished the specific identification of the sources of noise and that gives us a leg up toward further development effort to reduce noise.

Mr. ANDREWS. Do you think you could ever make a chopper as quiet as a fixed-wing plane?

General BETTS. I believe that the blade slap will preclude getting noise levels down to that of a fixed-wing aircraft similiar in flight performance. But I am sure we can reduce the noise levels from those we now experience.

Do you want to add to that, Mr. Poor?

Mr. POOR. I cannot add very much except most of the helicopters I have looked at seem to have been designed with the flight performance as their main objective.

For example, the directional control rotor on most helicopters is designed to be as small and light as possible and just do the job of steering the machine. This means they have very high tip speeds approaching the speed of sound and, therefore, these rotors become quite noisy. Noise is important, and we are beginning to learn more and more from our experience in Vietnam that quiet machines for certain special purposes would be very useful.

I think we can do a significant amount of noise reduction in helicopters by designing them specifically to this end. If we are successful in doing it, I think it also will have an important commercial implication. Looking to the noise level of some of our large helicopters and imagining them coming into New York City, I think the neighbors will be a great deal happier about it could we make them quieter.

Mr. ANDREWS. The noise inside the cabin is so bad, too. That is what I had reference to when I asked you if you thought you could conquer that.

General BETTS. That can be helped.

Mr. ANDREWS. What are you doing on that?

General BETTS. These techniques we are talking about here are reflected in lower noise levels within the cabin. Reductions of vibrations associated with the improvements related to noise will also reflect in a lower noise level within the cabin.

You also asked in this question what the cost of the program was. It is my understanding it was roughly $179,000.

CONTROL FOR HELICOPTER NOISE GROUND MEASUREMENTS

Mr. ANDREWS. The committee learned that in June 1969 AVLABS awarded a contract to Sikorsky to study rotor blade. Is this duplication of the ARPA program?

General BETTS. This particular program with Sikorsky was pointed at correlation of measured blade air loads with measured helicopter noise. I would assume from what I know of this program that it is not directly competitive with the effort that had been let with Kaman since the Aviation Laboratories, AVLABS, had been involved in both programs, and that—it does not guarantee but it is a strong indicator that they felt these were complementary efforts even though part of it was funded by ARPA and this part was apparently funded by the Army.

Mr. ANDREWS. You can comment further in the record.

General BETTS. Yes, sir.

(The information follows:)

The program with Sikorsky is to make noise ground measurements of the CH-53 helicopter in flight and to correlate these measurements with results of airloads measurement program supported by the Navy as well as an analytical airloads prediction method established by Sikorsky in their I.R. & D. program. The results of the noise measurements will also be correlated with a noise prediction method previously done by Sikorsky for the Army.

The major difference between the Kaman program and the Sikorsky program is that Kaman in the HH-43 is applying the current technology whereas the Sikorsky is an exploratory development investigation of the correlation of helicopter blade noise (slap) with measured helicopter airloads. The Sikorsky program should provide the Army with a better understanding of the phenomenia associated with the generation of helicopter blade slap. The Sikorsky program cost $75,000.

Mr. ANDREWS. What is the cost of the contract?

General BETTS. This program was $93,000.

USE OF 1970 FUNDS

Mr. ANDREWS. How will the aeronautical research funds be utilized in fiscal year 1970? You can put that in the record.

(The information follows:)

This exploratory development program is directed to provide a low-speed aeronautical technological base for the development of advanced performing Army aircraft. The following five major low-speed and subsonic aeronautical research and exploratory development areas are supported by this program: Propulsion systems research, funded at———for fiscal year 1970. This provides research on advanced high risk elements germane to aircraft engines including power transmissions, thrust-producing devices, and gas turbine components. Rotary wing research, to be supported at———for fiscal year 1970. The objectives are significant improvements in speed, range, and productivity of rotary-wing aircraft by analytical studies, experimental wind tunnel tests, and flight-test programs.

Aeronautical research, to be supported at———for fiscal year 1970. This project supports efforts in low-speed and subsonic aerodynamics research that have application to rotary-wing aircraft and subsonic aircraft. Included here are unsteady aerodynamic efforts, investigations of high-lift airfoils for rotor applications, and validation of rotor boundary layer equations and rotor noise associated with rotor blade slap.

Aircraft design load criteria with planned funding for fiscal year 1970 of ———. The program is to experimentally and analytically determine design load requirements for Army aircraft.

Aircraft structures research with planned funding for fiscal year 1970 of ———. This program continues research and evaluation of composite structures including studies of joints, cutouts, and attachments. The approach is to develop the most efficient application of advanced composites to aircraft structures.

Mr. ANDREWS. Any questions on aeronautical research?

Mr. RHODES. No questions.

ADVANCED DEVELOPMENT DEMONSTRATOR ENGINES

REDUCTION IN FUNDING

Mr. ANDREWS. The fiscal year 1970 program for demonstrator engines is ——— million, a reduction of ——— million when compared with fiscal year 1969. How were you able to reduce the effort for this year?

General BETTS. We were able to reduce the fiscal year 1970 effort because the demonstrator engine program completes its formal demonstration in the first quarter of fiscal year 1970. The remaining portion of this engine program is a lower funded effort and will involve refinement of the demonstrated engine technology.

COORDINATION OF ENGINE RESEARCH WITH OTHER SERVICES

Mr. ANDREWS. What type of demonstrator engine work is being done, and what was accomplished last year with the $6.5 million made available?

General BETTS. Program purpose is to advance engine state of the art by actual hardware demonstration. 1969 program funded two contractors—GE and Pratt & Whitney—to fabricate and test their version of an advanced state-of-the-art engine. Both versions designed to 1,500 horsepower, low specific fuel consumption—0.4 versus current 0.6—and high power to weight ratios (6:1 versus current T–53 approximately 3:1.

Mr. ANDREWS. For the record, tell us how closely your demonstrator engine work is coordinated with the Navy and Air Force.

(The information is as follows.)

Coordination with other services on the demonstrator engine program has been extensive. For example, during April 1969, the Army briefed Air Force, Navy, NASA, and interested industry representatives on the program; during July 1969, these representatives will participate in on-site reviews of the two contractor's (Pratt & Whitney and General Electric) programs; and each contractor has briefed Navy and Air Force representatives during the past year. In addition, the results of the demonstrator engine program will be published and distributed to all interested Government agencies.

Mr. ANDREWS. Any questions.

We will resume at 2 o'clock.

AFTERNOON SESSION

Mr. ANDREWS. The committee will come to order.

HEAVY-LIFT HELICOPTER

FUNDING REQUIREMENT

You are requesting $15 million in fiscal year 1970 for the heavy lift helicopter. This program was reduced by $5 million during the Nixon budget review. Why was this done?

General BETTS. It was a matter of the need to look for funds to meet the goals of readjustment of the total budget level.

Mr. ANDREWS. Was it done on a priority basis?

General BETTS. It was done on a priority basis. I must hasten to add as far as the Army is concerned this is our No. 2 priority within this category. That is to say, within the helicopter category.

Mr. ANDREWS. Is this the item that the Senate deleted from the authorization bill?

General BETTS. That is correct.

Mr. ANDREWS. Unless you reclama successfully before the House committee then there is no need for this Appropriations Committee to consider the request.

Mr. POOR. That would be correct. We intend to reclama and we hope to be successful.

Mr. ANDREWS. You indicate that $21 million has been spent on this program since 1963. What have you accomplished for this money?

General BETTS. In this general category one must recognize that the testing and evaluation of the presently available S-64, a Sikorsky heavy-lift helicopter, was evaluated. From those evaluations we came to the procurement ultimately of what we now call the CH-54A.

Mr. ANDREWS. Is that the heavy-lift helicopter?

General BETTS. That is our presently deployed heavy-lift helicopter.

Mr. ANDREWS. What is its designation?

General BETTS. CH-54A. We are now moving on to a modification of that and we have a B model now in procurement.

Mr. ANDREWS. How many of the CH-54A's have been produced?

Colonel GILBERT. In addition to the six for evaluation mentioned by General Betts, we bought ——— with fiscal 1967 dollars, ——— with fiscal 1968 dollars, ——— with fiscal 1969 dollars, and six are planned for acquisition in fiscal year 1970.

Mr. ANDREWS. For a total of how many?

General BETTS. ——— total for all of the years of procurement mentioned, plus the six that were procured for the original evaluation.

Mr. ANDREWS. That was for R. D. T. & E.?

General BETTS. Yes. But we used those operationally in the process of evaluation.

Mr. ANDREWS. You have ——— of those on hand?

General BETTS. No. The last six mentioned will be with 1970 procurement dollars. We also have lost several in Vietnam.

Mr. ANDREWS. The last how many?

General BETTS. The last six were for fiscal year 1970 procurement. I do not know what the present inventory is. I believe, however, that we have not received all of the 1969 buy.

Mr. ANDREWS. That gives you ——— in your inventory presently?

Colonel GILBERT. I don't have the figure here.

Mr. ANDREWS. Put it on the record.

(The information follows:)

We now have ——— CH-54's in the inventory. Of that number ——— are B Model prototypes and ——— are A Models.

Mr. ANDREWS. Now, if you have ——— or more on hand today why do you need additional money in R. & D. for the heavy-lift helicopter?

Mr. POOR. The reason for this is that the CH–54's do not have the lift capability that we are seeking in this new heavy-lift machine.

Mr. ANDREWS. What lift limit are you seeking?

Mr. POOR. We are seeking something of the order of 23 tons at 4,000 feet on a hot day.

Mr. ANDREWS. What do you have today?

Mr. POOR. The CH–54—we can provide that information for the record.

(The information follows:)

The CH–54A, combat configured, will lift 7.3 tons at 4,000 feet on a hot day while hovering out of ground effect. The CH–54B will lift a 9.1 tons under the same criteria.

REQUIREMENT FOR NEW HEAVY-LIFT HELICOPTER

Mr. ANDREWS. In other words, you have a chopper on hand that has about a 10-ton lift capability?

General BETTS. Yes.

Mr. ANDREWS. And you want to lift how many pounds?

General BETTS. About 23 tons.

Mr. ANDREWS. Twenty-three tons?

General BETTS. That is right.

Mr. ANDREWS. More than twice the lift of the one you have on hand?

General BETTS. Yes.

Mr. ANDREWS. How was the $1 million spent for in-house effort directed toward initiation of a heavy-lift helicopter? What did you do with the money?

Colonel NIXON. We have obligated $270,000 of that money and we have committed $511,000. These funds have been committed mainly to the definition of the requirement of 23 tons and the manpower and computer time that goes into making up this requirement. Also, it has been committed to contractual resources for printing up the resultant documentation that comes out of the study effort.

Mr. ANDREWS. What do you mean by requirements?

General BETTS. It is the effort to define what it is the Army seeks. In other words, just the 23 tons does not define a helicopter. One has to look at all of the parameters of speed, fuel consumption, power that we would estimate ought to be required, from the parametric design point of view coming to some estimate of what size rotors would be required. Now, we have to understand what we think the design will look like before we are prepared to commit the Army to a development program of subsystems that apply to that helicopter.

Mr. ANDREWS. How often have you required an heavy-lift helicopter in Vietnam to lift more than 10 tons?

General BETTS. There are loads that we cannot lift with 10 tons. For example, the one indivisible package in a logistics movement sense, a container that we would like to handle with this helicopter comes to about 23 tons when fully loaded. So that at the moment we cannot handle that container. We can handle smaller containers.

Mr. ANDREWS. What would be in that container weighing 23 tons?

General BETTS. Any items that we would want to move logistically, food, ammunition, it could be anything.

Mr. ANDREWS. Have you had any requirement in Vietnam for the 23-ton lift?

General BETTS. We have had a very considerable success in using the CH–54 in logistic movements.

Mr. ANDREWS. That is the 10-ton lift?

General BETTS. That is the 10-ton capability. My argument for the 23 tons as a number towards which to program a design from a very preliminary study point of view, the point of that 23 tons is that the most important indivisible load we could lift would be the logistic container I mentioned. Now, right in that same general weight class one can identify the self-propelled 155-millimeter Howitzer, a full tracked D–7 tractor, the mechanized infantry combat vehicle that has yet to be developed, the Sheridan, the Hawk missile system, and the 155-medium Howitzer. There are significant capabilities for air mobility inherent in this lift capability that will be denied to us if we cannot get on with the development of a new helicopter, because there is nothing else in sight that can do that sort of thing. What I am saying is that looking into the future development of air mobility as a way of operating, we are limited by the lift of our largest available helicopter.

The same would be true in large measure if we joined with the Navy on their helicopter that will lift about 9.8 tons in the same temperature-altitude conditions to which we relate our 23-ton figure.

EQUIPMENT TO BE TRANSPORTED

Mr. ANDREWS. Is the Air Force working on a heavy lift helicopter?

General BETTS. We have been in discussion with the Air Force with respect to the requirement, but to my knowledge they have no development effort underway on a heavy lift helicopter.

Mr. ANDREWS. Your statement indicates a need to lift heavy artillery, armored personnel carriers and scout vehicles, bridging equipment, and other combat-essential equipment. How many tons do each of these items weigh? Supply that for the record.

General BETTS. All right, sir. I will give you the list with the tonnage opposite each item.

(The information follows:)

Types of equipment and their weights to be lifted by the Army HLH

	Weight
Howitzer, medium, 155 mm., XM198, towed with prime mover truck, cargo, 5-ton, 6 by 6, M54A2, w/ammunition	22.2
Armed, reconnaissance airborne assault vehicle, AR/AAV (Sheridan)	16.8
HAWK, light air defense missile	19.0
Medium girder bridge, class 60, 100-ft. length	19.6
Mechanized infantry combat vehicle, MICV	22.0
Howitzer, medium, SP, 155 mm., M109E1	22.3
Tractor, full-tracked, LS, DED, medium, DBP, D–7, w/o blade	22.5
Container, cargo, 8 by 8 by 20	22.5
Semitrailer, tank, 5,000 gal	22.7
Semitrailer, stake, 12-ton	19.2
Semitrailer, van, cargo, 12-ton	19.6
Truck, tractor, wrecker, 5-ton, M62	23.0

NEED FOR LIFTING HEAVY EQUIPMENT

Mr. ANDREWS. Why would you want to lift heavy artillery, armored personnel carriers, and scout vehicles?

General BETTS. We have immediate application in Vietnam in trying to move fire bases, artillery fire bases, with reasonable flexibility. At the moment we either have to truck in or break down the equipment into smaller loads so that it can be lifted by the presently available equipment.

Mr. ANDREWS. I would think one of these 23-ton choppers would have been very useful in such engagements as Hamburger Hill and other mountain locations.

General BETTS. I am sure it would have helped to be able to move our artillery with more flexibility. But there is really a bigger picture than that, Mr. Chairman, that applies to the whole concept of air mobility. If we have a division that is designed to be air mobile, that means that in a large battle situation we would like to move all elements of it by air, if it is feasible. Now, at the moment the only way we can do this with our larger loads without breaking them down into pieces is with fixed-wing aircraft. It is a little hard to land a fixed-wing aircraft on a mountaintop like Hamburger Hill, for example.

What we would like to do with this program is to explore those major subsystems that relate to a helicopter of a lift like 23 tons so that we can pin down with reasonable confidence what the design would be, what the cost would be. At the moment we are not prepared to start the full-scale development of a helicopter as large as the one indicated, but somebody ought to be pushing the state of the art in rotors, transmissions, lifting devices, and those things that are critical to the performance of such a helicopter.

Mr. ANDREWS. How much does a CH–54A cost, Colonel Gilbert?

Colonel GILBERT. $2.1 million.

Mr. ANDREWS. What do you think a 23-ton heavy lift chopper would cost?

Colonel GILBERT. Sir, at this point in time we are estimating it at about ——— million to ——— million.

Mr. ANDREWS. ——— or ———.

Colonel GILBERT. No.

Mr. RHODES. Would you yield?

Mr. ANDREWS. Yes.

RUSSIAN CAPABILITY

Mr. RHODES. Tell us about the Russian capability in heavy lift helicopters.

General BETTS. We are in possession of firm information on the ——— that has a payload of about ——— pounds or a little over ——— tons, but we also have reasonably good information with respect to the development of a helicopter to which we have given the code name ——— that is supposed to have a payload of ——— pounds or a little over ——— tons. That helicopter has been seen. I am told it has an objective lift capability of ——— pounds or ——— tons.

Mr. RHODES. Would you say it has been built and prototyped?

General BETTS. It has lifted over ——— pounds.

Mr. POOR. I believe the Russians have claimed a world record for helicopter lift, based on this machine.

Mr. RHODES. Do you know how many of these two types of helicopters they have in their inventory?

Mr. POOR. No, sir.

General BETTS. I do not. I am told that since the test this aircraft of the Russians has crashed, about a ——— ago.

Mr. RHODES. They probably tried to put ——— pounds on it.

General BETTS. That may be a lesson for us.

But I do want to emphasize that this is not a proposal for a firm full development of a heavy lift helicopter. It is to push the state of the art of those subsystems, the success of which would determine the configuraiton of a helicopter of the size we described.

DETERMINATION OF LIFTING REQUIREMENT

Mr. ANDREWS. How did you arrive at a requirement to lift 23 tons?

General BETTS. The 23 came from the logistics load which I mentioned and the fact that there were many indivisable loads within a division that come up to about that tonnage.

Mr. ANDREWS. How many CH–54A's do you have in Vietnam operationally?

General BETTS. ———. Most of our inventory of CH–54's, if not all, are in Vietnam now. I would have to confirm that.

Mr. ANDREWS. I was just thinking here that you have a 10-ton capacity and I imagine you could get a little more out of it than that. You can buy the CH–54A's for about a third of what the colonel gave as the estimated cost of the 23-ton chopper. So you have enough of the 54's over there so you can get whatever job you need to have done, in my opinion.

Mr. POOR. It is very difficult, we think, to use more than one helicopter at a time to pick up a given weight load. There are formidable problems in flying them coupled so that you use two to pick up one unit load. So it seems to us the only way you can hope to pick up the heavy unit weights that the Army requirements study suggest may need to be picked up, is to build a machine big enough to do the job.

Mr. ANDREWS. What would you propose to carry on there? Would you propose to carry a Sheridan tank with one of these?

Mr. POOR. Yes. It would have the capability of picking up a Sheridan tank.

Mr. ANDREWS. That can be airborne now and dropped.

General BETTS. That is right. Where fixed-wing capability is available and where the situation would permit the drop, it could be handled in that way.

Mr. ANDREWS. Your opinion is that with a heavy chopper you could get better, more accurate delivery and sometimes delivery in places where it could not be air dropped?

General BETTS. We know it can be put down exactly where we intend it to be put down and that isn't always true of the air drop.

Mr. ANDREWS. Can a heavy-lift helicopter of 24-ton capability be carried in a C–5A aircraft?

General BETTS. Yes, if we disassemble it. We couldn't do it without some disassembly.

Mr. ANDREWS. Is it very difficult to disassemble and reassemble it?

General BETTS. It shouldn't be very difficult.

Mr. ANDREWS. You just take the long legs off?

Mr. POOR. And take the rotor off also.

Mr. ANDREWS. Why can't you modify the CH–54 Flying Crane to increase its load-carrying capability?

General BETTS. I think the B model is about as far as we can push the growth capability of this helicopter. There may be some incremental advantages that we can effect.

Mr. ANDREWS. The A has a 10-ton capacity. What does the B have?

General BETTS. About 11½ tons. So there has been some improvement between the A and B models. I am sure there are incremental improvements but nothing like the jump that we are talking about here.

INTERSERVICE USE OF NEW HELICOPTER

Mr. ANDREWS. What is the lift carrying capability of the Navy's CH–53?

General BETTS. Reduced to the same altitude and degree day criteria that we use for our 23-ton figure, the number is 6 tons for the Navy helicopter. I can point out that all of the loads I named within the division could not be lifted by the Navy helicopter.

Mr. ANDREWS. Why couldn't the Army and Navy get together in the development of an HLH?

General BETTS. The problem is the fact that the Navy cannot use a helicopter as large as that which we envision, in the cramped environment of a carrier. They feel that is a primary requirement for them.

Mr. ANDREWS. I think the Navy told us they want to put theirs on the C–5A.

Mr. POOR. We are talking about the aircraft carrier now.

Mr. ANDREWS. I know.

General BETTS. In an all-up operating configuration they want to be able to go aboard and come away from a carrier. Our helicopter would have too large a rotor for that application.

Mr. ANDREWS. Does the Air Force have a requirement for an HLH?

General BETTS. They have expressed an interest in this development. I hesitate to try to define their requirement for them.

TOTAL DEVELOPMENT COST

Mr. ANDREWS. How are you going to use the $15 million in fiscal year 1970, and how was the $5 million cut from this program to be used?

General BETTS. A specific goal for this fiscal year would be a competitive program we call contract definition. We would propose to select those critical components that must be successful if we are ever to have a successful heavy lift helicopter and compete those components in a contract definition.

Mr. ANDREWS. How firm is your estimate of ——— million to develop the heavy lift helicopter?

Mr. POOR. Mr. Chairman, I don't see how that number can be very firm at this time. The concept of this development program is the notion of competitive hardware component feasibility demonstration where we would take perhaps two different kinds of rotor systems,

one appropriate for driving with a gear system and one appropriate for driving with the so-called hot cycle system which uses gas flow out of the blade tips to spin the rotor and make experiments on these parts competitively to determine what the design characteristics of a good machine to do this job should be. So at this point in time I think it would be unrealistic to say that we really know what the full development cost will be.

Mr. ANDREWS. It could be much more, but you doubt it would be less?

Mr. POOR. I suspect because of the inevitable optimism of people when they start designing programs of this sort it is very unlikely that the cost will be less.

Mr. ANDREWS. How do you propose to develop this chopper?

Mr. POOR. We propose to develop it in a sequential component pattern in which we first, by building the critical pieces, determine how to make them, whether they will in fact work well in the very large size, a size in which we have no experience at all today.

With the base of design information that will come out of the first 2 years or so of the development program, we would hope to be able to have a high enough confidence in a final design to contract for the building of a complete machine. But that will not be started until the component development is firmly under our belts.

DEVELOPMENT PROCEDURES

Mr. ANDREWS. What kind of contract will you have and how much development and testing will be had before exercising production options?

Mr. POOR. The program hasn't been worked out in that much detail by the Army Materiel Command who are preparing the request for proposal at this time. The policy decision on this, however, is there would be no procurement of complete helicopters until the technology was well in hand through hardware experiments.

Mr. ANDREWS. In other words, you wouldn't buy until you fly?

Mr. POOR. I wouldn't buy until you come at least so closed to flying that you have tested all the pieces about which there is real concern.

Mr. ANDREWS. How much have you spent in R. & D. on the heavy lift helicopter to date?

General BETTS. On this new concept we have spent nothing that I can identify other than preliminary study and staff activity. The $1 million that is indicated here——

Colonel NIXON. Sir, there was $1 million in the 1969 program. There is $21 million in the past. That is it.

General BETTS. That was all on the CH–54?

Mr. POOR. The prior year moneys of some $20 million referred to work leading to the procurement of the S–64—CH–54 A and B.

Mr. ANDREWS. I wish you would put in the record the total amount spent on the heavy lift helicopter program to date.

Mr. POOR. That is $22 million, sir.

NUMBER OF HELICOPTERS NEEDED

Mr. ANDREWS. How many HLH vehicles will the Army require and what is the estimated production costs? I believe the colonel told us

the estimate production cost would be between ——— million and ——— million.

General Betts. That is correct.

Mr. Andrews. How many do you visualize the Army will need?

General Betts. These are very uncertain numbers at this stage. We would look for the full life of this helicopter on up to 1980 or 1985, that we might get up as high as —— aircraft, but we don't have any authorized level of procurement because this is in the very early stages of analysis.

Mr. Andrews. I judge there is no doubt in your mind that a 23-ton helicopter is possible.

General Betts. The Soviets have shown us that even larger loads than that can be lifted with an operational helicopter.

Mr. Andrews. What is their maximum load?

General Betts. As I mentioned before, their design goal was ——— pounds or ——— tons. They have already demonstrated ——— pounds or ——— tons.

Mr. Andrews. Questions on heavy lift helicopter, Mr. Lipscomb?

Mr. Lipscomb. No, Mr. Chairman.

Mr. Andrews. Mr. Rhodes? Mr. Davis?

Research Helicopter

Mr. Andrews. The fiscal year 1970 request for research helicopter is ——— million. The Congress appropriated $4 million for this program in 1969 and an additional $500,000 was reprogramed during this past fiscal year. Why does page 88 of the justification book show the fiscal year 1969 program at only $2.6 million?

General Betts. The 1969 program originally included $2.4 million for the tactical aircraft guidance system that fell under this same line item; $2.1 million was for the utility tactical transport aircraft system.

During the last fiscal year the utility tactical aircraft was transferred to another program element, 6.42.06. Therefore, the 1969 requirement shown here now becomes that only for the tactical aircraft guidance system plus a small amount of management support.

Mr. Andrews. Tell us at this point what is the research helicopter program.

General Betts. We identify with it those preliminary advanced development efforts that are sufficiently advanced toward specific hardware that we wouldn't carry them in the 6.2 exploratory development effort, but are not yet far enough advanced that we would program them for full development of an end item usable system.

Mr. Andrews. When you mention research helicopter you are talking about all choppers?

General Betts. I am talking about helicopter technology that may be in guidance systems, may be in rotor systems, could be in a new concept for a helicopter that was not sufficiently advanced to be a full-scale development.

Mr. Andrews. The program covers all choppers?

General Betts. Yes, sir; it covers all kinds of helicopters in that sense. Remember, we talked about the Bell aircraft that had gone to what is now claimed as a world speed record. Now, that kind of test bed development would be carried under this heading.

PROGRAM ACCOMPLISHMENTS

Mr. ANDREWS. Will you describe how the $4.5 million made available in fiscal year 1969 for the research helicopter program was utilized?

General BETTS. $2.4 million of it went for specific hardware in the tactical aircraft guidance system; $2.1 million went to the utility tactical aircraft system for both contractual and in-house parametric or preliminary design studies.

Mr. ANDREWS. How much has been spent on this program through fiscal year 1969 including the UTTAS dollars?

General BETTS. $2,566,000.

Mr. ANDREWS. What have you accomplished with these funds?

General BETTS. Well, we talked earlier today about the advances we made in the tactical aircraft guidance system. In UTTAS we have advanced to the point where we now have a pretty good idea of the variation in cost and size of this approach to an aircraft as we vary the requirements placed on it by the user. Now, I say that because at the moment it is not clear whether we want this aircraft to carry 10 people or 15 people or some number in between, or some number larger or smaller. We are going through the tactical employment studies to try to determine whether the efficiency of carrying more people is offset by losses to the extent that it is not a prudent way to go or whether we really ought to stay with the smaller aircraft like the UH–1. That is why we have not gotten on with this development faster than might otherwise have been the case because we have a concept question here that must be answered. Our only way of approaching this is extensive study and analysis of tactical application of the aircraft.

Mr. ANDREWS. I assume this program will be with you from now on; as long as choppers are flying.

General BETTS. Yes. We will certainly need an aircraft like the UH–1 for moving men about in a very flexible manner. Whether that aircraft should be larger than the UH–1 or whether it is sized right is yet to be determined.

TACTICAL AIRCRAFT GUIDANCE SYSTEM

Mr. ANDREWS. What is the tactical aircraft guidance system (TAGS) and why was it necessary to reprogram an additional $500,000 for this system in fiscal year 1969?

General BETTS. That is the automatic flight control system we discussed this morning, Mr. Chairman, as the fly-by-wire system.

Mr. ANDREWS. That would be a great breakthrough; would it not?

General BETTS. I think it will make a tremendous contribution to the ease of flying a helicopter when it is fully reliable and checked out and is operational.

Mr. ANDREWS. You said it would relieve the pilot of most of his duties once he got his course, and so forth, set?

General BETTS. That is right.

Mr. ANDREWS. Are you thinking about turning him into a gunner as well as a pilot?

General BETTS. We do at the present time. We do that with the pilot in the Cobra today and we would do it with the pilot in the Cheyenne. So at some point in the future if we prove this system to be reliable and at a cost that we can afford, it would be an ideal addition to either

one of those aircraft, to free the pilot from major concern about the aircraft.

Mr. ANDREWS. If I remember, the cost is about ———.

General BETTS. That ——— is one more expensive item on the aircraft. We believe it can be reduced.

Mr. ANDREWS. I know it isn't hay, but in comparison with some of these figures it can be considered peanuts.

General BETTS. We believe it can come down and we are going to try to bring it down.

Mr. POOR. I think the most important problem of the tactical aircraft guidance system at this point in time is to establish clearly the reliability level of a system of this sort so that we have enough confidence in it to entrust the safety of the pilot and the aircraft to this machine. Absent that, we shouldn't put it into the inventory. So the main thrust of the next year or so's development on this device would be to establish techniques for making it so reliable that we feel confident it is a safe way of flying aircraft.

Once that is done, I agree with General Betts that we can hope that the prices must come down. First we must convince ourselves it is a very safe and attractive thing to do, but we are still concerned about questions of vulnerability to enemy fire, what happens if components go out, and with designing a system so that it is of such high reliability that it is at least as safe as the conventional push rods and controls that the pilot now uses.

Mr. ANDREWS. Is the system patentable or would it be open to competition?

Mr. POOR. It is open.

NEED FOR ADDITIONAL FUNDS

General BETTS. It would be open.

Incidentally, I have not answered your question as to why we need an additional $500,000. I will have to get that and supply it.

(The information follows:)

The recommended 1969 Research Helicopter program included $2.1 million for the Utility Tactical Transport Aircraft System (UTTAS) project and $2.4 million for the Tactical Aircraft Guidance System (TAGS) project. The UTTAS project was transferred into the 6.42.06.A program element in anticipation of a start into engineering development during fiscal year 1970. This change was effected during fiscal year 1969; hence, the UTTAS dollars are no longer reflected in the research helicopter element. The $2.6 million which remained was for TAGS ($2.4) and Facilities and Installation Support ($.2). The $500,000 was reprogramed to bring TAGS up to the required level of $2.4 mlion.

General BETTS. This increase was required for the initiation of the system integration study that was part of the effort during this last fiscal year and the procurement of long leadtime items that would apply to the ongoing effort in fiscal 1970. Another thing I would like to add for your understanding, Mr. Chairman, is we find the Canadians very much interested in this development effort. The money you see in this program will not pay for the full development. We have reached an agreement with the Canadians that we will supply the development costs 60–40.

TOTAL PROJECT FUNDING

Mr. ANDREWS. How much have you spent on this program to date? Supply that for the record.

(The information follows:)

Since 1961, $5.3 million. Of this amount, $2.9 million was spent during the period 1961–68 for work done under the exploratory development phase. This work was done by the Massachusetts Institute of Technology Instrumentation Laboratories under an Army Aviation Materiel Laboratories contract.

ANTICIPATED OPERATIONAL DATE

Mr. ANDREWS. Now, if all goes well, when would you hope to have these systems installed and operational on your choppers?

Colonel NIXON. If everything goes well in the TAGS program and it is successful, the first future aircraft that we would hope to have the TAGS on would probably be the heavy lift helicopter which we are estimating for operational capability in fiscal year ———.

Mr. ANDREWS. What ———. The Secretary is shaking his head. He doesn't agree with that?

Mr. POOR. No. I just think that is too slow. We can do better.

General BETTS. There is no reason why we couldn't retrofit older aircraft if we chose to do so.

Mr. ANDREWS. You told us that this morning. I think you could expect much quicker delivery if you have this system retrofitted on choppers which you have on hand than you would waiting for new choppers to come out with the system factory-installed, so to speak. If the system goes well when would you hope to have some of the systems in some of your existing choppers?

General BETTS. I see no reason why we couldn't have this operational on the CH–47. That aircraft is very much like the one that it is on now as a test. So let's say about ——— or ——— years from now.

Mr. ANDREWS. Any way you look at it, we are talking about ——— or ——— years from now?

General BETTS. It is not immediately available.

Mr. ANDREWS. I was hoping you would have it next week.

General BETTS. They are scheduled to fly in the test configuration two CH–47 aircraft in May of 1971. So some time thereafter we could release it to production and retrofit some and then there would be the usual leadtime before it could be provided.

USE OF 1970 FUNDS

Mr. ANDREWS. You are requesting ——— million in fiscal year 1970 for TAGS, an increase of ——— million over fiscal 1969. What is the reason for the increase?

General BETTS. We are getting into more of the hardware phase, to go on these two CH–47 aircraft I just mentioned. That is a more expensive activity than the kind of high experimental effort we have been involved in in the past.

Mr. ANDREWS. Included in the ——— million under the Avionics subelement for fiscal 1970, page 77, is study on the application of the fly-by-wire concept to the UTTAS and HLH aircraft. How can

you spend funds in exploratory development for a fly-by-wire concept for UTTAS and HLH aircraft, and at the same time spend ——— million in fiscal year 1970 for TAGS which is a fly-by-wire concept?

General Betts. The ——— million is related to the hardware experimental program that we have been discussing. The Avionics program that you mentioned here is complementary in the sense that the Avionics Laboratory, helping us look at the future application to other aircraft, would take what we know of this program from a general technical capability point of view and would apply that to our design studies for the UTTAS and the HLH.

So these are complementary efforts and they fall in different parts of the budget so as to properly identify the kind of program involved.

Mr. Andrews. They are all parts of one system.

General Betts. It would apply to the same technology. We are talking about a design study and analysis in the Navy Avionics Laboratory. In the TAGS hardware program we are talking about putting hardware on an airplane and flying it in a test configuration.

Mr. Poor. Mr. Chairman, this is all in-house effort on the essential application of a fly-by-wire system to the advanced aircraft UTTAS and HLH, whereas the main program we are discussing is the experimental verification of the system by flying in the CH–47. This is just essentially planning effort for advanced aircraft. Should the systems be successful we will be ready to put it into these newer aircraft.

PROGRAM COST

Mr. Andrews. How much have you spent on TAGS through fiscal year 1969?

General Betts. $5.3 million.

Mr. Andrews. What is the estimated cost to complete this program?

General Betts. ——— million is our current estimate, Mr. Chairman.

SYSTEM USAGE

Mr. Andrews. In what helicopters do you plan to use the TAGS?

General Betts. We have named the Navy helicopter and the tactical air transport system. I do not have any present commitment that we would put it on our gunships, but if it is successful I predict we will make the decision to apply it to those aircraft.

Mr. Andrews. On the Cobra?

General Betts. On the Cobra.

Mr. Andrews. If you get a system to do what you say you hope this system will do, why wouldn't you be able to put it on all choppers?

General Betts. The decision is much easier for a new aircraft because for a new aircraft the only cost from the control point of view is that which is related to a properly designed system that takes maximum advantage of the TAGS capability. Going back to an airplane that is already flying and already has a control system we are talking about additional cost. The justification from an additional point of view——

Mr. Andrews. You would just put it on the ones in existence that you thought needed them?

General Betts. If we thought we could justify it; yes, sir.

Mr. ANDREWS. But it goes without saying that a chopper with this system is much better or useful?

General BETTS. Yes.

Mr. ANDREWS. Much more reliable also than one that is manually controlled?

General BETTS. Yes, sir, I agree. But you are just as aware as we that when we go through systems analysis-cost justification for all of our major expenditures, and I am sure that this will be treated in the same way.

Mr. ANDREWS. We have been hearing that since, I believe, when was it, 1961.

General BETTS. It is a way of life, Mr. Chairman.

Mr. POOR. I think if the reliability is sufficiently well demonstrated in this experimental program this system would be very good as a candidate for retrofit incorporation in essentially the whole Army helicopter inventory. The difficulty, of course, is that the system has to be designed for the machine in which it flies. They are all different in detail. It would be a fairly expensive matter to retrofit but I think we ought to try it.

Mr. ANDREWS. Once you conquer the system you can tailor it to fit most any chopper you have got, I would think.

Mr. POOR. That you could certainly do in principle, but the detailed designs are different.

Mr. ANDREWS. What about the small choppers?

General BETTS. At the moment this control system would cost more than the basic cost of the light observation helicopter. So there is a real question of whether you would be willing to use it on something like the light observation helicopter.

Mr. ANDREWS. I would say you would have to make your own decision and put them where they are needed most.

General BETTS. Yes.

ROTARY WING AIRCRAFT DEVELOPMENT

Mr. ANDREWS. You are requesting ——— million in fiscal year 1970 for rotary wing aircraft. How much have you spent through fiscal year 1969 on the rotary wing aircraft program element and what is the purpose of this research effort?

General BETTS. Through fiscal 1969 we spent $8.6 million, since 1964.

Mr. POOR. This is the part which developed the high speed helicopters, tested the hot cycle helicopter. It is a program under which we have sought to advance the state of art of rotary wing aircraft in general. The compound helicopter came out of it.

Mr. ANDREWS. What is the purpose of the research effort?

Mr. POOR. To build better helicopters that have higher performance characteristics than the things we now know how to build.

COMPOUND HELICOPTER

Mr. ANDREWS. By compound helicopter, do you mean it has both a rotary wing and jet engine as propulsion systems?

Mr. POOR. A compound helicopter is a machine that uses a rotor for its primary lifting device and has some form of auxiliary forward

propulsion device, and generally a small wing. The AH–56 is a compound helicopter, for example, using a propeller to push it forward through the air. Jet engines are not very suitable for compound helicopters, although we have used them for research helicopters.

Mr. ANDREWS. You are almost getting back to the V/STOL, are you not?

Mr. POOR. The compound helicopter has a couple of real advantages. It is a vertical takeoff machine. Because of your auxiliary propeller or other auxiliary propulsion device its attitude is independent of its forward flight pattern. In an ordinary helicopter to accelerate forward it is necessary to tip the machine over so that the rotor thrust pushes it forward. This means to go fast you have to put the nose down. It limits its utility as a gun platform because of that. So one of the things we think is of real advantage in the compound helicopter technology is its improved gunship characteristic. Another advantage is the inherent advantage of somewhat higher speed.

Mr. ANDREWS. What moves it forward once it gets airborne?

Mr. POOR. In the case of a compound like the AH–56 the propeller in back does the pushing.

Mr. ANDREWS. Certainly compound helicopters are nothing new. How much research effort has been done in the area of compound helicopters over the years?

Mr. POOR. There has been a great deal of it, almost all of it sponsored by Army aviation labs. I think I would have to provide the dollar and the time information for the record, if I may.

(The information follows:)

Prior year compound helicopter development effort has consumed $4,630,470. These moneys have been spent in contracts awarded to Bell, Kaman, Lockheed, Piasecki, and Sikorsky aircraft companies.

GOALS OF PROGRAM

Mr. ANDREWS. What is the estimated cost to complete the rotary wing helicopter, or compound helicopter program, and what is your ultimate goal? What will it replace?

General BETTS. That is a continuing level of effort wherein we would continue to advance the state of the art in all of the helicopters. When we come down to the specifics of one helicopter like the AH–56, we go into a development program that would be funded under another program element. So there really is no good answer to your question because we would expect this kind of development effort to go on at about this level of effort indefinitely.

Mr. ANDREWS. On page 88 it says:

Rotary wing aircraft: Fabrication of an advance research helicopter will begin so that flight testing of the slow rotor concept can be accomplished.

General BETTS. If the question was directed at the specific configuration of a research helicopter that we explored under this category, I have a figure of $8 million that will complete that research compound helicopter effort. But my prior answer applies to the general thesis that we have to do advanced development work under this category on a level of effort basis.

Mr. ANDREWS. General Betts, what is the goal here for this advanced research helicopter that you will begin flight testing? Are we trying

to develop a replacement for the UH–1–Cobra, for the Chinook, or Cheyenne? What are we aiming for in this advance research helicopter development?

General BETTS. I would say broadly what we are trying to do is to develop those aspects of helicopter technology that might apply to the UTTAS, might apply to the LTTAS when it is begun in development. As you are aware, we have not started that program as yet. It could well develop capabilities that we could go back and apply to helicopters already flying, although more likely it advances the state of the art for those new ones that we propose to develop in the future.

Our technique for exploring rotor technology is to put it on a test bed and fly it. In this case the compound helicopter is itself enough different from its predecessors that we felt it worthwhile to put several new ideas on an aircraft and called it a compound research helicopter.

That is whence I got the $8 million we are talking about. But I could not point it at a specific development because, as you are aware, if we go ahead with UTTAS we would go out to industry in a design competition, all of the information we learn from these development programs is available to the whole industry. Then we would evaluate the proposals as they come in from industry. Some of them may pick up the new ideas just as we generated them, some of the proposals may not. I think I remarked the other day that in the preliminary look we have taken with industry at UTTAS virtually all of the helicopter industry has said that now is the time to go to a rigid rotor rather than the hinged rotor that some have used in the past. What that means is that they are impressed with the performance of the rigid rotor as it was developed under earlier work similar to that about which we are speaking here.

USE OF DEVELOPED ROTORS

Mr. ANDREWS. The committee understands there were a couple of rigid rotors developed by Lockheed as a prelude to the Cheyenne. One of them was a compound type, I think.

General BETTS. That is right.

Mr. ANDREWS. As I understand it, the Army has one or two of those in storage. Why not test those?

General BETTS. We turned one of them over to NASA for their tests.

Mr. ANDREWS. Why wouldn't they be suitable to test rather than developing another compound helicopter?

Mr. POOR. I think this refers to the slowed rotor test program. The present compound helicopters are geared in such a way that the rotor speed is set by the gear ratios. They have a limitation on their top speed which is associated with the fact that at some speed not very much higher than the contemplated top speed of the Cheyenne the forward-going blade goes supersonic and the drag goes up very dramatically. One idea for increasing the top speed of a helicopter is, after you have used the rotor to develop the lift on takeoff, to slow it down by a variable gear ratio or something of this sort so that the advancing blade doesn't have to be supersonic. As a consequence the large losses associated supersonic drag are avoided.

There is another scheme involving contra-rotating rotors, both slowed down. It is this class of investigation that is contemplated here.

Now, the machines that we built before, the small machines, were constructed in a way that would make them inappropriate for this experiment. That is as close an answer as I can give you.

Mr. ANDREWS. Could you not put a slowed-down gear box on the one you have and use that in a test bed rather than fabricating a new one?

Mr. POOR. These were pretty cobbled-up machines to start with, and I believe it would be better to go to the new ones.

General BETTS. I wouldn't say that it might not come out of the competition that one of the competitive offers will offer a helicopter that we have already been using in a test configuration. That has occurred in the past and it could well apply.

LIGHT TACTICAL TRANSPORT AIRCRAFT SYSTEM

Mr. ANDREWS. You are not requesting funds in fiscal year 1970 for the light tactical transport aircraft system, the proposed follow-on to the CH–47 helicopter. No effort was expended in fiscal year 1969 on the LTTAS, although you were to have continued concept formulation studies during fiscal year 1969 on LTTAS according to last year's justification book. How much has been spent on LTTAS thus far and what is the status of this effort?

General BETTS. Nothing was spent because this effort has been limited to the preliminary design analysis to see what one can get by way of advances that would give us a better capability than is available in the CH–47. Now, the CH–47 is a very good aircraft and it would be some years before we would contemplate needing to get into a procurement program for anything, for any significant level of procurement to replace the CH–47. The LTTAS is very much an early requirement study at the present time. We do not have firm plans to get on with this development. We see a time frame like 10 years.

Mr. ANDREWS. It serves you well; you got it into production.

General BETTS. This is correct.

Mr. ANDREWS. You couldn't improve on it too much?

General BETTS. Not in the near time frame.

Mr. ANDREWS. What is wrong with the Chinook aircraft for this purpose?

General BETTS. Those comments apply to that aircraft, Mr. Chairman.

Mr. ANDREWS. As I stated earlier, in my opinion you are going to have a problem of redesigning and upgrading helicopters as long as you use them.

General BETTS. Yes, sir.

(Off the record.)

Mr. ANDREWS. Questions on research helicopter?

DEFECTS IN BODY ARMOR

Mr. RHODES. General, did you get the details on the armor matter we spoke of yesterday?

General BETTS. The main thing I found out, it is being bought by the Defense Supply Agency. No; I do not have a good answer.

Mr. RHODES. You are doing research on body armor?

General BETTS. That is correct.

Mr. RHODES. If there is a defective body armor——

General BETTS. It is not clear whether the defect stems from basic materials or whether it is a manufacturing process. I am told that a considered answer is being prepared for Mr. Laird to furnish to the Congress. But no, I did not get all of the details.

NEW SURVEILLANCE QUIET AIRCRAFT

TOTAL FUNDING OF PROGRAM

Mr. ANDREWS. Now we will talk about new surveillance aircraft.

The new surveillance aircraft program has been with us since at least fiscal year 1963. I would like to review with you the confusing funding picture disclosed from a review of previous justifications for this program.

The fiscal year 1967 justification book disclosed that a total of $41.7 million was programed for this effort through fiscal year 1966 and an additional $3 million was requested in fiscal year 1967. The fiscal year 1968 book indicated a total of only $39.8 million was programed through fiscal year 1967 and an additional $800,000 was requested for fiscal year 1968.

The fiscal year 1969 book indicated $40.1 million was funded through fiscal year 1969. The fiscal year 1970 book, on the other hand, indicates that only $37.4 million was funded through fiscal year 1968, and that only $7 million was funded for this entire program in fiscal year 1969. The committee is aware that $10.2 million has been reprograned during fiscal year 1969 for the YO-3A alone and an additional $4.7 million was reprograned for ——— aircraft.

Can you explain these discrepancies and tell the committee how much has been spent through fiscal year 1969 under the program element "new surveillance aircraft"?

General BETTS. It is my understanding that through fiscal year 1969 we have spent $59.95 million in accumulative total for this line item.

Mr. ANDREWS. How much?

General BETTS. $59,950,000. And the major jump is related to the effort that you have identified in the YO-3A aircraft.

QUIET AIRCRAFT DEVELOPMENT

Mr. ANDREWS. Tell us about the YO-3A aircraft.

General BETTS. You will recall that under ARPA's auspices two quiet aircraft were designed and sent to Vietnam for test.

Mr. ANDREWS. Will you describe them?

General BETTS. These were what I would call hybrid aircraft in that we started with a glider and put an engine in that glider with a rather contrived mechanism to get a drive system that was completely enclosed internally with adequate muffling so it would be a silent aircraft.

We also spent rather considerable engineering effort that was involved in streamlining and being very careful about all aspects of noise producing on the airplane.

The success of those two aircraft that we called the QT–2 in Vietnam was so marked we were able to approach within like distances of ——— with favorable conditions and ——— at night ——— and activities of that sort, and that the commanding general MACV gave us a very strong request to expand this effort and improve the airplane since that first effort was highly experimental in nature, it did not have integrated sensor capability, it did not have the kind of payload-carrying capability we felt one would need in an operational aircraft.

Mr. ANDREWS. It was a glider?

General BETTS. That is correct.

Mr. ANDREWS. What did you put in the glider to permit the glider to come back down?

General BETTS. We put a continential engine in that glider.

Mr. ANDREWS. Did you put it in the front or the back?

General BETTS. In the middle. It flew well and it did its job.

Mr. ANDREWS. How was the glider airborne?

General BETTS. It has a propeller and flies just like a fixed wing aircraft.

Mr. POOR. The machine used a belt drive to drive a propeller shaft mounted above the machine to gear the shaft to the engine. There was special attention paid to muffling the engine and special attention paid to the design of the propeller so it would be a low-noise-generating propeller.

Mr. ANDREWS. About as quiet as you could get a plane?

Mr. POOR. Yes. It carried very little in the way of ——— payload.

Mr. ANDREWS. It could slip up on the enemy daytime or nighttime?

Mr. POOR. Yes.

Mr. ANDREWS. What night capability did it have?

Mr. POOR. It was not terribly adequate. They used a ——— night vision device, but they did find even with this they had partially adequate ability to ———.

Mr. ANDREWS. What kind of armament did it have?

Mr. POOR. ———.

General BETTS. ———.

Mr. ANDREWS. Did it have a radio?

Mr. POOR. Minimum communications equipment.

Mr. ANDREWS. The purpose was to be a ——— then?

Mr. POOR. Yes.

Mr. ANDREWS. And communicate to relay the information back ———.

General BETTS. That is correct.

Mr. ANDREWS How many of them did you have over there?

General BETTS. We only had two for evaluation that were sent over.

Mr. ANDREWS. You got a request for more?

NEW DESIGN FOR QUIET AIRCRAFT

General BETTS. We now have a contract to develop ——— more aircraft at a higher payload capability we call the YO–3A. That has been the aircraft that was the subject of a request from the Army to this committee for authority to reprogram additional funds to complete that development and testing effort.

Mr. ANDREWS. Will you get away from the glider concept?
General BETTS. We are still using a basic glider configuration in order to ———.
Mr. ANDREWS. What type?
General BETTS. The ——— glider.

SOUND LEVEL OF QUIET AIRCRAFT

Mr. ANDREWS. What type engine will you use in the second one, the follow-on?
Mr. POOR. This has greater horsepower; 210.
General BETTS. An engine similar to the one used on the Cessna.
Mr. ANDREWS. You are getting away from the smaller engine and getting into a larger engine with more noise, and you are going to defeat the purpose for which you started out.
General BETTS. On the contrary, Mr. Chairman, we have tested two of the first made of this new configuration and at the moment it is pretty clear that we can do as well or better than we did with the first two QT–2 with respect to noise. level.
Mr. ANDREWS. Less noise?
General BETTS. Yes, sir. It is related to fact, as we have gotten into this development effort with added engineering attention, we have managed to get the aircraft down to an even configuration.
Mr. POOR. The test results to date show at ——— feet the original Q–2 glider had a sound level of ——— db. The Army requirement is for equivalent quietness of ——— db. The experimental data on YO–3 aircraft, the measurements are ——— db, which is considerably quieter than the first research machines.
Mr. ANDREWS. Is that with the sensor in it?
Genueral BETTS. It was put in early this week and is now in the early stages of test.
Mr. ANDREWS. You have not tested it?
General BETTS. No.
Mr. ANDREWS. What about the first one?
General BETTS. This is the one I was talking about. There was no integrated package in the QT–2.
Mr. ANDREWS. That was the one in Vietnam in service, two of them?
Mr. POOR. Yes. They used a ——— night vision device and the theater ——— asked us to develop for an integrated package.
Mr. ANDREWS. You said they liked it and requested more?
General BETTS. That is right.

CHARACTERISTICS OF ADVANCED QUIET AIRCRAFT

Mr. ANDREWS. They requested more and you go to the new version with a bigger engine, bigger payload?
General BETTS. Yes. Integrated sensors.
Mr. ANDREWS. It is still just to ———?
General BETTS. Yes.
Mr. FLOOD. Let's get this clear. Armor and armament are two different things.
General BETTS. ———.
(Off the record.)

BEST AVAILABLE COPY

Mr. ANDREWS. At what altitude does this aircraft operate?

Mr. POOR. It has been tested at altitudes like ——— for noise tests, but operates at ———.

Mr. ANDREWS. ———.

Mr. POOR. On the other hand, it is pretty hard to detect.

Mr. ANDREWS. Why?

Mr. POOR. Because it flies so quietly and so low. So the likelihood of it getting shot seems to be small. I understand the experience they had in Vietnam was very successful.

STATUS OF NEW DEVELOPMENT

Mr. ANDREWS. How do you stand with this second machine?

Mr. POOR. There are two of them flying.

Mr. ANDREWS. In Vietnam?

Mr. POOR. ———.

Mr. ANDREWS. How much do they cost?

Mr. POOR. To finish on the status, we have just tested the integrated sensor package and ———. The sensor package ——— gave very satisfactory results ———. So we think the integrated sensor is a very promising device.

The aircraft, as I say, has done better than specifications on noise level and somewhat better than specifications on cruise speed.

Mr. ANDREWS. What is the speed of the second one?

Mr. POOR. We originally specified I believe ——— knots and I think the machine has successfully flown at ——— knots. Now this is backward, but you have to understand that better performance in a quiet aircraft is slower flight because the slower you can fly, the less noise they make. So the aircraft has actually been able to fly slower than we initially hoped.

Mr. ANDREWS. Flying at ——— feet at ——— knots an hour ——— would that not put it in kind of a hazardous position?

Mr. POOR. I would have thought so, but the theater says it is one of the best things, it is grand, and they want more. They like them and they like their experience with the first machines and they want more.

Mr. ANDREWS. What do they cost?

General BETTS. As best we can analyze it from among the numbers we have available, about ———. The way we have gone into this program, one must recognize since it is experimental in nature as a new design, there have been some considerable engineering costs. That is particularly true as related to the sensor package. So that while we talk about getting ——— aircraft for a total program of roughly ——— million——

SENSOR PACKAGE IN AIRCRAFT

Mr. ANDREWS. Is that R. & D.?

General BETTS. Much of that is for engineering effort to support the program, much of it is for the sensor package we would want to put in the aircraft.

Mr. ANDREWS. Tell us something about the sensor package.

General BETTS. What we proposed to use for the sensors is a ———. In other words, ———.

Mr. ANDREWS. ———.

General BETTS. Yes.

And the image intensification night vision device that is designed to operate optimally in the same ———. It gives you a much greater range capability than would be available otherwise.

Mr. ANDREWS. At ——— feet in altitude, what can that pilot see through that gadget?

General BETTS. Through that night vision capability he can see ———.

Mr. ANDREWS. Over what range?

General BETTS. He would see about ——— resolution at ——— feet.

Mr. ANDREWS. You mean you see ——— of the ground?

General BETTS. No.

Mr. ANDREWS. How much of the ground will he see flying over it?

General BETTS. It is a ——— degree field of view.

Dr. LASSER. I think the field of view is ——— or ——— degrees, the ——— is ——— degrees.

Mr. POOR. The scheme here is if there is enough ——— the machine will work without any ———.

Dr. LASSER. The numbers Mr. Poor gave are without the ———. With the additional ——— you get higher resolution than that. Without using the ——— at ——— feet you get ——— resolution.

Mr. ANDREWS. What do you mean by that?

Dr. LASSER. You can see a thing ——— across when you are ——— feet away.

Mr. ANDREWS. If you are ——— feet above this room and flew over it, you would see a spot down here ——— wide?

Mr. POOR. You would see ———.

General BETTS. What we mean by resolution, as we could best describe it, when you look through binoculars badly out of focus you see people and know they are people but cannot define them very well. When you have it in focus the resolution is very precise. We are talking about a blur of about ——— at a distance of ——— feet.

Mr. ANDREWS. What I want to know, you say you operate at ——— feet. You fly down over this area at ——— feet, he looks through his scope, how much will he see?

General BETTS. He would see with an angle that is about ——— degrees wide, and he would see at distances like ——— feet ahead of him in ———. He would see people, trucks, military equipment, aircraft, roads.

Mr. RHODES. Would he see as much as he would in the daylight?

General BETTS. It would ——— and he would ———, but he would be able to define objects within that range that I mentioned.

Mr. ANDREWS. Are there any lights on this plane that would help identify him and make him a sitting target?

General BETTS. No, sir. He does not carry any riding lights. ———.

Mr. ANDREWS. That is the ———.

General BETTS. Yes. ———.

Mr. ANDREWS. (Off the record.)

General BETTS. That is correct.

NUMBER OF AIRCRAFT PURCHASED

Mr. ANDREWS. You say you have ——— of these second generation planes?

Mr. LIPSCOMB. You do not have ———.

General BETTS. We have ordered ———.

Mr. ANDREWS. How many do you actually have on hand?

General BETTS. The contractor has completed the fabrication of ——— aircraft and is continuing to build these aircraft just as though he still had funding from the Government. As of the end of March we informed him that we had no further funds to put on this contract and we did not know whether or not we would get authority to put additional funds on this contract.

Mr. ANDREWS. Who is the contractor?

General BETTS. Lockheed Missile and Space Company.

Mr. ANDREWS. How far away from production are you? Are you ready for production?

General BETTS. ———.

Mr. POOR. These are a second set of research aircraft for further operational evaluation ———.

Mr. ANDREWS. You plan to ———.

Mr. POOR. Yes.

Mr. ANDREWS. ———.

General BETTS. ———.

Mr. ANDREWS. You will have ———.

General BETTS. In this group of ——— aircraft, we would intend for further Army development and testing work ———.

(Off the record.)

Mr. ANDREWS. From what I have heard about this plane, I am very favorably impressed. I can see the need for it. Do you think you need any more than the ——— that you plan ———.

General BETTS. If we went beyond this number we would go out to competition.

Mr. ANDREWS. Would you have any problem getting the plane by competition?

General BETTS. Beyond this number, I see no reason why we would.

Mr. ANDREWS. How long would it take them to establish a line?

AIR FORCE DEVELOPMENT OF QUIET AIRCRAFT

General BETTS. You are well aware that the Air Force proposes to go out on competition. Something like ——— from now they should have aircraft from that competition.

Mr. ANDREWS. Is this the same type plane?

General BETTS. I do not know. If it is competitive, this aircraft might win the competition.

Mr. ANDREWS. Do they want the same type of surveillance aircraft?

General BETTS. They have been interested in greater payload and greater gross load than is inherent in this configuration.

Mr. POOR. There is another difference I think between the Air Force requirement and the Army requirement. I understand the Air Force contemplates flying at considerably higher altitudes than the ——— feet or so that the Army feels is necessary. So they can stand a somewhat noisier aircraft than we can.

Mr. ANDREWS. This type plane would give you a better capability to keep track on ——— especially, and ———.

General BETTS. And it has proved most useful in surveillance of ——— where we picked up ———.

Mr. ANDREWS. What is the range of this plane, how long can it stay airborne?

Mr. POOR. The endurance is about ——— hours. Its range is ——— miles approximately.

Mr. ANDREWS. In other words, it could go out on a mission, cover ——— miles out and back?

Mr. POOR. No. A round trip.

Mr. ANDREWS. I said ——— miles out and back, a round trip.

Mr. POOR. Yes, ——— miles each way.

REPROGRAMING OF 1969 FUNDS

General BETTS. Mr. Chairman, you will remember that this committee looked at our request for reprograming and said no, and I remarked to Mr. Mahon the other day that we were discussing the matter with Dr. Foster's staff because we felt there was additional information available that had not been available at the time our request was submitted to you and that if Dr. Foster supported our request for reclama that we would be back to you.

It is my understanding you now have a letter from him that does express support for our going ahead with this group of aircraft for ——— evaluation.

Mr. ANDREWS. His letter is in connection with this budget request before the committee at this time?

General BETTS. It applies to the reprograming for the YO-3 aircraft. It is not for the fiscal year 1970 budget, it talks about reprograming related to the fiscal year 1969 budget.

Mr. ANDREWS. In other words, you want to finance it out of 1969 funds.

General BETTS. That is correct.

Mr. FLOOD. With the kind of war we are fighting in Vietnam, I certainly am impressed by what you said so far. I see a place for that weapon in that kind of show.

General BETTS. I believe it has very useful capabilities.

Mr. ANDREWS. You have nothing comparable to it now, have you?

General BETTS. No, sir; we do not.

Mr. FLOOD. Neither does anybody else.

General BETTS. Not to my knowledge. As a matter of fact, there is a lot of very important new technology that is wrapped up in this development. When Lockheed entered this program, they went into it as though this was not a real tough problem to take a glider and put propulsion in it and make a quiet aircraft. The reason this reprograming action is necessary, they found it required a great deal more attention to refined engineering in order to get the kind of aircraft that we have now seen in test with the sort of performance that Mr. Poor described. It is not a simple matter to get aircraft down to these levels of sound.

Mr. FLOOD. That is the old story of it. "It takes me 15 minutes to write an hour speech and an hour to write a 15-minute speech."

LETTER TO CHAIRMAN

Mr. POOR. The letter from Dr. Foster to Mr. Mahon was dated the 3rd of July, 1969.

Mr. ANDREWS. I wish you to put it in the record at this point.
Mr. POOR. Yes.
(The letter follows:)

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING,
Washington, D.C., July 3, 1969.

Hon. GEORGE H. MAHON,
Chairman, Committee on Appropriations,
House of Representatives,
Washington, D.C.

DEAR MR. CHAIRMAN: Secretary Laird has asked me to respond to your letter of June 24, 1969, regarding various reprograming requests relating to the Department of Defense quiet airplane programs. We would like to place these programs in their proper perspective and then ask you to reconsider your objection to the YO-3A program.

The quiet airplane programs are the result of a very successful and innovative concept developed by the Advanced Research Projects Agency (ARPA). This concept offers the potential of a fundamentally new military capability; that is, the ability to observe enemy activities at night from an aircraft without being detected. Such innovations involving largely new concepts, multidisciplined technologies and unproven capabilities are precisely where ARPA has made the greatest contributions to our military capabilities. Initial ARPA efforts led to the construction and deployment of two quiet airplanes to South Vietnam which operated highly successfully during the 1968 Tet offensive and afterward. The startling capabilities of these early, relatively crude aircraft caused the Army, Navy, Marine Corps, and Air Force all to state urgent needs of a quiet airplane-night vision system for current operations in Southeast Asia. These actions led directly to the current quiet airplane programs.

Initially, we believed that a single triservice program could best satisfy these varied needs and the YO-3A program was started toward that end. It soon became apparent that the different missions of the services demanded differing levels of quietness and sensor effectiveness. Specifically the Air Force is primarily concerned with the location of trucks operating generally outside South Vietnam and for this mission a less sophisticated and, therefore, less costly, quiet airplane-night vision system might suffice. I discussed this with Dr. Flax, then the Assistant Secretary of the Air Force (R. & D.) and we decided that a separate program would be worthwhile based on some experiments the Air Force had made with a modified Wren 460 airplane. The Air Force proposal promised not only a substantially more economical system, but also approached quiet flight by a fundamentally different technique and, therefore, explored an area of new technology. Quietness in flight is obtained by combinations of slow flight and extreme attention to streamlining (in addition to certain other necessities such as engine muffling). The Air Force concept emphasizes very slow flight whereas the YO-3A design gives more attention to careful streamlining. Our relative inexperience in this area prevents us from knowing precisely the best combinations or the exact results we will get. Your action of June 24, 1969, will permit us to explore the concept proposed by the Air Force, and I am convinced that program is well worth the modest cost.

The YO-3A airplane program is well advanced with several aircraft currently in flight tests. A sensor system has been completed, bench tested, and installed in an aircraft. Flight testing of the sensor system will commence the week of July 9, 1969. At this point, we can predict with relatively high assurance the performance of the completed system. It is correct, as you stated in your letter, that all specifications will not be met. However, the critical mission capabilities of the YO-3A in the surveillance role will be met and provide an important military capability. To terminate the program at this stage would mean the funds and efforts expended would be wasted whereas the requested reprograming authority will provide a useful system. The total program costs with the small number of aircraft being procured have resulted in what appears to be an inordinately high unit cost for each aircraft. This is the result of the extensive research and development costs of the system and the fact that the quantity could not support production line fabrication efficiencies. When viewed as a total R. & D. program, including both an aircraft and an advanced sensor, the total costs are not unreasonable.

In summary, the results of our efforts to date give us assurance that the YO-3A will attain the noise level and characteristics essential to the Army and

Navy/Marine missions. Our confidence in the Army sensor is not as high and it may be necessary to deploy the aircraft initially with other less capable sensors currently available. On the other hand, our experience does not provide high confidence that the Air Force program will produce an aircraft quiet enough for the more demanding mission of observing enemy troops. The Air Force sensor has demonstrated excellent results for the less demanding mission for which it was designed.

In view of the above considerations, your support of the Air Force proposal is appreciated. I am confident that a remunerative program will result. In addition, I request that the committee reconsider its initial position on Army reprogramming fiscal year 1969–92 related to the YO–3A quiet airplane and permit completion of this highly promising effort. Navy actions will be based on subsequent assessments of both programs at a later date.

Sincerely,

JOHN S. FOSTER, Jr.

PREVIOUS DEVELOPMENTS UNSUCCESSFUL

Mr. ANDREWS. A review of your efforts under this program element discloses a history of terminated projects. I refer to the XV–4A, the XV–5A, the SV–6A. The OV–10A aircraft is not in the Army inventory and it cannot be considered as a major success for the Navy and Air Force because it is not being used in the COIN role for which it was originally developed.

Your recent experience with the YO–3A, an interim quiet aircraft development program, suffered from severe cost overruns before the committee objected to the additional expenditure of ——— million.

From the foregoing, I believe you can appreciate the committee's disappointment over the lack of accomplishment for the millions of dollars spent in the new surveillance aircraft program. How much scrutiny has this overall program had at the Army staff level?

General BERTS. I think it has had a great deal of scrutiny. As a matter of fact, it has had a great deal of attention at a level higher than ours over the years.

You are well aware that we went ahead with several different approaches to what were V/STOL aircraft, like the XV–6A, XC–5A and 4A, a pattern of development that we felt did push forward the state of the art in aircraft technology generally and in particular explored those approaches. Whether or not it was prudent to pursue those developments in their time frame, with 20–20 hindsight one might say it was not. At the time it seemed as though it was appropriate and the right way to go.

The OV–10A, as you are well aware, was generated by a joint committee of the assistant secretaries for Research and Development of each of the three services, with great attention to the question of whether or not there is not a good way to get a tactical aircraft configured for what is mostly an observation mission, but might also carry armament under certain circumstances.

I cannot give you an assessment of the OV–10A; that is not our program, but it is my impression that the aircraft development came out about the way it was originally conceived. If it is not being used in

large numbers it is because the user in terms of operational organization has not been overly impressed with its capability.

Mr. ANDREWS. Which was the one you tested in Vietnam?

Mr. POOR. The OV-1 Mohawk.

Mr. ANDREWS. I am talking about the surveillance aircraft. You said you had two over there.

General BETTS. QT-2 quiet aircraft. They are not any of those I named. As far as I am concerned, the quiet aircraft program QT-2 and this follow-on YO-3A from a technical point of view has been a very successsful effort.

Mr. ANDREWS. It has no problems?

General BETTS. It has grown in costs because we have learned a lot about the engineering problems of making quiet aircraft we did not know about before. We also ran into some more difficulties with this sensor package than we had anticipated.

ENGINEERING PROBLEMS WITH CURRENT DEVELOPMENT

Mr. ANDREWS. But, the YO-3A was seriously overweight; its takeoff distance was ——— feet instead of the required —— feet; its rate of climb was less than specified; its takeoff distance over a 50-foot obstacle was unknown, its endurance hours was less than required, and you had to redesign the sensor package. To reduce weight, you were planning to eliminate the dual flight control feature, the communications ———, redesign the canopy, and possibly eliminate the TACAN in the aircraft.

In addition, you proposed to accept a sensor package which does not meet original specifications. After spending ——— million thus far, some of it to correct contractor design errors, you wanted Congress to approve another ——— million for a degraded aircraft which still would not meet all of the original Army specifications.

What was the original estimate to develop this aircraft?

Mr. POOR. While they are looking up the original estimate, I would like to comment on the airframe specification problem. The committee has no doubt been informed that the loiter speed is lower than specification; that is ——— knots as against ———.

As I mentioned earlier, this might appear to be a failure to meet specification. It actually is exceeding specification. The noise level has been measured at ——— plus or minus 0.5 db as against a specification level of ——— db. So it is substantially quieter and flies slower; these being the two most critical characteristics of the aircraft.

Mr. ANDREWS. That is what you wanted?

Mr. POOR. In those two important respects, it is what we want. Takeoff distance is slightly longer than specification or original design hope. It is about ——— feet as against about ———. And the takeoff distance over a 50-foot obstacle is about ——— feet longer out of ——— feet.

Mr. FLOOD. Does it need a hardtop runway?

Mr. POOR. It needs a runway.

Mr. FLOOD. What about grass?

Colonel NIXON. It is no problem.

Mr. POOR. In the development of this aircraft, it did prove necessary to give very careful attention to the landing gear, to all protuberances, to clean the machine up.

Mr. ANDREWS, Does it have retractable landing gear?

Mr. POOR. It has a retractable landing gear, a feature not present in the original request for the aircraft.

Mr. FLOOD. It could land in emergencies on any highway?

Mr. POOR. I think it very well could. Its landing speed is very low, but the wing span is very large. If the highway has a lot of poles along the side I think it may be a controlled disaster.

Mr. FLOOD. What is the spread?

Mr. POOR. It is about ——— feet or something like that.

EFFECTIVENESS OF SENSOR PACKAGE

Mr. LIPSCOMB. It has flown with the sensor?

Mr. POOR. It has been flown with the sensor package.

Mr. LIPSCOMB. Last night?

Mr. POOR. Yes.

Mr. LIPSCOMB. What is the decibel rating?

Mr. POOR. It is two decibels better than specification. It is ——— as against ———.

Mr. LIPSCOMB. Does the sensor package make a difference?

General BETTS. This would not make any difference.

Mr. POOR. I doubt the sensor package makes a significant difference.

Mr. LIPSCOMB. I understood the night optical vision sensor on this was a kind of a ———.

Mr. POOR. The original scheme was to put a rather large ——— device that hung out in the airstream. This would have increased the noise level and decreased performance of the machine significantly, and one of the things that has been done is to build a special ——— device which can be faired into the lower part of the aircraft in relatively low-drag arrangement. That was one of the elements that increased the cost over the original expectation.

However, that seems to have been well worthwhile because the sensor package does work well, and as far as we know it does not degrade the sound level performance. I have seen proposals for other machines which contemplate external sensor installations and we are a little pessimistic from our own experience as to how difficult it is to quiet an aircraft that such draggy sensors will work well.

Mr. LIPSCOMB. But the sensor package was flown on the aircraft last night and I understand there are tests the 7th, 8th, and 9th.

Mr. POOR. I assume so; I do not know.

Mr. LIPSCOMB. And the sensor packages being used in flight test this week are the ones you anticipate using on the aircraft if we go ahead with the reprograming?

Mr. POOR. That is correct. EOS sensor.

Mr. LIPSCOMB. With that sensor package, you got down to what, ——— decibels?

General BETTS. ——— db.

Mr. POOR. I do not think confirmatory measurements have been made, but we expect it will not change it.

Mr. LIPSCOMB. The one you are using is without the sensor package?

Mr. POOR. They did not have the sensor in, but had a protuberance representing the drag element of the sensor, so the dummy package should have made the aerodynamic equivalent. So I do not anticipate any change in noise levels.

Mr. LIPSCOMB. Do you consider the night optical sensor a real breakthrough in that area?

Mr. POOR. No; it is a state of the art device I think, not a real breakthrough.

Mr. LIPSCOMB. Do you consider it a good device?

Mr. POOR. I would like Dr. Lasser to comment on that. He is more closely related to it.

Dr. LASSER. The Seaniteops program you have heard about uses very similar ——— so it is not altogether new. The new thing is the change in configuration outside of the aircraft. There is a bubble and I believe that bubble was tested at ——— db, so with the sensor in there should not be any change in noise level. The new sensor does not have the protuberance. So I believe the numbers are equivalent. I have not heard the numbers of last night, but it seems quite obvious it must be.

Mr. LIPSCOMB. I understood this was a sophisticated night optical sensor and it was a very good development.

Dr. LASSER. I suppose. It was based on things that had been developed and flown in other aircraft. It is sophisticated, and I guess that is a relative term. While something similar to it has been flown before, this is a very good technical solution to a difficult integration problem.

Mr. LIPSCOMB. I understood it was a subcontract by Lockheed.

Dr. LASSER. Yes. Electro-optical system.

Mr. LIPSCOMB. It is made in Pomona, Calif., which is a very interesting place from any point of view.

REASON FOR INCREASED COST

General BETTS. You asked about the cost picture, Mr. Chairman. We started with an estimate of ——— million. We, with this reprogramming request, are now asking for authority to add ——— to that.

The changes that are involved, to give you some feeling for how the cost grew to this, ——— million can be attributed to engineering design changes that were discovered in the course of early testing and to the cost of correcting for the design deficiencies that were found during testing.

Another approximately ——— million was related to the overhead and cost schedules of a lengthened program and it became a lengthened program because we got into the technical difficulties I just mentioned.

Furthermore, within that same ——— dollars there were some components within the aircraft that required redesign.

Now with respect to the sensors, we had originally thought that ——— million would pay for all sensors for all —— aircraft. Our current estimate is ——— million, so there is ——— million cost growth in that item alone.

There was a development failure in that development effort in the scanning head. The time to correct that and the engineering effort that was involved are what caused this cost growth.

Furthermore, we called for a level of logistical backup for that that we had not thought to estimate in the original program. There is no question but what we should have estimated it, but it was an oversight.

There is ——— of Government-furnished equipment for avionics and the TACAN navigation system that was not included in the original estimate. And then for contractor personnel to back up the program and plan for the training we would require another approximately ——— that had not been estimated in the original estimate.

Furthermore, we had expected that as our procurement of the initial aircraft was completed the Navy would pick up from where we left off with further procurement of these aircraft. That effort has been denied. So far at least their request for reprograming of funds to do it has not yet been approved, and consequently there are attendant overhead costs that will have to be paid we would have had to assume in making our estimate.

I remarked earlier this was a program that had been defined, had been priced out, at an estimate that we now find to be wrong. Nevertheless, we told the contractor when we ran out of those funds that we had no more, that we were making a request for authority to reprogram, but any further work he did would be on his own responsibility.

The work that has been going on since the end of March has been on Lockheeds own responsibility, not that of the Army.

Mr. ANDREWS. Last night, July 7, 1969, you had a successful test flight. Tell us when you first started to work on this plane, and what the total cost of R. & D. to date has been.

General BETTS. The total cost will be the ——— million that the Government has put in this program depending on whether or not you approve the reprograming request. That is all that there will be or we will go up to the ——— million if you so authorize.

Mr. ANDREWS. When did you start to work on it?

General BETTS. Work commenced in July 1968.

Mr. POOR. The very first development.

COMMITTEE INCORRECTLY ADVISED ON COST

Mr. ANDREWS. What was the original estimate for the development of these aircraft and sensor packages?

Mr. POOR. ——— million.

Mr. ANDREWS. Reprograming action fiscal year 69—11 reprograms, ——— million, for a total of ——— for this program, and nothing was said about an additional ——— million being required to complete the program at all in this reprograming.

General BETTS. We had ——— million granted to this program from OSD emergency funds. The 6.3 request gave us the total of ——— that we then felt was necessary to do the job.

Mr. ANDREWS. This reprograming action does not say that. It says the total program is ——— million. There is no mention of any prereprograming of emergency funds.

General BETTS. Then this is just our mistake. We were not trying to cover up the fact we had asked for the emergency funds.

Mr. ANDREWS. From this reprograming fiscal year 69—11, Congress is led to believe the total cost of the program would be ——— million dollars. There is a subsequent reprograming action——

General BETTS. It was actually started on the emergency fund allocation, so I understand. So if we did not specifically point out that

part of the program, then this is our oversight. I can assure you it was not deliberate because I have no other estimates than the ——— I have given you.

NOISE LEVEL AND OVERWEIGHT PROBLEMS

Mr. ANDREWS. The committee has been told by Army officials earlier this year that the ——— or ——— db noise level was accomplished without the sensor package. After development of the sensor package it was found that the sensor caused additional noise in the aircraft and it was necessary to redesign the sensor package.

General BETTS. And the outside configuration, in order to get that noise back down to where it is now. That is a highly developmental program in nature. Unquestionably we had engineering design changes as we went through the development process.

Mr. ANDREWS. When the aircraft became seriously overweight, what was removed from the aircraft in order to get the weight down?

General BETTS. I do not know I can address that because I do not remember any time we thought it was seriously overweight. There were weight problems. As far as I know, that has been taken care of in the kind of specifications we have given.

Colonel NIXON. We reduced the crew weight. We had originally specified a man weighing 240 pounds and we intend to take care of the overweight condition of the aircraft through specification to the field, and placard in the aircraft for example that a man over 200 pounds will not fly the airplane. That type of operation is a limitation, but is not going to be serious.

We have already asked about acceptance of the limitations because of weight and condition and they have accepted and said, we want the airplane.

Mr. ANDREWS. Does it have a position for an observer too?

Colonel NIXON. Yes, sir.

Mr. ANDREWS. Does it have dual controls still?

Colonel NIXON. Yes, sir.

Mr. ANDREWS. That originally had dual controls and the Army said they were going to take out one set of controls.

Colonel NIXON. To my knowledge, the dual controls were never taken out. We left them in.

Mr. ANDREWS. How about the communications? Was that removed?

Colonel NIXON. You are getting into detail I think we ought to provide for the record.

General BETTS. As far as I know, we still have TACAN and still have a modern avionics package in that aircraft. My information is we have modern avionics, LOHAP communications package, and TACAN in the aircraft.

Mr. ANDREWS. Would you provide for the record the noise level of this aircraft at 125 feet with the sensor package as a result of the testing going on now?

General BETTS. Yes.

(The information follows:)

Acoustics measurements were made on July 8, 1969, on a YO-3A equipped with sensors. These tests indicated that the sensor package added one db to the overall sound pressure level. YO-3A's equipped with sensors will have an overall sound pressure level of ——— ±0.5 db and will exceed the specified acoustics level.

QUESTIONABLE QUALITY OF SENSOR PACKAGE

Mr. ANDREWS. With respect to the sensor package, Dr. Foster's letter indicates:

Our confidence in the Army sensor is not as high, and it may be necessary to deploy the aircraft initially with other less capable sensors currently available.

General BETTS. When they wrote that, we knew they had not yet installed or tested the sensor package. Having had initial success in the particular environment we were worried about, we were worried that aircraft vibration or the Servo motors related to the stabilization system would not be adequate to the job. The first result would indicate that our worries were not very well founded.

This should be a good sensor package, but this was very early and his caution here reflects the fact we have not tested it enough to give you assurance it is a good sensor. And I assure you we will not buy any more than the first test item until we are sure it is a good sensor package.

Mr. ANDREWS. Could we have for the record the cost of developing the original sensor package and the cost of developing the new sensor package?

General BETTS. Yes.

(The information follows:)

The first proposed YO-3A sensor was never fully developed. Final contract negotiations have not been accomplished because of a lack of funds. However, we estimate that ——— were spent for preliminary engineering designs and testing of the first sensor. The nonrecurring development costs for the present YO-3A sensor is ——— million.

DEVIATIONS FROM SENSOR PACKAGE SPECIFICATIONS

Mr. ANDREWS. Do you have any idea how far the sensor package contractor deviated from the original specifications?

The Army testified earlier that some deviations from the original sensor specification have been proposed to the Army as mentioned in testimony of Brigadier General Mellon on May 5. These deviations have been reviewed. Some are acceptable, but others must be negotiated with Lockheed.

General BETTS. I will have to get that detail.

The optimism from our first test would indicate that we feel it is coming out more successfully than we thought, but I will just have to dig out the information.

(The information is as follows:)

Some sensor deviations were proposed to the Army. These deviations related to optical characteristics and sensor acceptance test procedures. In general, the deviations are regarded to be minor in nature and will not materially influence the performance or estimated costs of the sensor. Initial flight tests of the sensor is capable of performing the specified Army night surveillance missions.

Mr. ANDREWS. Does the sensor package, the current one, have a laser target designator in it?

(Off the record:)

CONTRACTOR'S INVESTMENT

Mr. ANDREWS. I believe you indicated the Army ran out of money March 31.

General BETTS. That is March 20.

Mr. ANDREWS. How much has Lockheed and the subcontractors spent in their own funds since that time?

General BETTS. I would have to get the subcontract funds for you.

It is my understanding that at their present level of activity Lockheed would have put roughly ——— million of their money in by the end of August. They may be cutting back from that because of the prior turndown that we had received.

Mr. ANDREWS. How many complete aircraft do you have at the present time?

General BETTS. My understanding is there are ——— aircraft already built.

AIR FORCE DEVELOPMENT EFFORT

Mr. ADDABBO. On the surveillance plane, does not the Air Force have the same program?

General BETTS. The Air Force wants a quiet aircraft but they are not happy with the growth potential and the present system capability of the one we are developing. So they propose to go out with a competitive proposal seeking such a quiet aircraft, and have done enough experimental work that they have a pretty good idea they can get something that will meet their requirement.

But remember, one of the key differences between what they think they need and ours is that their mission is not the same as ours with respect to finding individual people on the ground.

They would not propose to fly at treetop level as we would. They would be up at ——— feet. Consequently, quieting that aircraft is a very different problem, and I suspect if it turns out to be less expensive to accept an aircraft less quiet, then they will come out with a cheaper aircraft, but they will not come out with this until something like a year from now at best.

Mr. ADDABBO. Is the basic plane much cheaper?

General BETTS. Under those conditions it may be, I do not know the estimated costs they have submitted.

Mr. ADDABBO. Was there not a report recently that the Air Force plane would cost in the neighborhood of about $30,000 and your one estimate cost at about ———.

General BETTS. I do not think they would claim anything like that. It is my understanding they talked about ——— aircraft. I could not go into their program, I just do not know their program.

Mr. ADDABBO. Isn't there any coordination between these programs?

General BETTS. Absolutely. But it is present to Dr. Foster's staff and the coordination is in that staff. As Dr. Foster brought out in his letter to Mr. Mahon, he feels these programs are complementary and the prudent course is to go ahead with what the Army has proposed in a competitive environment to satisfy the Air Force mission to go out on competition.

COORDINATION OF ARMY AND AIR FORCE DEVELOPMENT EFFORT

Mr. ADDABBO. When you say all this information is given to Dr. Foster for his deciphering, aren't you fellows looking at it yourselves?

General BETTS. Of course we are; of course we are. But the specifications that the Air Force would put on this aircraft would not sat-

isfy our requirement. They are not as interested as we are in the quietness of this aircraft. They are more interested in performance at higher altitudes.

Mr. ADDABBO. The sensors you are developing, are they strictly for low level or can they be used for high-level work?

General BETTS. (Off the record.)

Mr. ADDABBO. Thank you.

Mr. POOR. I think one of the most important points to remember in this is that the YO-3 aircraft are well along in construction and they will be available for delivery ——— quite soon, really. It seems difficult to imagine that the process of going through a competition, starting all over again could conceivably meet the ——— needs which would be filled by the YO-3 should the committee and the other committees concerned view with favor our 1969 reprograming.

Mr. ADDABBO. When you say "quite soon" what would that mean in time?

Mr. POOR. ———.

Mr. ADDABBO. 1970?

Mr. POOR. ———. You see, they are very well along. The aircraft are flying, and a number are completed.

Mr. ADDABBO. Thank you.

Mr. ANDREWS. With respect to the Army requirements, particularly with regard to the noise level, the committee has been told by Army officials that the requirement for the noise level in this aircraft was ——— to ——— decibels at ——— feet. That was the original MACV specification, ——— decibels plus or minus two decibels. The Air Force officials advised the committee that they had been testing a WREN aircraft and had obtained noise levels of approximately ——— decibels, as I recall, and that, with quieting features they proposed for the engine and a wooden propeller, had excellent confidence in reducing that ——— decibels. That would bring the Air Force aircraft well within the MACV specifications laid down by the Army. In addition, it would give——

Mr POOR. At what altitude?

Mr. ANDREWS. All these measurements supposedly were at the ——— foot decibel level.

Mr. POOR. I talked to Secretary Hansen a little and I talked to Dr. Foster. The point I think I would like to make about this is that it is true that the Air Force has a goal which they may be able to achieve by modification of conventional aircraft. The YO-3 has accomplished a goal of measured noise levels below the Army requirement level. It is in being and it does it. One can hope that later on the Air Force machine might approach the requirements which are being met by the YO-3. In that case it would be only prudent for us to join the Air Force in their procurement when it came time to obtain a number of these machines. But the research objective is more than being met by the YO-3 as it now flies.

Mr. ANDREWS. To meet your objective, you need another ——— is that correct?

Mr. POOR. That is correct.

General BETTS. That is correct.

Mr. MAHON. Are there any questions, gentlemen? If not, we will resume the hearing at 10 a.m. tomorrow.

WEDNESDAY, JULY 9, 1969.

Mr. ANDREWS. The committee will come to order.

When we adjourned yesterday, we were discussing the new surveillance aircraft program element. I would like to discuss the ——— aircraft for the ———.

The justification book does not mention these aircraft, but the committee has been advised that a total of $4.7 million for fiscal year 1969 SEA emergency funds have been approved for these aircraft. What type of aircraft does the Army have in mind for this mission?

General BETTS. These will be fixed wing aircraft, Mr. Chairman, and the designation is unknown.

Mr. ANDREWS. What is the mission of the aircraft?

General BETTS. This is to detect enemy ——— by this method.

Mr. ANDREWS. How will the detection be made?

General BETTS. ———. The ——— on the aircraft will ——— as they ——— the enemy ——— and they are adequately ——— that we can ——— ———.

Mr. ANDREWS. Are these aircraft in production at this time?

General BETTS. The particular aircraft we are after are not in production.

Mr. ANDREWS. Is the Air Force buying these aircraft at this time?

General BETTS. No, sir; not for this purpose.

Mr. ANDREWS. Tell us a little more about the aircraft, General Betts, size, speed, range.

General BETTS. What we were looking for was a twin-engine turboprop aircraft capable of carrying ——— operators to operate the equipment and about ——— pounds of ——— gear. The total payload on the aircraft would be about ——— pounds. From a research and development point of view, what we want to determine is the feasibility of combining into one aircraft ——— capability. This combined capability does not exist at present. As far as we are concerned, it results in an operational sense in our not being able to ——— that otherwise we could find.

Mr. ANDREWS. You have nothing today comparable with what you hope to get with this?

General BETTS. We have ——— aircraft flying today, but they do not have the combined ——— capability in one aircraft with on-board operators who can complete the process of ———.

Mr. ANDREWS. What type aircraft are used for this mission at the present time?

General BETTS. We have been using the U–8 aircraft and the RU–21 in inventory, but they do not have anything like the payload capability that we would be able to get from the proposed program.

Mr. MINSHALL. What make aircraft is this? Is this something you have developed yourself, R. & D., or is this an off-the-shelf item that you have modified?

General BETTS. The RU–21, as I understand it, is a modified Beechcraft aircraft.

Mr. MINSHALL. What type of Beechcraft is this, what is the civilian counterpart?

General BETTS. May I go back one step?

Mr. MINSHALL. Yes.

General BETTS. That is the intended model if there is not a competitor that is better. We intend to complete the procurement but our general specification of aircraft is drawn so that it can be met by aircraft readily available in the market and not one that has to be developed from scratch.

Mr. MINSHALL. You mentioned what type of Beechcraft plane?

General BETTS. I understand the RU–21 is like the King Air Beechcraft aircraft. The King Air is the company name for it.

Mr. MINSHALL. They are a pretty expensive bird for this type of mission.

Mr. POOR. I do not think they are.

Mr. MINSHALL. Maybe you and I have a different idea of what "expensive" is.

Mr. POOR. I think it is a matter of what the aircraft has to do.

Mr. MINSHALL. What are you planning on paying for these? Give us a dollar figure.

General BETTS. We expect them to cost about ——— each.

Mr. MINSHALL. That "ain't" peanuts.

General BETTS. No, sir, I recognize that.

Mr. MINSHALL. ——— do you think that is an inexpensive airplane?

Mr. POOR. This aircraft has a fairly difficult job to do. It will carry a large number of ——— the gear ——— from the ground, something like ——— operators. It is not a small machine.

Mr. MINSHALL. You mentioned ——— pounds a minute ago.

General BETTS. That is the payload. Besides the crew of the aircraft we want to carry ——— operators and a considerable amount of ——— gear on the airplane.

Mr. MINSHALL. Describe how you would use the aircraft, give us a type mission.

General BETTS. Typically, it would fly in the general vicinity of the area that we want to ——— in that general vicinity looking ——— to the tactical units interested in that area.

Mr. MINSHALL. What kind of warfare would this be usable in? Would you use it in Vietnam?

General BETTS. This is directly applicable to Vietnam.

Mr. MINSHALL. What altitude would it fly in the search mission?

Colonel NIXON. The ——— mission, sir, really came into its own in Vietnam———.

As General Betts said, the aircraft that we are now using in Vietnam have only the capability of ——— or ——— but not both and the enemy uses ———. So what we are trying to do here with these three aircraft is put on board these three aircraft both capabilities in an attempt to work out the ——— problems we will have in doing so, and that is what we intend to use the ——— aircraft for. They are an off-the-shelf competitive procurement.

Mr. MINSHALL. How much for ——— gear. Is this ——— the basic price of the aircraft or does this include the ——— gear?

Colonel NIXON. I am not sure about that.

Mr. MINSHALL. Let's find out. Who knows the answer?

Colonel NIXON. I think we will have to go back to our technical expert and ask that specific question and put it in the record, if we may.

Mr. MINSHALL. Do you know, General? Is this just the basic bird without the ——— gear on it?

General BETTS. I have these in program numbers and I do not have them for specific aircraft.

In the 1969 commitment of a total of $4.7 million, $1.47 million was committed to the aircraft, $1.23 million would have been avionics, and $2 million for the R. & D. engineering effort involved to create this capability.

Mr. MINSHALL. What does this make each bird cost then? Divide those figures by ———.

General BETTS. And there is another ——— million requested in fiscal year 1970 for the R. & D. program, making a total of ——— million for the entire program.

Mr. MINSHALL. In other words, ——— aircraft, ——— million?

General BETTS. To achieve this capability from an R. & D. point of view, it is going to cost ——— million. If we intend after the combat evaluation to buy operational numbers of these aircraft, it would cost in the order of the price we quoted for the aircraft, but I do not know what the cost is of the ——— gear that has to go in the aircraft. I do not have that information with me.

Mr. MINSHALL. What bird are you using for this job out there now?

General BETTS. We have a mixture of aircraft. I named the U–8.

Mr. MINSHALL. What is that?

General BETTS. The U–8 is a twin-engine Beechcraft.

Mr. MINSHALL. What type of Beechcraft?

Mr. POOR. Utility twin-engine aircraft we have a great many of.

Mr. MINSHALL. What is the civilian name of it?

Colonel NIXON. The model that was below the Queen Air, sir. It is called the Twin Bonanza.

Mr. MINSHALL. What is the payload capability of the bird you are presently using?

Colonel NIXON. It runs about 1,500 pounds. The exact figure I do not know offhand.

Mr. POOR. I would like to emphasize to the committee the tremendous payoff we have gotten from these aircraft that we have in Vietnam today.

I talked to the ——— people and have read the current ——— reports. This airborne ——— has proved to be the most effective way of ———.

Mr. MINSHALL. Is this the only airborne ——— equipment our military has in Vietnam?

Colonel NIXON. No, it is not.

Mr. MINSHALL. What other?

Colonel NIXON. I would have to provide the inventory of airborne ——— equipment for the record, but I am told ———

Mr. MINSHALL. You are not the only one doing this job?

Colonel NIXON. No. But the capability provided by the ——— in this area has proved to be outstandingly useful.

Mr. MINSHALL. I would like to have detailed in the record the entire military effort in this direction, Army, Air Force, Navy, whoever else is in on the act, whatever else of our ——— agencies are in the act. I would like to have the whole thing put in the record and find how much overlap there is.

Colonel NIXON. We will be glad to provide it.
(The information provided the committee is classified.)

FUNDING HISTORY FOR NEW SURVEILLANCE AIRCRAFT

Mr. LIPSCOMB. General Betts, you mentioned you have $4.7 million that you have reprogramed for the fiscal year 1969 program.

General BETTS. That was the total of the fiscal 1969 program. That was all from the emergency fund, Mr. Lipscomb.

Mr. LIPSCOMB. But it was a reprograming?

General BETTS. Reprogramed to the Army from the emergency fund, that is correct.

Mr. LIPSCOMB. Then you mentioned ——— million was your fiscal year 1970 program. We have a fact sheet that was submitted to our committee on the 24th of June which indicates an additional ——— for fiscal 1970 in this program. Could you tell us what the difference is? If not, maybe we could start at a different level here. Could you tell me where the money for the fiscal year 1970 R.D.T. & E. program for this ——— aircraft appears in the justification book? Where are your fiscal experts?

General BETTS. Within the new surveillance element it is 6.32.05, in fiscal 1969 we carried the efforts that I described in the $4.7 million. It is on page 253 of the green book and 254 of the green book. That is the $4.7 million I identified.

Mr. LIPSCOMB. You just referred me to pages 253 and 254 of the justification book.

General BETTS. Yes, sir, it is under the ——— activities.

Mr. LIPSCOMB. Advanced development ———, is that right?

General BETTS. That is right.

Mr. LIPSCOMB. And you are telling me this ——— R. & D. aircraft program is in that account. Do you not have any budget experts with you, General?

General BETTS. We do.

Colonel JOY. If I may, the $4.7 million that we are talking about on the reprograming action does not show up in your budget justification book because it occurred after the budget material was put together. That is reprogramed into the element known as new surveillance aircraft in the one we are looking at. You only show I believe ——— in there now.

Mr. LIPSCOMB. We show for fiscal year 1969 program $7 million.

Colonel JOY. That is right.

Mr. LIPSCOMB. So we would have to add another $4.7 million as a result of the reprograming.

Colonel JOY. That is correct.

Mr. LIPSCOMB. Which makes an $11.7 million program for fiscal year 1969?

Colonel JOY. Yes. And in addition to that, there is also the other reprograming action in that element which is YOA–8.156.

If that were added to it, it would increase it that much more. The ——— million dollars General Betts is talking about is the avionics in 1970 which shows up on page 253 or 54.

Mr. LIPSCOMB. Are you telling us that the avionics for fiscal year 1969 are included in the surveillance aircraft budget part and then for

1969 you are including the avionics in a completely different account? If so, what kind of budgeting is this?

Mr. POOR. There are two different kinds of ——— equipment on the aircraft, avionics required to fly the aircraft and navigate it, and there is the ——— equipment which is the mission equipment, ——— and equipment of that sort so that the onboard people can perform their mission.

I believe that the development of the onboard ——— equipment is carried under the program element 3.10.11A on page 253 and the aircraft equipment is carried under the new surveillance aircraft.

Mr. LIPSCOMB. Whatever the figure is ——— million or ——— million, if the program was not decided as of the make-up time for the budget which is before us, how did that ——— and/or ——— million get in the justifications for fiscal year 1970? Or are you just grabbing at straws?

General BETTS. I believe that the confusion stems from the fact that the total capability represented here is in two different places in the budget. The ——— million in the other fact sheet was the line item ——— 3.10.11.

I do not have sufficient detail with me to pick out the specific pieces.

Mr. LIPSCOMB. Would we be jumping ahead too far if we asked at this point what was programed for fiscal year 1970 in program element No. 3.10.11.A entitled advanced development ——— for fiscal year 1970?

General BETTS. According to our budget submission, that is ——— million.

Mr. LIPSCOMB. What is included in the ———?

General BETTS. That is my difficulty, Mr. Lipscomb, I do not have that breakout. I would have to get that breakout. But the ——— million we were talking about would be within the ———. I do not have the rest of it.

Mr. LIPSCOMB. Inasmuch as it is confused, Mr. Chairman, for the record could we have entered the total program for the new surveillance aircraft for the ——— and itemize the whole program as to the airframe, the aircraft and equipment that goes into it?

General BETTS. I will.

Mr. LIPSCOMB. And where it is located in the budget?

General BETTS. Identify the line items.

Mr. MINSHALL. A minute ago you gave me a figure of ——— million for the program including the R. & D. and the basic aircraft and the avionics. Does that figure still hold?

General BETTS. We will have to straighten that out and come back to you.

Mr. ANDREWS. Now you are talking about 11 million dollar plus program?

General BETTS. There is some confusion and I cannot resolve this with the data available to me here.

Mr. ANDREWS. In line with Mr. Lipscomb's questions, I wish you would place in the record at this time the total cost, including everything of these ——— aircraft for the ———.

General BETTS. We will do so.

(The information follows:)

The following is a breakout of the ——— aircraft program funding requirements:*

Program element 6.32.05.A (project D649) fiscal year 1969:

	Millions
——— R. & D	$1.20
Avionics purchase	1.23
Airframe purchase	2.27
Total	4.70

Program element 3.10.11.A (project D910) fiscal year 1970:

———R. & D

Total fiscal year 1969 and fiscal year 1970 program

*Specific items of equipment cannot be identified until contract competition and negotiations are complete.

AIRCRAFT IN DOD INVENTORY

Mr. MINSHALL. Mr. Chairman.

You say you need this aircraft and I understand the mission and you need a payload of ——— pounds. What other special characteristics do you need in this aircraft aside from the capability of carrying ——— pounds of ——— gear?

Mr. Poor, can you answer that question?

Mr. POOR. I am not aware of any very special characteristics. The aircraft has to be capable of staying on station for a reasonably long time and give adequate room for the operators to work the equipment.

Mr. MINSHALL. We have a lot of Constellations and DC–6's standing by that could be utilized for this purpose, it seems to me. Why could you not use some of those for much less cost aside from the fact that the Army is not permitted to operate anything over a certain weight?

General BETTS. I am sure there is some aspect of that in our decision to go for a lesser aircraft but for the long pull—you see this is R. & D.-oriented and if indeed it is sufficiently successful that we can justify an operational capability that goes into numbers of aircraft far beyond anything we are talking about here, then the question of whether we had available other aircraft——

Mr. MINSHALL. Why could you not test this ——— gear in one of the pieces of equipment I just mentioned?

General BETTS. I think the problem is ——— configuration, compatibility with the aircraft ——— system. Just putting it in some other aircraft does not test it as a system.

Mr. MINSHALL. But you could build your system around a more reasonably priced aircraft. That is my point.

Mr. POOR. I cannot imagine that procuring new aircraft or even trying to keep old Constellations running would be cheaper than buying a twin-engine Beech aircraft off the shelf.

Mr. MINSHALL. They have been using Constellations over in Vietnam for the TV broadcasts very successfully. There are a lot of them still running.

General BETTS. They have other missions, Mr. Minshall. We did discuss the whole subject of availability of aircraft, the long term cost of operation and everything that was involved and concluded that this was the most pruduent course to follow.

Mr. MINSHALL. You come up with an extremely expensive program when it seems to me, looking at it from this side of the table, you could have gone with a much less expensive program and still got the same results.

Mr. POOR. In order to discuss this adequately, I think it would be necessary to really understand the integration of the ——— equipment, the ——— into an airplane. I would suggest, if it seems appropriate, that at the time we get to this item in the program, element 3.10.11.A, that I bring with me an expert able to discuss the details of the installation in the aircraft. It is an integrated thing and the problem of ———, ends up affecting the whole system design.

I am reasonably convinced that the plan here using an essentially off-the-shelf commercial small aircraft will be less expensive in the long run. It looks expensive in the first set of ——— experimental aircraft, but if it pleases you I would like to bring an expert when we come to this part who can describe the plans for the machine.

Mr. MINSHALL. If you want this money kept in the budget, you better send a very good expert up here.

Mr. POOR. I will be happy to try. I think it is a very important program.

ESTIMATED TOTAL PROGRAM AND COST

Mr. MINSHALL. The committee has been advised that the Army Aviation Systems Command is conducting a survey of twin turboprop aircraft capable of performing light reconnaissance duties. The survey is restricted to aircraft with cruise speeds of 220 knots, loiter of 130, and gross weight of 15,000 pounds. This aircraft would be used in a classified research and development project and its buy would be very limited.

Is this survey being made in connection with the ——— mission aircraft?

General BETTS. I believe that identifies the ——— mission aircraft.

Mr. Poor says that is correct.

Mr. MINSHALL. How many aircraft will be required to fulfill the ——— mission, and what is the estimated total procurement cost?

General BETTS. I do not know what their total operational planning will require, Mr. Chairman. I will have to supply it for the record. Ours is simply an R. & D. evaluation. We are limiting this program to the ——— evaluation aircraft.

(The information follows:)

The Army tentatively is planning on procuring ——— twin engine, fixed-wing aircraft for future ——— use. It is estimated that PEMA procurement costs for this number of aircraft will be approximately ——— million spread over a 5-year period.

Mr. ANDREWS. General Betts, I do not think we received a complete answer. If you could put in the record, please, the five different types of fixed wing aircraft being utilized by ——— for this mission and compare their characteristics with what you will obtain in this aircraft.

Mr. POOR. Do you have five? My paper shows U–6's, U–1's, U–8's, and U–21's.

Mr. ANDREWS. The fact sheet of June 24, 1969 indicates that ——— are equipped with an assortment of five different fixed wing aircraft with an average age of over 10 years.

Mr. Poor. That probably includes the Mohawk, which is not on this list. We will provide that for the record.

(The information follows:)

TABLE COMPARING EXISTING —— AIRCRAFT WITH PROPOSED AIRCRAFT[1]

	Payload (pounds)	Endurance	Cabin volume (cubic feet)	2 engines	Design gross weight (pounds)
1. RU1A	1,800	6 hrs. 50 mins	293	No	8,000
2. RU6A	1,080	3 hrs. 6 mins	125	No	5,100
3. RU8D	682	5 hrs. 30 mins	115	Yes	7,300
4. RU21A	1,400	5 hrs	158	Yes	9,650
5. Proposed new aircraft	——	9 hrs	[2] 325 [3] 675	Yes	15,000

[1] The Navy P2V aircraft is on loan to the Army for —— purposes. It is not compared here because its age and the lack of spare parts preclude its continued economical use. In addition, its weight (80,000 lbs.) and size preclude its use from small, forward-area airstrips.
[2] Minimum.
[3] Maximum.

PROPOSED FISCAL YEAR 1970 PROGRAM

Mr. Andrews. How much is in the fiscal year 1970 budget for this purpose?

General Betts. In view of the confusion we discussed before, I think we had better correct that.

Mr. Andrews. For fiscal year 1970 you are requesting ——— for the new surveillance aircraft program. According to the justification book, all of this was to have been used for the YO–3A aircraft. Is that correct?

General Betts. No. In the fiscal year 1970 program there is no YO–3A funding requirement.

You will recall that in asking for a reprograming of fiscal 1969 funds that would complete the effort that we had described to get 11 aircraft for evaluation.

Mr. Andrews. What is the ——— to be used for?

General Betts. For the concept and system analysis studies related to the manned aerial vehicle force surveillance we call MAVS.

Mr. Andrews. Then the justification book is in error, General Betts. Page 92.

General Betts. Yes, I understand the justification book has a mistake.

Mr. Andrews. Page 92 indicates the fiscal year 1970 program would be to continue Conus product improvement testing on the YO–3A aircraft, and various Sensor installations.

General Betts. That is in error. That was prepared long before we got into the point of asking for these programs and it is no longer valid.

SURVEILLANCE AND TARGET ACQUISITION AIRCRAFT SYSTEMS

Mr. Andrews. The justification book indicates the Research Analysis Corp. completed a study in fiscal year 1968 on a concept for an analysis of a surveillance and target acquisition aircraft system. How much did this study cost and what use was made of it?

General Betts. I do not have information on the cost. The study was to define the concept of employment of a surveillance and target acquisition aircraft system.

Mr. ANDREWS. Put the cost in the record.

General BETTS. I will determine its cost.

Mr. ANDREWS. Also what use was made of it.

General BETTS. It has contributed to the concept formulation process with respect to this aircraft we call now the manned aerial vehicle for surveillance.

TARS 1965 STUDY

Mr. ANDREWS. Also in fiscal year 1968, the Combat Development Command in June 1967 submitted a study on ——— but the Chief of Staff deferred approval of the study recommendation dealing with the manned aerial vehicle surveillance pending a determination of what it takes to support ——— airspace.

Who conducted the TARS 1965 study and what did it cost?

General BETTS. I do not think I have any numbers to identify the cost. It was handled partly with in-house capability and partly by contract support of that in-house capability. It was under one of the field agencies of the Combat Development Command.

I would have to find the cost and supply that for the record.

(The information follows:)

The Surveillance and Target Acquisition Aircraft Systems (STAAS) studies were conducted by Research Analysis Corporation in the 1964–66 time frame. These studies cost $1,183,311.89 and conducted a trade-off analysis of various aircraft concepts applicable to the Army's required new Surveillance aircraft. Based upon these studies, the Army decided that it should not enter the OV–10 Air Force and Marine aircraft program.

The ——— study was conducted during the 1966–69 period at a cost of $2,284,163. It examined current and proposed mixes of organic (Army) and non-organic (USAF) manned and unmanned aerial ——— systems to determine what improvements and development efforts are required in the field. This study defined the need for a MAVS vehicle.

The ——— study, now called a survivability analysis originated in fiscal year 1969 to study "cost of supporting ———." This study effort will be completed in the first quarter fiscal year 1970 and cost $102,550.

COMBINED ARMS RESEARCH ORGANIZATION STUDY

Mr. ANDREWS. Subsequently a ——— study was to have been completed in June 1969. Who conducted that study and what was the cost?

Colonel NIXON. The ——— Combat Development Command is conducting that study now. It cost $102,550. It is not finished yet.

Mr. ANDREWS. Was it done in-house or by contract?

Colonel NIXON. It is being done through the auspices of an in-house effort, but we have a combined arms research organization which is actually civilian contractors who work for CDC on a number of contracts and they are assisting in this study.

Mr. ANDREWS. What company is that?

Colonel NIXON. The Combined Arms Research Organization.

Mr. ANDREWS. Who are located here in Washington?

Colonel NIXON. No, sir; in the Fort Leavenworth area, Kansas City.

Mr. ANDREWS. What was the conclusion of the ——— study and what use has been made of it? You say it has not been completed?

Colonel NIXON. Yes, sir.

Mr. ANDREWS. When do you expect it to be completed?

Colonel NIXON. It should be completed this summer, sir.

CONTRIBUTION OF THESE STUDIES TO THIS PROGRAM

Mr. ANDREWS. What contribution does any of these studies make toward the YO–3A program or any other aircraft development under this subelement "new surveillance aircraft"?

General BETTS. These studies were not pointed at the YO–3 quiet aircraft requirement. They were pointed at the concept formulation process for the aircraft we now call manned aerial vehicle for surveillance. We are attempting to define what kind of a development program we ought to pursue in order to develop an aircraft that would be a follow-on to the OV–1 Mohawk.

Mr. ANDREWS. What about the ——— aircraft?

General BETTS. That is a very special purpose aircraft for ——— and does not do the general surveillance mission.

Mr. ANDREWS. Mr. Lipscomb?

Mr. LIPSCOMB. You mean you are making studies for an aircraft that goes beyond the YO–3?

General BETTS. I would say it goes beyond the OV–1 Mohawk now in inventory and is used as the general surveillance aircraft.

The YO–3A is a very special purpose aircraft in the Vietnam environment where so much activity takes place at night that it is very profitable to have a surveillance aircraft that can fly right down on the deck, be quiet enough to ——— nighttime activities. Something like the OV–1 Mohawk is much more a general purpose surveillance aircraft. The main capability is reflected in its radar, but it also has other sensors on board to expand on that capability, including photographic equipment.

This is something that we have product-improved to the extent that the Mohawk airframe would permit it. But what is proposed here is to look at the concept of an aircraft that might replace the Mohawk 5 to 10 years from now. It is in the very early study and analysis stage in that sense. The YO–3 would be very special purpose.

VARIOUS SURVEILLANCE AIRCRAFT IN ARMY INVENTORY

Mr. LIPSCOMB. How many surveillance aircraft does the Army now have of different types?

General BETTS. We have the special purpose ——— aircraft we mentioned, and we have the OV–1 general purpose surveillance aircraft. As far as I know, those are the only type aircraft we have.

Actually, the light observation helicopter could be called a surveillance aircraft, yet not in the same sense we can use the OV–1 for broad area surveillance.

NEED TO REEVALUATE ROLES AND MISSIONS OF THE MILITARY

Mr. LIPSCOMB. Is there any study being made of the roles and missions of the U.S. Army?

Are we getting down to a point where we should reevaluate the roles and missions of all of the military services?

General BETTS. I do not think that we are out of line in that regard.

Mr. LIPSCOMB. You ought to sit here and listen to budget requests for Army and Navy, Air Force and Marines and note the duplication.

YO–3A AIRCRAFT PROGRAM

General BETTS. We got together with the Air Force in connection with quiet aircraft.

Mr. LIPSCOMB. You are not together today on the quiet aircraft.

(Off the record.)

General BETTS. May I offer that we do very carefully work out our programs with the other services and take the YO–3 as an example.

This program started with an exploration approach that was sponsored by ARPA since it was clear that there was multiservice interest, and that effort produced the request for the two aircraft that we have described to you.

As it became clear in the use of the aircraft that it would be a very important capability, the Army, Navy, and Air Force got together to discuss their mission requirements, and the way to satisfy those mission requirements.

The Navy felt that their mission requirements could be satisfied by this YO–3 aircraft that we had been discussing in connection with the reprograming action. And the sensors we had proposed to put on it were satisfactory to the Navy.

The Air Force felt their mission requirements were different from those of the Army and sufficiently different that they did not feel it could be satisfied by the YO–3. Therefore they went into the Wren approach to get a capability that they felt could satisfy their mission requirement. And this was related to their feeling that they would be flying at much higher altitudes and be interested in much longer range surveillance capability than was important to the Army. If you look at Dr. Foster's letter talking about our reprograming, he says that he has looked at both programs and feels that they are complementary.

I feel these are coordinated requirements.

RU–21 AIRCRAFT

Mr. LIPSCOMB. The Army is purchasing seven RU–21's surveillance aircraft in their 1970 budget. Why do you not tie on to that?

General BETTS. If we got authority to do this program, I am sure it would.

Colonel NIXON. That is the aircraft we have over there now. That is one of the types of aircraft we have that does not combine both the ——— capability.

Mr. LIPSCOMB. You can install that?

Colonel NIXON. No, sir, you cannot. It weighs too much, it takes up too much room, and the U–21 would not take it.

Mr. MINSHALL. Do you know off the top of your head, Colonel, how much this gear weighs, this ——— gear?

Colonel NIXON. I am sorry, I do not have that.

Mr. MINSHALL. You are going to bring an expert in?

Mr. POOR. Yes, we will.

MANNED AIRCRAFT VEHICLE SURVEILLANCE (MAVS)

Mr. ANDREWS. Will you explain the manned aircraft vehicle surveillance for which you may initiate contract definition after fiscal year 1970?

General BETTS. That is the follow-on of the Mohawk I discussed before.

Mr. ANDREWS. Put something else in the record about it, what it is used for and so forth.

General BETTS. Yes.

(The information follows:)

The current OV-1 (Mohawk) aircraft provides the ground commander with either an infrared/photo or side looking airborne radar/photo surveillance capability on any one mission but not both. It is limited in its employment areas because it is not capable of vertical takeoff and landing. To replace this fixed-wing aircraft, a manned, integrated multisensor, vertical takeoff and landing (VTOL) surveillance aircraft system is required. The development program to provide this replacement system is called the Manned Aerial Vehicle for Surveillance (MAVS).

The MAVS is being designed to provide ——— collection of information ———. The airborne surveillance and target acquisition vehicle of the MAVS concept design considerations will include ——— sensors, together with ——— equipment. This concept will enhance target/background discrimination by ——— an appropriate combination of sensors. It will allow target location and/or designation with a laser target designator or computerized target coordinate location equipment. After-action radiological detection by radiac sensor will also be considered during the development program.

FUTURE QUIET AIRCRAFT PROGRAM

Mr. ANDREWS. Does OSD propose an optimum quiet aircraft development program as a tri-service effort in the future?

General BETTS. I know of no other quiet aircraft program than the two efforts that are described in Dr. Foster's recent letter to you in connection with our reprograming. If there are follow-on efforts they are in other services.

Mr. ANDREWS. The committee has discussed the quiet aircraft program at great length with the various services. D.D.R. & E. advised the committee that the quiet aircraft program is being developed in three phases.

Phase 1 was the QT-2 effort, phase 2 is the effort going on now by the Army and Air Force. It is only an interim aircraft effort in Vietnam to see how they work out. It is not the ultimate or optimum configuration of a quiet aircraft for the military development.

This is according to D.D.R. & E.

General BETTS. We do not now have a program for the follow-on to the YO-3.

Mr. POOR. I think that Dr. Foster's people recognize that neither of the kinds of machines that are now being developed, the YO-3 and the not yet initiated Air Force program to adopt off-the-shelf aircraft to a quiet aircraft role can represent optimum systems. I do not think it is necessarily their opinion, because I do not think we have had time to think about it, that it is ever going to be possible to build one quiet aircraft to meet all the essentially disparate roles the quiet aircraft might fill.

One might, for example, want a very large quiet machine to perform the kinds of roles that Puff the Magic Dragon now performs, a quiet reconnaissance aircraft with substantial on-board armament. One might, at the other end, want an optimum machine to fulfill the very small scale search role the YO-3 is intended to perform.

I cannot imagine these two aircraft would look the same. So I do not believe that we have a program for a follow-on that is well enough defined to discuss at this point.

USE OF RU–21 AIRCRAFT

Mr. ANDREWS. We should clarify in the record whether the R.D.T. & E. side of the Army had planned to get together with the PEMA people in buying RU–21 aircraft. I am speaking of the ——— for the ——— mission and the seven in the PEMA budget for other surveillance work.

Mr. POOR. There is an essential difficulty that Colonel Nixon pointed out, namely the aircraft, as I understand, does not carry the payload required. Therefore, if it will not pick up the weight, it does not make sense to buy it for this experimental role.

Mr. ANDREWS. Are you speaking of the RU–21?

General BETTS. I think the problem is that we looked at the RU–21 and proposed modification of Beechcraft as suggested would meet our mission requirement. So in our testimony, and we will straighten that out in the record, we have been using this term rather loosely.

We did say we are going out in competition for the aircraft that will meet that ———-pound payload and the space requirement. Part of the difficulty is space, not just weight payload. And that competition, in the judgment of the people that buy aircraft, will probably end up with this modified Beech that is larger than the RU–21, but built on very much the same lines.

Mr. MINSHALL. Is speed an essential characteristic you need?

General BETTS. No, sir, I do not think that speed is a critical characteristic.

Mr. MINSHALL. How about range?

General BETTS. Range is important because of time on station, but it is not a dominating requirement.

Mr. MINSHALL. What are you talking about, how many hours of time on station?

In other words, what is your endurance time, out and back?

General BETTS. Our going in requirement is ——— hours, but whether or not we can get that in the competition we will have to see since we do want to get an aircraft that is essentially off the shelf, it may be a modification.

Mr. MINSHALL. How far out from home base do you plan to use this bird?

Mr. POOR. Would it be appropriate, Mr. Minshall, to defer answering these performance questions until we discuss the ——— part of the program?

Mr. MINSHALL. Just so we get the answers sometime from somebody who knows what they are talking about.

Mr. POOR. I think the point is in the group today we do not have the ——— people who do this kind of reconnaissance activity. We do have people who understand aircraft design but I think we can answer your questions far better with them than at present. So I will defer if I may.

AIRCRAFT WEAPONIZATION

Mr. ANDREWS. For advanced development of aircraft weaponization in fiscal 1970, you are requesting $——— million, an increase of about $——— million over fiscal 1969. Why was the original fiscal year 1969 program of $3.8 million decreased to only $2 million?

FISCAL YEAR 1969 FUNDS DECREASED BY REPROGRAMING ACTION

General BETTS. The decrease in this program by a reprograming action was to provide for higher priority effort that was named in our submission of our reprograming paper DOD No. 69–28.

Mr. ANDREWS. For what?

General BETTS. I will see if I have that with me.

Mr. ANDREWS. Put it in the record.

Does it mean that the $3.8 million appropriated last year had a downgraded priority for this project.

General BETTS. It means there was something of higher priority that demanded our attention, and that is what I am looking for at the moment.

The reprograming went to the work on a gun subsystem. I can't identify the specific item to which it went. It was part of an omnibus reprograming to meet several higher priority requirements.

Mr. ANDREWS. Now, does this mean that about half of the ——— million requested in fiscal 1970 will be reprogramed for something else?

General BETTS. Not according to our present plans.

Mr. ANDREWS. But it could be?

General BETTS. It could happen.

FISCAL YEAR 1969 PROGRAM EFFORT

Mr. ANDREWS. How was the $2 million in fiscal year 1969 utilized? Give us some examples.

General BETTS. That effort went for advanced development work in a radar system for the UH–1 series and the AH–1G helicopters, for advanced development work on a laser rangefinder for a multiweapon fire control system, to initiate design of a breadboard system for the neodymium rangefinder; for work on analytical studies to determine delivery efforts and required density for standoff delivery of freefall weapons; to perform a study effort on the development of an electro-optical seeker that might ultimately contribute to a better missile capability, and also to begin design of breadboard hardware for an optical data link for possible application to electro-optical seekers. So there was a whole series of small efforts that went on under this category.

NEODYMIUM LASER RANGEFINDER

Mr. ANDREWS. General Betts, did you mention in fiscal 1969 work on a neodymium laser rangefinder for a multiweapon fire control system?

General BETTS. I did; to begin design of a breadboard approach to that.

Mr. ANDREWS. Page 95 of the justification book indicates that in fiscal year 1970 you propose to initiate design of a neodymium laser-rangefinder for the multiweapon fire control system for the AH–56A. Was it initiated in 1969?

General BETTS. It is my understanding that we actually began the breadboard design of that in 1969, but a breadboard is not a final installation by any means. I suspect that is the difference. I will check that out and confirm that in the record.

Mr. ANDREWS. If you could, put in the record how much you propose to spend on this effort in fiscal 1970 and how much has been spent in previous years.

(The information follows:)

Multiweapons fire control and the AH–56A are separate development efforts. Both efforts were designed to use a ruby laser rangefinder. Since development was initiated on both of these systems, laser technology has improved so rapidly that an advanced laser (neodymium) is now preferred. The planned ruby laser effort provided for range finding only. The neodymium is more efficient (lightweight, better coolant, achieves greater range, illuminates, designates and is a rangefinder). We propose to spend ——— million advanced engineering development) in fiscal year 1970. In prior years we have spent $30,000 in this program on the neodymium effort.

PROPOSED FISCAL YEAR 1970 PROGRAM

Mr. ANDREWS. How will the fiscal year 1970 funds be used?

General BETTS. We will continue the effort to evaluate the improved MTI radar fire control system; we will continue the work on the neodymium laser range finder; we will do studies of the new launching and dispersion concept for a variety of munitions with experimental hardware fabricated in laboratories that would apply to these studies: we would continue work in analytical studies of standoff delivery of the free fall weapon systems I mentioned for 1969. We would look at improved suspension systems for illuminating and marking munitions. That has to do with the basic drag characteristics of the installations. We would also plan to begin development of a dual mode radar. That would be the next capability beyond the MTI radar work that we have already been involved in.

Mr. ANDREWS. You can expand that for the record and give a brief description of all the programs that you plan to undertake.

(The information follows:)

In fiscal year 1970 we propose to accomplish the following:

(*a*) Develop an airborne demonstration model of the Emerson adaptive memory tracker for integration into the multiweapon fire control system.

(*b*) Initiate the replacement of the 3 p.p.s. ruby airborne laser-rangefinder for the UH–1 with a 10 p.p.s. neodymium laser rangefinder.

(*c*) Utilize the stabilized optical sight for evaluation of the retrofitted laser as a source of light for target designation and/or as an airborne rangefinder.

(*d*) Evaluate radar techniques for the target detection and acquisition role. Data processing techniques to be considered include adaptive filters' stationary target filter and digital filters. These techniques will be integrated into the MTI radar.

(*e*) Fabricate and flight-test a working model of a feed system for gun-type weapons to permit in-flight selection of different type ammunitions.

(*f*) Fabricate and test a stabilization system for weapon turrets.

(*g*) Evaluate the small arms caseless ammunition program to define areas for possible application to aircraft weaponization requirements.

(*h*) Conduct investigations and studies to support the development of a target marking system for Army aircraft.

(i) Initiate a study for a compact warhead that has optimized antipersonnel, antimateriel, and antiarmor effectiveness in spite of guidance sensors located in missile nose.

j. The armed helicopter application for point target missile with system design and hardware efforts conducted previously. Determine the possible application of semiactive and optical control guidance aircraft armament.

k. Initiate concept formulation for selected effects armament subsystem (SEAS). The objective of the project is to develop a reliable, easily maintainable, lightweight armament system for installation on Army aircraft for attacking enemy personnel, materiel and armored vehicles. The system will provide significantly improved lethality against personnel and materiel targets and a high kill probability against armored vehicles. The system will replace the 2.75-inch folding fin aerial rocket (FFAR). The system will have a family of warheads (HE, Flechette, Smoke, CS, Incendiary) and fuzes (Super Quick, Delay, Time, Proximity).

l. Continue analytical studies to determine the most promising concepts for standoff, freefall, delivery subsystem. Limited amount of prototype hardware will be fabricated and tested under controlled static conditions.

MOVING TARGET INDICATOR (MTI) RADAR FIRE CONTROL SYSTEM

Mr. ANDREWS. During fiscal year 1970 you propose to conduct an evaluation of the improved moving target indicator radar fire control system. How much will be spent on that effort?

General BETTS. I do not have a dollar breakdown of these individually.

Mr. ANDREWS. Put something in the record on that.

(The information follows:)

For advanced development in fiscal year 1970 we propose to spend ——— on the moving target indicator (MTI) radar.

Mr. ANDREWS. In program element 6.22.01, aircraft weaponization exploratory development, page 74 of the justification indicates that in fiscal year 1970 you will conduct system evaluation and formulate concepts for improved moving target indicator radar fire control system. Is this a duplication of effort?

General BETTS. No. Page 74 of the justification addresses a study effort of an improved MTI and page 95, that part of the justification refers to filters for the MTI radar. Now, what we are saying is that we are in some basically new radar technology and we have bought ——— MTI radars that will attempt to satisfy an urgent Southeast Asia requirement for this multisensor gunship that we call the SMASH, the Southeast Asia multisensor armament system. It would apply to the Hueycobra. The majority of the exploratory effort for these MTI radars was accomplished in civilian industry, a good bit on their own funding. What we have done is to take one of these complete systems and do exploratory work on it to improve it by refining it to operate in our particular environment to meet our requirements.

On page 95 of the justification the advanced development effort is associated with the MTI improved radar but it addresses a specific improvement that they call an adaptive filter. I am not enough of an electronic technician to describe this exactly, but it is my understanding that it will offer a significant increase in target detection by reducing the noise, the clutter in the background.

We would hope by the spring of 1970 to be able to deploy some of these to Southeast Asia for actual combat evaluation.

Mr. ANDREWS. All these systems are constantly being improved and upgraded?

General BETTS. The technology is moving very fast, no question about it.

Mr. ANDREWS. And it is expensive to keep up with them?

General BETTS. Yes, sir.

MISSILE-ROCKET WEAPONS

Mr. ANDREWS. Getting back to the advanced development program, the committee notes that about ——— million of the ——— million requested for this program element will be devoted to missile-rocket weapons, an increase of ——— million over fiscal 1969. Will you explain how these funds will be spent?

General BETTS. We have been in the business of launching missiles and rockets from aircraft to include helicopters for some time, but there is a great deal we have to learn on this general subject. Under this line item we would expect to direct our primary effort on development of air-launched antitank missile systems such as would be represented by the application of the Tow to helicopters. That doesn't mean that we would do nothing but Tow under this category, but we would identify on this line item the kind of effort that applies to the Tow application or other rocket delivery from helicopters. There is also a program we call the selective effects armament subsystem. We would hope from that effort eventually to replace the 2.75-inch folding fin aerial rocket that is now being used and from this gain a significant increase in accuracy and lethality against both personnel and materiel targets.

The 2.75 is a rocket that has been in the system for a long time. In the words of the experts, it is far behind the state of the art. We can certainly do better.

Mr. ANDREWS. What about its accuracy?

General BETTS. I believe we can make significant increase in improvement of the accuracy of an air-launched rocket.

Mr. ANDREWS. Do you plan to study that under this program?

General BETTS. We plan to work on that capability under this advanced development item.

Mr. POOR. I am sure the chairman is aware of the fact that the 2.75-inch rocket originally was designed for launch from relatively fast fixed-wing aircraft. From the slow helicopter launch it is much more difficult to get high delivery accuracy with that rocket because of the lack of forward speed which prevents the fins from doing the effective stabilization that they get when they are launched into a high speed airstream. So the problem of improving the rocket accuracy after launch is a serious one. Our people at Redstone Arsenal have some very good ideas on this matter, growing largely out of what they have done in developing rockets for infantry use. We are hopeful that combined with significant improvements in fusing techniques and warhead fragmentation techniques, this will result in a far more effective weapon than we now have.

Mr. ANDREWS. General Betts.

QUESTION OF DUPLICATION IN RESEARCH BY MILITARY SERVICES

General BETTS. Could I go back one step and address the question Mr. Lipscomb raised before?

The failure is ours in the services to help you to understand the extent to which our work is complementary and not duplicatory. In this weaponization business itself we have a working group among the services looking at the specific requirements, trying to make these requirements mutual where we can, where the environment is such that there is no reason to have different developments for each of the services or any one of the services. That effort is monitored rather closely by Dr. Foster's people. So that when we present these several different programs to you it is not always clear the extent to which we have coordinated these efforts. I would not presume to argue that we have never made the mistake of duplicating things unnecessarily, but there is a massive effort to avoid it. I say sincerely that we do not intend to push into a new development if it has already been done or is being done by other services. We just cannot afford to.

QUIET AIRCRAFT PROGRAM

Mr. ADDABBO. But, General, what can't you see at ——— feet that the Air Force plane can see at 17,000 feet?

General BETTS. It is a matter of resolution and range. With these night vision devices we are talking about range capabilities in the order of a ——— or ——— feet.

Mr. ADDABBO. But I am saying that you have a plane that goes in at ——— feet; is that right?

General BETTS. That is right.

Mr. ADDABBO. You can see what is going on. Why must the Air Force have its own plane operating at 17,000 feet? Can't you see the same thing better at ——— feet that he can see at 17,000 feet?

General BETTS. We wouldn't cover anything like the area that he can from the point of view of the broad area of surveillance. Remember, his mission is hunting trucks, more an interdiction mission. What we are looking for is individual Viet Cong on the ground.

Mr. ADDABBO. Thank you; no further questions.

AVIONICS

Mr. ANDREWS. You are requesting ——— million for avionics advanced development, a slight increase over fiscal year 1969. Congress approved only $4.2 million for this program in fiscal year 1969. How did it reach the ——— million level?

General BETTS. We reprogramed into this item in order to provide an adequate level of funding for the development of potential military potential test models of what we refer to as the helicopter multifunction radar system for Southeast Asia. Also we have some work yet to do and wanted to complete development of—and deploy for test—the models of what we refer to as the Loran-Decca interface device. This is a way of relating the Decca navigation to broad area Loran navigation capability.

Mr. POOR. This latter device allows Army aircraft to operate in the Air Force navigation aid environment, Loran, that is now available in Southeast Asia. It is of great importance to be able to do that. The helicopter radar system developed I think by Bell and Texas Instruments, represents a very promising advance in the ability to find targets from helicopters using radar aids. It paints a map of the terrain under the helicopter. It is quite an exciting development.

HELICOPTER MULTIFUNCTION RADAR SYSTEM

Mr. ANDREWS. Are you experiencing cost increases on the helicopter multifunction radar system and will you describe this radar system a little more in detail than you have? What about the cost increases first?

General BETTS. We had a contract for this system for ——— advanced development models. At least, that contract is presently under negotiation. Negotiations have not been completed.

The negotiations with Bell-Texas Instrument Co. is working together. Now, when we got this estimate in June of 1969 it required a total of $1.784 million to meet what the contractor felt was required to do the job. Since that was some $924,000 over the developing agency's original estimate, we were forced to meet this or cease going ahead with the effort.

Mr. ANDREWS. The cost more than doubled.

General BETTS. It represents a difference between our basic Government cost before we got into negotiations and the price we finally reached in negotiations with the contractor.

Mr. ANDREWS. The cost more than doubled?

General BETTS. Well, it is approximately that, yes.

HELICOPTER MULTI-FUNCTION RADAR SYSTEM

Mr. ANDREWS. The committee learned recently that the Army Electronics Command received a proposal from Bell to design and fabricate an advanced development feasibility model of a rotor blade mounted antenna for a doppler direction-finding system for use on a Huey helicopter. Has the Army awarded a contract for this work and, if so, what is the cost of the contract?

General BETTS. I know that we have been discussing this with them. Major Dilday of my staff can address this question.

Major DILDAY. The contract for this particular effort has not been awarded at this point. There was an effort to award it by the 30th of June, but due to the increased contractor's estimate over the costs, we have deferred award of this contract and it is being investigated at this time to determine in what direction we should move.

The original estimate was the developing agency's estimate and not the contractor's firm price quotation.

Mr. ANDREWS. Tell us something about this rotor blade mounted antenna for a doppler direction-finding system. What difference, if any, is there between this system and the helicopter multifunction radar system?

Major DILDAY. This helicopter multifunction system, sir, incorporates in the rotor blade of a helicopter a radar waveguide which is desirable from the standpoint of putting it inside the rotor blade itself rather than attaching it to the aircraft as an appendage or

hanging from the aircraft. It makes use of the structure of the aircraft in such a way that you take maximum advantage of having it within the internal configuration of the aircraft. Also, you have a wide sweep with the rotor blade radar by incorporating it into the structure of the aircraft. It has a range of ——— miles. It is supposed to have the capability to afford navigation, as a landing aid. There are several functions which it will be able to perform.

Mr. ANDREWS. Now, what about the other system?

General BETTS. The other system is under a different program element (3.10.11.A). It is the ——— project titled ———. This system uses a phase shift technique to determine ———. Its antennas are installed on the tips of the rotor blades of the UH-1 helicopter. This is a ——— system and would be used on only a few selected helicopters.

The HELMS (Helicopter Multifunction System) being discussed is an entirely different system and is directed toward navigation and radar mapping to give the pilot a picture of the ground and objects around him. If successful, HELMS could apply to the entire inventory of Army helicopters of the future.

Dr. LASSER. There is the question of adding doppler to what Major Dilday said. That is, you can add the doppler capability but that is not necessarily a very simple thing to do.

Mr. ANDREWS. What is the difference?

Dr. LASSER. A doppler will tell you whether or not there is a moving target. The conventional rotor blade radar will give you a map picture. It will use a large radar antenna to give you a picture of what is on the ground. The doppler feature tells you whether what is on the ground is moving. That additional feature is hard when the antenna is in a moving configuration.

Mr. ANDREWS. Where does the moving target indicator come into the picture?

Dr. LASSER. That is what I am saying. Doppler is a MTI. Doppler is a form of moving target indicator. The terms are really synonymous. Doppler is something you get from moving targets——

Mr. ANDREWS. What you are working on is that you are trying to get something in the chopper to permit the pilot to see what is on the ground?

Mr. POOR. Two things, Mr. Chairman: The basic radar paints a map of the picture on the ground, shows you where the buildings and roads and water tanks are. The ——— gives the ability to ———. This is not a radar. It is a ——— system.

Mr. ANDREWS. Do you have such a radar at this time?

Mr. POOR. The demonstration prototypes of this system I believe have been flown by the companies. The additional feature which we in some of our fixed radar installation tests, for example, the side-looking radar on the Mohawk represented by this doppler thing, is the ability to bring out from the background those things that are moving at any significant rate over the terrain, so that by throwing a switch you can put on the screen all the trucks that are moving and bring the attention of the aircraft to that moving traffic. It is a very valuable way of discriminating useful targets from the background. That is what Dr. Lasser is talking about.

Mr. MINSHALL. What advantage does this type of radar on a rotor have over a radar that would be in the belly of the helicopter?

Mr. POOR. The big advantage is that to get fine angular resolution on the ground, to pick out a small target you need a very big antenna to focus the beam down to a very fine beam. The helicopter rotor is itself a long thing, so that you can get a much bigger antenna apperture by using the rotor itself as an antenna. Otherwise you would have to put a big dish underneath it, something like the great big radar antennas that flew on top of the Constellation, to get the same performance. So it is an exciting development, the possibility of using a piece of the machine as the scanning device.

Mr. MINSHALL. How large a piece of equipment is this on the rotors?

Mr. POOR. Just a little slot in the leading edge of the rotor and an appropriate slip ring machinery to feed the signals into the antenna which is integral with the rotor blade. Externally, you hardly see it. So aerodynamically, the thing is equivalent to an ordinary rotor blade but it buys you at no aerodynamic cost a large scanning antenna. So it is a thing of considerable potential.

Dr. LASSER. It gives you excellent maps. The picture on the display shows you what is under the aircraft as the rotor sweeps around, and it gives you a map the likes of which you wouldn't see in a helicopter unless you put the thing out on the blades the way this is done.

Mr. POOR. Or alternatively, a 25- or 30-foot-wide dish, which obviously you couldn't fly on a small helicopter.

Mr. ANDREWS. I think we should clear up the record on this point because we previously discussed the Army having four or five moving target indicator pieces of equipment that they are evaluating. If that is so, why is the Army in negotiation with Bell for the development of another doppler system for a helicopter?

Dr. LASSER. My understanding is—and I am not sure of this—that we will not include doppler on the rotor blade radar because of its complexity. Now, MTI is a subject in itself, with respect to a nonmoving blade radar—that is, there are MTI's on helicopters, on the Cobra, but that is not a rotor blade radar. The rotor blade radar gives you this map and has the big antenna. You don't need a big antenna to get MTI. It would be very nice to have MTI on this map.

General BETTS. An area coverage is the difference between the kind of radars that we would be testing in the SMASH program and what one might get from the rotor blade radar that we are discussing under this item. I think they end up giving this rather different capability.

Mr. ANDREWS. The record is not too clear on this. It is our understanding that the Army Electronics Command received a proposal from Bell to design and fabricate an advanced development feasibility model of a rotor blade mounted antenna for a doppler direction-finding system for use on a Huey helicopter. Now, is this an MTI piece of equipment?

Mr. POOR. The doppler DF, that is the difference. That is a way of finding your way home or finding your way to a beacon with doppler direction finding. Neither of the systems (rotor blade radar or direction finding) being discussed employ MTI.

Mr. ANDREWS. When you get the record, will you read this over carefully and straighten it out?

Mr. POOR. Yes. There is an essential difficulty with all of these broad area advanced development programs because they include

some related elements and it is very easy to confuse one with another, just the way we aggregate our program. I am afraid it does make it very difficult to explain.

IMPROVED ANTENNAS FOR HELICOPTERS

Mr. ANDREWS. How much has the Army spent on development of improved antennas for helicopters, and what is the result of this research effort?

General BETTS. In 1968 we spent $1.4 million, in 1969 $1 million even. You asked for the results. Our goal, primary goal, was to overcome this severe helicopter vibration that does affect the performance of the antenna on a helicopter. Some of this effort has gone into the rotor blade radar we talked about. Feasibility has been demonstrated for a frequency modulated homing antenna that was installed in the rotor blade. That is part of that same effort. A broad band whip antenna has been developed to replace the electromechanical coupler. I have to confess my technical ignorance. I cannot describe precisely what that means in terms of its significance.

Mr. ANDREWS. Put something in the record about it.

(The information follows:)

Present whip antennas are referred to as "narrow band" which means each time a new channel is selected at the radio we must employ an electromechanical tuner at the base of the antenna in order to tune the antenna to the proper wavelength of the frequency selected for transmitting and receiving with the radio.

This electromechanical tuner creates maintenance problems and requires spare parts to accomplish repairs. It also adds weight and complexity.

A broadband antenna offers potential for selection of a broad range of frequencies at the radio without retuning the antenna each time a new frequency channel is selected, thus eliminating the need for a troublesome electromechanical tuner at the antenna.

General BETTS. We have also demonstrated some other things under this item.

SEMIAUTOMATIC FLIGHT OPERATION CENTER (SAFOC)

Mr. ANDREWS. What is the Semiautomatic Flight Operation Center and how much has been spent on the development of this center?

General BETTS. We obligated $5.1 million to date for this effort. It is for the development and fabrication of an advanced development model to determine the extent to which enroute air traffic control can be automated. It is being developed to overcome the line-of-sight problems associated with our present manual air traffic control in order to reduce the workload of air traffic controllers, and provide positive control during poor weather and at night.

Mr. ANDREWS. Where is the work being done?

General BETTS. Hughes Aircraft Co. is the contractor that is doing this for us.

Mr. ADDABBO. Will you yield?

Mr. ANDREWS. Mr Addabbo.

PROBLEM ON NONVISUAL CONTROL OF LOW-FLYING HELICOPTERS

Mr. ADDABBO. Actually, you can save all this money. All you have to do is come up to Kennedy Airport. We have a beautiful working system up there.

General BETTS. It is much too complex and expensive for an Army tactical environment application. This is a very much simplified system.

Mr. ADDABBO. We have that, too. We have Floyd Bennett intermingled with Kennedy Airport. We have everything up there in the air at the same time without problem——

General BETTS. But we don't have those in the tactical environment in Vietnam where we have to control our helicopters. Those are expensive items.

Mr. ADDABBO. We have the helicopters involved, too. The Port Authority is running theirs in among all of this air traffic.

General BETTS. The technology is well known and understood. What we are trying to get is a simple, as simple as possible and portable system for a tactical field operation, where we can furnish air traffic control in a combat environment.

Mr. ADDABBO. But why do you need this money? You can go out to Calverton, where we have Grumann Aircraft. They have an airport there where they have the same problem, air traffic intermingled with Republic Aircraft.

Mr. POOR. Sir, I think the air traffic control environment around New York City depends on the existence of some very big radars which are not the kind of thing you can pick up and put in a little trailer and put out in the boondocks of Vietnam.

Mr. ADDABBO. I am sorry, but we have some of those small radar trailers monitoring there now.

Mr. POOR. They are contributing to the monitorship. But the system includes the big radars. Without them you would be in terrible trouble in New York.

Mr. ADDABBO. We are.

Mr. POOR. Even with them it is bad enough, but without them it would be very difficult. The point here is that in the kind of flying operations going on in places like Vietnam where you have dense helicopter traffic coming into little landing zones you cannot take the time to build the very big fixed installations. You have to have something that you can carry with you, put down on the field and put to work right away, with a few people to operate it.

Mr. ADDABBO. Does the Air Force have this problem?

General BETTS. The Air Force has a field tactical capability, but again it is much more expensive and complex than what we are seeking with this development.

CIVILIAN PORTABLE AIR TRAFFIC CONTROL TOWERS

Mr. MINSHALL. How about some of the civilian portable tower arrangements? One of them happens to be made out in Ohio. It is called the Portacon. Are you familiar with that?

General BETTS. Not that particular item, Mr. Minshall. I am familiar with some of the civilian developments that we have seen.

Mr. MINSHALL. The Navy seemed to think they are pretty good, because I understand that they are trying several of them out.

General BETTS. It is a matter of the degree of control.

The kind of control that a portable tower for visual control offers can be performed in many cases with a radio mounted on a jeep or even a backpack radio. The problem we propose to solve is when the

conditions of weather or night are such that neither the pilot nor controller knows their relative positions to all other air traffic. When weather conditions are such that they can see each other there is no problem.

Mr. MINSHALL. If you are not familiar with it, it is a trailer-type arrangement with air conditioning. It has its own integral power system. You could put any kind of radar in it, it seems to me, a small one or a big one would be no sweat at all. This is a thing that is going, it is in business and reasonably cheap. As a matter of fact, some of these civilian airports, rather than build a tower, have taken these and put the entire unit on top of a building permanently. But it can be on wheels.

Dr. LASSER. All those systems that you are discussing are line-of-sight systems. The SAFOC system involves non-line-of-sight, low flying helicopters that can fly at the nap of the earth. In order to be picked up by these antennas it is non-line-of-sight.

Mr. MINSHALL. How are you going to employ your equipment?

Dr. LASSER. We must conduct extensive testing to tell us how to best employ this equipment. Testing will commence about October 1, 1969. This is an entirely new capability. We are seeking to determine whether we can automate and through data processing means provide positive control and management of the Army's air traffic to the degree that will allow us to operate under poor weather conditions and at night throughout the combat zone. To do this each aircraft must know where he is in relation to all other traffic. By using low frequency signaling from the aircraft that indicates where the aircraft is but not requiring line-of-sight. The high frequency does not require line-of-sight.

Mr. MINSHALL. Why couldn't you put the receiving equipment in one of these portable towers?

Dr. LASSER. You can put the receiving equipment in one of these towers, but I think the problems that we are discussing are: How do you establish a low frequency air control system? To answer your question about whether or not it can go on the tower, I don't think would affect the size or magnitude of the program. That is, it is a different sort of technique, rather than only one of where do you mount the equipment.

This is not just a matter of receiving equipment. We must be able to receive, process, store, correlate and provide appropriate direction to every aircraft that is operating without the benefit of visual reference. This must be done accurately and with great rapidity in order to avoid collisions in the clouds.

Mr. MINSHALL. What are you talking about with respect to low frequency?

Dr. LASSER. HF, about 5 megacycles; whereas, everything that you talk about in traffic control is at very high frequency, hundreds of megacycles where you have to have line-of-sight. It is practical to do that in an airport, it is not practical to do this with a helicopter system.

Mr. MINSHALL. Has the Navy or Air Force any equipment like this?

Dr. LASSER. No.

Mr. MINSHALL. Are they researching it at all?

Dr. LASSER. I don't believe so. I do not see why they should have this requirement. They are usually flying high-performance aircraft that are not coming in low all the time. It is a capability that is not used in civilian use. The FAA is well aware of this program and are working with us on the SAFOC and see this as a different application or an additional capability.

PROPOSED CAPABILITIES OF SAFOC

Mr. MINSHALL. What will the capabilities of this system be? What is its range, minimum altitude that you can pick up something?

Dr. LASSER. The minimum altitude is down to the nap of the earth because the plane does not have to be in sight of the SAFOC system. So that at any altitude the plane provides its own information. The range of HF depends on the strength of the receiver. It is the order of a number of kilometers, but I am not sure I know what power HF transmitter they are putting out.

General BETTS. Could we have Major Dilday add to that response?

Major DILDAY. I would like to shed just a little more light on the SAFOC. It is a semi-automation of air traffic flight control. Present-day methods of controlling aircraft traffic under instrument and bad weather and nighttime conditions is by manual means. The present manual operations will allow one single operator to control about eight different aircraft at one single time. The SAFOC is an attempt to get a system such that we can automate the air traffic control through programing computers and predicting air traffic conflicts and air traffic possible collisions. The system as we are designing today has a capability for handling up to 120 local flights within the system through the computer programing with three operators at the controls; two operating from the console and one man to receive flight plans and process them through to the two operators on the controls.

Mr. MINSHALL. Where does the low frequency come into the act?

Major DILDAY. The low frequency will provide the data link between the flight operations center or the van on a semitrailer van, will provide the data link and the data transfer between the van itself and the aircraft. This gives you an over-the-horizon capability so that you are not restricted to line of sight. The line of sight is a critical problem to the Army since we operate at the nap of the earth with our helicopters and we would like to be able to further this in order to take advantage of the concealment and the valleys, and this sort of thing, that the terrain offers.

Mr. MINSHALL. How far are you along with this development?

FAA ASSISTING IN SAFOC DEVELOPMENT

Major DILDAY. The delivery of the system is supposed to be September 30 at the NAFEC facilities at Atlantic City. The FAA is working with us on this program on a cost-reimbursable basis to assist us in providing their simulation facilities which they have available and also Hughes Aircraft has the basic contract for the SAFOC, which will be delivered on September 30 at Atlantic City.

Mr. MINSHALL. Reimbursable? How much reimbursable?

Major DILDAY. The FAA, sir, will give us a cost-reimbursable item as the cost occurs.

By letter agreement of February 4, 1969, the Army agreed to reimburse the FAA for services furnished, including necessary personnel, and equipment and facilities wherever extra expense is incurred by the FAA on a cost reimbursable basis.

This agreement was signed jointly by the FAA, Director Systems Research and Development Service and the Commanding General, U.S. Army Materiel Command.

Mr. MINSHALL. How is the FAA cost going to be determined?

Major DILDAY. They have the facilities already available. It will just be a matter of paying for labor and assistance of personnel in testing the program.

Mr. MINSHALL. Are they sharing in the cost of this program?

Major DILDAY. No, sir.

Mr. POOR. They are benefiting from the results of the tests which will be conducted at their facility in Atlantic City. I believe we are paying the costs, the extra costs incurred by FAA by carrying out the tests there.

Mr. Minshall. How much is FAA putting into this program?

Major DILDAY. They are putting nothing into it. They are extremely interested because they feel it will perhaps advance air traffic control into the year 2000.

Mr. MINSHALL. They must be supplying personnel.

Mr. POOR. They are supplying the test facility.

Major DILDAY. The facilities and necessary personnel, and we are reimbursing them.

Mr. MINSHALL. You are reimbursing FAA?

Major DILDAY. Yes.

Mr. MINSHALL. How much do you plan to reimburse them?

Major DILDAY. We are estimating it at $200,000.

TOTAL COST OF SAFOC PROGRAM

Mr. MINSHALL. What is the total cost of the program?

Major DILDAY. The total cost of the program, at the present time we have spent $5.1 million in the program so far.

Mr. MINSHALL. How have your tests been so far?

Major DILDAY. We have not conducted tests thus far, sir.

Mr. MINSHALL. This is just the equipment?

Major DILDAY. Yes.

Major MINSHALL. What have you done with the $5.1 million?

Major DILDAY. The Hughes contract was for $3.4 million to develop and fabricate the equipment. I don't have the name of the company right at my fingertips, I do have it available—We have another contract with American Electronics Laboratory for $457,813. Now, that was for design of the test and experiments to be run with it. The remainder of the $5.1 million has been to buy Government-furnished equipment to operate with the system, such as the HF radios.

REDESIGN OF TSQ–51 RADAR

Mr. MINSHALL. How did Hughes get this contract? Was it on a competitive basis?

Major DILDAY. No, sir. This was a sole-source contract with Hughes.

Mr. MINSHALL. Why was it sole-source?

Major DILDAY. Because Hughes had done—we are developing this system from a TSQ–51 which was in the air defense system. The TSQ–51 was an old air defense piece of equipment. We find that by using this already developed equipment we could reprogram it with the software and refurbish it, reuse it. And Hughes built the TSQ–51.

Mr. MINSHALL. You mean, this is for refurbished equipment; that is what you are using here?

Major DILDAY. The basic equipment——

Mr. MINSHALL. Is refurbished?

Major DILDAY. It is not refurbished, it is being redesigned and reprogramed.

Mr. MINSHALL. What do you mean by that?

Major DILDAY. They are actually rebuilding the equipment from the old basic framework of the TSQ–51. In other words, the consoles of the TSQ–51 were present and the consoles and scopes and sweeps, they had to reprogram the computer, a part of it, and rebuild it from scratch.

Mr. MINSHALL. If this involves only rework of equipment——

General BETTS. This is an experimental effort.

Mr. MINSHALL. I know, but experimental to the tune of $5.1 million, General?

General BETTS. The point is that it does require a basic automatic data control system.

Mr. MINSHALL. I thought it was something all brand new, new electronics, new low frequency, and everything, and now we find out it is just old equipment that you just refurbished.

General BETTS. It is new, but in order to save money on this experimental situation we are using the basic capability of the TSQ–51.

Mr. MINSHALL. Who are you working with in FAA up at NAFEC?

Major DILDAY. I don't have the name of the individual.

(The information follows:)

The letter agreement between the Army and the FAA is with the Director, Systems Research and Development Service, Federal Aviation Administration, Department of Transportation.

Mr. MINSHALL. Who is in charge of the program as far as the Army is concerned?

Major DILDAY. The Army Electronics Command at Fort Monmouth is the program manager.

Mr. MINSHALL. Is that the gentlemen you are going to bring down to explain this other gear, in this other program?

General BETTS. The other program would not be the same individual; no, sir.

Mr. ADDABBO. When did this program start? How long ago?

Major DILDAY. The start date on the program, the contract was signed with Hughes on April 30, 1968.

Mr. ADDABBO. Back in, I believe it was October of 1964, we had in New York "Operation Survival" in which the FAA, the Army and the Air Force took part. At that time we had intermingling the STOL aircraft, helicopters, transporting trucks, ambulances, and everything else, and all systems were out because it was supposed to be a time of disaster, and we were operating with a radar control system at a pier on the East River. Now, we were landing STOL aircraft, helicopters, all intermingled and intermixed. This was in 1964. Now, you tell us in 1969, first, we don't even have the equipment to do this, and we have to take old equipment and spend $5.1 million to obtain this capability for the Army.

General BETTS. All of the equipment that you were using in that kind of an operation depended on radar line-of-sight to determine the location of the aircraft involved. What is involved here is an effort to set up a tactical aircraft control system, not just a question of landing, but a tactical aircraft control system that does not depend on our ability to see the aircraft. These aircraft will be flying at altitudes where we cannot see them from the point of control.

Mr. ANDREWS. You do not have that capability today?

General BETTS. We do not have that capability today. The idea is to use this technique to prove out a semiautomatic system. In order to do it at the least possible expense we turned to an automatic data processing capability that was already in the Army system. That was the TSQ-51. We turned to Hughes because they built that system and had the best capability immediately ready to revise and reprogram it, to do this job in an experimental way. We would propose if we went out on a major procurement of this that those aspects that are procurement oriented would be completed.

Mr. ANDREWS. Tell us something about your accident record in Vietnam because of not having such equipment.

General BETTS. The Army does not maintain the type of statistics to respond to that question, Mr. Chairman. We do have problems with aircraft control at night and in bad weather. We have also problems with respect to limitations on our operations.

Mr. ANDREWS. Put something in the record about it.

General BETTS. We felt we could not operate because we lack the capability, in situations as I have just described but I will have to get statistics for you.

(The information follows:)

There is no existing capability to control and account for the movement of aircraft in the forward areas of the combat zone during poor weather conditions and at night. Experience has shown that the enemy will take advantage of the weather and night to initiate major offensives. The Army's objective is to be able to provide reinforcements, resupply and medical evacuation regardless of the weather or time of day.

To accomplish this when air traffic densities are high (425 helicopters per Airmobile Division) and in remote areas requires continuous positive control of every aircraft. Since they cannot see each other and often can not be seen by radar at remote locations some external means must be devised to receive, store and keep continuous track of all aircraft. This requires continuous update and

instant recall to avoid aircraft collisions. The Semi-Automatic Flight Operations Center (SAFOC) is an attempt to develop and test a device with this capability and also relieve the tremendous workload on air traffic controllers. Even with radar, which is not available in forward areas, and cannot provide a control means beyond the line of sight, one air traffic controller can manage only about eight single aircraft tracks at a time.

It is expected that through data processing means and high speed data links such as those planned for the SAFOC up to 120 different aircraft tracks can be sequentially polled about every 90 seconds to ascertain their position and altitude and determine possible conflicts with other air traffic in the system.

RENEGOTIATION BOARD REVIEW OF R.D.T. & E. CONTRACTS

Mr. RHODES. Mr. Chairman, may I ask a question at this point?

Mr. ANDREWS. Mr. Rhodes.

Mr. RHODES. Mr. Poor, is a contract like this one with Hughes for development of this piece of equipment subject to review by the Renegotiation Board to determine whether or not an unconscionable profit is made? Are your R. & D. contracts reviewed?

Mr. POOR. It is my understanding that all of them are subject to renegotiation.

Mr. RHODES. Will you check that out pretty carefully and put a rather definitive statement into the record, including those portions of the law, if applicable, to determine that this is so?

Mr. POOR. I will.

(The information follows:)

The Renegotiation Act (50 U.S.C. appendix 1211, et seq.) applies to all defense contracts and related subcontracts with certain exemptions in section 1216(a). One of the exemptions would be applicable to R. & D., that is, R. & D. contracts with a foreign government or agency thereof would not be covered by the act. However, only when the receipts or accruals of a contractor in a given fiscal year exceed the minimum amount prescribed by the statute, which is currently $1 million, are they subject to renegotiation. (Section 1215f(1) "Minimum amounts subject to renegotiation.") The armed services procurement regulation in the implementation of the act sets forth mandatory renegotiation clauses for R. & D. contracts in section VII, parts 3 and 4.

AIR FORCE NONINVOLVEMENT IN SAFOC DEVELOPMENT

Mr. LIPSCOMB. Mr. Chairman.

Mr. ANDREWS. Mr. Lipscomb.

Mr. LIPSCOMB. General, why is the Air Force not involved in a program such as the SAFOC development?

General BETTS. Nobody has the problem except the Army. We are the ones who have developed the whole concept of air mobility for combat operation using helicopters that gain their security from ground attack by flying at treetop level where the ground attackers get very little opportunity to bring fire power to bear on those helicopters. When you get up higher in altitude, line-of-sight radar is not only adequate but it is the best way to go. If we were not flying at these very low altitudes this problem would not be a problem.

MARINE CORPS INTEREST IN SAFOC DEVELOPMENT

Mr. LIPSCOMB. What do you think the Marines will do?

General BETTS. They would be interested in this capability if we develop it and it proves to be successful. What we all do now when we

get into a situation where we need traffic control is to fly at the higher altitudes and accept the inherent risk.

Mr. LIPSCOMB. Are you aware of whether or not the Navy in behalf of the Marines is looking at something of a similar nature?

General BETTS. The Marines are interested in a system that can provide the capability such as the SAFOC offers since they are also quite dependent upon helicopter operations and must control large numbers of aircraft. They are participating in the program only to the extent of monitorship. Their concept of operation is normally along a beachhead and does not involve the extreme ranges associated with Army operations.

Mr. LIPSCOMB. Is the system that is being modified, or refurbished, or whatever, by Hughes on original Army equipment?

General BETTS. The TSQ-51 is an Army Air Defense System that is operational in the Army today. It was developed for Air Defense.

Mr. LIPSCOMB. For Air Defense by the Army?

General BETTS. By the Army.

Mr. LIPSCOMB. Thank you, Mr. Chairman.

TACTICAL LANDING SYSTEM

Mr. ANDREWS. What is the tactical landing system referred to on page 97 of the justification book?

General BETTS. That is an effort to develop the landing system or landing control system that can be employed in forward and remote areas for provision of landing guidance for helicopter operations, for trooplift, resupply, medical evacuation, under poor weather conditions or at night when line-of-sight will not be possible.

Mr. ANDREWS. How does this differ from what we are talking about here just a few moments ago?

General BETTS. The Semiautomatic Flight Operations Center is an air traffic control——

Mr. ANDREWS. Where you have a lot of traffic?

General BETTS. A lot of traffic, and we want to keep it sorted out so that the aircraft do not run into one another. This landing system is to pick up an aircraft coming into a base and guide it down to land in poor weather and at night.

Mr. ANDREWS. How many of these systems will you have? I mean by that, how many stations would you have?

General BETTS. We would have one at a base but I don't have a tactical inventory number at the moment because this is a development effort right now.

Mr. ANDREWS. What you are telling us about the Semiautomatic Night Operation Center is that the Army has a unique problem in guiding choppers into a base or a field that other services do not have?

General BETTS. That is right.

Mr. ANDREWS. Because their aircraft fly high enough to be seen visually?

General BETTS. Or by line-of-sight radar; that is correct, Mr. Chairman.

Mr. ANDREWS. Your problem is that the choppers have to fly so low that you need this system to bring them over the tree tops, make contact with them before the air traffic controller can see them?

General BETTS. That is correct; that is correct. Then the landing system would pick up when they get back to the base, and if they have visual conditions they can fly themselves down; if the visibility is so poor that they cannot, we would want an automatic or controlled landing system that would bring him down safely.

Mr. ANDREWS. That is what you mean by a tactical landing system?

General BETTS. That is why we call it that; yes.

Mr. ANDREWS. What are you using today to handle situations like this?

General BETTS. We are not able to operate under conditions of visibility such as this, they cannot land safely.

Mr. ANDREWS. Does the Navy or Air Force or Marines have tactical landing systems?

General BETTS. They have landing systems of considerably greater size, weight, cost, and complexity than what we are trying to develop under this item.

Mr. ANDREWS. Why don't you use their system?

General BETTS. We are trying to find something that is more portable, much less expensive than that which they use at their larger fixed-wing bases.

TERRAIN AVOIDANCE RADAR FOR HELICOPTERS

Mr. ANDREWS. You also refer to development work on a terrain avoidance radar for helicopters. Why is this necessary and how much has been spent on this effort?

General BETTS. All we have done in this program so far is related to in-house investigations to determine the feasibility of adapting fixed-wing terrain avoidance radars to helicopters.

Major DILDAY. So far in the terrain avoidance for helicopters—this relates back to the HELMS—the HELMS offers a potential for terrain avoidance also, but in helicopter terrain avoidance we have not done any contractual work. We do have terrain avoidance for fixed-wing aircraft both in the other services and in the Army. We have in the 1970 program $90,000 for in-house investigation to see if this can be—if the fixed-wing terrain avoidance system can be adapted to helicopter application. That is, to guide the helicopters in bad weather into confined areas where we have only limited avenues of approach, through valleys and things such as this.

Mr. ANDREWS. Why isn't this work being included—or is it—under HELMS?

Major DILDAY. The HELMS offers several possibilities. It offers a possibility or feasibility for collision avoidance, terrain avoidance, because you get the radar map. If you can see the terrain that you are flying over then it offers this kind of possibility. This particular thing we are discussing now is not under the HELMS, but the HELMS program will offer a potential for doing this particular work.

Mr. ANDREWS. What you are trying to do is to take $90,000 and see if you can adapt a system now used by fixed-wing aircraft to choppers?

Major DILDAY. Yes.

General BETTS. That is the point of this particular investigation.

Mr. ANDREWS. I can easily see why such a system is badly needed for choppers.

General BETTS. It would be very helpful.

Mr. ANDREWS. Much work is done by helicopters at night.

General BETTS. It would be very helpful. The key problem is the high cost of terrain avoidance radar. We would not expect to make a direct adaptation of the high cost units that the Air Force and Navy are now using.

FACILITIES AND INSTALLATION SUPPORT

Mr. ANDREWS. What is the purpose of the $230,000 for facilities and installation support? Put that in the record.

(The information follows:)

Effective July 1, 1969, a new accounting system was initiated whereby cost of facilities and installation support was to be charged to the R.D.T. & E. programs conducted at the various posts and installations rather than funded from a separate account.

The $230,000 for program element 6.32.07 D235 represents the fiscal year 1969 statistical distribution of the facilities and installations support costs to make fiscal year 1969 and fiscal year 1970 funding comparable.

Mr. ANDREWS. Are there any questions on these subjects that we have discussed up to this point, Mr. Addabbo?

AVIONICS PROGRAM COORDINATION WITH OTHER SERVICES

Mr. ADDABBO. Most of the description you give on page 96 with respect to avionics sounds like work that has been done by the Air Force. Has everything been coordinated and is everything being coordinated as far as previous research is concerned? I imagine that when they had smaller planes they must have been worried about the same things you are worrying about with the helicopter.

General BETTS. We are all worried about terrain avoidance, navigation, we are all worried about communications air to air and air to ground. There have been times in the past when these efforts were not adequately coordinated. I would insist today that they are adequately coordinated and the work we are doing is only that which is necessary to adapt to the conditions of the Army aircraft involved. We do not have the range requirement that the Air Force and Navy have, by and large. Also, we do not have the payload capability inherent in the larger aircraft.

Mr. ADDABBO. When speaking of avionics we are speaking predominantly of work with helicopters, not other aircraft?

General BETTS. The Army effort is largely related to helicopters in avionics, although I might point out that some part of it applied to that direction-finding effort that will be applied to fixed-wing aircraft and will be carried in fixed-wing aircraft.

AIRBORNE FORMATION FOR FLIGHT DISPLAYS

Mr. ADDABBO. How much money is going to be spent for the flight test and evaluation of airborne formation for flight displays?

General BETTS. Major Dilday.

Major DILDAY. I can give you the 1970 program. There is programed ——— for formation flight.

Mr. ADDABBO. Can you not use previous experience gained by the Air Force in this situation? They must have had flight tests as far as formation flying is concerned.

General BETTS. To the extent that the kind of technology they have developed will apply we would use it, but the specifics of our application may require something different.

Mr. ADDABBO. Thank you. No further questions.

Mr. ANDREWS. Mr. Lipscomb?

Mr. LIPSCOMB. No questions.

Mr. MINSHALL. No questions.

Mr. ANDREWS. Mr. Rhodes?

BREAKOUT OF SAFOC DEVELOPMENT COSTS

Mr. RHODES. I don't think we have an adequate explanation of why it cost $5.1 million to refurbish an old piece of equipment. Would you expand on that for the record, as to just what you are spending that money for?

General BETTS. Yes. It is primarily engineering effort. But we will expand it beyond that.

Mr. RHODES. I understand that, but that is a lot of engineering effort.

General BETTS. Yes, sir. But it takes a lot of people to write software when you get into a reprograming of a computer. This is the essential effort, to get the high frequency signals, receive them, process them. That will take electronics and engineering effort which goes into that. I would be glad to explain it in detail and give you the full task breakout.

(The information follows:)

The word "refurbished" was an incorrect choice of words. The intent was to show that the Army had taken advantage of some previous technology, experience, and hardware to develop another system to perform another different function and not to convey the impression that we were merely refurbishing old equipment.

The TSQ-51 is an air defense system that uses consoles, displays, sweeps, and symbology that can be applied to an air traffic control system. The SAFOC has been developed to take advantage of as much prior experience, knowledge and harware as possible in order to minimize cost and risk.

The SAFOC funding committed to date follows:

1. Basic SAFOC contract: Hughes Aircraft Co.	
(a) Design (preliminary design, design plan, detailed design)	$1,130,771
(b) Fabrication and assembly	1,325,562
(c) System integration, van installation	403,386
(d) Contractor testing in-plant	69,391
(e) Program manager expenses, technical reports and manuals	478,623
Subtotal	3,407,733
2. Airborne subsystem: Hughes Aircraft Co.	
(a) Design, fabricate, assemble and test sets Nos. 1 and 2	392,890
(b) Complete sets Nos. 3 and 4	66,573
(c) Technical literature	7,365
Subtotal	466,828
3. Leasing high frequency single side band modems, NAFEC	11,810
4. Engineering services, repair and spare parts (estimate)	600,000
5. Equipment documentation, reports (estimate)	150,000
Subtotal	761,810
6. Design of experiments contract: American Electronics Laboratory, detailed test and evaluation plan to be used in the SAFOC Engineering design test	457,813
Total funds	5,094,184

SAFOC DEVELOPMENT PROGRAM SCHEDULE

Mr. MINSHALL. When was this contract awarded to Hughes Aircraft for $5.1 million?

Major DILDAY. The contract ceiling with Hughes was $3.4 million and was signed on April 30, 1968.

Mr. MINSHALL. Are they on schedule with it?

Major DILDAY. Yes, sir; they are on schedule. Delivery is scheduled from the beginning for September 30 and they will meet the schedule of September 30.

Mr. MINSHALL. How long do you anticipate the R. & D. on it after you get it installed at NAFEC?

Major DILDAY. We have plans for 1 year of testing, sir; testing and evaluation.

Mr. MINSHALL. Thank you.

Mr. ANDREWS. Mr. Davis?

Mr. DAVIS. No questions, Mr. Chairman.

Mr. ANDREWS. Two o'clock, gentlemen.

AFTERNOON SESSION

Mr. ANDREWS. The committee will come to order.

AVIONICS SYSTEMS

We will discuss the engineering development of the avionics systems.

You are requesting ——— million for avionics systems engineering development, which is ——— million more than the fiscal year 1969 program. What is the reason for this increase?

You can supply that for the record.

(The information follows:)

This increase is for equipment that has progressed to "Engineering development" and is needed to solve the position fixing and navigation problems that exist in Southeast Asia as well as other areas of the world. This includes the Loran manpack receivers (PSN-2) and a low frequency beacon (TRN-30).

LORAN-D GROUND STATION

Mr. ANDREWS. Will you explain the reason for the relocation of the Loran-D ground station to the Southwest United States, mentioned on page 99 of the justification book?

General BETTS. The Army has one loran-D transmitter that is part of the joint development effort with the Air Force for application of the Loran-D system. Relocation of the Loran-D chain is therefore a joint effort to establish a chain in the Southwest where we would be doing our testing. The Army needs the loran signal in the general area of Fort Huachuca. That is where we would carry out the testing effort.

Mr. ANDREWS. Is this to be used for navigational purposes?

General BETTS. The application of the Loran-D system is for navigational purposes.

The question at issue here is related to a testing effort and Fort Huachuca is the area in which we would do this kind of testing.

Mr. ANDREWS. I wish you would explain what the Loran-D system is.

General BETTS. I will be glad to.

It is a system whereby the moving unit, whether it be an aircraft or vehicle on the ground, carries a receiver. There are stations located at fixed positions and the receiver has the ability to pick out from the signals from these several transmitters the kind of information it needs to correlate those signals and from them compute its position on the ground. So that in effect, by listening to the signals from several stations, it can figure out its position with reasonable accuracy.

Mr. ANDREWS. Can it be done from the air, too?

General BETTS. It can be done from the air or on the ground.

REQUIREMENT FOR LORAN–D GROUND STATIONS

Mr. ANDREWS. What vehicles would use it on the ground?

General BETTS. At the moment we do not have it in any of our ground vehicles as a routine installation. We are in a test program that would build the unit small enough to be put on a jeep, a truck, or carried on a man's back.

Mr. ANDREWS. What are we testing in the Southwest United States?

General BETTS. We are testing the package that would be the receiver, the unit that receives the signals, computes from them the actual location of the man on the ground or the aircraft if this goes in an aircraft.

Mr. POOR. Mr. Chairman, may I suggest that the Loran-D system offers a terribly important operational advantage. It lays down a pattern of radio navigation data all over the battlefield and if the ground units have appropriate loran receivers, they can report their position in the same coordinate system that the Air Force or Army helicopters are using to their own receivers, and this makes it possible to coordinate operation in space without necessarily any reference to maps, transfer of coordinate information. It is a most important potential.

Mr. ANDREWS. We have had loran for a number of years?

Mr. POOR. Yes. Loran-D is a relatively new form of loran, I think. You remember Loran-A and B.

Mr. ANDREWS. I am talking of the overall Loran system.

General BETTS. The original Loran did require a receiver system that was much bigger than would be appropriate in a Field Army environment. What has happened in the microminiaturization of electronic circuitry, we are now able to package a receiver in a small enough package to make it practicable for Field Army use.

Mr. ANDREWS. We are testing jeep-mounted Loran receivers?

General BETTS. That is correct.

Mr. ANDREWS. Do you have any such capability in Vietnam today?

General BETTS. We do not have it in Vietnam yet for the man-pack unit. We would hope to have it over there for field evaluation in the near future.

Mr. ANDREWS. There is a requirement for that over there?

Dr. LASSER. There is a requirement for the positional location. The man-packed one can be mounted in a jeep.

There are receivers over there. There were four over there, and more are being made smaller and lighter for the same purpose to be used both by the troops and Vietnam.

Mr. ANDREWS. Just what is the purpose of this? They have maps. How will this supplement the map knowledge?

Dr. LASSER. You can read off coordinates directly from the device without having to rely on a map. You cannot always use a map in the jungle. You can use a Loran receiver in the jungle. It is low frequency and penetrates the jungle and gives directly the coordinate, either Loran or regular.

Mr. ANDREWS. Here is an outfit that goes in the jungle. They have one of these receivers. Do you have your Loran back——

Dr. LASSER. ——— or ——— miles around.

Mr. ANDREWS. Can he tune in on that beam?

Dr. LASSER. Yes.

Mr. ANDREWS. And tell exactly where he is?

Dr. LASSER. To within about ——— or ——— feet.

Mr. ANDREWS. I assume he does that by knowing where the Loran station is located.

Dr. LASSER. Yes. The Loran stations are in fixed positions, they are permanent.

Mr. ANDREWS. He knows where they are?

Dr. LASSER. Yes. They are coupled to each other so he really does not have to know exactly the system location.

Mr. ANDREWS. He is in the jungle and has a receiver and he knows where the Loran station is and he tunes in on it?

Dr. LASSER. Yes.

Mr. ANDREWS. What will the station tell him that will enable him to know approximately where he is?

Dr. LASSER. The ——— stations will send out a signal. The time at which the ——— signals get to him uniquely determines where he is and the receiver just has a computer in it which reads out that information. He does not have to do anything other than read it.

Mr. POOR. And more important, he has this information and if he wants, for example, a helicopter to come to join him, all he needs to do is say my coordinates are thus and so on my receiver. The helicopter carrying similar receiver can come precisely to him. It is a very useful capability.

Mr. ANDREWS. How long have you had that capability in Southeast Asia?

Mr. POOR. I do not know when the Loran chain first went in.

Dr. LASSER. It has been in a couple of years. I do not think any Army airborne aircraft have Loran at present.

Mr. POOR. Most of the Air Force does.

PROPOSED TEST PROGRAM

Mr. ANDREWS. Are you going to test a small ground receiver in Arizona?

General BETTS. That is correct. We do not have the operational capability to use this kind of equipment and we would propose to test—remember, we have several different performance levels related to size and stage in technology.

When we talk about the Air Force having Loran in Vietnam and using it routinely now, we are talking about a system that would not be appropriate for field Army use.

What we are trying to do is miniaturize the receiver and get it into the kind of rugged field package we can use in Vietnam.

Dr. LASSER. There are only something like ——— or ——— some such number, over there now being evaluated and working and giving the accuracies I quoted.

Mr. ANDREWS. What you are trying to do in Arizona is the same thing that is being done now in Vietnam?

Dr. LASSER. Also for aircraft, being evaluated to see the capability for aircraft at Huachuca, being tested in that area.

General BETTS. We can do controlled experiments in an engineering sense in the testing area of Fort Huachuca that we could not do in a combat environment. That is part of the difference.

Mr. ANDREWS. How long is it going to take to finish these tests?

Major DILDAY. I would like to set something straight for the record if I could at this point, regarding this Loran-D.

We have gotten off in two separate areas, the receivers and the transmitters. The Loran-D was a part of a development jointly between the Army and the Air Force. The Air Force, the last perhaps we had—the Loran-D requires at least ——— transmitters to establish a chain or grid over the ground. We have ——— transmitters, the Air Force has ———. The latest Air Force plans call for them to move to the Southwest United States a capability to establish a chain within this area. And we are more than willing to participate in this because it would give us then a grid established in the Fort Huachuca area in which we could test Loran receivers.

It also gives the Air Force the capability for their central guidance test facility. If the Air Force goes through with their program, we are more than happy to join.

The transmitters are separate from the receivers. There are some evaluation receivers, man packed 20-pound items in Vietnam today undergoing evaluation and scheduled for completion of this evaluation by August 31 of this year.

PURPOSE OF THE TEST PROGRAM

Mr. ANDREWS. Will the field commander in the jungle have a transmitter and a receiver?

Major DILDAY. No, sir. The transmitter is placed in a fixed location. In Vietnam today there is a Loran-C chain which is about twice as big and twice as heavy as the Loran-D. The Loran-D was an effort to make a transportable system which could be used for a tactical or a combat environment.

This Loran-D was at Eglin as a test and development item. Now the plans are to establish a chain on the west coast or in the Southwest. There is no Loran chain in the west coast area. There is a Loran-C on the east coast.

Mr. ANDREWS. I do not think it is too clear on the reason for the tests. Are we trying to test a piece of equipment that will be used say on patrols or for observation post personnel to call in artillery strikes? What is it we are testing and for what purpose will it be used?

Major DILDAY. The establishment of the chain in the Southwest is so that we can then run tests on Loran receivers. We do many tests at Fort Huachuca. This is the area where we send many pieces of equipment, receivers to do just that kind of testing. So if we establish a grid, we can test the receivers in a Loran environment which it is triggered by and which they are set to receive.

The receivers themselves, the patrol sometimes has difficulty locating themselves in the jungle or maybe become lost, but the receiver will tell him by receiving from the transmitter a signal what his location is, and then he can coordinate this location with someone else who has a receiver or a grid that is overprinted and tell them I cannot read my location off the map but I can read my location from this receiver and it tells me I am located here. You can get assistance to me at this location or you can support me with fire.

Mr. POOR. It is clear, is it not, the transmitters are put down once and for all and establish a pattern all over the region.

Mr. ANDREWS. Kind of like a radio?

Mr. POOR. Yes. They are big radio antennas and the receiver anywhere in that service area that can receive from three of these transmitters reads out directly where it is.

The Huachuca tests will be continuing tests of new forms of Loran receivers, new forms of tactics to exploit the possibility of measuring position for several different things, men, vehicles, and from the air.

AN/AAS-24 SENSOR SYSTEM FOR OV-1D MOHAWK AIRCRAFT

Mr. ANDREWS. The committee was advised in April 1969 that the Army Electronics Command awarded a $6.8 million contract to Texas Instruments for production quantities of the AN/AAS-24, an advanced sensor for the OV-1D Mohawk aircraft to provide a major expansion in reconnaissance and surveillance. Will you describe the use to be made of this equipment and advise whether it is a subsystem of a system such as the AN/UAS-4A or the AN/URQ-16 systems?

General BETTS. You will recall earlier today I said the OV-1 aircraft is our broad area surveillance capability now in inventory. This AAS-24 airborne infrared set is a new high resolution, high sensitivity infrared detection system we have selected for application to the OV-1D, a more modern model of the Mohawk aircraft.

In addition to the improved resolution and better sensitivity, the system will provide a real TV type display in the cockpit. That is a considerable improvement over the capability available from the older USA-4A infrared set.

Mr. ANDREWS. Is this a subsystem of a system which will perform a function similar to JIFDATS under development by the Navy?

General BETTS. No, sir. The JIFDATS is a data link that could be used in many applications, but the idea is to have an adequately broad band data link that we can take information from—airborne sensors may be the application—but take it from there and bring it back to a station on the ground.

JOINT IN-FLIGHT DATA TRANSMISSION SYSTEM (JIFDATS)

Mr. ANDREWS. Any questions on engineering development avionics system?

Mr. RHODES. Mr. Chairman, I am somewhat interested in JIFDATS, knowing a little bit about it.

Do you know how far along this is? I recognize the Navy is the agent for development of it, but I also understand the Army is very much interested.

General BETTS. We are very much interested and, as you are well aware, it is a joint program. We have specified the kind of data link we think would be most useful for our application. I would have to get more information unless my staff has it here.

It is my understanding that the program has slipped somewhat because of technical difficulties. It is my understanding from Colonel Nixon that fiscal year ——— is the earliest date of availability as now predicted. I will correct that for the record if that is not right and put in more detail.

Mr. RHODES. What sort of data transmission does the Army require for this system?

Dr. LASSER. The Army is interested in transmitting the IR, infrared data taken currently on the OV–1B and C. The band width requires about 15 megacycles. JIFDATS has a broader band with photo data and we are saying we would like our infrared and radar data sooner and do not want to wait for full completion of JIFDATS.

This also includes very broad band operating photographically.

Mr. RHODES. Is there any capability to transfer a picture to the ground station?

Dr. LASSER. This is the more complicated part I am talking about. There will be in time; there is not today. I predict we are going to have a lot of trouble or at least delay in that aspect of it because it needs a broader bandwidths, needs different antennas. It should be developed, hopefully in the ——— or ——— time frame.

What we are looking for is the capability to transfer data in the sooner time frame from the IR and radar.

Mr. RHODES. What sort of a system are you going to use in the interim while you are waiting for JIFDATS?

Dr. LASSER. The OV–1B and C which are in Vietnam now has its own data link.

Mr. RHODES. How does it work? You say data link. From an airborne sensor can you transfer the data to the ground station?

Dr. LASSER. That is right. It is like a TV transmission, narrow band, so it takes longer for the picture to get there, but yes.

Mr. RHODES. What is the nomenclature of that equipment?

Dr. LASSER. It is part of the UAS–4 system.

Mr. RHODES. Can you supply that for the record?

Dr. LASSER. Yes.

(The information follows:)

The data transmission for the OV–1B is a part of the AN/UPD–2 side-looking airborne radar (SLAR) surveillance system. The SLAR data transfer equipments are the AN/AKT–18 airborne transmitter and the AN/TKQ–2 ground sensor terminal.

The AN/UAS–4 is the OV–1C airborne infrared (IR) surveillance system which includes the data transmission. The IR data transfer equipments are the AN/ART–41A airborne transmitter and the AN/TAQ–1A ground sensor terminal.

Mr. RHODES. Has the Army made any requirements on the Navy as agent for JIFDATS as to the type of transmission where you want a digital transmission or some other type?

Dr. LASSER. No, we have not, but we have been in discussion with them on it. I guess the best I can say, we are planning on formalizing it as their program progresses, but it is still in the contract evaluation stage. It is kind of meaningless to do it just yet.

Mr. RHODES. Have they picked the sources yet?
Dr. LASSER. Not to my knowledge. My information like 3-weeks old.
Mr. RHODES. Thank you.

AIRCRAFT WEAPONIZATION SYSTEMS

Mr. ANDREWS. The fiscal year 1970 request for aircraft weaponization systems is ——— million. Your fiscal 1969 program is shown as $22.9 million, but Congress approved only $20.1 million last fiscal year. Why was this program element increased?
General BETTS. There were two reprograming actions.
Mr. ANDREWS. During 1969?
General BETTS. During fiscal year 1969.
Mr. ANDREWS. You got $20.1 million, and how much did you reprogram?
Colonel LAMB. The reprograming action was for SMASH sensor set-up for $2 million, fuel air explosives for $400,000, and $370,000 for missiles and rocket projects.
Mr. ANDREWS. So fiscal year 1969 you had $22.870 million?
Colonel LAMB. Yes, sir; rounded off to $22.9 million.
Colonel LAMB. The reprograming action was for Smash sensor set-up
Mr. ANDREWS. This year you are asking for $18.6 million. So that is a decrease from what you had in 1969?
General BETTS. The 1970 request is a decrease; that is right.
Mr. ANDREWS. Why the decrease? We welcome them, but want to know why.
General BETTS. It relates to the fact we have completed a major engineering development effort during fiscal 1969.
Colonel BONIFACIO. We completed the ET/ST on the XM-229 for the 2.75 rocket, the XM-28 flexible turret for the AH-1G, the XM-129 improved 40-millimeter grenade launcher. There were many others.
Mr. ANDREWS. You do not have as big a program ahead of you as you have in 1969?
Colonel BONIFACIO. That is right.

MAJOR PROGRAM ACCOMPLISHMENTS IN FISCAL YEAR 1969

Mr. ANDREWS. I wish you would put in the record some of the major accomplishments of this program in 1969 and explain them, Colonel. Tell us what they were, what they will do, and whether or not any of the items are being used in Vietnam at this time.
Colonel BONIFACIO. Yes, sir.
(The information follows:)

MAJOR ACCOMPLISHMENTS IN FISCAL YEAR 1969

(*a*) Completed engineering and service tests (ET/ST) of the XM-129, 40 mm. grenade launcher. This launcher is used in the XM-28 subsystem for the AH-1G, is planned for the XM-8 subsystem for the LOH and the XM-51 subsystem for the AH-56. The system will also be used in replace the present M-75 launchers in the M-5 subsystem (used on UH-1B/C helicopter) as they wear out. The 40 mm. grenade is used as an area fire weapon and has an effective ranges of 1,800 meters. The XM-129 is presently being used in Vietnam.
(*b*) Completed ET/ST of the XM-28 flexible turret for the AH-1G. The XM-28 is a twin-mounted nose turret with two M-134 7.62 mm. machineguns, two

XM–129, 40 mm. grenade launchers, and/or one of each. The system is being used with the AH–1G helicopter in Vietnam. Presently action is underway to classify the system as standard.

(*c*) Completed ET/ST of the XM–27E–1 minigum (7.62 mm.) for the LOH. The system is mounted on the left side of the LOH and is used as an area fire weapon. Presently, action is underway to classify the system as standard.

(*d*) Completed ET/ST of the XM–596 proximity fuze for the 40 mm. grenade. The lethality of the round was increased approximately 100 percent. The fuze has been adopted limited standard and is being procured for use in Vietnam.

(*e*) Completed engineering design of the following:

(1) The XM–140, 30 mm. The XM–140 will be the primary weapon on the Cheyenne. The weapon will be used primarily against point type targets.

(2) Multi-weapon fire control. This system will be evaluated on one AH–1G and will be tested during the Sea Niteops Evaluation II. One system is being maintained on a UH–1 for continued test and evaluations. The objective of the program is to develop a fire control system that will provide improved target detection and delivery accuracy.

(3) XM–35, 20 millimeter gun. The XM–35 development is in response to an Ensure requirement submitted by the field command in Vietnam for a point target weapon system that will provide improved accuracy, greater range, and greater standoff capability for the Huey-Cobra. Planned deployment to Vietnam is———

(*f*) Continued engineering design of the following:

(1) XM–170 flare. This flare is being developed as a replacement for the MK–45 parachute flare that is presently being used in Vietnam. The flare is a lightweight, double candle, fuze-activated illumination flare capable of providing 2 million candlelight power for 2 minutes.

(2) XM–8, 40 millimeter grenade launcher. The XM–8 uses a XM–129 grenade launcher. It will be mounted on the left side of the LOH. Presently the system is being evaluated in Vietnam.

(3) Fuel air explosive (FAE). The FAE warhead will be used to clear helicopter landing zones of mines and booby traps. Static tests have been completed and live airdrops have been initiated. The basic principle of the FAE is the generation of high pressures (200 to 300 p.s.i.) in the immediate vicinity of the target to be destroyed. The pressure pulse is generated by a two-step detonation process. The FAE liquid fuel is dispensed as an aerosol and a secondary high explosive charge detonates the aerosol cloud that creates the pressure. The munition developed will be compatible with the UH–1 series, the AH–1G and the AH–56A.

(4) AVROC 40. AVROC 40 is a 40-millimeter boosted grenade round designed to be fired from helicopters. The range of the round has been increased by 50 percent and the time of flight reduced by 25 percent.

(5) 2.75-inch rocket control panel. The rocket launcher panel has been designed to identify and permit discreet selection of varying combinations of warhead/fuzes for attacking various targets. Presently panels are being procured for a Vietnam operational evaluation.

(6) 2.75-inch rocket delay fuze. A resistor-capacitor fuze is being designed for jungle canopy penetration of variable heights. Presently, the fuze is undergoing TECOM safety evaluations.

(7) SMASH. AH–1G Cobras armed with the XM–28 subsystem and either the XM–35 (20 millimeter) or the XM–158 (2.75 FFAR) will be equipped with a POD mounted MTI radar, and a forward-looking infrared (FLIR) to provide long-range target detection and terminal target identification and fire control. Presently, plans are to evaluate the system during SEA NITE-OPS Evaluation III. Plans are to deploy ——— SMASH aircraft in the spring of ———.

(8) TOW/Cheyenne. The TOW missile is being integrated into the Cheyenne weapon system to provide an anti-tank capability. The missile has been fired successfully from the Cheyenne.

(9) Aluminum casing for 30-millimeter round. Development was initiated in order to reduce the weight of 30-millimeter round for the XM–140 gun. It is estimated that a weight saving of one-fourth pound per round will be obtained.

(*g*) Completed ET/ST of the XM–200 repairable 2.75-inch rocket launcher. The XM–200 is capable of firing 100 rockets per tube (19 tubes total). The launcher is designed so that major replacements and repairs can be made by

field maintenance without special tools. The system will be compatible with the UH–1, AH–1G and AH–56 helicopter.

(*h*) Initiate engineering design of a proximity fuze for the 30-millimeter round. The objective is to improve the lethality of the round.

(*i*) Initiated engineering design of a boosted 30-millimeter round. The objective is to increase the range and accuracy of the round.

SELECTIVE EFFECTS ARMAMENT SUBSYSTEM (SEAS)

Mr. ANDREWS. Page 102 of the justification book indicates you will initiate the development of the selective effects armament subsystem (SEAS) to replace the 2.75-inch rocket on the AH–1G and the AH–56A. How much will be devoted to SEAS?

General BETTS. ——— million will be allocated to that development effort.

Mr. ANDREWS. Colonel, is that one of the programs you said you had completed in 1969?

Colonel BONIFACIO. No, sir.

INITIATING SIMULTANEOUSLY CONCEPT FORMULATION AND DESIGN OF SEAS

Mr. ANDREWS. How can you initiate development of SEAS in fiscal 1970 under this program element and at the same time initiate concept formulation of SEAS under program element aircraft weaponization advanced development as indicated on page 95 of the justification book?

General BETTS. This is not so large and complex an effort that we will have to take more than the time in a fiscal year to complete the concept formulation and get on with the beginnings of the development. We would expect to do it just that way.

Mr. ANDREWS. What does the program cost?

General BETTS. The number I gave you was ——— million for the fiscal year 1970 program.

Mr. ANDREWS. What is the total cost?

General BETTS. I do not have it.

Mr. ANDREWS. Put that in the record.

Also, how much has been spent on it in previous years, and describe the program for us.

(The information follows:)

At the present time, the total estimated cost for development of the subsystem is ——— million. In fiscal year 1969 we spent approximately $150,000 on analytical studies and experiments to determine the effectiveness of a selective effects armament subsystem and other armament systems. SEAS will replace the 2.75-inch folding fin aerial rocket now being used. The subsystem will provide significantly improved lethality against personnel and materiel targets and a high kill probability against armored vehicles. SEAS will have a family of warheads and fuzes.

General BETTS. You remember earlier today I spoke about the problem of inaccuracy of the 2.75-inch rocket. This is the effort that will seek a more accurate and more effective system to replace that rocket. SEAS may be a rocket, a recoilless rocket assist weapon, or a closed breech system.

Mr. ANDREWS. What kind of rockets are you talking about?

General BETTS. We are talking about free flight air-to-ground rockets. The 2.75-inch is used by all three services.

Mr. ANDREWS. Do you use it from a chopper?

General BETTS. We can use it from the chopper.

Mr. ANDREWS. Are you?

General BETTS. We are and the other services also use it from fixed-wing aircraft.

Mr. ANDREWS. Are you using it in South Vietnam?

General BETTS. We are.

Mr. POOR. It is the workhorse armament against reasonably hard targets. It is used for helicopter landing zone preparation in Vietnam. It is used by all three services. We use a great many of them.

Mr. ANDREWS. Is it used as an antipersonnel weapon?

General BETTS. Yes, particularly in helicopter landing zone preparation. It is effective against buildings and personnel.

One of the significant things we have been able to do is improve the fuzes so it is more effective as an antipersonnel weapon than it originally was.

Mr. ANDREWS. What is the length?

General BETTS. The 2.75-inch rocket is 4 feet long.

Mr. LIPSCOMB. I did not quite understand your answer, General Betts, when the chairman asked about initiating the concept formulation and going ahead with the initial development at the same time.

General BETTS. We would expect to be able to complete enough concept formulation activity in the early part of this fiscal year to be ready at the latter part of the fiscal year to begin the engineering development.

Mr. LIPSCOMB. Have you initiated it yet?

General BETTS. We have done some work in this area.

Mr. LIPSCOMB. Be specific with me for a change.

General BETTS. I do not have specific numbers.

What I do have is evidence that we have done some in-house effort exploring the possibility of increasing the effectiveness and accuracy of these free flight rockets and we know that several companies have spent their independent R. & D. dollars on technology that would lead them to believe they could do a lot better than we can now do with the 2.75.

What we mean by our comment about the concept formulation is that we would hold this study and analysis effort together during the beginning part of the fiscal year and hope we have it well enough in hand by the latter part of the fiscal year to start the development effort.

Mr. LIPSCOMB. Do you think you will finish the development effort in fiscal 1970?

General BETTS. I would doubt it.

Mr. LIPSCOMB. Do you think you will be able to spend the entire ——— million dollars?

General BETTS. We see several years of development effort likely in this program.

Mr. LIPSCOMB. How much is in the development effort for fiscal year 1970?

General BETTS. Our total funding for fiscal year 1970 related to this item is ——— million.

Mr. LIPSCOMB. In development?

General BETTS. I would expect we would spend some of that for in-house effort. I do not have the breakout of that number.

I will break that out for the record.

(The information follows:)

We expect to spend ——— million for in-house effort related to this item in fiscal year 1970.

Mr. LIPSCOMB. Do you have, General, by any chance the amount of funds that are requested in the other budget classifications?

That is program element 6.32.06.A on page 94 of the justification book.

General BETTS. That was in the technology effort.

Mr. LIPSCOMB. Do you know what is programed for that?

General BETTS. I do not know how much of that I can specifically identify to this item. We do not have it broken out that way, but I can identify it for the record.

(The information follows:)

We have ——— million programed in advanced development for this item in fiscal year 1970.

Mr. LIPSCOMB. Do you suppose you could get by, for instance, on a million dollars for this program for fiscal 1970 if you are going to initiate the concept formulation and get into development, do you think you can get by on a million dollars instead of ———.

General BETTS. If we went through a competition to get a contract started, it seems to me we would need adequate funds to assure the contractor that we really meant what we planned to do. I do not think we could ask him to come in with a full development program plan that carried on into later fiscal years and not have in hand the funds to do the job.

Mr. LIPSCOMB. What is the difference if you have 1 million, ——— million, or more if it is going to be a multiyear program?

General BETTS. It was our judgment that that was the level of funding effort we should have in hand for funding from the time we would start the development until the time we would be able to add fiscal 1971 increment to it.

WEAKNESSES IN R.D.T. & E. PROGRAM

Mr. LIPSCOMB. This is not one of the contingency areas you might be using for fiscal year 1970, is it?

General BETTS. I would not so identify it.

Mr. LIPSCOMB. This is a high-priority item?

General BETTS. Higher than some. We have been with the 2.75-inch rocket for a long time.

Mr. LIPSCOMB. It has been very successful.

General BETTS. But it is not really an accurate rocket in terms of what the technology can do today. I think it is time we upgraded this capability.

As far as I am concerned, the additional effort that we put on the technology part of it in 1969 reflects our interest and our priority consideration of this project.

Mr. LIPSCOMB. You know the Senate Committee on Armed Services has proposed a deletion in R.D.T. & E., Army, authorization of about $211 million?

General BETTS. I am painfully aware of it.

Mr. LIPSCOMB. The chances are almost certain there is going to be a deletion in the authorization.

Faced with a cut in the authorization, I have been trying to seek where this committee can be most helpful, but every time I try to discuss various items with you, everything is always "most important". Now you are going to have to face up to a cut. If you do not want that cut to come in places that will hurt your important programs, you better tell us where you are weak.

Do you get my point?

General BETTS. I certainly do.

Mr. LIPSCOMB. If you cannot tell us where some of the weaknesses are—that is, valid programs but not highest priority programs—we are going to be cutting you up where you do not want it.

General BETTS. I understand.

Mr. LIPSCOMB. Yet every time I ask about something, it is "most important" and the Army cannot live without it.

General BETTS. I certainly have not been trying to convey such impression.

I do want to assure you when we put something in the budget, we are sincere about it and we believe it is a useful effort.

Mr. LIPSCOMB. I know. The whole budget is a shopping list.

General BETTS. We know as well as you do in something like the improvement of a present capability the world would not come to an end if we were told we could not develop a better rocket at all. That is generally true of the whole area of 6.2 and 6.3 effort in that these are exploratory and advanced development efforts.

If we had to take a cut, we were told today we had to take a cut of $200 million, I would propose to my secretary that a good part of that cut be taken in those two categories. I would want to go through the entire list and sort out those things I thought had the least promise.

Mr. ANDREWS. That would be the smart thing to do, in my opinion.

General BETTS. It may be necessary to go after some of the big systems as the Senate did although that is not clear in terms of relative priority of need.

Mr. LIPSCOMB. I wanted you to at least get a feeling of where I stand on this thing. I would like to see the Loran-D fully funded so you could go ahead, and I would like to see all of your fire control systems and everything else also barge ahead, but that is not where we stand today.

General BETTS. I understand.

Mr. LIPSCOMB. Thank you, Mr. Chairman.

PROGRAMS FOR CHEYENNE AND COBRA HELICOPTERS

Mr. ANDREWS. Identify the projects in the engineering development program element for the AH–56A and the AH–1G aircraft, together with the costs therefor.

Do that for the record.

(The information follows:)

The Cheyenne development program has two engineering development program elements. One is for the aircraft ($16.5 million), and one for installing the Tow missille ($6 million). No Cobra funds are indicated in the President's budget. We hope, however, to initiate engineering development efforts to improve the Cobra as indicated in Secretary Resor's letter of June 27, 1969.

Fire Control Subsystems

SOUTHEAST ASIA MULTISENSOR ARMAMENT SYSTEM (SMASH)

Mr. Andrews. Pages 103 and 104 of the justification book indicate that on September 6, 1968, the Army initiated the Southeast Asia Multisensor Armament System (SMASH) for the AH–1G Huey Cobra in response to a MACV request for a hunter/killer, night/all-weather target acquisition capability in the shortest time possible. How much has been spent on this effort through fiscal year 1969 and what does SMASH consist of?

And what do you indicate or predict it will cost?

General Betts. The funding status of this effort is that we committed $4 million in the fiscal year 1968 supplemental. We got $2 million in the fiscal year 1969 emergency fund, and we would hope to be able to apply something in the order of $——— million in fiscal 1970 even though it is not immediately available as the budget is now structured.

That would mean we may not be able to move as rapidly with this program as we would like. What we are trying to do with this, and it goes back to our discussions this morning of the MTI radar, is to put both the MTI radar and a good forward-looking infrared system on a Huey Cobra and make it into kind of a hunter/killer aircraft since it also has the XM–28 armament system and of course the capability for carrying the 2.75-inch rocket.

The total system weight of the sensors would be in the order of 640-some odd pounds. So that does cut into our payload somewhat.

Mr. Andrews. How far away from delivering the sensors are you?

Colonel Bonifacio. The system SMASH should be prepared for deployment in spring of ———. That is the target date. The SMASH program consists of ——— test bed aircraft for the AH–1G. It is the first multisensor gunship that we are employing. It is a test bed program which we should learn a great deal from about MTI and FLIR multisensor configuration.

Mr. Poor. Can we say that in English?

This project is an attempt to give the Huey Cobra the ability to find targets at night and shoot at them.

Mr. Andrews. In cloudy weather?

Mr. Poor. And in cloudy weather, but primarily at night. The MTI will be very useful in finding moving targets and the FLIR is that high quality ——— system we discussed on the first or second day to let you see ———. It should offer a great deal of use in Southeast Asia. This is to build a few of them to try it out.

ARMAMENT TO BE USED WITH SMASH SYSTEM

Mr. ANDREWS. What will you do about the armament?

Mr. POOR. As General Betts said, we expect that the armament will consist of the existing XM–28 system together with a fixed forward gun XM–35 or alternatively the XM–158, which is the 2.75-inch free flight rocket. So it can fire rockets and guns.

Mr. ANDREWS. Will that be additional to what they have today?

Mr. POOR. These are all things that can be carried, as I understand it, on helicopters of this class.

Mr. ANDREWS. You will then have a hunter/killer chopper. Does that definition describe it?

General BETTS. That is a reasonable definition of it.

Mr. ANDREWS. Do you have any such capability in Vietnam at this time?

General BETTS. We have the Huey Cobra; but we do not have that integrated with this kind of target-finding capability. That is the point to this particular development.

Mr. ANDREWS. In other words, the ship that you have in mind for the forces in Vietnam will have a greater kill capability than the ships you have there today?

General BETTS. That is correct.

Dr. LASSER. It will operate at night as well as in the daytime. MTI picks up a moving target and the FLIR is a close-in firing tool.

Now currently we do have ships flying over there with the ——— sensors, but it does not have the MTI. ———. It combines it into a single aircraft.

Mr. ANDREWS. Do you have an aircraft that could be described as a hunter/killer chopper with fair-weather capabilities?

General BETTS. Fair-weather capability we do have.

Mr. ANDREWS. The only advantage of what you are working on in this SMASH program is to give them an all-weather capability?

General BETTS. All-weather and night, that is correct.

Mr. POOR. That is a pretty important advantage.

FISCAL YEAR 1970 PROGRAM FOR SMASH

Mr. ANDREWS. How much is in this budget for SMASH, 1970 Budget?

General BETTS. In the fiscal year 1970 budget we have programed ———.

Mr. ANDREWS. Is that enough to get this job done?

General BETTS. We do not consider it enough.

Mr. ANDREWS. When you are talking about priority, I would think this should be pretty high on your list of priorities. This is something the boys can use in Vietnam today.

General BETTS. Yes, sir; but that is the real tough problem that we have gone through in structuring this whole budget. When we started with a submission to the Secretary of Defense there was over $2 billion, and we worked it down to this present level. We have had to readjust among a lot of things, each of which we thought was important.

There are obviously many differences of opinion among the Army staff, but this funding at the moment represents the staff judgment as to where this——

Mr. ANDREWS. You got this request from MACV for a hunter/killer on September 6, 1968, which was long before you put your final budget request before DOD for 1970.

General BETTS. As I said, our budget request for 1970 went into the first submission at a lot higher figure than what we now have submitted.

Mr. ANDREWS. What was your first request for this hunter/killer capability that you are working on as a result of a request from South Vietnam?

General BETTS. I do not have that information with me.

Colonel BONIFACIO. Sir, our first request really came in MACV problem area identification May or June of 1968 and from the supplemental funding we got $4 million, and then later, early this year, we received $2 million. We thought this was sufficient to do the job; however, since that time we found there were some additional things we wanted to do to the aircraft, like adding navigation devices and finalizing the system integration.

MACV's request was for a very short-term program. In other words, we would like to have it in a year to 18 months.

Mr. ANDREWS. They needed it?

Colonel BONIFACIO. They needed it and still need it.

Mr. ANDREWS. You have not answered my question. The question was, how much did you originally request for the SMASH program to the DOD in your initial budget request?

Colonel BONIFACIO. For 1970 it was ———.

General BETTS. Apparently we underestimated at the time we submitted the original budget.

Mr. ANDREWS. Underestimated what, the need or the costs?

General BETTS. The cost to complete and what we are stating here, when I said I do not think this money is enough it represents our latest judgment on what it takes to complete this program.

Mr. ANDREWS. What do you estimate it is going to cost today? You had about $6 million.

General BETTS. We had about $6 million. We had about $6 million and we asked for ——— we think it will probably take another ——— million above that.

OTHER PROPOSED IMPROVEMENTS TO HUEYCOBRA HELICOPTER

Mr. ANDREWS. General Betts, you have $6 million committed to this program thus far, and you feel you need another ——— million in fiscal 1970 to give the HueyCobra an all-weather fighter capability. At the same time, Secretary Resor's letter of June 27 requested another ——— million for development of a TOW missile, 20–30 millimeter gun system and night vision for the Cobra. Does this not in some way duplicate this effort?

General BETTS. In trying to upgrade the Huey Cobra to replace the capability we lost when we lost the Cheyenne and we were looking for the same kind of capability inherent in the Cheyenne.

The ——— million in Secretary Resor's letter proposes a development program that would go for a much better capability than we can provide with the technology that was available at the time we started this development. If indeed we did not get that ——— million, the kind of effort being done here would apply to the Cobras that we would put in the system to replace the Cheyenne.

Mr. LIPSCOMB. Why should not the ——— million be applied to the better system and discontinue this SMASH effort?

General BETTS. It is a matter of timing. This is almost ready now for flight evaluation. It will be a year to a year and a half before the fruits of a new development effort would be available.

Dr. LASSER. Much of the FLIR work is going to be used on the improved Cobra. One of the questions we get involved in here, can you fire the TOW at night with the night-vision equipment. This takes more money to do that, to incorporate the night-vision equipment we currently have—rather to incorpoarte the TOW into the night-vision equipment we currently are using on SMASH.

Mr. LIPSCOMB. Why should we go for a Cobra for which it is going to take a ——— to develop this capability? Why not wait for the Cheyenne? It is the same period of time involved.

General BETTS. But we have lost the Cheyenne production and at the moment, until we have satisfied ourselves and the Congress that we can develop a good Cheyenne, I do not think we ought to make a specific proposal with respect to its production.

AH–56A CHEYENNE DEVELOPMENT

Mr. MINSHALL. Just several days ago, General, you told us it was reasonably certain you would correct the rotor problem in the Cheyenne.

General BETTS. I certainly did and I still feel that way.

Mr. MINSHALL. The remark you just made indicated much doubt, though.

General BETTS. What I cannot predict is the time by which we will do this and the cost of the Cheyenne in production. The two are very closely related in that, as you are well aware, the cost of the Cheyenne had grown in the course of the development program to numbers that cast doubt on our ability to justify that cost. With the time that is made available to the program by the slippage in R. & D., we can go back and do a complete new production study job with respect to what the cost of the Cheyenne should be. We can put out some of the subsystem for competition.

And it would be my view there is a chance we can reduce these costs considerably. If we cannot, I do not think we will be able to justify it to the Army itself or to you that we ought to produce it.

Mr. Minshall. What route do you want to go if the Cheyenne does not work out?

General BETTS. The route that I would propose to take the armaments, fire control, and sensor subsystems that have been developed for the Cheyenne and that we can now go ahead and test to determine their capability and effectiveness, and apply those to an improvement program of the Cobra. A part of that is reflected in the ——— million we were talking about for the Cobra.

Mr. MINSHALL. How long will the improvement program take for the Cobra?

General BETTS. I just estimated a little while ago a year to ———.

Mr. MINSHALL. How long will it take for you to get over the hump on the rotor problem with the Cheyenne?

General BETTS. That is the big unknown. I do not know.

Mr. MINSHALL. It was not so unknown a week ago. This is what concerns me so far as your statement is concerned.

General BETTS. I said I was confident we could do this, but I do not recall I put a time frame on it and I would hesitate to put a time frame on it.

Mr. POOR. Mr. Minshall, it is my recollection in the earlier testimony we said that we were hopeful that if the control system as presently conceived for the Cheyenne could be indeed fixed, and technical opinion on this is divided, that we would know within perhaps 6 months that that was the case.

I think we also said that if that proves to be impossible and we need to go to an alternative control system that it might take as much as 2 years before we were sure that we had a satisfactorily flying version of the Cheyenne. So there is a good deal of uncertainty in our minds as to how long it will take to get a successful Cheyenne control system. We feel very little doubt that it can indeed be done. It is a question of whether the present control system with minor modifications gets us there or whether we have to go to an alternative backup control system to get there. The time spread is at least a year between those two possibilities.

Mr. MINSHALL. At least a year?

Mr. POOR. Between those two possibilities at least a year, and maybe more than that.

Mr. MINSHALL. What is the total maximum length of time that you think it will take to get the Cheyenne rotor problem ironed out?

General BETTS. I think the kind of times Mr. Poor just mentioned give that spread. Let me say if we did have to go to a backup control system I don't see any reason why it should take us more than ——— because the electronic technology is reasonably well known and it should be possible to do that kind of a development program in a period like ———.

May I add something else that I believe I did say the other day, and this is my personal conviction—it may or may not be shared by the contractor—I believe within 3 months, 4 months at the most, we will have done enough wind tunnel work and mathematical model simulation work with respect to the present control system of the Cheyenne helicopter that we will be able to predict then whether or not it will succeed or fail and what kind of a time frame will be necessary. At that time we might want to come back to you and restructure this whole effort.

Mr. MINSHALL. In other words, you would like to come back here the first part of next year and tell us how far down the road you can see?

General BETTS. Yes. As soon as we have an adequate base for high confidence in this program we ought to come back and talk to you about it in terms of what the course of action should be then.

Mr. MINSHALL. You will have some answer for us, one way or the other, by January of 1970?

General BETTS. This is my personal optimism that we will have it within 3 or 4 months.

Mr. MINSHALL. Do you agree with that, Mr. Poor?

Mr. POOR. Yes.

General BETTS. That is for the success or failure of the aircraft.

Mr. ANDREWS. Are they really working on the Cheyenne now?

General BETTS. Yes.

Mr. ANDREWS. Who is paying for this testing?

General BETTS. At the moment it is on Lockheed since they have an R. & D. contract with us.

Mr. ANDREWS. But the Government is not putting up any money for the work being done on the Cheyenne?

General BETTS. I don't know that I can say that.

Mr. POOR. Lockheed is still under contract and, as I understand it, we haven't made full progress payments on the AH–56. So since they are under a R. & D. contract I assume they are still incurring charges on the R. & D. contract. I am confident that in the area of Government-furnished equipment and support we are continuing to spend money on the development contract. The production contract, of course, is terminated.

Mr. ANDREWS. Unless and until the Cheyenne is perfected your best hope now is the Cobra?

General BETTS. That is correct.

Mr. ANDREWS. With the improvements that you have discussed?

General BETTS. That is correct.

FLIR/SMASH VERSUS MTI/SMASH

Mr. ANDREWS. The justification book also refers to Flir/Smash and MTI/Smash. What are these systems, for what are they being developed, and what has been the total cost through fiscal year 1969?

General BETTS. The three programs that you have named all fall within the general program we call SMASH. The numbers I gave you for the SMASH program include the FLIR/SMASH and the MTI/SMASH effort. So that is all one program.

Mr. ANDREWS. Explain in the record again the FLIR and MTI.

General BETTS. All right.

(The information follows:)

Forward Looking Infrared (FLIR) is a passive infrared device offering two fields of vision (20° x 40° and 5° x 10°) and operating in the 8 to 14 micron region. It will provide terminal target identification and fire direction. The moving Target Indicator (MTI) system is capable of long-range detection, acquisition, and tracking of personnel or vehicle targets moving from ——— to ——— mph regardless of light conditions, weather and/or vegetative clutter.

IROQUOIS NIGHT FIGHTER AND NIGHT TRACKING (INFANT) PROJECT

Mr. ANDREWS. Is the Forward Looking Infrared System (FLIR) a part of the Iroquois Night Fighter and Night Tracking (INFANT) project for the UH–1C helicopter?

General BETTS. The Night Vision Program that we refer to, the INFANT on the Iroquois Night Fighter would approach the Night Vision with a different technology. In this case a single Night Vision system that uses low light level television and the direct image, direct

view image intensifer sensors. It is true that we would apply these to HUEYS but probably to the HUEY-1B and 1C helicopter gunships that are already in the inventory.

Mr. ANDREWS. Tell us something about the Iroquois Night Fighter capability, how many of them you have in South Vietnam and what experience you have had with them.

General BETTS. The Iroquois is a name for the Hueys. As you are aware, we have had versions of the Huey with armament that were used as gunships before we got the HueyCobra. We do have on it 7.26-millimeter machineguns. We can fire from those aircraft the 2.75-inch rockets. It is that armament capability that we would integrate with this Night Vision capability we are discussing under the code name Infant and we will ship ——— aircraft so configured to Vietnam for evaluation in ———.

Mr. ANDREWS. There are none there at this time?

General BETTS. None with this Night Vision capability.

Mr. ANDREWS. Let me ask you again: Do you have any choppers in Vietnam today with a night fighting capability?

Mr. POOR. No; we do not have any integrated systems. We have done some very limited experiments in Vietnam with low light level TV systems to see whether or not we could pick up targets. This Infant system will be, as I understand it, the first time we put it together in the Huey to exploit the full integrated system capabiliy. As General Betts said ——— of these are scheduled to be shipped into Vietnam for experimental evaluation.

Mr. ANDREWS. What will they have that is different from FLIR?

Mr. POOR. They will have this low light level TV night vision system. It is a different kind of night vision system from the FLIR that we described earlier and the armament that is normally on such machines.

Mr. ANDREWS. Describe that night vision capability.

Mr. POOR. I would like Dr. Lasser to describe it.

Mr. ANDREWS. Doctor?

Dr. LASSER. The Infant has a dual low light level TV type night vision set of equipment. The one for the pilot has TV and the copilot has something called an image intensifier which is a starlight scope with an optical cable that comes up to his sight. The sights are integrated with the guns so that it is a system. The answer to your question whether or not this is the first system? Yes, it is, because the sights and the gun are slaves to each other. There is also a light source to complement this.

Mr. ANDREWS. What does that pilot see and what does the copilot see?

Dr. LASSER. The pilot sees a TV screen which is similar to what the pilot would see if he had a FLIR, but the mechanism is different. In the original Seanitops program, which is still ongoing, we felt that we needed a comparison of the two systems, the one referred to here as Infant which incorporates the low light level TV and the other one which uses the FLIR. The systems are being evaluated in the Seanitops program. There are advantages in both systems. They are very similar and very complementary.

Mr. ANDREWS. Tell us again so we can understand it.

Dr. LASSER. It won't do much different than you heard in the Smash except the Smash is in the Cobra. So what I am saying is you are

going to start hearing many of the same things over again. That is, in the Huey-1C, not the Cobra, it is configured as a gunship—it is not as efficient as a gunship as the Cobra but still configured as a gunship and has nighttime capability by using low light level TV system. If you compare it to FLIR, the FLIR probably has a longer range but weighs more and costs more.

DUPLICATE DEVELOPMENTS OF HELICOPTER NIGHT VISION SYSTEMS

General BETTS. Mr. Chairman, what tends to make this confusing is that perhaps we haven't laid the right groundwork. You are well aware that we have never had enough of the Cobra gunships in Vietnam to date and the recommended buy for Cobras in 1970 is not even up to what our combat losses are or have been if the level of combat had continued at the level of the past year. But we do have the older gunships. We felt that while we did not want to afford the more capable and much more expensive FLIR capability for the older gunships, it would be appropriate to configure them with this low light level TV approach to night vision. Consequently, this is a capability that makes these gunships more effective and we can use them effectively at night, but it doesn't change the fact that looking farther down the road the Cobra will have a greater capability than is provided in this system we are describing here.

Mr. ANDREWS. You mentioned the FLIR providing the Cobra with a greater capability than the Huey-equipped Infant. Would this capability be as great as the additional cost of FLIR?

General BETTS. I think so because it requires no supporting ambient light, whereas the Infant either has to have ambient light from moonlight or searchlights. You will notice in this system we have proposed to provide the lights along with it when the circumstance is such that they feel it is safe to use them.

Mr. ANDREWS. How much do you have in the 1970 budget for Infant?

General BETTS. I don't have that figure. I will have to furnish that for the record.

(The information follows:)

We expect to spend ——— million for the Infant task in fiscal year 1970.

Mr. ANDREWS. Also, how much was spent in fiscal 1969 on Infant?

(The information follows:)

In fiscal year 1969 $4.200 million was spent for procurement and support of Infant systems.

Mr. ANDREWS. I think you have done this but I am going to ask the question: Explain the differences between Smash and Infant as well as the differences between FLIR/Smash, MTI/Smash and FLIR/Infant for the record.

(The information follows:)

Smash is an acronym for SEA Multi-Sensor Armament System for Hueycobra. The AH-1G is the aircraft and weapons platform. An MTI radar will provide target detection out to ranges greater than ——— kilometers. The FLIR will provide the terminal sensor for target identification and fire control. The armament configuration will consist of the existing flexible XM-28 armament system (twin miniguns or twin 40-millimeter grenade launchers, or one of each), and the fixed forward firing XM-35 (20-millimeter gun) or optionally the XM-158 rocket launcher (7 tube, 2.75-inch rocket). The Iroquis Night Fighter and Night Tracker (Infant) is a low-light-level television (LLL/TV) and a direct view image intensifier. It is mounted in the nose of a UH-1C.

FLIR/SMASH is being developed by Aerojet General and MTI/SMASH is being developed by Emerson Electric. The two developments when integrated are referred to as Smash. The integration contractor is Bell Aerosystems.
FLIR is a ——— night vision device that requires ———. Infant ———.

Gun Type Subsystems

Mr. Andrews. Your fiscal 1970 program for gun type subsystems is ——— million. How much was spent for this purpose in fiscal 1969?

The actual program for gun type subsystems in fiscal year 1969 was $8.193 million.

XM–140 30–MM GUN FOR CHEYENNE HELICOPTER

Mr. Andrews. The committee notes that a portion of the fiscal year 1970 request will be used for the XM–140 gun and its ammunition for use on the Cheyenne. What is the cost of this effort?

(The information offered follows:)

——— million are programed to complete engineering and service tests on the XM–140. ——— million are included for continued development of improved 30-millimeter ammunition.

Mr. Andrews. How much will be spent on the 20-millimeter gun for the HueyCobra and does this not conflict with your proposal to adapt the Cheyenne weapons systems to the Cobra?

Lieutenant Colonel Bonifacio. No additional funds are programed in fiscal year 1970 for development of the 20-millimeter gun, XM–35, for the HueyCobra. The present effort does not conflict with the proposal. The current development work is in response to an Ensure requirement submitted by the field command in Vietnam for a point target weapon system that will provide improved accuracy, greater range and greater stand-off capability for a limited number of HueyCobra's. The feasibility and configuration of the "20/millimeter system" for an improved HueyCobra, as addressed in the proposal, has not yet been determined.

Mr. Andrews. Provide a table showing the work to be done under this program subelement for Cheyenne and HueyCobra together with cost data.

(The information follows:)

The only work being done on Cheyenne and Cobra under this program subelement is installing the Tow missile on the Cheyenne. This is funded at $6.0 million for fiscal year 1970.

PROGRAM ACCOMPLISHMENTS AND OBJECTIVES

Mr. Andrews. What was accomplished in fiscal year 1969 and what do you hope to accomplish in fiscal year 1970?

Lieutenant Colonel Bonifacio. In fiscal year 1969 we completed engineering and service tests of the XM–129, 40-millimeter grenade launcher; the XM–27E1 minigun subsystem for the OH–6 helicopter; and the XM–28, 7.62 and 40-millimeter subsystem for the AH–1G. We initiated engineering and service tests of the 40-millimeter high explosive antitank round; the 40-millimeter airburst fuze; and the XM–140, 30-millimeter automatic gun system for the AH–56A. We continued development of the XM–8, 40-millimeter grenade launcher sub-

system for the OH–6; the 30-millimeter aluminum case; the boosted 40-millimeter grenade; and the 20-millimeter automatic gun system for the AH–1G. We adopted the 40-millimeter airburst fuze as limited standard. We initiated development of a proximity fuze and boosted round for the 30-millimeter automatic gun.

In fiscal year 1970 we plan to complete engineering and service tests of the 30-millimeter automatic gun and to continue development of an aluminum cartridge case, an airburst round and a boosted round for the XM–140. We plan to submit the following items for adoption as standard: the XM–129; the XM–27E1; the high explosive antitank round; the boosted 40-millimeter grenade; and the 40-millimeter airburst fuze. We plan to submit for adoption as limited standard the 20-millimeter gun and the XM–28 for the AH–1G.

Mr. ANDREWS. Are there any questions thus far?

Mr. DAVIS. No questions.

MISSILE-ROCKET SUBSYSTEMS

Mr. ANDREWS. Next we take up the missile-rocket subsystems.

Your estimate for missile-rocket subsystems totals ——— million. What was the fiscal year 1969 actual program for this effort and what was accomplished during fiscal year 1969?

General BETTS. I do not have the 1969 information broken out. I will have to furnish that.

(The information follows:)

The actual program for missile-rocket subsystems in fiscal year 1969 was $12.258 million.

In fiscal year 1969, we initiated development and began engineering and service tests of the XM–200, a repairable, reusable 2.75-inch rocket launcher. We adopted as standard the XM–429, a proximity fuze for the 2.75-inch rocket, and continued development of the time/delay fuze for the 2.75-inch rocket. We suspended work on the advanced point target missile subsystem, XM–26/UH–1C, and directed our effort to the development of TOW/Cheyenne control equipment. In initiating development of the TOW/Cheyenne, maximum use was made of components developed under the XM–26/UH–1C program.

Mr. ANDREWS. What tasks do you have under this subelement?

TOW/CHEYENNE CONTROL EQUIPMENT

General BETTS. We have the TOW/Cheyenne control equipment.

Mr. ANDREWS. Explain that for the record.

(The information follows:)

A requirement exists for TOW/Cheyenne control equipment for use on the Cheyenne helicopter. This equipment must be compatible with the helicopter, stabilized sight and launcher. The TOW/Cheyenne control equipment components are as follows:

a. Remote armament control.
b. Missile command signal generator.
c. Electronic power supply.
d. Electrical equipment rack.
e. CSG error detector.
f. Signal processing amplifier.
g. Weapon system control.
h. Infrared tracker.

Six million dollars was included in the President's budget for fiscal year 1970. Plans are to develop preproduction TOW hardware that is representative of an optimized integrated weapons system. This equipment will undergo laboratory qualifications and reliability testing in fiscal year 1970.

SELECTIVE EFFECTS ARMAMENT SUBSYSTEM (SEAS)

General BETTS. We also have the program we discussed earlier, the SEAS.

Mr. ANDREWS. Explain that for the record.

(The information follows:)

The selective effects armament subsystem, SEAS, will replace the 2.75-inch folding fin aerial rocket systems now being used. SEAS will provide significantly improved lethality against personnel and materiel targets and a high kill probability against armored vehicles. The subsystem will have a family of warheads (HE, Flechette, Smoke, CS, Incendiary) and fuzes (Super Quick, Delay, Time, Proximity).

TOW/CHEYENNE CONTROL EQUIPMENT

General BETTS. We have a small sum of $220,000 allocated to support of test aircraft that would be working in this technology.

Mr. ANDREWS. Page 109 of the justification mentions the TOW/Cheyenne control equipment. How much will be devoted to this effort?

General BETTS. That is the $6 million I just mentioned for fiscal year 1970. I might point out that that $6 million was in the President's budget and we had submitted it that way. In the interim period between the time you submitted the budget and the time Mr. Resor wrote to this committee with respect to the difficulties we had with Cheyenne, there has been cost growth in the Tow system elements that we need to relate to the Cheyenne so that we now find in Mr. Resor's letter a commitment of ——— million to this TOW/Cheyenne control equipment.

Mr. ANDREWS. I believe you stated that the TOW/Cheyenne equipment or system does work?

General BETTS. The TOW firing capability has been checked out on a Huey helicopter. It has actually been fired from the Cheyenne aircraft but not in all aspects of the flight performance envelope, nor under all conditions that the user would be interested in having it tested before he would be prepared to accept this as an aircraft ready for contract.

Mr. ANDREWS. You do not anticipate any major problems?

General BETTS. We do not anticipate any major problems. We do anticipate a considerable period of testing and modification to make the highly reliable, fully acceptable system.

Mr. ANDREWS. Before going into production, if you ever go into production?

General BETTS. That is correct.

Mr. ANDREWS. I don't want to belabor this subject of the Cheyenne, but is the main problem with it due to that rotor?

General BETTS. That is the key question, key difficulty.

Mr. ANDREWS. All the inside avionics and armament and everything else you think is in good condition or could be put in good condition with no major problems?

General BETTS. Yes, sir. Those were the systems we expected to have trouble with and actually they have come out very well.

Mr. ANDREWS. How does this effort differ from the additional ——— million required for TOW/AAFSS development mentioned in Secretary Resor's letter of June 27th?

General BETTS. If we are talking now about the ——— million that was in Mr. Resor's letter for this activity, it would go to design, fabrication and integration of Tow control equipment into the Cheyenne and ——— million would be used for testing and support.

The difference here is that the program as we now see it will require more testing and more support effort than we had originally anticipated.

XM–26 TOW SYSTEM FOR UH-1C HUEY HELICOPTER

Mr. ANDREWS. Why was the Tow development for the UH–1C terminated and how much has been spent for this purpose before it was terminated?

General BETTS. We spent $29.446 million of R.D.T. & E. money and $1.576 million of PEMA dollars in support of R. & D., making a total of $31.022 million for the XM–26 program?

Mr. ANDREWS. What is the XM–26 program?

General BETTS. That is the designation we give to the Tow application, to the UH–1C helicopter. When we completed the engineering development we suspended this work indefinitely because we did not have the resources to go ahead with that development and begin the effort to adapt Tow to the Cheyenne aircraft. At the time we made the decision to stop the XM–26 work and shift the effort to the Cheyenne things were going very well with that program and we thought it was the prudent thing to do.

We have actually stored two test systems of the XM–26. If things change and we decided to go back to that system we would be well along towards final development.

Mr. ANDREWS. Same as you had for the Cheyenne?

General BETTS. That is right.

SOUTHEAST ASIA REQUIREMENT FOR 2.75-INCH ROCKET

Mr. ANDREWS. You propose to conduct Southeast Asia evaluation of the 2.75-inch rocket control panel and delay fuze during fiscal year 1970 and to classify standard A the 2.75-inch proximity fuze and the repairable launcher. Will any of these items be used for the selective effects armament system (SEAS) on which you propose to initiate engineering development during fiscal year 1970?

General BETTS. Although the descriptive summary we submitted does indicate adoption of the time delay fuze as a standard item in fiscal 1970, that adoption of both the fuze and the control panel was dependent upon an estimate—a statement of requirement within the Army R. & D. structure. At the moment we do not have such a statement of requirement, and in addition——

Mr. ANDREWS. What do you mean, you don't have a requirement?

General BETTS. Well, the organization within the Army that is responsible for expressing requirements for new equipment, new weapons, is the Combat Developments Command. In this particular item they have not expressed a requirement for it even though there has been such a request expressed from MACV. So that our worry on the staff is to validate the requirement that was expressed by the people in the fighting theater. That validation has not been received.

Mr. POOR. Maybe we are having trouble making the distinction.

Mr. ANDREWS. Yes. Why do we spend money developing these systems if you have no requirement for them?

Mr. POOR. It is really very simple. We have an Ensure requirement, which is a statement from the theater in Vietnam that they want this device.

Mr. ANDREWS. That means a requirement is present, then.

Mr. POOR. We are going ahead and building them to meet that Ensure requirement. The kind of requirement needed for military standard A is a different thing. This says we want to equip the whole Army wherever it fights with this equipment for the foreseeable future. That requirement process is more elaborate and different from the Ensure requirement for the theater. So what General Betts is saying is: Yes, we are going to build these things; yes, we are going to give them to the theater for their operational use and evaluation. If they are as well pleased with them as we hope, this may influence the normal Army requirement system under the Combat Developments Command to standardize them standard A for world-wide use.

Mr. ANDREWS. This sounds like you are trying to generate requirements.

Mr. POOR. MACV asked for something which they need and we are providing it. It is not yet clear that the Combat Developments Command will find that this is of sufficiently general utility to justify procurement for, for instance, the units in Europe. I think they will, because I think the system will prove good enough so that we will get such a requirement but at the moment that step has not been taken. It sounds complicated but it isn't.

Mr. ADDABBO. When will the system be operational?

Mr. POOR. I would have to provide that for the record. I don't know. The delivery for evaluation in Vietnam is scheduled for ———. That in a legal sense is not operational but it will be there in a theater and they will be using and trying it out.

Mr. ADDABBO. The only reason I ask that question is that the President said we may be out of there by next year so that we don't want to spend money for stuff now that we won't need there next year.

Mr. POOR. I suspect whether we are out of there or not this kind of weapon would be very useful for the South Vietnamese forces as a leave-behind item.

COSTS IN ADAPTATING TOW TO VARIOUS HELICOPTERS

Mr. ANDREWS. General Betts, I think we should have something clarified at this point in the record. That is, how much have we spent over the years in adapting the Tow missile to various aircraft of the Army? I speak of the UH–1C, the Cobra, the Cheyenne, and any other aircraft. And the requirement for this antitank missile——

General BETTS. Antitank, antivehicle, antibunker, just any hard target.

Mr. ANDREWS. It is listed in the justification book as an antitank missile.

General BETTS. The Tow by definition is an antitank missile.

(The information follows:)

As of June 30, 1969, a total of approximately $41 million has been spent adapting the Tow missile to helicopters. Of this amount, $31 million was spent on the UH–1B and $10 million has been spent on the Cheyenne.

QUESTION OF ROLES AND MISSION

Mr. ANDREWS. We spoke of missions earlier with respect to surveillance aircraft that the Air Force was primarily interested in trucks, tanks, et cetera, whereas the Army's mission was different. We have supplied the Air Force with considerable funds for the development of ordnance to be used against the tanks and the trucks. Now, why the Army has an urgent mission for weapons such as the TOW on a helicopter I think you should clarify in the record at this point.

General BETTS. I would be glad to explain that. I think it comes out that there has been no armament invented for any of our aircraft, high or low performance yet that promises what the TOW can promise in this role, at the ranges that are available to the TOW.

Mr. ANDREWS. Mr. Lipscomb mentioned earlier that he was not sure as to the roles and missions for some of these weapons. I think this is one of the areas that seems to be confusing.

General BETTS. All right. I would be glad to explain that.

(The information follows:)

The Air Force has the mission of interdiction and close air support. In a war, both of these missions can and will involve attacking tanks at one time or another. The Army also fights and destroys tanks and other armored vehicles with antitank weapons, rocket launchers, and so forth. The Cheyenne with TOW will have this capability. It will be working as an integral part of the ground forces encased in this fight and will be able to fight in much closer quarters and under more adverse weather conditions than fixed wing aircraft.

FISCAL YEAR 1970 PROGRAM EFFORT

Mr. ANDREWS. What do you hope to accomplish during fiscal year 1970 with the ——— million requested?

Put that in the record.

(The information follows:)

We plan to continue work in integrating the Tow missile into the Cheyenne weapons system and to initiate development of the selective effects armament subsystems, SEAS. In addition, we will provide support for test aircraft that will be working in this technology.

AIRCRAFT ENGINES

Mr. ANDREWS. Your fiscal year 1970 estimate for aircraft engines is ——— million, an increase of ——— million over fiscal year 1969. What is the requirement for this increase?

General BETTS. This increase is required to fund the beginnings of the engine development program for the utility tactical transport aircraft system (UTTAS). This first year of a 4 year ——— million program will initiate the design and parts procurement to support the effort.

Mr. ANDREWS. What happened to the $1.8 million originally programed for this purpose in fiscal year 1969?

General BETTS. Additional funds were required in the 6.3 demonstrator engine program. As a result, $940,000 was reprogramed from the 6.4 engine program into the demonstrator engine program on fiscal year 69–2 reprograming action (DOD fiscal year 69–28). An additional $720,000 was reprogramed, on the same reprograming action,

from the 6.4 engine program to meet other requirements. After these reprograming actions, $140,000 remained to support 6.4 engine fiscal year 1969 efforts.

RELATIONSHIP TO DEMONSTRATOR ENGINE PROGRAM

Mr. ANDREWS. How does this program element relate to the demonstrator engine program element?

General BERTS. This program is the follow-on program to the demonstrator engine program. As technology is demonstrated in the form of a new advanced engine and, as a requirement for that new engine is defined, then the funding support for the new engine is placed within this element.

CONTRIBUTION TO HEAVY LIFT HELICOPTER ENGINE

Mr. ANDREWS. Page 110 of the justification book states the fiscal year 1970 program will be initiating the UTTAS engine development program. How has the demonstrator engine program contributed to the engine for the proposed heavy lift helicopter?

General BERTS. For HLH, the demonstrator engine program has made little direct contribution because it is aimed at an engine (1500 hp.) possessing one-fifth the horsepower needed for the HLH. Current HLH requirements show a need for the engines of approximately ——— hp. each, or four engines possessing approximately ——— hp. each, for a total of over ——— hp. The Army will seek to incorporate maintainability features of the demonstrator engine program in HLH engines; however, the main development effort with the HLH engines within this element will be to combine several existing, proven engines into a multiengine configuration.

ESTIMATED COSTS OF NEW ENGINE DEVELOPMENTS

Mr. ANDREWS. What is the proposed cost of developing engines for the UTTAS and for the HLH?

General BERTS. For the UTTAS, ——— million and for the HLH, ——— million.

ACCOMPLISHMENTS IN FISCAL YEAR 1969

Mr. ANDREWS. What was accomplished during fiscal year 1969 and what do you propose to accomplish during fiscal year 1970?

General BERTS. There was little effort in this program in fiscal year 1969. During that time, we supported in-house efforts to monitor the engine state-of-the-art and conduct limited investigations into future trends and requirements. For fiscal year 1970, we intend to begin the engine development program for the UTTAS. This first year of a 4-year ——— million program will initiate the design and parts procurement to support the effort.

SUPPORTING DEVELOPMENTS FOR AIR MOBILITY

Mr. ANDREWS. We will now take up the supporting developments for air mobility.

You are requesting ——— million in fiscal year 1970 for supporting developments for air mobility. The justification book shows that the fiscal year 1969 program was $4.6 million. What was the actual fiscal 1969 program?

General BETTS. $4.7 million is the figure that I have, Mr. Chairman.

Mr. ANDREWS. Where did you get the extra $100,000?

General BETTS. I could not identify the place from which we transferred it.

Mr. ANDREWS. Try to find out and put it in the record.

(The information follows:)

In fiscal year 1969 $4.670 million was approved by Congress for this program. The justification book should have shown $4.7 million instead of $4.6 million.

Mr. ANDREWS. What was accomplished during the fiscal year 1969 program? Put that in the record.

(The information follows:)

The following was accomplished in fiscal year 1969 in 6.42.04.A, supporting development air mobility.

(*a*) UH–1 diagnostic equipment test bed program initiated.

(*b*) Standard trailer system (basic trailer plus 2 adaptors) in process of being accepted as standard equipment.

(*c*) Initiated component development for air dynomometer for the turbine engine test stand.

(*d*) Lightweight aircraft maintenance workstand for CH–47 and CH–54 accepted as standard equipment.

(*e*) Initiated ET/ST for airmobile aircraft maintenance shops and initiated actions to procure 200 shops as limited standard (concurrent ET/ST).

(*f*) Completed engineering design test of 500–lb. capacity controlled airdrop cargo system.

(*g*) *Airdrop:*

(1) Completed EDT and ET of 500-lb. capacity low cost cargo parachute.

(2) Completed ET of a lightweight gantry.

(3) Completed ET of 35,000 lb. airdrop cargo system.

(4) Type classified container, freedrop, for liquids.

(5) Completed ET on coupling, airdrop, extraction for transfer.

(6) Initiated joint service test of low altitude parachute extraction system (LAPES).

(7) Initiated ET/ST of release, parachute, cargo release (Medium capacity—2,500—35,000 lb.).

(8) ED and fabrication of components for steerable parachute assembly.

(*h*) Continued engineering design and development of leg armor.

(*i*) Completed development of aircrewman's body armor with increased protection from projectile splash and spall.

(*j*) Developed cockpit and critical component armor for OV–1 and a removable head guard for UH–1 pilot's seat.

(*k*) Conducted testing to determine effects of body armor on parachuting and ejection.

(*l*) Refined critical component armor for CH–47, OH–54 and 0–1 aircraft.

(*m*) Developed crash resistant fuel systems (CRFS) for UH–1, T–41 and TH–55 aircraft.

(*n*) Continued development for CRFS for following aircraft (to be completed in fiscal year 1970): (1) AH–1G, (2) CH–47, (3) CH–54, (4) OH–58, (5) OH–6, (6) AH–56, (7) OV–1, (8) U–21.

AIRCREW BODY ARMOR DEVELOPMENT

Mr. ANDREWS. How much will be spent during fiscal year 1970 for air crew body armor?

General BETTS. During 1968 we spent $1.1 million; in 1969 another $350,000. From that we have standard aircrew body armor that was

type-classified in January of 1968. All of the efforts in that program now would be devoted to improvements or refinements of the standard body armor.

Mr. ANDREWS. Tell us something about the aircrew body armor. You have discussed it previously.

General BETTS. It is configured so that we can apply it to the seat so that he does not have to haul it around when he gets in and out of the aircraft. That gives him part of his protection. Then he would put on his chest protection and leg protection if he so desires.

Mr. ANDREWS. Is this the same armor you described earlier?

General BETTS. Yes, sir; it is the same technical approach and the same kind of thing also used for drivers of vehicles, for example.

Mr. ANDREWS. Put something in the record about it.

(The information follows:)

Development of aircrewman's armor has been very successful in recent years. In 1965 the best protective material available was aluminum oxide reinforced plastic which could only be manufactured in flat 5-inch square tiles and was relatively heavy. Consequently, original aircrew armor was heavy, cumbersome and flat in design. Continued research and development have produced lighter weight materials that can be shaped to the body. The present standard armor, which can defeat .30-caliber armor piercing ammunition, is the result of continuous testing and improvements, optimized shaping and sizing, and test and evaluation in combat. To date over 50,000 pieces of aircrew body armor have been shipped to Vietnam. A recent Army study attributes the use of aircrew armor for reducing aircrew fatalities from gunshot wounds by roughly half during the period 1962–67.

We are encouraged by this favorable experience and are continuing to improve our knowledge in this field. Current research and development efforts are focused on designing leg armor, improving current body armor, and developing lightweight armor to defeat larger caliber ammunition.

AIRDROP EQUIPMENT

Mr. ANDREWS. You propose to spend about ——— million on airdrop equipment. What are you doing in this area and how does it duplicate Navy and Air Force work?

General BETTS. During this year we would expect to go ahead with engineering design of a low-altitude airdrop system for personnel, 500 feet or less. There is ——— allocated to that. We would also have some effort on a check test for low-cost, 500-pound capacity parachute. There is a small amount of ——— applied to that. We would have a check test of parachute reserve for personnel that would be ballistically deployed, ——— allocated to that. Service test of lightweight gantry which is used for airdrop rigging, and we would hope to complete the service test of the 35,000-pound capacity airdrop system that we discussed the other day.

Mr. ANDREWS. Is any of this money designated for C–5A airdrop equipment?

Colonel BONIFACIO. That effort is still in the exploratory area.

General BETTS. This is closer to success. They are in two different line items.

Mr. ANDREWS. Why must you expend effort in this area in addition to the Navy and the Air Force?

General BETTS. We are the ones that do the jumping, we are the ones that do the airdropping to scattered field units from low altitude, and

we have the greatest interest in the overall combat airdrop capability. What I can add to that is what work the Navy and Air Force do is closely correlated. For example, things like the low-altitude parachute extraction system which is an Air Force program, is a good technique for certain things under conditions where you can get a fixed-wing aircraft down close to the ground. I believe our work is effectively and satisfactorily complementary to that which the other services are doing. We do, of course, have joint tests with the Air Force on all our heavy airdrop testing.

Mr. ANDREWS. Describe your fiscal year 1970 program.

General BETTS. In airdrop, that was the program I was discussing, Mr. Chairman.

UTILITY TACTICAL TRANSPORT AIRCRAFT SYSTEM

Mr. ANDREWS. You are requesting ——— million in fiscal year 1970 to develop a new aircraft system called the utility tactical transport aircraft system (UTTAS) which will replace the UH–1 Huey in the mid-1970's. In view of the fact we have modified and improved the Huey over the years, why is a replacement necessary?

General BETTS. The Huey aircraft, even though there have been modifications and improvements over the years, is basically a 10-year-old aircraft in terms of helicopter technology. It is our conviction that in a period like 5 or 6 years from now we ought to be prepared to replace it with more modern technology. If we start a development in this time frame it will be that time frame before we would be ready to produce it.

COST OF MODIFYING AND IMPROVING HUEY HELICOPTER

Mr. ANDREWS. How much have you spent in modifying and improving the Huey over the years? Supply that for the record.

(The information follows:)

The Army has spent $57.8 million since 1956 improving the UH–1 aircraft. This money has purchased three XH–40 aircraft in 1955, six YH–40 aircraft during fiscal years 1956–59, six YUH–1B aircraft during fiscal years 1959–61, and seven YUH–1D aircraft in fiscal years 1959–64. These 22 aircraft have been used to complete necessary preproduction testing and evaluation. Changes recommended from tests were incorporated in the production aircraft. In addition, since 1956, the Army has spent $31.5 million in developing and improving the T–53 engine. This engine is used on the UH–1 Army series of aircraft and on the Army's OV–1 surveillance aircraft.

(Clerk's note: Above insert does not include all PEMA cost of improving and modifying the UH–1 Huey helicopter.)

UTTAS DESIGN

Mr. ANDREWS. Now getting back to this question of ——— million for the development of a new aircraft system, how will that money be spent? How will the work be done?

General BETTS. We have been engaged in concept formulation studies on this aircraft for some time.

Mr. ANDREWS. Through contract or in-house?

General BETTS. It has been a little of each, although most of it has been in-house. What we are after is an optimization between the effi-

ciency of carrying a lot of people in an airplane and the flexibility from a combat point of view of having a lot of airplanes, each of which carry only a few people. So that the primary attention we have paid to this program is to cost out a total system of aircraft in terms of numbers of people to fly them, to maintain them, the cost of the individual aircraft, supplies, in the several different versions and sizes I mentioned.

Frankly, at the moment we have not reached a hard decision saying that there is a specific-sized aircraft and a specific passenger-carrying load that we propose.

Our studies have not reached the point where we are prepared to go after a hard design. What we would propose to do with these funds is to begin the completion of designs that would lead to UTTAS through the typical contract definition phase. But I say in all candor that we would not start that unless we can solve the question of an optimum size in our own design studies.

REQUIREMENT FOR UTTAS HELICOPTER

Mr. ANDREWS. What you are telling us is that the Huey has been a good chopper and it is expected that the life of a chopper of that type is 10 years and in the next 5 years you will have need for a replacement for the Huey and you want to start work on that replacement?

General BETTS. That is correct.

Mr. ANDREWS. What will the UTTAS provide you that the latest twin-engine Huey will not? Compare the characteristics of the twin-engine Huey with the proposed UTTAS.

General BETTS. The best of the Huey's available now carry a crew of 3 and 7 combat-equipped troops. They will do this for 2 hours on a typical mission and hover out of ground effects at 4,000 feet with that kind of a payload. We believe we can get an airplane that will carry ——— to ——— combat loaded troops in addition to a crew of ——— with a duration of ——— hours and will hover out of ground effect at more than the ——— foot altitude that I just discussed, or at least at that altitude.

Furthermore, we believe that helicopter technology has come so far in the recent past that we could get a speed of ——— knots as against 105 knots.

Mr. ANDREWS. Are you comparing that future hope with the present twin-engine Huey?

General BETTS. UH–1N is the model Huey I was comparing it to.

Mr. ANDREWS. Is that the twin-engine?

General BETTS. That is the twin-engine.

Mr. ANDREWS. And what you are talking about is 5 or more years from now?

General BETTS. That is a good round number for a development effort of this sort, 5 to 6 years.

WORK ON UTTAS PROGRAM THROUGH FISCAL YEAR 1969

Mr. ANDREWS. What have you accomplished with the $2.7 million spent on UTTAS through fiscal year 1969?

General BETTS. We have defined various design considerations that we felt were necessary to meet the UTTAS characteristics. There have been some contractual efforts in logistics studies and technical approaches, system development engineering support efforts which have contributed to this overall design analysis, and there have been in-house efforts in the order of $1.2 million that support those people in the Aviation Systems Command, in the Electronics Command who have worked in the design, trade-off and cost effectiveness analyses.

Mr. ANDREWS. Why do you require a helicopter to airlift a rifle squad of ——— men and the Chinook to airlift a platoon?

General BETTS. It is our feeling that we begin to lose flexibility of combat operations when we start going to the larger Chinook as opposed to a smaller aircraft that would be operated by UTTAS.

Mr. ANDREWS. They can't get in and out as fast.

General BETTS. Can't get in and out as fast, also you are tied to larger individual units, and even more importantly the aircraft costs more and losses are higher when you lose one aircraft in combat operation.

NAVY'S SEA KNIGHT HELICOPTER AND ARMY REQUIREMENTS

Mr. ANDREWS. How many men will the Navy's Sea Knight helicopter transport?

General BETTS. I don't know the answer to that.

Colonel BONIFACIO. That is the CH–46 and it will essentially lift 15 combat troops, that is, combat-equipped.

Mr. ANDREWS. Do you consider the Sea Knight better than your Huey?

Colonel BONIFACIO. I do not consider it so, sir.

General BETTS. I believe we find it more expensive.

Mr. ANDREWS. More expensive than the Huey?

General BETTS. Yes, sir; and more difficult to maintain. That is a twin-rotor helicopter. It takes more parking space also.

Mr. ANDREWS. How does it compare with the UTTAS you were talking about?

General BETTS. I think it would fall far short of what we could get with modern helicopter technology.

Mr. ANDREWS. What is the age of the Sea Knight and the age of the Huey?

General BETTS. They are about the same time frame in their basic design.

Mr. ANDREWS. Do you know whether the Navy is thinking about a follow-on for the Sea Knight?

General BETTS. I do not. They have expressed an interest in the UTTAS but they have not expressed any willingness to put money into its development effort.

Mr. ANDREWS. They want you to do the work?

General BETTS. We will discuss this further with them. I believe if we went ahead with this development and it turned out to be the size carrier that was appropriate to their requirements or the Marines' requirements, that they would be interested in it.

Mr. ANDREWS. I don't want to see any more TFX's during my lifetime, but I would think that when you get to talking about a chopper the services at least can get together.

General BETTS. Just as we have in the Huey.

Mr. POOR. All three services have various versions of the UH–1A.

Mr. ANDREWS. Is the Sea Knight a version of the Huey?

Mr. POOR. No. That is a Chinook class aircraft, somewhat smaller version of the Chinook which we have.

Mr. ANDREWS. Midway between the Huey and the Chinook?

Mr. POOR. Yes.

USE OF UTTAS HELICOPTERS BY ALL MILITARY SERVICES

Mr. ANDREWS. Now, this UTTAS you were talking about, there is no reason why it shouldn't appeal to all the services?

General BETTS. None that I can see.

Mr. ANDREWS. If you could get together in time and agree on the UTTAS some money could be saved, in my opinion.

General BETTS. I would agree.

Mr. ANDREWS. You would save on the R. & D. and you could get a cheaper production cost.

CONTRACT DEFINITION SCHEDULED FOR OCTOBER, 1970

If you do not propose to solicit contract definition proposals from industry until October 1970, why do you require ——— million in fiscal year 1970?

General BETTS. We have the difficult problem of long leadtime for the engines that would be used. As quickly as we can determine in our own minds the design that we would want for this aircraft in terms of size, we can pin down the engines that we would use and make the purchases necessary to have those ready for competition.

UTTAS ENGINE DEVELOPMENT FUNDED UNDER TWO DIFFERENT PROGRAMS

Mr. ANDREWS. Isn't this engine money in another appropriation? Page 110 of the justification book states "The fiscal year 1970 program will be devoted to initiating the UTTAS engine development program."

General BETTS. Engine development is one question. Buying engines for the competition, the actual aircraft competition, would be funded under this line item.

Mr. ANDREWS. Why has this program slipped about 12 months?

General BETTS. I don't consider that it has. We did not expect that we would be much farther along than we are now in defining the requirement. Now, this is kind of a moot question. If we had had a firm picture of exactly what it was we wanted we could have moved out more rapidly. But I think it is prudent to explore this optimization question in adequate depth so that when we do go ahead with this development it has a firm justification.

Mr. ANDREWS. Will the UTTAS program be a tri-service development to satisfy Navy and Air Force requirements for a helicopter of this size? You have expressed the hope that it would be.

General BETTS. It should be discussed further with them. I could not promise that.

COMPLETION OF COST EFFECTIVENESS STUDIES

Mr. ANDREWS. Page 114 of the justification book indicates that cost effectiveness studies will be completed during fiscal year 1970. Why is this not done prior to requesting funds to initiate development?

General BETTS. This goes back to my comment about the long leadtime on the engine. It seems to me if we are going to go ahead with the kind of schedule that we have discussed during fiscal year 1970 we would need to make contractual arrangements for the long leadtime aspects of the engine procurement.

TOTAL COST OF UTTAS DEVELOPMENT

Mr. ANDREWS. According to the justification book, a total of ——— million will be required to complete development of this aircraft, excluding the engine and avionics. What is the estimated cost of developing the engine and avionics?

General BETTS. Our guess or estimate is that it would be about ——— million for the actual engine development and somewhere between ——— million and ——— million for the avionics development, depending on the degree of sophistication that we would attempt to achieve.

Mr. ANDREWS. And that would be a total of around ——— million?

General BETTS. That is correct.

Mr. ANDREWS. How firm do you consider those estimates to be? When were they made?

General BETTS. Within the last 6 months. They are as good as we could hope to do until we have a design. These are very broad brush considerations.

Mr. ANDREWS. You are shooting in the dark?

General BETTS. We are.

Mr. MINSHALL. Would you yield?

Mr. ANDREWS. Yes.

AIRCRAFT ENGINES WHICH MAY BE UNDER DEVELOPMENT

Mr. MINSHALL. You say you are going into this extensive research and development program for a new engine. Don't some of these larger manufacturers have aircraft engines on the drawing boards or in development?

General BETTS. I am sure that the major engine contractors do a certain amount of development work on their own with their own funds for new engine work, but it has been our experience in the past that—and by our experience I mean all three services—that when we get really serious about a particular engine size it takes the kind of money that comes only by going into a competition and picking the winner of that competition and developing exactly what it is we need.

Mr. MINSHALL. How do you know what they may already be developing, or have under development? Who are some of the major aircraft engine people? Continental is one.

General BETTS. Continental is one, Pratt & Whitney, General Electric.

Mr. MINSHALL. Lycoming. Now, all these people have things on the drawing boards, they have research and development staffs.

General BETTS. Surely.

Mr. MINSHALL. They are looking down the road.

General BETTS. But they do not go ahead with a full-blown development with their own money to the tune of the kind of money it takes to do what we are talking about here.

Mr. MINSHALL. They might if they thought they had a reasonable chance to bid in on it, wouldn't they?

General BETTS. I don't know how to predict what sort of a risk they are willing to accept.

Mr. MINSHALL. They won't accept any risk if you are going to do it for them.

General BETTS. Well, they do spend their own money on getting into position to compete with other engine manufacturers, when one goes into this kind of a development. But I am not aware of the circumstances under which they are willing to go out to the tune of ——— million on the gamble that they might have the engine that would satisfy our requirements. That has not been the case in the past. I might ask Colonel Nixon to expand on that. He is closer to the program than I am.

ADVANCED TECHNOLOGY ENGINE

Colonel NIXON. Sir, any time you put an engine into an aircraft it is sized according to the needs of that aircraft. The Army in the UTTAS aircraft has believed for about 2 or 3 years that we have a size requirement of about ——— horsepower. The Lycoming engine we currently use is right in that ball park. However, it is an old technology engine. As a result, and unfortunately we don't have this testimony before us because it was in the demonstrator engine testimony and also the aircraft engine; we have gone out in the last 2 years and contracted in the competitive environment with Pratt & Whitney and GE to build us an advanced technology engine that is low weight, low specific fuel consumption. In other words, low pounds of fuel consumed per horsepower hour as compared to what we have now. Also, it has maintainability and reliability features which we do not have in our current engines. One real good example is we have inspection ports in the hot end of the engine that we can look into, on this advanced technology engine which we cannot do in our present engines.

In order to look into that hot end we have to take the entire engine off, which costs time and manpower effort. So that we have this engine now that is in the state of development where it is almost complete in its demonstration phase, and which will be complete in fiscal year 1970. It is sized for the UTTAS. We would like to be able to put that engine into the UTTAS. Now, we require about ——— million to do it because we have only got about one of these engines built per manufacturer. In order to qualify an engine before you can put it into an aircraft to fly it with a man in it, you have to spend innumerable number of test hours where you actually destroy the engine on the test stand to determine what its operating limitations are. Through this process of

building and testing and destroying engines we finally come up with the limitations of the engine. Then it is a man-rated engine, so to speak. This is what costs money. It is a very expensive proposition.

ENGINE DEVELOPMENT PROGRAM TO BE COMPLETED

Mr. MINSHALL. My queston is, why aren't the manufacturers willing to at least assume a part of this risk?

Colonel NIXON. The current Secretary of Defense regulations prescribe that any development program we go into be fully funded so that anybody in the United States could legally, realistically be allowed to compete in the program. That is why it has to be a fully funded program. Large corporations like Pratt & Whitney and GE are fully capable of doing this. However, we then set up a monopolistic sort of situation in the engine program. So all of our development programs are supposed to be fully funded.

Mr. MINSHALL. Thank you, Mr. Chairman.

ESTIMATED UNIT COST OF UTTAS

Mr. ANDREWS. What is the estimated unit cost of the UTTAS? Supply that for the record.

General BETTS. It is very early, but in broad terms we are thinking of ———. That is a very shaky estimate at this time.

Mr. ANDREWS. What is the proposed number of such aircraft required?

General BETTS. In the pattern of total replacement of the Huey's we see something between ——— and ——— aircraft.

Mr. ANDREWS. Questions thus far? Mr. Addabbo?

Mr. ADDABBO. No questions.

Mr. ANDREWS. Mr. Minshall?

Mr. MINSHALL. No questions.

Mr. ANDREWS. Mr. Rhodes?

Mr. RHODES. No questions.

Mr. DAVIS. No questions, Mr. Chairman.

Mr. ANDREWS. Two o'clock tomorrow, gentlemen.

THURSDAY, JULY 10, 1969.

MISSILES AND RELATED EQUIPMENT

Mr. ANDREWS. The committee will come to order.

Today we will consider your request for $914.9 million for various missile development efforts. Of this sum, $400.9 million is for the Safeguard ABM system. The committee heard both Secretary Laird and General Starbird on the ABM program so we will not question you on the ABM at this time.

NIKE-HERCULES SURFACE-TO-AIR MISSILE

You are requesting ——— for further development of the Nike-Hercules surface-to-air missile system. The requested funds are for the development of an improved high explosive warhead. What warhead improvements are sought?

General BETTS. I will refer that question to Colonel Tobey.

Colonel TOBEY. We are looking for a clustered disc warhead which will be much more effective than the current warhead for the Nike-Hercules.

Mr. ANDREWS. Would that be an atomic warhead?

Colonel TOBEY. No, sir, a nonatomic warhead.

Mr. ANDREWS. Do you have any atomic warheads for your Nike systems?

Colonel TOBEY. Yes, sir.

Mr. ANDREWS. The Nike-Hercules is a follow-on of the first Nike?

Colonel TOBEY. That is correct, sir.

Mr. ANDREWS. Are you looking beyond Nike-Hercules other than ABM?

Colonel TOBEY. Yes, sir. The SAM–D is a follow-on to the Nike-Hercules and the Hawk.

Mr. ANDREWS. Have you phased out all of your Nike-Ajax?

Colonel TOBEY. The Nike-Ajax. They are all deactivated.

Mr. ANDREWS. You have now on site Nike-Hercules?

Colonel TOBEY. That is correct.

Mr. ANDREWS. Beyond that, you are looking for SAM–D?

Colonel TOBEY. SAM–D. Surface-to-air missile, and the "D" stands for "Development." There is no name assigned to it as yet.

We are still in the advanced development stages.

Mr. ANDREWS. So all of your Nike-Hercules in place are equipped with either conventional warheads or atomic warheads?

Colonel TOBEY. Yes. Each site has a specified number of nonatomic warheads.

Mr. ANDREWS. We were very enthusiastic about the Nike-Hercules when it first came out. Do you think today it would be as effective if used as when it was first installed?

Colonel TOBEY. The Army is very proud of the Nike-Hercules program.

NIKE MISSILE TEST FIRINGS

Mr. ANDREWS. Tell us about some of your latest tests.

Colonel TOBEY. I have some data. There is an active firing program almost every week at McGregor Range at Fort Bliss. We have the records of the past several years of those missiles that have been fired.

Mr. ANDREWS. Put the results of those tests in the record.

(The information follows:)

Since 1958, we have had a total of ——— firing of which ——— were successful. This is a success rate of ———. A successful flight is one in which no failures occured on the ground or in the air and the vector miss distance was less than ——— yards or ——— yards per 1,000 yards of range whichever is greater.

Mr. ANDREWS. What are you firing, the Nike Ajax or the Nike Hercules?

Colonel TOBEY. Some Nike Ajax and some Nike Hercules, depending on the purpose of the firing test.

COST OF NIKE-HERCULES WARHEAD IMPROVEMENT

Mr. ANDREWS. What is the estimated total cost of the warhead improvement effort that is underway now?

Colonel TOBEY. We expect fiscal year 1970 funding for the warhead effort to be ———

Mr. ANDREWS. How much more effective will the Nike-Hercules system be if the new warhead is successfully developed?

Colonel TOBEY. We expect it to be twice as effective as the current warhead and will give a kill probability of ——— at a range of ——— kilometers as opposed to ——— for the current warhead.

Mr. ANDREWS. This new warhead you are talking about, is it conventional?

Colonel TOBEY. Yes, sir. It is high explosive as opposed to atomic.

ADVANTAGE OF NEW WARHEAD

Mr. ANDREWS. Explain the difference between what you hope to get and what you are working on now and what you have on hand at this time.

Colonel TOBEY. The design of the new warhead is completely different, using the same type of concept as we showed you in the movie for the improved munitions known as COFRAM. I have a drawing of the warhead. It has a high explosive core and cylinders, or discs around that core. ——— They are fired from the Nike Hercules warhead, projected forward into the path of the oncoming airplane and these explode, have fuzing mechanisms in them to make them explode.

Mr. ANDREWS. Is this the warhead that LTV is working on?

Colonel TOBEY. No, sir; I think there is no contract.

Mr. ANDREWS. Where will the effort on the warhead development be undertaken?

Colonel TOBEY. It will be primarily at Picatinny Arsenal.

Mr. ANDREWS. Contract, or in-house?

Colonel TOBEY. Initially, in-house.

Mr. ANDREWS. What other activities are included in the ——— in addition to the warhead development?

Colonel TOBEY. We are looking at improving the ——— of the Hercules and also improving the ———.

Mr. ANDREWS. I assume the new warhead, when developed, will be used on the existing missiles.

Colonel TOBEY. That is correct, sir.

PRIORITY OF NIKE HERCULES PROGRAM

Mr. ANDREWS. The justification for fiscal year 1970 shows that no funds were programed for Nike Hercules development in fiscal year 1969. The fiscal year 1969 budget included $4 million for Nike Hercules development. The funds were applied to higher priority programs. How high a priority do you give the 1970 program?

Colonel TOBEY. The priority of the 1970 Hercules program is tied very closely to the SAM–D. If SAM–D continues on schedule, we feel there is a minimum requirement for the improved Hercules. If SAM–D slips, or has some other happenings to it, we would need the Hercules to fill the gap in ———.

General BETTS. You will realize, Mr. Chairman, if SAM–D goes at its present schedule, we are talking about first-availability of ——— or even ———. Consequently, the Hercules must stay in the system for at least another ——— years before we can build up enough inventory of SAM–D to replace it.

Mr. ANDREWS. Will this program probably be deferred if overall reductions are made?

Colonel TOBEY. I would think probably yes. It would be deferred in a tight budget although we have some discussions to go through before we could make that a final decision.

Mr. ANDREWS. Is the SAM–D program something entirely different from the Nike program?

General BETTS. It is a brand new development.

Mr. ANDREWS. You couldn't use any part of the Nike missile with the SAM–D missile?

General BETTS. There is a very different technical approach in the radar and data processing within the system and it is a different guidance system.

Mr. ANDREWS. It is a brandnew system.

General BETTS. That is correct.

Mr. ANDREWS. The fiscal year 1969 funds were requested in part for the development of ———. What became of their requirements?

Colonel TOBEY. The requirement still exists for the improved ———.

Mr. ANDREWS. You received no money for that project in 1969?

Colonel TOBEY. That is correct.

Mr. ANDREWS. Are you asking for money this year?

Colonel TOBEY. Yes, sir.

Mr. ANDREWS. Another justification given in support of the $4 million requested last year was based on maintaining the capability to respond to full implementation of the MOHEC program for fiscal year 1970. What happened to this project?

Colonel TOBEY. This is all the same project we are talking about. MOHEC and improvements to the Hercules are the same program and the same argumentation would apply.

Mr. ANDREWS. Describe MOHEC.

Colonel TOBEY. It is the maintenance of Hercules capability. That is an acronym, of course. The physical work that would be done on the Hercules systems is that work that I just described.

COST OF NIKE-HERCULES DEVELOPMENT

Mr. ANDREWS. The descriptive summary presented last year indicated that the total estimated cost of Nike-Hercules development was ——— million. The descriptive summary for fiscal year 1970 indicates that the total estimated development cost is "not applicable." Why not?

Colonel TOBEY. Well, we felt a degree of security that perhaps was not warranted on the SAM–D. We were very confident SAM–D would meets its schedule and it would be unnecessary to go into the MOHEC program any further and redraft of the funds.

Mr. ANDREWS. What is the estimate now?

Colonel TOBEY. It would be the same estimate if the program were conducted.

Mr. ANDREWS. ——— million.

Colonel TOBEY. As we understand it, for the same ground rules that this ——— million would apply to.

Mr. ANDREWS. Now, you talk about the total estimated cost of Nike-Hercules development. It was ——— million?

Colonel TOBEY. Yes, sir, this applies to the basic program plus the improvements to the Hercules program.

Mr. ANDREWS. In other words, this is applicable to what it would cost to upgrade your Hercules program that has been with us for some time.

Colonel TOBEY. No, sir. ——— million is the total estimated cost of development including MOHEC improvements.

Mr. ANDREWS. Both the Ajax and the Hercules?

Colonel TOBEY. That is correct.

NIKE-HERCULES DEVELOPMENT COST INCREASE

Mr. ANDREWS. The descriptive summary for fiscal year 1967 indicated that the total estimated development cost of the Nike-Hercules was $149.4 million and that only $2 million would be required after fiscal year 1967 to complete the program. What happened to cause the Army to change this estimate?

Colonel TOBEY. Sir, I don't have those numbers immediately available to me. I would like to research that and provide it for the record.

General BETTS. I think you would have to dig back into that program, Mr. Chairman.

We would have to check back into those descriptive summaries and relate it to the program at that time.

Mr. ANDREWS. These figures, $149.4 million and ——— million just discussed, are they related to the same program?

General BETTS. I just don't know.

Mr. ANDREWS. I am told that the $149.4 million figure and the ——— million figure do refer to the same program. Now, one of the two things has happened. You have had what the Air Force refers to as a cost growth which is, in plain and simple language, cost increases, or you have added something to the program which was not in your original estimate.

Colonel LUNN. The $149.4 million figure was the basic program. When we went to the ——— figure, that was the MOHEC improvement increase in R. & D.

Mr. ANDREWS. How much are you asking for for this program in this budget?

General BETTS. ———.

Mr. ANDREWS. How does the ——— under R. & D. relate to the request under PEMA for the $19.6 million for Nike-Hercules modifications?

Colonel TOBEY. I can't identify that PEMA expenditure.

Mr. ANDREWS. Put something in the record about it.

(The information follows:)

The PEMA expenditure will complete the purchase of certain MOHEC improvements which do not require research and development.

HAWK SURFACE-TO-AIR MISSILE

Mr. ANDREWS. You are requesting ——— million in fiscal year 1970 for further improvement of the currently deployed Hawk surface-to-air missile. This compares with $3.9 million in fiscal year 1969 and $7.3 million in fiscal year 1968. Since production delivery of the improved self-propelled Hawk will start in fiscal year 1970, what is your requirement for an additional ——— million in R.D.T. & E. funds?

Colonel TOBEY. We have a breakout of that ——— million as follows:

——— will be used to fund a 12-month contract with Raytheon for the improved self-propelled Hawk. Test and evaluation of the improved Hawk will be ———. In-house salaries, ———. Support of the missile command research and development laboratories, ———, and flight services for the firing program will be ———.

General BETTS. With regard to the Raytheon work on the self-propelled Hawk, that is work that would apply the improvements coming out of the Hawk program to the self-propelled Hawk that has been put in the inventory. You will realize that we went back into the old Hawk program and took some elements and put them on tracks so we would have a self-propelled Hawk system.

What we are looking at here are means by which we can pick up some of the improvements in the improved Hawk program and apply it to those systems that are new in inventory.

Mr. ANDREWS. When you broke down the ——— million request, did you include such topics as tropic tests and production phototype hardware?

Colonel TOBEY. Yes, sir.

Mr. ANDREWS. What do you mean by "tropic tests"?

Colonel TOBEY. This is a test of the equipment, the complete battery set of equipment, in Panama, in our tropical test center in Panama. Each system that is type classified standard A and becomes a part of our inventory is tested in both the Arctic and the Tropics.

Mr. ANDREWS. In the PEMA budget the Army requests $98.7 million for ——— Hawk XMIM–23–8 missiles. Are they the improved Hawk or the old Hawk?

Colonel TOBEY. Those are the improved Hawk.

Mr. ANDREWS. They have been improved under your R.D.T. & E. program?

Colonel TOBEY. That is correct, sir.

COST OF HAWK DEVELOPMENT

Mr. ANDREWS. Last year the committee was told that Hawk development would cost a total of $170.5 million. This year the justifications indicate a total cost of ——— million. What is the cause of the ——— million estimated increase?

Colonel TOBEY. The ——— million increase in the funding reflects the cost of adapting the improved Hawk modifications to the self-propelled Hawk. General Betts described the two systems to you.

Mr. ANDREWS. In fiscal year 1968 the estimated total cost was $157.8 million. What program changes does this increase reflect?

Colonel TOBEY. The approximately ——— million increase was due to two items: ——— million to effect engineering modifications identified in the surface-to-air missile capability study, which examined the Hawk's ———.

USE OF HAWK MISSILES IN VIETNAM

Mr. ANDREWS. Are you using the Hawk in Vietnam today?

Colonel TOBEY. Yes, sir.

Mr. ANDREWS. What kind of experience have you had?

Colonel TOBEY. We haven't had any target.

Mr. ANDREWS. You haven't used them for anything?

Colonel TOBEY. They are there, but there have been no raids.

Mr. ANDREWS. You wouldn't use them against ground targets?

Colonel TOBEY. No, sir.

Mr. ANDREWS. They are solely for surface-to-air aircraft.

Mr. POOR. The guidance system is not appropriate for ground level.

Mr. ANDREWS. The ones that you have in place over there, are they first generation?

General BETTS. That is right.

Colonel TOBEY. The other amount within the ——— million, ——— million correction for the increased cost for the years 1963–67 caused primarily by the program difficulties and slippages. There were two increments.

HAWK SCHEDULE SLIPPAGE

Mr. ANDREWS. Is your present program of modification on schedule?

Colonel TOBEY. It is now essentially on schedule.

Mr. ANDREWS. Essentially on schedule?

General Betts. There has been a slippage of some months due to technical problems.

Colonel TOBEY. To include a recent ———.

Mr. ANDREWS. ——— slippage. How many months did you anticipate for the full program?

Colonel LUNN. The selfpropelled program started in 1963 and the improvement on the missile started in 1964.

Mr. ANDREWS. ——— slippage on a 5-year program.

Colonel LUNN. The ——— slippage is recent and is on the missile program. Total program slippage, since 1964 inception, is about ———. I do not know the slippage on the selfpropelled Hawk program.

REDUCTION IN HAWK FUNDS

Mr. ANDREWS. The fiscal year 1969 budget request for Hawk development was $4.9 million. $3.9 million was actually programed. What part of the fiscal year 1969 planned program was deleted?

Colonel TOBEY. I would have to research that, sir. I would suspect nothing was deleted and that it slipped because of reduction of funds.

Mr. ANDREWS. You asked for $4.9 and you got $3.9 million. Were you able to continue your program?

Colonel TOBEY. Yes, sir.

Mr. ANDREWS. Or did you have to delete part of it?

Colonel TOBEY. The program was continued at a lesser level of effort.

(The information follows:)

Nothing in the total planned program was deleted. The improved selfpropelled program was not funded to the extent anticipated. The result was a slower start to that development program and a consequent slip of ——— in the IOC.

IMPROVED HAWK DEVELOPMENT AND TEST PROGRAM

Mr. SLACK. When will the development and testing of improved Hawk be completed?

Colonel TOBEY. The first unit will be operational in about ———.

Mr. SLACK. When will the XMIM-23-B Hawk be Type classified "A"?

Colonel TOBEY. Essentially about that same time.

We will provide that for the record.

(The information follows:)

Improved Hawk will be operational about ———. This date is still somewhat questionable in light of the recent slippage, however, the ——— date provided above should be conservative. Type classification standard A is dependent upon completion of some or all of the initial production testing. This is scheduled for completion in or before ———. It is therefore expected that action on type classification will be between ——— and ———.

Mr. SLACK. With further reference to the question I just asked regarding developing and testing of the improved Hawk, your answer was ———. That is the first operational capability, is that correct?

Mr. POOR. Yes.

Mr. SLACK. Do they continue R. & D. after that date?

Colonel TOBEY. There may be some testing that goes on after that date.

Mr. SLACK. There will be some testing after ———?

Describe the current activity in research and development on the wings for the Hawk missile. Why are the new wings needed?

Colonel TOBEY. I would have to research that question, sir.

(The information follows:)

The research and development on the improved Hawk wings is complete and delivery of industrial prototype wings is now being made. The new wings are needed because of increased performance of the improved Hawk missile, both in maneuver capability and in speed. This increased performance makes it necessary to have wings of greater structural strength.

CHAPARRAL/VULCAN

Mr. SLACK. You are requesting ——— million to continue development of the Chaparral/Vulcan system. How much of the ——— million is requested for the Chaparral missile and how much for the Vulcan gun?

Colonel TOBEY. The Chaparral, of that ——— million, receives ———. The Vulcan, ———. The remainder of the ——— million is divided between the forward area acquisition radar for ——— and the project manager's office, ——— a total of ———.

CHAPARRAL/VULCAN TESTING

Mr. SLACK. Will all testing of the Chaparral/Vulcan be completed in fiscal year 1970?

Colonel TOBEY. The testing goes into ———.

Mr. SLACK. The answer is, it will not be completed in fiscal year 1970.

Colonel TOBEY. That is correct.

DEVELOPMENT COST OF TRAINING DEVICES

Mr. SLACK. What is the estimated total cost of the development of training devices for this system?

Colonel TOBEY. The Chaparral mount simulator is ——— and for the gun, the Vulcan mount simulator, ———. The Chaparral has one additional item called a simulator evaluator for ———.

Mr. SLACK. And the total is ———.

Colonel TOBEY. That is correct.

PRODUCT MODIFICATION

Mr. SLACK. What modifications have been found necessary in production of Chaparral missiles as a result of findings in the R. & D. program since production as initiated?

Colonel TOBEY. There have been several improvements in the missile guidance section and in the design of the ground support equipment and in the area of the fins of the Chaparral missile.

Colonel LUNN. There are two significant areas that I know of now, sir. One is the canard which required a shear pin to prevent the missile from going into the ground when fired at a target at low elevation.

The second had to do with four capacitors in the guidance system. These were required in the air-to-air role, in the Sidewinder. It was not desired to be used by the Army and these were cut out of the circuits.

SCHEDULE FOR TYPE CLASSIFICATION A

Mr. ANDREWS. When will the Chaparral be Type Classified A and explain what "Type Classified A" means.

Colonel TOBEY. Type Classified A is a certification by the Army that the weapons system meets the military requirements.

Mr. ANDREWS. And ready for production?

Colonel TOBEY. And it is ready for production.

Mr. ANDREWS. When will the Chaparral be so classified?

Colonel TOBEY. ——— is the date.

Mr. ANDREWS. Haven't you already started production?

Colonel TOBEY. We have limited production.

Mr. ANDREWS. Well, that's production.

Colonel TOBEY. Yes, sir.

Mr. ANDREWS. Why are you starting to buy before you fly?

Colonel TOBEY. We have flown and we have tested on the order of 100-and-some-odd missiles and we were convinced that we had enough test data and enough test information to ——

Mr. ANDREWS. Are you sure all the bugs are out of it?

Colonel TOBEY. We are sure that enough bugs at this time are out of it to warrant its deployment in the field; yes, sir.

Mr. ANDREWS. When did you say you were going to type classify it A?

Colonel TOBEY. ———.

PRODUCTION DECISION

Mr. ANDREWS. And yet in the PEMA budget there is a request for $99.5 million for ——— Chaparral missiles. Now, in this particular case who made the determination to go into production?

General BETTS. It is a general staff determination, Mr. Chairman. Elements of the staff who are interested in the problem are brought into the subject before the Chief of Staff makes the final decision.

Mr. ANDREWS. But they act on recommendations from your office?

General BETTS. My office, from the Deputy Chief of Staff of Logistics and the Assistant Chief of Staff for Force Development. Those are the three major elements of the staff.

Mr. ANDREWS. They are asking for this nearly $100 million for production in 1970 and you won't certify type classified A status until ———.

Colonel TOBEY. That is correct.

Mr. ANDREWS. Somebody is taking an awful chance.

Colonel TOBEY. Sir, there has been ——— Chaparral firings as of about the 19th of June, about a month ago.

Mr. ANDREWS. What was the result of the ——— firings?

Colonel TOBEY. Overall, ——— percent success rate and ——— with no tests and ——— of the ——— missiles were successful.

Mr. ANDREWS. Well, what are you waiting on to type classify it?

Colonel TOBEY. The AIT firings, the most recent firings by soldiers being trained in the field, they are averaging a success of ——— percent. These ——— percent that I give you were the test program which is designed to explore all of the most difficult conditions of the specifications and also reflect the learning that you go through as the missile system is developed.

DELAY IN TYPE CLASSIFICATION

Mr. ANDREWS. Let me ask you this question: It may be hard for you to answer. If you are satisfied with the tests, you have gone into production. That is, the Army has. Would you say you are dragging your feet in R. & D. to wait until ——— before you classify this missile as type A?

Colonel TOBEY. One of the ground rules for the type classification is that it has to have completed its Arctic tests in the cold weather climate of Alaska, and the tropic test program. Those tests have not yet been completed and are essential to a standard A classification.

Mr. ANDREWS. What you are telling us is that you are satisfied with the program in all areas except the Arctic area and the tropical area. Now, Vietnam is in a tropical area.

Colonel TOBEY. That is correct.

Mr. ANDREWS. Have you sent any of these missiles to Vietnam?

Colonel TOBEY. No, sir.

Mr. ANDREWS. What are you waiting on there, lack of production?

Colonel TOBEY. There seems to be no threat and there seems to be no justification to send over this kind of a weapon to Vietnam at this time.

Mr. ANDREWS. You think the Hawk can do whatever job needs to be done promptly?

Colonel TOBEY. That is correct, and then they have the low altitude guns.

SCHEDULE SLIPPAGE

Mr. ANDREWS. How close is the Chaparral/Vulcan program to the time and cost estimates first presented to Congress?

Colonel TOBEY. 1965 projected first activation in October 1967. The actual achievements, the Vulcan, August 1968, 10 months slippage.

The Chaparral, January 1969.

COST GROWTH

General BETTS. Mr. Chairman, this is a perfect example to explain why some programs get into very severe cost growth. We were seriously devoid of field Army air defense for what we call proliferation weapons. With considerable optimism we phased gun air defenses out of the operating field Army with the confidence that the Mauler, a surface-to-air, mobile field Army air defense system, would come in on schedule. It got into serious technical difficulties. It began to appear that Mauler was much too expensive for the proliferation role that we wanted it to fill. The Army faced up to that problem with a decision to cancel. That put us in the position of having nothing with which to fill a very serious void. It was then proposed that we go on very high priority, almost a crash effort, to fill the void with a combination of an air defense gun—that is the Vulcan—take an existing gun that had been well proved and put it on a tracked vehicle. The tracked vehicle was to be one in the inventory that was well proven. That should have been a very simple, straight-forward engineering task with no identifiable technical difficulties of risk.

We thought also at that time that the air-to-air missile system, the Sidewinder, could be readily adapted to a surface-to-air role. You will recall that it was a Navy missile. Preliminary testing showed that it would be effective. The problem that arose as we got into the engineering program was to integrate this Sidewinder missile into a field Army environment. One problem was that the magnitude of the difference in the environment on a tracked vehicle with a lot of vibration, and with all of the things that relate to that, it was so different from the environment on an aircraft that we just couldn't do it in the simple way that had been proposed. So that rather extensive engineering was required. It stretched out the program by the some 13 months we have indicated here and the additional engineering effort demanded an increase in funding.

The driving motivation was to get a capability in the field Army where none existed. This judgment was made. These risk judgments are reflected in the cost growth indicated on this submission.

PRODUCTION DECISION

Mr. ANDREWS. General Betts, did I understand you a few minutes ago to say that the decision to go to production before type A classification was made by the Chief of Staff?

General BETTS. The recommendation to the Secretary of the Army was made by the Chief of Staff. In major systems that final decision is made by the Secretary of Defense. He approves or doesn't approve the programs, as the case may be.

Mr. ANDREWS. I have just been furnished with a copy of a report by the Armed Services Investigating Committee of the Committee on Armed Services, House of Representatives, 91st Congress, first session, entitled a technical review of the Army tank program.

A statement is made on page 4 thereof:

The official approval of the production classification for weapons introduced into the Army Arsenal is granted by the Army's Chief of Research and Development in accordance with Army regulations. Not the Chief of Staff, as might be expected.

Would you comment on that?

General BETTS. All of the staff participated in the coordination process. If there is no disagreement among the elements of the staff, then the authority is delegated to the Assistant Chief of Staff for Force Development to go ahead and release the authority for standard A designation. Prior to December 1966 this authority was delegated to the Chief of Research and Development. In cases where there is disagreement, the matter is taken up to a higher level.

Mr. ANDREWS. In the case of the Chaparral, who made the determination to go to production? Was it you or the Chief of Staff?

General BETTS. I don't know, sir.

Mr. ANDREWS. Mr. Secretary, do you know?

Mr. POOR. I would have to check the record.

Mr. ANDREWS. I wish you would put something in the record about it.

(The information follows:)

In the case of Chaparral, the recommendation to go into production was concurred in by the Army General Staff and the formal approval was given by the Chief of Research and Development of that time frame.

Mr. MINSHALL. When was the decision made?

General BETTS. The decision to go into limited production—I don't have a date on that.

Mr. ANDREWS. I hope everything goes right and I hope we don't have any lemons on our hands, but if that happens, somebody is going to have a red face.

Mr. POOR. That somebody is sitting right here, Mr. Chairman.

The Chaparral missile system, because it is a derivative of the Navy's Sidewinder, is, in my opinion, a really substantially good weapon. The test firings have been very successful to date. We have activated units who are using these equipments in the field and the reports are very favorable.

I think you will appreciate there are times when the urgency of obtaining a capability makes it reasonable to field a set of equipment, even knowing that some improvements will be needed. I think when we come to the discussion of the tracked and wheeled vehicles that General Betts and I will both wish to discuss further, the report will go to what you have just referred to. At this time we are sure the Chaparral system will work well.

General BETTS. Type classification of the Chaparral missile and fire unit for limited production was accomplished on September 29, 1965, for the missile; November 12, 1965, for the fire unit, and these elements were both part of a recommendation—a program recommendation that was approved by Secretary of Defense decision guidance on December 6, 1965.

Mr. MINSHALL. That is Mr. McNamara?

General BETTS. In that time frame, that is correct.

Mr. MINSHALL. Thank you.

TIME FROM R. & D. TO PRODUCTION

Mr. ANDREWS. I understood Colonel Tobey to say that that type classification A would be made for this missile in ———.

General BETTS. That is our projected date for type classification standard A. I was referring to what we call limited production.

Mr. MINSHALL. Mr. Chairman, I hate to interrupt you, but this program first went into R. & D. in calendar 1964. Am I correct in that?

General BETTS That is correct.

Mr. MINSHALL. How could you get into even limited production so quickly, a year later?

General BETTS. Remember, in the original concept this was a suggested program to take an existing vehicle, an existing missile, an available launch platform, if you will, and, by relatively limited engineering changes, put them together to get a quick air defense capability.

Mr. MINSHALL. It just didn't work out that way?

General BETTS. It did work out fairly well, but demanded additional engineering. I don't think a 13 months slip in this difficult a program is unusual.

Mr. POOR. I think on the contrary, it did work out well. The Army first felt that the system should be placed in Europe as a matter of urgency because of the void in the European air defense that General Betts mentioned earlier.

As the program proceeded, it was so successful that the Army users who required us to redesign the launch equipment—the thing on which the missiles are moved about, the vehicle which carries the Chaparral, to meet worldwide requirements. That caused additional reengineering of the vehicle and provisions to put more missiles on the vehicle. I think it imposed some other restraints about railroad gages and so forth.

ORIGINAL COST ESTIMATE

Mr. MINSHALL. What was the original cost estimate on this, Mr. Poor?

Mr. POOR. I have $61.8 million as the original cost estimate.

Mr. MINSHALL. Is that research and development?

Mr. POOR. For the two programs, for R. & D. That has grown by about $35 million. Much of that growth is associated with the redesign of the equipment to meet the broader worldwide objective. There has been a cost overestimate and I understand the cost overestimate amounted to $1.2 million in 1967 and $1.3 million in 1968. It has been a pretty orderly program.

The limited production category does permit us to put units in the hands of training troops, initiate early battalions and to get the production line going.

The risk on the Chaparral should be particularly low because there is a wealth of Navy experience on the Sidewinder.

Mr. MINSHALL. You say, a 50-percent overrun on your original R. & D. estimate, is an orderly program?

General BETTS. It was a complete change in the scope of the program, Mr. Minshall. From a quick and dirty effort to a solid system for worldwide application.

REQUIREMENT FOR CHAPARRAL MISSILES

Mr. ANDREWS. Would you consider $100 million for ——— weapons, Chaparrals, to be limited production? That is your PEMA request.

General BETTS. It would fall within the category of a limited production authority depending on the circumstances involved.

Mr. ANDREWS. How many missiles are you thinking about to satisfy your needs?

General BETTS. ——— missiles.

SYSTEM IMPROVEMENT STUDIES

Mr. ANDREWS. What is the nature of the system improvement studies included in your fiscal 1970 program? What is the estimated cost of these studies?

Colonel LUNN. I am not aware of any study effort in fiscal year 1970 on the Chaparral.

Mr. ANDREWS. We are talking about system improvement studies. Let me read from page 125 of the justifications:

"Program to completion. (c) Complete testing of all systems. Complete development of training devices. Perform system improvement studies and refine hardware through product improvement program. Adapt as standard in June, 1970."

Colonel LUNN. That is beyond 1970. That is the fixes for ET/ST. That is in the ——— million program after fiscal year 1970.

PERFORMANCE CHARACTERISTICS

Mr. ANDREWS. How do the performance characteristics of the Chaparral/Vulcan system compared with those originally planned?

Colonel TOBEY. They are rather close to those originally planned. It is meeting the QMR requirement. No major deficiencies.

General BETTS. I know of no short fall from the basic requirement, Mr. Chairman. I would have to go back and research that.

Mr. ANDREWS. Put something in the record about it.

(The information follows:)

A special Department of the Army directed in-process review was held in December 1968 for the purpose of assessing the Chaparral's suitability for activation. At this time it was pointed out that Chaparral did not meet three performance characteristics specified in the QMR.

The Chaparral launch and control station is required to be helicopter transportable. During testing it was determined that the launch and control station could be damaged during takeoff and landing. Subsequently a modification of adding crushable pads to the launch and control station was made. Testing to date indicates this will solve the problem. The final assessment by the test and evaluation command has not been made.

The Chaparral system is required to have a certain system effectiveness. This effectiveness is defined as the product of the probability of the system being operational, the probability of target detection and transfer to the gunner, the probability of a successful launch and flight, and the probability of the warhead damaging the aircraft sufficiently for a target kill. At the time of the in-process review Chaparral had not achieved the effectiveness figure specified in the QMR. It is felt that the effectiveness figure established in the QMR is not realistic knowing what is now known about the lethality and reliability of the Chaparral missile, which in this respect is essentially the same as the Navy Sidewinder 1C. To increase the effectiveness to the QMR figure would require a major redesign of the Chaparral guidance, warhead, and fuze and would require additional time

and money. There will probably be some minor engineering changes to get some small improvement, such as the shearpin and removal of the capacitors mentioned earlier in the testimony, after all test firings are completely evaluated. Any major improvements will be deferred to future years.

The last area where it was pointed out that the QMR was not being met was in the mean time to repair. Again, it was felt that the achieved figure was more realistic and was satisfactory. The Combat Developments Command, which represents the user, subsequently recommended that the QMR figure be changed to the achieved figure and this has been approved.

As stated earlier these QMR shortcomings were presented at a special in-process review to assess the suitability of Chaparral for activation. The participants in the review were the Continental Army Command, the Combat Developments Command and the Army Material Command. Their recommendation was that Chaparral units be activated. The Army General Staff concurred in this recommendation. To date three batteries of Chaparral have been activated. The conclusion was that sufficient testing had been accomplished to provide confidence that Chaparral could accomplish its assigned mission. (Additional classified information has been furnished separately to the committee).

Coloney TOBEY. The Chaparral missile homes in on the infrared energy of an aircraft tailpipe. Therefore, you have now what we call "forward aspect capability." You have to wait until the airplane comes abreast of you and launch when it is at about 90° from you and fire.

Now, at target speeds of mach 0.7, you have a minimum range of ——— meters and a maximum range of ——— meters. At mach 0.9, you have a minimum engagement range of ——— meters and a maximum range of ——— meters. Range limitations then become a function of the speed of the target.

Mr. ANDREWS. It is correct to say that Chaparral is an Army adaptation of the Navy Sidewinder and that adaptation being to make it a ground-to-air missile rather than an air-to-air missile like the Sidewinder?

Colonel TOBEY. That is correct.

SPEED OF CHAPARRAL DEVELOPMENT

Mr. ANDREWS. You have spoken several times, General Betts, about the speed with which you were able to follow this program. Is one of the reasons for your ability to progress so rapidly with this Chaparral program the fact that you had the Sidewinder to start with?

General BETTS. That is correct, Mr. Chairman, and we had a vehicle that was basically acceptable for this purpose.

Mr. ANDREWS. For launching?

General BETTS. I am talking about the tracked vehicle upon which we placed the launching mechanism. Without that kind of thing, it would have been a completely new development effort.

CAPABILITY OF CHAPARRAL MISSILE

Mr. ANDREWS. What are the capabilities of Chaparral against maneuvering aircraft?

Colonel TOBEY. The Chaparral is required to engage targets executing a ——— maneuver.

Mr. ANDREWS. What do you mean by ———

Mr. POOR. The pilot flying the aircraft, when he pulls back on the stick to turn, experiences centrifugal force which pushes him down in

the seat. Under a ——— turn, that is strong enough for him to weigh ——— times as much as he normally would as a result of his acceleration and his aircraft going into a turn.

Mr. ANDREWS. That is a complete turn of 180°.

Mr. POOR. Any portion of the turn.

Colonel TOBEY. During testing the Chaparral has destroyed a droned F4F aircraft traveling at ——— knots and executing a ——— maneuver. Those are the specifications.

Mr. ANDREWS. Fired from the platform on the truck?

Colonel TOBEY. Yes, sir.

Mr. MINSHALL. What range was that?

Colonel TOBEY. I don't have the range on that. It is within the Range specification envelopes.

Mr. MINSHALL. What is the normal range of this weapon?

Colonel TOBEY. ——— meters to ——— meters.

Mr. MINSHALL. It does not have a supersonic capability, then. It is just subsonic?

Colonel TOBEY. Subsonic, yes.

Mr. ANDREWS. And it homes in on the plane.

Colonel TOBEY. Yes, sir. Infrared homing on the tail pipe.

Mr. ANDREWS. What does the gunner have to do?

Colonel TOBEY. He sits in a small cupola, and gets an early warning signal that airplanes are in the area. He can pick that airplane up, track it, get an audible tone.

Mr. ANDREWS. How, by radar?

Colonel TOBEY. No, sir; visual. He gets an audible tone when the missile seeker is locked on the target, and he then fires.

General BETTS. This is a fair weather system, Mr. Chairman.

LANCE MISSILE

PROPULSION PROBLEMS

Mr. ANDREWS. Are there any questions about the Chaparral? If not, next is the Lance. You have experienced serious failures in the flight testing of Lance because of the feed system. Premature mixing of the oxidizer and fuel after launch have produced catastrophic explosions. As a result, a new rocket engine has been designed. Has flight testing of the new engine been initiated? If so, what results have been obtained?

Colonel TOBEY. I would like to correct an interpretation that is quite possible, but the redesign of the rocket engine was not associated with the failures of the propulsion system—the feed system.

First, the rocket engine was designed to get higher specific impulse to meet the range requirements of the so-called XRL extended range Lance, as directed by the Secretary of Defense. The propulsion problem had to do with the bypassing of the pistons by explosive gases, and mixing fuel with the oxidizer in a hot environment and getting disastrous results. That problem has been corrected, and it has been thoroughly demonstrated with ——— ground tests and ——— flight tests of the five ring engine, and ——— tets with the two ring engine. We feel very confident we have solved the propulsion problem. We feel very confident about the new five-ring engine.

DESCRIPTION OF LANCE MISSILE

Mr. ANDREWS. The Lance is a ground-to-ground missile?
Colonel TOBEY. That is correct.
Mr. ANDREWS. With a conventional warhead.
Colonel TOBEY. That is correct.
Mr. ANDREWS. For what mission is it designed?
Colonel TOBEY. For the mission of general support for a corps.
Mr. ANDREWS. Is it an antipersonnel weapon?
Colonel TOBEY. Yes, sir; and antimateriel. In addition to the nonnuclear warhead, it has a nuclear capability.
Mr. ANDREWS. It does have a nuclear capability?
Colonel TOBEY. Yes, sir. Its minimum range is ——— kilometers and its maximum range is about ——— kilometers with a nuclear warhead and ——— kilometers, plus, with the nonnuclear warhead.

PRODUCTION DATA

Mr. ANDREWS. How many have been produced?
Colonel TOBEY. Just test quantities have been produced so far. It is about ———.
Mr. ANDREWS. You have not gone into full production?
Colonel TOBEY. No, sir.
Mr. ANDREWS. Do you anticipate going into full production at an early date?
Colonel TOBEY. We anticipate going into full production to meet a readiness date of ———.
Mr. ANDREWS. Is there any request in the PEMA fund for the Lance missile?
Colonel LUNN. It starts in ———. There is a minor PEMA request for 1970.
General BETTS. Colonel Lunn says there are PEMA funds in the 1970 budget. They are related to long leadtime items. It is advance production engineering primarily. Major request for production would be made in fiscal ——— if all goes well.
Mr. ANDREWS. You do not hope to get into production on this missile if all goes well before ———.
Colonel TOBEY. Before ———. It would be fiscal year ——— PEMA dollars.
Mr. ANDREWS. ———?
Colonel TOBEY. Yes, sir.

PLANNED USES OF LANCE MISSILE

Mr. ANDREWS. Would this missile be useful in South Vietnam?
Colonel TOBEY. Yes, we think it would be useful in South Vietnam.
Mr. ANDREWS. Are there any other serious difficulties of which the Army is now aware in the Lance program?
Colonel TOBEY. We know of no serious difficulties in the Lance program.
Mr. ANDREWS. What will this missile replace in our arsenal?
Colonel TOBEY. We are planning to replace both the Honest John and the Sergeant with the Lance missile.

Mr. ANDREWS. Did they have defined about the same mission as this missile?

Colonel TOBEY. ———.

Mr. ANDREWS. Do you have any Sergeant's in Vietnam?

Colonel TOBEY. No, sir.

Mr. ANDREWS. Any Honest Johns?

Colonel TOBEY. No Honest Johns in Vietnam.

Mr. ANDREWS. Does Honest John have a conventional capability as well as an atomic capability?

Colonel TOBEY. It has a nonnuclear capability.

Mr. ANDREWS. Is either Honest John or Sergeant in production today?

Colonel TOBEY. No, they are not.

HONEST JOHN MISSILE

Mr. MINSHALL. How many Honest Johns do you have in inventory?

Colonel TOBEY. There are some ——— battalions.

Mr. MINSHALL. How many weapons?

Colonel LUNN. Approximately ——— sir. I am not firm on that figure.

Mr. MINSHALL. The range on that is about ——— miles, if I remember correctly, maximum.

Colonel LUNN. ——— kilometers with the light warhead and ——— kilometers with the heavy warhead.

Mr. MINSHALL. But it is not too accurate.

Colonel LUNN. No, sir.

Mr. MINSHALL. What is the CEP on an Honest John at the maximum range?

Colonel LUNN. It is called a ——— mil system, sir.

Mr. MINSHALL. What does that mean?

Colonel LUNN. ——— meters at 10,000.

Mr. MINSHALL. How would you describe the CEP, if you are trying to hit target X? How close do you come to it in yards?

Colonel LUNN. If I were shooting at 1,000 yards, I would be ——— yards or less from the target.

LANCE GUIDANCE SYSTEM

Mr. POOR. I think there is something very important to understand about this Lance missile, and perhaps it has been described to the committee before. It is a guided missile with a guidance scheme called the ——— which was invented by one of our employees at Redstone Arsenal, the Army Missile Command. This guidance scheme is extraordinarily simple. It uses ———. So the guidance scheme is so inexpensive that the cost to produce the rocket is not substantially larger than that of a free rocket. Nevertheless, its accuracy approaches that of the complicated inertial guidance systems we had in prior missiles like Sergeant where the cost of the guidance scheme alone is greater than the cost of the rocket, plus guidance for this missile system. It is a very significant technical advance and one of which the Army is extremely proud. We think it is a grand system.

1970 FUNDING REQUIREMENTS

Mr. ANDREWS. You are requesting the very large sum of $51.4 million for Lance in fiscal year 1970. Detail your requirement for this sum. You can put that in the record.

Colonel TOBEY. Yes, sir.

(The information follows:)

——— million will go to the contractor for missile development, engineering and hardware. ——— million will be required for design, hardware procurement and testing of the adaption kit for the nuclear warhead, and ——— million for similar development of the non-nuclear warhead. $3.2 million will provide needed support from in-house Army laboratories, $0.9 million will support testing at the White Sands Missile Range, $0.9 million will be used directly in management functions by the project manager's office and $0.7 million will go to a number of Government agencies for project support. The total amount is required to provide for design, engineering, test hardware procurement, and operational and engineering development testing of the entire missile system so as to complete development prior to the Army readiness date of ———.

COST GROWTH

Mr. ANDREWS. When did the Army first request funds for Lance? What was the estimated total cost of the development program which was given to Congress at that time?

Colonel TOBEY. The original R. & D. cost estimate was $158.9 million. The current estimates are $429 or essentially $430 million.

Mr. ANDREWS. Quite an increase.

Colonel TOBEY. Yes.

Significant additional costs were incurred by the decision to field the extended range version of the Lance. In other words, to get a capability to go from the original maximum range of ——— kilometers to a maximum range of ——— kilometers.

Mr. ANDREWS. This could be also considered an IRBM, could it not?

Mr. POOR. Yes, sir.

Mr. ANDREWS. With an atomic warhead it would be.

Mr. POOR. Yes.

TWO DEVELOPMENT PROGRAMS FOR LANCE

General BETTS. This is actually two development programs. We had the Lance at that point in development where there was still some service testing to do, and we thought that the technical problems were solved. We were urging that they allow us to ask the Congress for money to do the advance production engineering when we got into the technical difficulty that was described, the mixing of the oxidizer with the fuel that blew up the missile. We had to slow down and go back into the testing program—as a matter of fact, into a long analysis effort—to find out how to work our way out of that technical problem. Because we had hit that point, the decision was made that we would not release it to production in the version we called the standard version that would be a ——— kilometer missile as had been originally planned. At the same time, it was recognized that by further development of the engine, and some other relatively minor changes, we could with a nuclear warhead extend the range out to the ranges that Colonel Tobey mentioned. So the decision was made in parallel to the no-production commitment that we would then begin the development

of the extended range Lance. So at that point we were really starting a second development program.

Mr. ANDREWS. What happened was when you got into the R. & D. effort on the Lance missile you changed your mind as to the capability you wanted to give the missile.

General BETTS. That is right.

Mr. ANDREWS. You doubled almost everything in connection with it except the warhead.

General BETTS. We had held up the development of the warhead while we looked at this problem.

WARHEAD DESIGN

Mr. ANDREWS. What are you thinking of in terms of a warhead now?

General BETTS. The AEC is in development of a warhead specifically for this missile.

Mr. ANDREWS. The payload of the missile that you are working on now, how would it compare with the ——— kilometer missile you started out with?

Colonel TOBEY. The nuclear warhead is smaller. The original weight was ——— pounds in the warhead, approximately. The current design is on the order of ——— pounds.

Mr. ANDREWS. What about the conventional warhead?

Colonel TOBEY. The conventional warhead still stays at ——— pounds.

Mr. ANDREWS. The only thing really that you have upgraded was the projected range?

General BETTS. That is correct.

Mr. ANDREWS. But for all practical purposes it is a different weapon?

General BETTS. That is right.

Mr. DAVIS. What time frame are we talking about when the decision was made to change your concept?

General BETTS. December, 1967 the change in program decision was made.

COST GROWTH

Mr. ANDREWS. In the fiscal year 1966 justifications, the total cost of Lance development was estimated at $172 million. In fiscal year 1967 it was $218.1 million. In 1968 it was $259.8 million. In 1969 it was first given as $377.1 million and later $401.6 million. This year, the fiscal year 1970 estimate is $427.2 million. This is a terrible example of cost growth. How could the Army have been so wrong in estimating the cost of this relatively short-range missile?

I think you have partially answered that question.

General BETTS. Yes, sir.

Mr. ANDREWS. You might expand on your answer for the record.

General BETTS. Yes, sir.

(The information follows:)

While there are many reasons for the cost growth, and no way to briefly summarize them all, there are three major contributing factors. The first was the decision to develop an extended range version of Lance in parallel with the originally planned ——— kilometer version, and the subsequent decision to field only the extended range model. These two decisions added approximately $105

million to the program. The second factor was the unexpected difficulty with developing the propulsion system. Program delays and additional testing required to solve the problems increased costs approximately $91 million. The final major cause of increased costs have been program stretchout due to fund limitations and delays. The impact of these has been approximately $50 million.

Mr. ANDREWS. Let me ask you if this is correct. Had the program grown from the original estimate of $172 million to $377.1 million before you decided to go for the more sophisticated longer range missile? You better check that because looking at these dates that is our impression.

General BERTS. It had grown.

(Clerk's note: The following information was provided subsequent to the hearings:)

Costs had grown to $372 million prior to the decision to field only the extended range Lance and not the basic model, but the $372 million does include a $69 million cost addition to develop the extended range version in parallel with the basic model.

Mr. ANDREWS. Which came first, the trouble with the missile feed system or the decision to reorient the program to the extended range Lance?

General BERTS. The trouble with the feed system came first.

RELOCATION OF DEVELOPMENT EFFORT

Mr. ANDREWS. In its action on the fiscal 1969 budget, this committee reduced the funds for the Lance program by $5 million. The committee was disturbed that it was proposed to move the development effort from the contractor's plant in Dallas, Tex., to Warren, Mich., at an additional cost totaling $11 million.

The Army contended that the additional cost would be offset by savings from the utilization of an Army facility in Michigan. With the great cost growth which has been experienced in this program, did the projected offsetting savings materialize?

Colonel TOBEY. We can find no figures that will substantiate a firm amount of the savings resulting from that move.

Mr. ANDREWS. In other words, you did not achieve the savings you predicted when you moved from Dallas to Michigan?

General BERTS. No, sir; I do not think that is quite right. We do not have figures available that we can quote that show exactly what we saved. The argument was that we already have a plant in which we could produce these missiles in Michigan, whereas in Texas we would probably have had to build one. The fact that we did not have to build one is a saving, but we do not have figures to support how much of a saving.

(Discussion off the record.)

ORIGINAL DEVELOPMENT COST OF EXTENDED RANGE LANCE

Mr. ANDREWS. When the program was reoriented to the extended range Lance, what was the estimated total development cost? What was the estimated initial deployment date?

Colonel TOBEY. I think we will have to research that answer, sir, and provide it for the record.

(The information follows:)

When it was decided to develop only the extended range model, the estimated total development cost was $408 million, and the initial deployment date was ——as it is presently.

SLIPPAGE IN LANCE PROGRAM

Mr. ANDREWS. Last year, the justifications stated that the first Lance unit would be equipped, trained, and become the school battalion at Fort Sill in the —— quarter of fiscal year ——. The fiscal year 1970 justification gives no such data. Have these plans been changed?

Colonel TOBEY. The plans have been modified to some extent.

Mr. ANDREWS. How much slippage has there been in the program since you went to the extended range version?

Colonel TOBEY. Could I complete the answer to the first one on the activation of the units at Fort Sill?

Mr. ANDREWS. Very well.

Colonel TOBEY. The new equipment training for crewmen who will conduct the engineering service tests will start in the —— quarter of fiscal —— as opposed to the —— quarter that you identified.

Mr. ANDREWS. That is 3 months slippage.

Colonel TOBEY. It could be as little as one, from the end of the —— to the beginning of the ——. It could be as much as three, yes, sir. Unit training will start in the —— quarter and this will be the unit that will conduct the services. So the plan is essentially the same although modified somewhat.

Mr. ANDREWS. Do you remember the second question?

Colonel TOBEY. Yes, sir. I would like to provide that answer for the record, if I may. We might have it here.

Colonel LUNN. Since the decision to field only XRL, there have been no slippages and the deployment date remains ——.

PROGRESS ON LANCE PROGRAM

Mr. ANDREWS. Mr. Secretary and General Betts, are each of you satisfied with the progress being made in the Lance extended range program?

Mr. POOR. I think my answer is now yes. I was extremely unhappy about the results with the feed system. Since that problem has been put behind us I think the program is a very satisfactory one.

Mr. ANDREWS. General Betts, do you concur?

General BETTS. I would agree with Mr. Poor.

Mr. POOR. I would add that I am as discouraged as are others that these programs do slip. I might point out that we did not have the resources to put on this program to support our original date of availability. Since we were not able to put enough dollar resources in to move the program along as fast as it could have moved technically we must accept a later date.

Mr. ANDREWS. What is the amount requested for R. & D. in this budget for Lance?

General BETTS. $51.4 million.

Mr. ANDREWS. What is the presently planned total procurement of Lance missile systems?

Colonel TOBEY. The present authorization is —— and the necessary ground support equipment to equip —— battalions.

EXPLANATION OF LANCE SYSTEM

Mr. ANDREWS. What is included in a Lance missile system including all necessary equipment?

Colonel TOBEY. The basic organization is a Lance battalion. It has three firing batteries with two launchers and two transporter loaders in each battery. It has a headquarters battery and a service battery. The service battery has two or three transported loaders. The table of organization for the service battery has not yet been completely firmed up.

Mr. ANDREWS. A track vehicle can handle only one missile?

Colonel TOBEY. The track vehicle can handle the transporter loader with two missiles and the launcher one.

Mr. ANDREWS. Is it true it takes four track vehicles to launch one missile?

Colonel TOBEY. No, it takes one track vehicle to launch a missile.

Mr. ANDREWS. Including the radar and everything?

Colonel TOBEY. There is no radar associated with it.

Mr. ANDREWS In other words, you will have one track vehicle with two Lance missiles on it and that is all there is to it?

Colonel TOBEY. That is the transporter loader.

Mr. POOR. That is the resupply vehicle.

Mr. ANDREWS. The resupply vehicle has 2 additional missiles.

Colonel TOBEY. Yes, the launcher itself carries one Lance missile on the launcher vehicle.

Mr. ANDREWS. Ready to go?

Colonel TOBEY. Yes, sir.

Mr. POOR. With this very simple guidance scheme you do not need any radar or anything. You fire the thing like field artillery. This ——— that we talked about, the first day or so, that one missile is equivalent to something like a ——— tube TOT of conventional artillery with the older kind of shell. It is a very impressive way of getting very quick artillery support.

Mr. ANDREWS. You are talking about conventional weapons.

Mr. POOR. Yes. The efficient use of conventional munitions is very important.

Mr. ANDREWS. Where would this Lance missile system be deployed? How far back of your forward troops would the system be deployed?

Colonel TOBEY. It could be deployed as far forward as the light artillery positions, which would be on the order of 1,500 to 2,000 meters behind the forward elements and back as far as maybe 10 miles.

COST PER SYSTEM

Mr. ANDREWS. What is the estimated procurement cost of the average Lance missile system? When we say system, I understand you to mean the launching vehicle and the auxiliary vehicle that has two extra missiles on it. What else would you have in the system?

Colonel TOBEY. We like to look at the system as a complete battalion, as I described it before. The complete battalion, $28.8 million with the Lance peculiar items. That is three firing batteries of six launchers. So for one system complete it would be one-sixth of $28.8 million or a little over $4½ million.

Mr. ANDREWS. What is the total estimated price of all procurement associated with the Lance including spares, test equipment, et cetera?

Colonel TOBEY. That is the number I just gave you, I believe.

COST EFFECTIVENESS OF LANCE MISSILE

Mr. ANDREWS. The extended range Lance is expected to have a range of ——— kilometers with a nuclear warhead and ——— kilometers range with a nonnuclear warhead.

In flight tests to date, has the accuracy of the missile been such that the nonnuclear warhead would be effective enough to justify the high cost of each round?

Colonel TOBEY. Yes.

NAVY INTEREST IN LANCE SYSTEM

Mr. ANDREWS. Last year the Navy expressed an interest in a seaborne version of Lance. Does the Navy have such a program in fiscal 1970?

Colonel TOBEY. The Navy is not participating at this time in the Lance program.

WARHEAD DEVELOPMENT

Mr. ANDREWS. What is the status of the effort to develop a lightweight nuclear warhead for Lance?

Colonel TOBEY. The AEC is actively engaged in the development of a warhead. We are developing the fusing system for it.

Mr. ANDREWS. Is it correct that ——— million of the $51.4 million requested is for this effort?

Colonel TOBEY. Yes.

Mr. ANDREWS. Is the XM-188 warhead the only nonnuclear warhead to be used on Lance?

Colonel TOBEY. We have a practice warhead and a chemical warhead under development in addition to that.

Mr. ANDREWS. Do you still estimate that after 1970 a total of ——— will complete the development of this warhead?

LANCE SYSTEM REACTION TIME

Mr. ANDREWS. From your test program to date, what do you estimate will be the reaction time of the Lance system?

General BETTS. It has demonstrated a ——— minute daylight reaction time and ——— minute night reaction time.

Mr. ANDREWS. Is that good?

General BETTS. That is good for a missile system of this size.

Mr. ANDREWS. After Pershing had supposedly completed development, we spent millions giving Pershing a quick reaction capability. Will this be avoided with Lance?

General BETTS. It is rather inherent in the design of the system.

In other words, each launcher is ready to go. What we did with Pershing was to increase the ability of the tactical unit to launch all its missiles with more simultaneity. If we decided to put the Lance battalion configuration that every missile was carried on a launcher it would increase the price. But there are no such plans at the present time.

REDUCTION IN 1969 FUNDS

Mr. ANDREWS. The Army requested $40 million for Lance in fiscal 1969. Only $34.9 million was actually applied. What was the effect of the $5.1 million reduction?

Colonel TOBEY. This reduction delayed the start of the five-ring engine testing approximately 4 months. We have several items to put in the record.

(The information follows:)

Additional effects include postponing seven 2-ring engine flights, and deferring improvements on Lance test facilities at Redstone Arsenal until fiscal year 1970, terminating development of a bladder system as a backup solution to propulsion feed system problems, and reducing to a minimum level funding for development of the monitor programer, the contact support test set, and a backup accelerometer. The additional cost in the years beyond fiscal year 1969 will be $8.8 million.

Mr. ANDREWS. If a general reduction is made this year, will a part of the $51.4 million requested probably be deferred?

General BETTS. It is hard to make an estimate where we would have to take our decreases if in fact the budget comes out at less than this level. If history is any example, the decrease in Lance funds last year was in response to the expenditure restrictions that had been placed on us. So it could happen.

Mr. ANDREWS. Do you have firm plans to spend $51.4 million requested in 1970 on the Lance program?

General BETTS. Yes, we do.

Mr. ANDREWS. Do you consider it to be of such priority that if the $51.4 million request was cut, would you then plan a reprograming effort to keep the Lance program going at the $51.4 million?

Mr. POOR. I do not think we can answer that at this time, Mr. Chairman. It would clearly depend on the overall budget level. We would have to see that in order to know whether we could reprogram up to the full amount. It is of great importance. We would like to do it at the recommended rate. But if the budget as a whole is seriously reduced, Lance may have to take its share.

Mr. ANDREWS. I do not know whether you can say this program was designed for Vietnam, but you say the missile would be very effective and useful in Vietnam. You have given Vietnam programs the very highest priority.

General BETTS. We have. I might say that as we were reduced from our request roughly $2.1 billion down to the $1.8 billion in the President's budget, we did not reduce this item.

Mr. ANDREWS. What did the other body do in the authorization bill for Lance?

General BETTS. As far as I know it was not changed.

Mr. ANDREWS. Are there any questions on Lance?

USE OF LANCE IN VIETNAM

Mr. RHODES. Yes, I am interested in what you would use this missile for in Vietnam.

General BETTS. It is a good antipersonnel weapon.

Mr. ANDREWS. But why would you use a missile when you have aerial superiority and lots of aircraft?

Mr. Poor. We are using the 175-millimeter guns in Vietnam in a most remarkable way. I think it would not have occurred to me that this long-range artillery was of real utility in Vietnam, and yet I have been told that it has been very successful for interdiction of road junctures, and things of this sort. They use it by patrols finding targets of opportunity and shooting at them. The Lance system—and I am certainly not sure it would ever get to Vietnam—can perform that role very well.

Mr. Rhodes. You are pretty sure it won't get to Vietnam, aren't you?

Mr. Poor. I think it is unlikely we will have enough of them in time to seriously consider putting them there.

Cost of Lance versus artillery

Mr. Rhodes. If you had them running out of your ears you would not put them in Vietnam because they are too expensive. You have air superiority. You are not going to use the Lance in Vietnam.

Mr. Poor. When we started the design of Lance it was a matter of great controversy in the Army whether a missile of this sort could be a cost-effective replacement for artillery. We were persuaded that it indeed could. The number of people required to deliver a heavy equivalent of a TOT—one sudden fire on a target—is enormously reduced through the use of Lance since one missile in one shot can do something like what ——— tubes of artillery could do.

Mr. Rhodes. Using conventional ammunition?

Mr. Poor. Using conventional rounds. You understand that this has one of those ——— that we discussed in the first days. So it covers a quite large area in one shot. It has the obvious advantage of surprise and great precision. There is no need of a spotting round so the target is completely unwarned when it comes in. I think it is unlikely we could get them to Vietnam but if they were there, it would be very useful.

Mr. Rhodes. If you could pinpoint the location of a bivouac or some sort of center like that, I can see it.

Mr. Poor. One round takes care of it.

General Betts. We extend the application of sensors for broad area intelligence. It could well be that coupled with a broad area weapon like this we might find a very effective combination. I do not say that is a planned proposal, but certainly one that we will consider.

Mr. Rhodes. Thank you, Mr. Chairman.

Pershing Missile

Mr. Andrews. Are there further questions on Lance? If not, we will take up Pershing.

The fiscal year 1970 request of ——— for further development of the Pershing missile system is ———.

Colonel Tobey. ———.

Mr. Andrews. When will you be through with the Pershing program?

Colonel Tobey. Fiscal year ——— will complete the program.

COST OF R. & D. PROGRAM

Mr. ANDREWS. Put in the record how much you have spent to date on this program in R. & D., and what you expect the balance of the program to cost.

(The information follows:)

The funds expended on the basic and improved Pershing are $550.3 million. The balance including fiscal year 1970 funds is expected to be ——— million.

REDUCTION IN 1969 FUNDS

Mr. ANDREWS. The fiscal year 1969 request for Pershing was for $12.3 million. What effort was deleted by the reduction to $0.6 million?

You can put that in the record.

(The information follows:)

The level of effort in the special test progam was reduced for fiscal year 1969 and the length of the program was extended into fiscal year 1971.

PERSHING MODIFICATIONS

Mr. ANDREWS. What relationship exists between the funds requested in R.D.T. & E., for Pershing and the $13.5 million in the fiscal 1970 PEMA budget for Pershing modifications?

Colonel TOBEY. We do not have that relationship with the PEMA program. If we could supply that for the record.

Mr. ANDREWS. Very well.

(The information follows:)

$5.1 million of the $13.5 million PEMA funds are set aside to purchase modifications determined necessary and developed in the special test program. The modifications will harden the Pershing system to the electromagnetic pulse environment. The remainder of the PEMA funds is associated with modifications to correct shortcomings in the overall system.

DEVELOPMENT COST

Mr. ANDREWS. How does the presently estimated total development cost of Pershing of ——— million compare with the original estimated total development cost?

Colonel TOBEY. We cannot identify the $497 million figure you quote, but we believe this to be the cost for the basic system. It is the right ball park for that number but does not agree with our specific number.

Our records indicate that the R. & D. for the basic system costs $518.3 million. Our estimate to convert the Pershing system to the P–1A configuration for the quick reaction alert role was ——— million. This estimate is valid and we anticipate obligating ——— million for the P–1A program.

Mr. ANDREWS. In fiscal year 1966 after the QRA role for Pershing had been established, the total development cost was estimated to be $497.1 million. Why has this estimate been exceeded by ——— million?

Mr. POOR. That prior answer I think was addressed to this question.

Colonel TOBEY. Yes, sir.

Mr. ANDREWS. Put something else in the record about it.

General BETTS. I think we have to sort out the difference between what was the basic program and when we introduced the improved

program and whether or not these numbers did not get mixed up along the line. We will correct that.

(The information follows:)

We cannot identify the $497.1 million figure. Our records indicate the basic Pershing system R.D.T. & E. cost was $518.3 million. The original estimate to convert Pershing to the P–1A configuration for the quick reaction alert role was ——— million. The remainder includes ——— million for microminiaturization of components and ——— million for penetration aids not included in any original plan.

SPECIAL TEST PROGRAM

Mr. ANDREWS. Describe the Pershing's special test program.

Colonel TOBEY. The Pershing special test program is designed to test the vulnerability of Pershing equipment to high yield, outside the atmosphere nuclear explosions. Test results will be analyzed and the modifications necessary to protect against this kind of phenomena will be introduced into the P–1A system. This is the so-called electromagnetic pulse. These tests are conducted at Orlando, Fla., by the plant, and they have a high single electrical cable type wire of about 100 yards in length which they pulse with proper amounts of electrical current, and they get a reading on the actual Pershing equipments and can test its vulnerability to the electromagnetic pulse.

DESCRIPTION OF MISSILE

Mr. ANDREWS. Tell us what the Pershing program is and what its mission is and something about the characteristics of the missile.

Colonel TOBEY. The Pershing is about a ——— nautical mile system maximum range, with a minimum range on the order of ——— miles. It is a two-stage missile. It is launched now from the erector launchers that are truck drawn on wheels as opposed to the track vehicle we had in the basic Pershing program. The ground support equipment consists of the erector launcher I have just described, a programer test station which does all of the computation of the fire mission, keeps track of the missile on the ground, and a power station that provides the power for the missile and the program test station.

Mr. ANDREWS. What is the mission of the missile?

Colonel TOBEY. The system is on quick reaction alert in Germany now, and a prescribed number of the missiles are in a ready to fire condition 24 hours a day around the clock, 7 days a week.

Mr. ANDREWS. It is an IRBM?

Colonel TOBEY. It could be classed as an IRBM.

Mr. ANDREWS. What type warhead does it carry?

Colonel TOBEY. It carries a nuclear warhead.

Mr. ANDREWS. What about conventional?

Colonel TOBEY. It has no conventional warhead.

Mr. ANDREWS. It takes the panic button to push it.

Colonel TOBEY. That is correct.

SPECIAL TEST PROGRAM

Mr. ANDREWS. The fiscal year 1969 justification indicated that the special test program would be essentially completed in that year. The fiscal year 1970 justification states that the special test program will continue. Why?

Colonel TOBEY. This is a test program that is a leadoff in the military services—all three services—for systems of this type against the EMP or electromagnetic pulse. We are finding that there is not very much known about this at this time. We are finding out more as we go along. The Pershing is the test vehicle for this, if I can use that term.

Mr. ANDREWS. The Air Force has spent millions on this in their Minuteman program. Has the Army learned anything from their tests?

Coloney TOBEY. Yes, sir.

Mr. ANDREWS. Is the Pershing still in production?

Coloney TOBEY. The production of the ground support equipment in the P1–A configuration is essentially complete, and they are in the process of trading the equipments to Europe. That program has begun this month.

INVENTORY REQUIREMENTS

Mr. ANDREWS. Have you completed the missile inventory?

Coloney TOBEY. The inventory was completed but there is an additional buy of some ——— additional missiles. I am not sure whether those are all for the Germans or whether we have some. I understand those are ours, U.S. Army missiles.

Mr. ANDREWS. What does this missile cost?

Coloney TOBEY. ———.

Mr. ANDREWS. Who is the contractor?

Colonel TOBEY. Martin in Orlando is the prime contractor.

Mr. ANDREWS. Are they made in Orlando?

Coloney TOBEY. Yes, sir.

Mr. ANDREWS. What is the rate of production?

Coloney TOBEY. I do not have that. I can supply that for the record, sir.

(The information follows:)

Production of the original missiles was at the rate of ——— missiles per month. The planned production rate for the additional missile purchase is ——— missiles per month.

Mr. ANDREWS. You have an additional requirement for ———.

Coloney TOBEY. That is correct.

SPECIAL TEST PROGRAM

Mr. POOR. Mr. Chairman, on this special test program, I got the impression from a question you feared we might not complete it in time to protect the missiles properly, the problem in EMP or electromagnetic pulse is that a large nuclear weapon set off perhaps many miles away, or many tens or even hundreds of miles, will produce a big electric field over the whole battlefield. This has the effect of knocking out telephone lines, communication links, and various thinks of this sort. You are quite correct in your statement that the Air Force has done a great deal of work in electromagnetic pulse hardening in the Minuteman installation. In the Pershing system its vulnerability is ——— and things of that sort as the system is deployed. So the tests that are now going on will show us the special little points of vulnerability to such an electromagnetic disturbance.

As we find them we can add appropriate ——— to the system at presumably very low cost to harden it against this kind of threat. That is what is now going on.

IN-FLIGHT RELIABILITY

Mr. ANDREWS. What kind of record have you made for Pershing in the test program?

Colonel TOBEY. The test program for Pershing has been very, very successful. We are riding now on an in-flight reliability of nearly ——— percent which is among the highest of the missiles that I know of.

Mr. ANDREWS. That is good?

Colonel TOBEY. Yes, sir. It is very accurate in in-flight reliability. We hope that the preflight reliability will be improved with the P1–A equipment.

COMPONENT IMPROVEMENTS

Mr. ANDREWS. What missile component improvements will be initiated in 1970?

Colonel TOBEY. We hope to initiate the ———.

Mr. ANDREWS. If you had such wonderful success in testing these missiles, ——— percent, why do you need to continue research and development on the missile?

What are you shooting at—100 percent?

Colonel TOBEY. Yes, sir. ———.

COST OF COMPONENT IMPROVEMENTS

Mr. ANDREWS. At what cost in 1970 and at what total cost have these component improvements resulted?

Colonel TOBEY. In fiscal 1970 we have to spend ——— million on these components, and fiscal 1971, ——— million, and that is the end of that improvement program.

Mr. ANDREWS. Why must the power station undergo an improvement program? What are its deficiencies and what is the estimated total cost of the power station improvements contemplated?

Answer the first part of that question now, if you can, and supply the other for the record.

Colonel TOBEY. The power station is a very complex piece of power equipment that supplies compressed air, air-conditioned air, two or three voltages of electrical power, and DC as well as AC power. It is packaged in a very tight compartment made necessary by the room that was available on the track vehicle. These components can be repackaged to help with the maintenance and upgrade the reliability of this critical element of the system.

(The information follows:)

The cost of the power station improvements will be about ——— million R. D. T. & E.

Mr. ANDREWS. I guess you will have with you from now on the problem of maintenance and close inspection of these missiles to determine that when the button is pressed the missile will go.

Colonel TOBEY. Yes, sir.

REACTION TIME

Mr. ANDREWS. What reaction time has been achieved with Pershing? How long after arriving at a new site can Pershing be effectively fired?

Colonel TOBEY. The reaction time of the Pershing when it is in position thoroughly checked out is ——— minutes. This means that in its day to day environment it can fire on ——— minutes' notice and has done so in the shakedown operational test.

Mr. ANDREWS. That is good?

Colonel TOBEY. That is very good. This represents a decrease of countdown time from ——— minutes to ——— minutes. The time to put the Pershing in position is not critical because in the QRA role they ——— and they ———. It has been done in an little as ———.

CONTRACT FOR COMPONENT IMPROVEMENT

Mr. ANDREWS. With whom would you contract for component improvement and power station improvement? Would it be with the prime contractor or with the vendor of the component?

Colonel TOBEY. The prime contractor in this case, because he packages the complete power station.

COST OF SPECIAL TEST PROGRAM

Mr. ANDREWS. Martin Marietta was awarded a $1,739,075 cost plus fixed fee contract for conducting the special test program. Is this the total cost of the special test program?

Colonel TOBEY. I would think it would not be the total cost of the special test program, ——— for fiscal 1970.

SERVICES OF COL. ROBERT V. KANE

Mr. ANDREWS. Are there questions on the Pershing system? If not, I have been informed that our old friend, Col. Bob Kane is leaving tomorrow for a new assignment at the Presidio and before closing we would like to take this opportunity to thank him for the many services that he has rendered members of this committee. It has been a pleasure to have you with us through the years, Colonel, and I hope that you will enjoy your next assignment as budget officer at the Presidio.

Colonel KANE. Thank you, Mr. Chairman. I have much enjoyed my associations with this committee and with the members and the extremely competent staff of this committee. I learned more in the last couple of years than I have in my Army service before. This has really been a great experience.

Mr. MINSHALL. You have done a great job, we are proud of you.

Mr. ANDREWS. Good luck to you, Colonel Kane. The committee will stand adjourned until 10 o'clock Monday.

MONDAY, JULY 14, 1969.

Mr. WHITTEN. Gentlemen, the committee will come to order.

We shall resume the hearings on the Army fiscal year 1970 R.D.T. &. E. budget request.

LAND COMBAT SUPPORT SYSTEM (LCSS)

You are requesting $5.7 million to continue the development of the Land Combat Support System which is to provide automatic electronic test equipment for general and depot maintenance of Army

surface-to-surface missiles. A total of $52 million has already been spent in this effort. What is the estimated total development cost of equipment which will support Lance, Tow, Shillelagh, and Dragon?

General BETTS. As we project the LCSS program, at this time the estimated cost to complete is ——— million; but may I point out, Mr. Chairman, having provided the basic capability represented by the Land Combat Support System that permits us to use automatic data processing for the test and checkout of complex systems, we would hope that as time goes by with relatively minor modifications to that basic system it can be adapted to the test and checkout of any new complex system that comes into the Army inventory.

Mr. WHITTEN. When will the R. D. T. & E. effort be completed?

Colonel LAMB. It is estimated it will be completed in fiscal 1974.

Mr. WHITTEN. Is it your intention that a single test set will be able to support the four missiles, Lance, Tow, Shillelagh and Dragon?

Colonel LAMB. Yes; a single test set will support all four.

FISCAL YEAR 1969 PROGRAM INCREASED

Mr. WHITTEN. The fiscal 1969 budget requested $1.9 million for this program. The fiscal 1970 justification indicates that $7.8 million was actually planned for 1969. What is the basis for this large increase in fiscal 1969?

Colonel LAMB. We had some difficulties that came out during ET/ST and additional funds were required to correct the deficiencies that were discovered in the ET/ST of the set.

Mr. WHITTEN. Where did your funds come from?

Colonel LAMB. The reprograming was just short of $6 million, $5.3 million.

Mr. WHITTEN. Is that all the money that you actually used?

Colonel LAMB. Yes, sir; that is the money we actually used in LCSS. I do not know the exact source of the funds.

Mr. WHITTEN. Supply that for the record.

(The information follows:)

In fiscal year 1968, $1.9 million was requested for LCSS and approved by Congress. Subsequently, $1.985 million was added to the fiscal year 1968 funds for a total of $3.885 million. The additional funds were reprogramed from program element 6.21.09.A, environment ($0.285 million); program element 6.27.03.A, airborne surveillance and target acquisition ($1.420 million); program element, 6.27.04.A, ground surveillance and target acquisition ($0.080 million); and 6.46.01.A, infantry supporting weapons ($0.200 million). In fiscal year 1969, $2.5 million was requested for LCSS and approved by Congress. Subsequently, $5.3 million was added to fiscal year 1969 by reprograming action fiscal year 1969–2 (DOD No. fiscal year 1969–28) for a total of $7.8 million. This action was the fiscal year 1969 omnibus reprograming action totaling $74 million and a specific source of funds cannot be related to LCSS.

General BETTS. It was part of our omnibus reprograming as submitted to the committee.

Mr. WHITTEN. The PEMA budget includes $30.9 million for the land combat support system. How many sets will this buy?

Colonel LAMB. In fiscal year 1970 we would plan to buy ——— for the $30.9 million.

Mr. WHITTEN. What missiles will be supported by these sets?

Colonel LAMB. The Shillelagh and the Tow, initially, will be supported by these ——— sets.

Mr. WHITTEN. The descriptive summary states that the basis for estimating the cost to complete this development is not firm. This would seem to indicate that procurement is premature.

General BETTS. No, sir. I think it comes back to my comment that we would plan in the future by relatively minor adaptation to make this capability available to handle other complex systems as they may come into the Army inventory at a later time.

Mr. WHITTEN. How many sets have already been funded and how many deployed?

Colonel LAMB. There have been ——— sets funded and ——— sets deployed.

Mr. WHITTEN. Why should so many be procured before completion of the R.D.T. & E. program?

Colonel LAMB. The land combat support system, as General Betts has said, provides support for four systems and we have to field the land combat support system as the systems become available. Shillelagh is the first one to be out of R. & D. and in the field. So the land combat support system has to be fielded to support Shillelagh. For example, we have one in Japan to support the Sheridans in Southeast Asia.

General BETTS. We might point out that the capability of this system for Shillelagh has been demonstrated by test so that we have no misgivings about whether or not it will function properly in that role, even though we are going on with the further adaptation to other systems.

Mr. WHITTEN. How is it possible to design a testing system prior to completing the development of the missile system that you are to test? I have in mind the Lance and the Dragon missile systems, for example.

General BETTS. We are able to block out the design of what it is we want within this system to handle new systems as they come through the development and test cycle, but before we would field a land combat support system and the additional equipment that relates to test and checkout of a particular missile, we will have gone—and in the past we have gone—into adequate testing of production missiles of that kind.

Mr. WHITTEN. But how would you go about designing a test set for the lance missile which is still under development?

Mr. POOR. I think I can comment on that a little bit, Mr. Chairman. The land combat support system, while it is complicated and automated, is very much like the kind of test equipment that you use to check out your television set at home. It has instruments in it that can measure the performance of components in a missile system. Now, in the Lance guidance system, for example, essentially all of the critical components are already defined and this equipment can be used not only for testing the missile in production and in the field but it also can be used for determining how the thing works during engineering service tests, that sort of thing. Since we know what components are in the missile that need to be measured then we can define pretty well what kind of programing, software, and what kind of end instru-

ments measuring equipment to feed into the land combat support system we need to support Lance right now, even though the decision to field Lance in its final configuration has not yet been taken.

So it is that sort of thing. You need the right kind of measuring gear.

DESCRIPTION OF THE LAND COMBAT SUPPORT SYSTEM

Mr. RHODES. Before we leave this topic may I ask a question?

Mr. WHITTEN. Mr. Rhodes.

Mr. RHODES. Would you care to describe what you are trying to do by this Land Combat Support System? How does it work?

Mr. POOR. We are trying to make the job of field maintenance a lot easier than it is now.

Mr. RHODES. How does it work; would you describe that, please?

Mr. POOR. The system consists of a programer-comparator central gadget that can tell, by hooking the device up to the system under test, whether the parts in the system are in or out of tolerance. Now, the old-fashioned way of doing it was to take a man with a voltmeter to go in and plug into the equipment and do it step by step. As guided missiles become reasonably complicated, it is a lot easier and takes a lot less people if you can hook computer-controlled test equipment up to the system under test, which will quickly sort out for the operator those things he needs to fix. It is the application of that kind of new technology to the testing that the Land Combat Support System is intended for.

Mr. RHODES. Of course, if you don't have all four of these missiles located at the same place you can't support all four systems, can you?

Mr. POOR. I think you can. We have subsystems of the Land Combat Support System that interface specifically with the missiles in question and at the depots, of course, you have the whole system and you can bring the missiles to it.

Mr. RHODES. How many of these systems worldwide will we have to have?

Colonel LAMB. Sir, we have a requirement for ———.

Mr. RHODES. How much per copy are they when you get to procurement?

Colonel LAMB. If you take this year's buy of ——— they are about ——— per copy. That is $30.9 million in PEMA and we are getting ——— sets. They run cheaper—for fiscal year 1971 we plan to buy ——— and it comes down to just about ——— per set at that rate.

Mr. RHODES. Are these missiles tested when they leave the depot for the field or are they tested while they are in stock?

Colonel LAMB. The missiles primarily are not checked by the Land Combat Support System. It is the electrical equipment and electro-optical and electromechanical equipment necessary to fire the missile. For example, on the Sheridan vehicle things that would be checked would be the black boxes on the vehicle itself, not the Shillelagh missile. The Shillelagh missile is checked at the depot when issued to the unit and it is ready to fire. It is not checked by the Land Combat Support System.

Mr. RHODES. The tanks are presumably in the field?

Colonel LAMB. Yes, sir.

Mr. Rhodes. Where is the computer?

Colonel Lamb. At the general support or depot level.

Mr. Rhodes. You have to bring the tank in to the depot to be checked?

Colonel Lamb. Or the black boxes which are faulty.

General Betts. You see, at the organizational level they have a maintenance capability but not a maintenance capability of such competency that it could go into the individual parts of the system and correct them. They can find out that a subsystem is not working properly. If it is bad enough that they can't do anything about it they will pull it out and send it back to the depot and get another black box to put in its place.

Mr. Rhodes. Could this same type of system be used to check similar equipment on aircraft?

General Betts. Yes, sir. And it may well, if we get the Cheyenne in the system, may well be used in support of the fire control and other elements of the Cheyenne system, although that is not yet determined.

NO COST EFFECTIVENESS STUDY COMPLETED ON LCSS

Mr. Rhodes. How do you determine the cost effectiveness of a system like this as against the old system, as you described it, of just having a man with a voltmeter go around and manually checking it?

General Betts. We worked out an analysis of what sort of maintenance structure would be necessary at a depot to do the old way as compared to doing it with this kind of equipment.

Mr. Rhodes. Have you done a cost effectiveness study on this system?

General Betts. I am not personally familiar with it. I am sure we have justified it.

Mr. Rhodes. Will you furnish for the record the cost effective data on this system?

General Betts. Yes, sir.

(The information follows:)

A formal cost effectiveness study has not been conducted on the LCSS. However, the justification for the multisystem test equipment approach of LCSS has been found related to the inherent characteristics of the Army missile systems. Army Ordnance Corps studies completed in 1958 proved that, although configuration and methods of testing were different, approximately 85 percent of the basic functions of each peculiar missile system test equipment are common to all systems. It has been usual in the past to design special test equipment peculiar to each missile system. This practice brought about an expensive multiplicity of similar test equipment, a lack of uniformity, and an undesirable logistic burden. These early studies included the analysis of the testing requirements for 10 missile systems and were the basis for the award of the initial contract for development of multisystem test equipment in 1962.

In 1965 two cost comparison studies were conducted between LCSS and system peculiar test equipment. These studies indicated a cost comparison of $90.7 million for LCSS and $108 million for comparable system peculiar test equipment for Shillelagh, TOW and Lance. A similar study conducted by the Institute for Defense Analysis (IDA) in 1966 concluded that LCSS was more economical than the system peculiar or bench type test equipment.

LCSS COMPARED TO MULTISYSTEM TEST EQUIPMENT

Mr. WHITTEN. My attention is called to the fact that you formerly had what was called multisystem test equipment program. You spent lots of money on it and it proved something of a dud. What is the history of this multisystem test equipment? How long did you have the program in operation? How much money did you spend on it? When did it fail and why did it fail?

General BETTS. I will turn to Colonel Lamb for that.

Colonel LAMB. In June of 1964 actually an Army study showed that savings to the Army would result from fielding this multisystem that you referred to, or land combat support system. The feasibility of the approach was established and we also knew that the larger, more complex Air Defense systems were being maintained by some system-peculiar equipment that would not be adaptable to the more mobile Shillelagh-type equipment.

Mr. WHITTEN. Isn't that an indication that you might be getting the cart before the horse? In other words, if you spent a whole lot of money on developing a testing system and then it turns out the missile system is a failure, you didn't have anything to test. You are going ahead and developing a test set system for four missile systems prior to completing the development on two of them. What makes you believe that you will have the lance and dragon systems to test when you get through building this expensive LCSS test equipment?

General BETTS. I think that we can say that we got from the multisystem testing equipment the basic technology that has led to improved design which is now represented by the land combat support system. In fact, this system has been demonstrated to work effectively in the way it has already been put into use.

Mr. WHITTEN. I don't question that you got something out of it, but if I understand it correctly, it failed. You should have learned not to do this again. Now you come along with a new system and buy a number of them before you complete all your development work. Isn't that a whole lot of expenditure before you know what you are doing?

General BETTS. No. I believe we have tested out the land combat support system in its present configuration well enough that we know very well what it will accomplish. We have demonstrated this.

Mr. WHITTEN. You won't have the same experience you had with the multisystem test equipment?

General BETTS. As far as I am concerned, we learned from our failures in the other system and improved the design of the land combat support system accordingly.

Mr. WHITTEN. Did the sets you purchased in 1969 require modifications prior to procurement?

General BETTS. I suspect that they did. I would have to confirm that in detail. I would have to check that out.

(The information follows:)

The sets procured in fiscal year 1969 incorporated all modifications resulting from prior MTE development and LCSS engineering tests that has been developed at the time of contract award.

Mr. WHITTEN. Were the modifications made after the procurement or prior to procurement? Did you procure them on the condition that modifications would be made or did you buy them and then learn you had to go back and modify the systems to make them work?

General BETTS. I would have to furnish that. I don't know.

Mr. WHITTEN. You might supply that for the record.

(The information follows:)

No known modification requirements were omitted from the procurement action for the sets in fiscal year 1969. Subsequent to this procurement, additional scheduled testing and supported system changes resulted in the requirement for modifications to increase the suitability of LCSS for operation in extremely humid environments and to provide certain software revision to accommodate supported software changes. These modifications are not considered unusual for this type of development. A portion of the ——— sets (tactical sets only) will be retrofitted with the environmental modification. The software changes will be provided for all sets.

MISSILES EXPLORATORY DEVELOPMENT

Mr. WHITTEN. The fiscal 1970 request of ——— million for exploratory development of missiles compares with $16 million in 1969 and $17.5 million in 1968. What is the basis for the ——— increase over 1969?

General BETTS. May I turn to Colonel Tobey.

TERMINAL HOMING SYSTEMS

Colonel TOBEY. We are increasing ——— in a new project known as terminal homing systems. This has been directed by the defense research and engineering. ——— is to support some integrated studies with the NATO allies on radar clutter, terrain masking and tactical radar design in support of NATO. It is a cooperative research project. The remaining ——— is distributed among the 16 projects that we have, in missile exploratory development.

Mr. WHITTEN. Your justification notes to us do not carry the ——— million for new projects.

Colonel TOBEY. This is added and will be added to the summaries. It was developed since the descriptive summaries went to press; yes, sir.

Mr. WHITTEN. How long ago was that?

Colonel TOBEY. I think it was March.

Mr. WHITTEN. March? You mean since March you haven't notified the committee of any change in your budget justifications? The record shows you revised this on the 16th of April. Why did you leave that item out?

Colonel TOBEY. I may be incorrect on the exact date that we got the directive from D.D.R. & E., but this is the major new item in that budget.

Mr. WHITTEN. This budget which came down to us, the revised budget, which was revised April 16, you asked for ——— extra but at that time you hadn't decided what you wanted it for; is that right? You just wanted the money and you would then find some use for it. That is the way the record seems to stand.

Colonel TOBEY. Our page 138 of the descriptive summary shows terminal homing in fiscal 1970 program. It does not break it out on the listing on the front but it shows terminal homing, not as a separate project.

Mr. WHITTEN. Is that your new project?

Mr. POOR. That is the new element.

Colonel TOBEY. January 13, as amended——

Mr. POOR. I think Colonel Tobey was in error. The additional work on Terminal Homing was contemplated prior to that as reported on page 138.

Mr. WHITTEN. Where is the project listing?

Colonel JOY. It is listed on page 5 of the justification project listing by budget subactivity.

Mr. WHITTEN. Where is the new item there?

Colonel JOY. It is listed as part of the guidance and control for guided missiles which shows an increase on page 15 of the budget subactivity listing.

Mr. WHITTEN. As ——— million?

Colonel JOY. Yes, sir.

EFFECT OF HOLDING TO FISCAL YEAR 1969 FUNDING LEVEL

Mr. WHITTEN. The fiscal year 1969 budget requested $18 million in this area. Only $16 million was applied. What would be the effect of keeping this program at the 1969 level of effort for the coming year?

Colonel TOBEY. In that event we would restructure the program to make the best utilization of the available moneys.

Mr. WHITTEN. Is that what you did do in fiscal 1969?

Colonel TOBEY. That is correct; yes, sir.

Mr. WHITTEN. If that proved reasonably satisfactory, you should be able to do the same thing in fiscal 1970?

Colonel TOBEY. It is undesirable to cut this program to that degree. It is possible——

Mr. WHITTEN. You mean, it is unpleasant?

Colonel TOBEY. No, sir.

Mr. WHITTEN. You don't like it, or just what do you mean by undesirable?

Colonel TOBEY. There are studies and projects and supporting research that are critical to the missile developments that will be coming forward in the next fiscal several years.

Mr. WHITTEN. Let's break it down a little closer than that, Colonel. What did you leave out in 1969?

Colonel TOBEY. I think we had a reduced level of effort in several areas and I would have to provide the specifics for the record.

Mr. WHITTEN. If you know it enough to have a firm opinion on it, it looks like you ought to know enough about it to tell us now without having to get somebody to work up something to support your plea.

Colonel TOBEY. I don't have the specifics.

Mr. WHITTEN. Do you mean that you asked for ——— million last year and spend only $16 million, and you now want the ——— mil-

lion back. It seems that you are just required to say: you needed that much or you wouldn't have asked for it in the first instance. You claim that you suffered because of the reduction last year and you couldn't afford to absorb it, but you don't have a thing to support you here? You want to go back to the Pentagon to get somebody to support you; is that it?

Mr. POOR. Mr. Chairman, I am sure you realize that in the 6.2 class of line item which is exploratory development, that from this comes the beginning of new technology which appears in missiles a good many years later. It is the seed work that starts the new technology. The best way to assess the value of it is to go back and look and see what of the prior work is incorporated into present missiles. Now, it is very difficult for Colonel Tobey to assert with any emphasis that it will be a disaster if we cut this work. I can tell you that as a result of the reduced level in fiscal year 1969 we are simply not as far along in things like the development of homing missiles, ones which you can launch and leave, as we could have been had we expended that effort on it. I happen to think that part is important. The President's Science Advisory Committee thinks it is important. The ground warfare panel of the President's Science Advisory Committee has urged us to get on faster with this kind of work. Really, all that will happen if we reduce the level is that we will do it more slowly.

Mr. WHITTEN. When you say "at a reduced level" you mean at a reduced level from your original request in fiscal year 1969. What we are talking about is carrying on in fiscal year 1970 at the same level as last year. You made a very good statement there about the necessity of developing new ideas and new technology. Exploratory research is always essential in order to find new horizons, new techniques, new solutions, new ideas. But with the folks in the scientific field, there is no limit to what they would like to spend on any general subject. The question is you have lived and prospered and apparently made progress on $16 million in 1969. Why can't you do that for 1970, the same level? What would be the result, in measurable terms? Now, we have heard lots of generalities but let's get specific.

Mr. POOR. I am confident we can do something at the level of the 1969 budget. I point out in fiscal 1968 the funding level was $17.5 million. It was reduced somewhat in 1969 and the ——— million in 1970 would barely get us back, making appropriate allowance for the increased cost of doing business, to the level that we had in 1968. Granted this is a general statement, but it is difficult to be very much more specific. I am concerned about the importance of doing more work on some of the promising new developments. Terminal homing is one of them. New electronic techniques for making components in missiles which offer much more reliability and much simpler and cheaper systems in the field also come out of this program. I hope we will be able to convince you that the proposed level of effort is prudent.

Mr. WHITTEN. Mr. Secretary, I am asking questions without being well grounded, as you know, in this overall matter. But where the increased cost of doing business in simple terms means inflation, there

are those that feel the only way to stop inflation is to keep your spending down. If you don't buy as much, if everybody keeps their spending down to the prior level, it stands to reason that we might be able to get back to where we were. But if we try to keep up with it, it is one of those things where the faster you try to keep up the faster the galloping horse stays ahead of you. Now, I want to make it clear at this point that we are not discussing the necessity for the program. We are discussing the $16 million which you had last year and the ——— million program which you want in fiscal year 1970. So it is that difference between the two that is the subject of discussion here.

Missile Propulsion

The fiscal 1970 request of ——— million for missile propulsion is comparable to $12.6 million in fiscal 1969 and $9.6 million in fiscal 1968. What have been some recent accomplishments in this area?

RECENT PROGRAM ACCOMPLISHMENTS

Colonel Tobey. In fiscal year 1969 we made some rather significant accomplishments in the supporting research on missile propulsion. We discovered and demonstrated the feasibility of a new boron compound catalyst that increases the burning rate three times and permits the use of casebonded internal burning grains as required by the light assault weapon. So we have made accomplishments that would pertain to the light assault weapon.

Similarly, we have developed new components, ultrafine ingredients that will fit into the solid propellants that will give booster engines for the Sprint follow-on greater impulse and hence greater speed. We have developed a polymer that reduces the cost of solid propellant missiles, solid propellants for use in missiles. This would be applicable to any solid system, particularly Mars, where we are looking for a low cost system. This ingredient reduced the cost by about half.

We have developed a new class of smokeless propellants capable of increasing the range of missiles appreciably and these would be particularly applicable to the missiles that have to work and live in the forward areas of the battlefield, the advanced air defense missiles, for example.

SCRAMJET ENGINE APPLICATION

Mr. Whitten. Of what value was the work on Scramjet engines which was carried out under this heading?

Colonel Tobey. The Scramjet engine has an application to a cruise-type missile. This would be as opposed to a ballistic-type missile. A secondary application is a sustainer engine for an air defense missile of the replacement for Chaparral type. The Scramjet engine was successfully developed. It is available using ethane as a fuel. Ethane is not a very practicable fuel as we understand it today, but development work could continue to get another hydrocarbon that would act as a fuel in this Scramjet engine.

FORWARD AREA AIR DEFENSE SYSTEM

Mr. WHITTEN. You are requesting ——— million for the program entitled forward area air defense system. You were provided $8 million for this program last year. Do you still plan to start engineering development of a new air defense system in fiscal year 1971?

Colonel TOBEY. I think we will still stay in advance development in these air defense systems.

Mr. WHITTEN. Is fiscal year 1970 the last year of the 3-year effort referred to both last year and the year before in the justifications?

Colonel TOBEY. We project the project to be completed in fiscal year 1972.

Mr. WHITTEN. It is becoming a 5-year program instead of a 3-year program.

General BETTS. We have not been able to fund this program the way we had projected several years ago. That has been true each year since. So that its ends up by stretching out to a longer term effort than we had planned or hoped.

RELATIONSHIP OF PROGRAM TO SAM–D DEVELOPMENT

Mr. WHITTEN. The title, forward area air defense system, just what is involved, in general terms, in this program? What are you seeking?

Colonel TOBEY. We are looking forward to a companion piece for the SAM–D surface-to-air missile development which is a large, complex system. Now, these are small, hopefully inexpensive systems, to be used in the forward areas of the battlefield to protect against the air-supported threat. We have three categories of systems that we are in concept formulation phase of now. These are a man-portable system as a replacement for the Redeye; a gun system which would replace our Vulcan, and a possible missile system that would be a replacement for the Chaparral.

TOTAL FUNDING REQUIRED

Mr. WHITTEN. How much money will you require for the coming year through 1972?

Colonel TOBEY. We are hoping for an increased level of effort through 1972, sir.

Mr. WHITTEN. For the record, will you say what that is, give the dollar figure at this point so that we do not have to look it up?

(The information follows:)

Funds required through fiscal year 1972 are to complete the prerequisites for contract definition, conduct contract definition and begin engineering development on two weapon systems. The Army proposed fuding requirements through fiscal year 1972 are as follows (dollars in millions):

Weapon system	Fiscal year 1970	Fiscal year 1971	Fiscal year 1972
Man portable air defense system	——	——	——
Low altitude forward area gun	——	——	——
Low altitude forward area missile	——	——	——
Total	——	——	——

Under this funding level the following milestone starts could be maintained:

Weapon system	Contract definition	Engineering development
Manportable air defense system	———	———
Low-altitude forward area gun	———	———
Low-altitude forward area missiles	———	———

REDEYE SURFACE-TO-AIR MISSILE

Mr. WHITTEN. Why do you require a new seeker and new motor for Redeye? What is the estimated cost of these modifications?

Colonel TOBEY. The new motor is required to obtain a capability against higher speed aircraft than we can now engage. This has been supported by the Marine Corps who are very interested in this development program and are providing ——— million to forward this program. The new seeker gives us, hopefully, a forward aspect capability which means the new seeker using new materials in the seeker would be able to track the plume of the incoming aircraft. The plume flares out behind the aircraft so it can be seen from the forward aspect. This would give the Redeye a capability to fire before the plane comes abreast of the Redeye position and gives us a forward aspect capability.

General BETTS. Mr. Chairman, you are aware of the fact that the Redeye is now limited to aircraft of about ——— knots and does not have a forward aspect. We have to get a good solid view of the tail of the aircraft, the jet, in order to make the Redeye work with its present limitations. There is seeker technology available that could improve this. There is certainly propulsion technology available to push it up, from the 6.2 program we were discussing, push it up to where it could handle a ——— knot aircraft. The ——— knot aircraft is well within the capability of the enemy today.

Mr. MINSHALL. What is the range of the Redeye in its present configuration?

General BETTS. ——— meters or yards.

Mr. MINSHALL. Is that maximum or optimum, or what?

General BETTS. That is essentially maximum. It is dependent on the target vector and speed. This particular one, that range is against a ——— knot aircraft pulling a ——— maneuver at ——— foot altitude.

Mr. RHODES. The enemy has the capability of developing a ——— knot attack aircraft completely loaded?

General BETTS. The enemy have fighter aircraft today that can go at speeds of ——— knots.

Mr. RHODES. I wasn't talking about a fighter aircraft, I am talking about an attack aircraft because Redeye isn't going to be any good against an air superiority-type fighter plane anywhere.

General BETTS. You are right. I am identifying the Foxbat.

Mr. RHODES. Don't worry about the Foxbats. At its optimum altitude, you are not going to have to shoot any Foxbats with the Redeye. Let's talk about airplanes that you might engage.

General BETTS. If they have an aircraft like the Foxbat they can use it to come down on the deck and make speeds like ——— knots and have armament that would attack the field army.

Mr. RHODES. That would be a very uneconomical use of the Foxbat but, of course, it could be done. We have been using the F–4 as an attack aircraft. I guess maybe that would be about as uneconomical.

Do they actually now have any attack aircraft that at altitudes of ——— feet or under can make a ——— nautical-mile per hour speed?

General BETTS. The Fishbed at sea level is ——— miles per hour. The Fitter is ———. These are tactical aircraft. Whether they would be used in the tactical attack role I don't know, but they could be. They are available in Western Europe.

Mr. RHODES. Actually, General, isn't it true that for an attack aircraft going that fast on a ground attack mission, your accuracy is sadly lacking anyway? I am just wondering if you really need this extended capability on the Redeye to engage the more efficient type of attack aircraft.

Mr. POOR. I think the problem is that a very good tactic for approaching a target, the kind that a tactical aircraft might engage is to get down low out of the influence of the larger missile systems like SAM–D and Hawk as you come over the forward edge of the battle area. There is no question that in the terminal engagement the aircraft can slow down to get precision. The point is that one would like to be able to exact attrition from the enemy tactical air during the approach to the target. Now, a Redeye or follow-on Chaparral system that could deny that corridor to the enemy tactical air would appear to be extremely useful. If it does not more than push the guy up to the point where the SAM–D's can handle him it will do the job we need.

Mr. RHODES. You are just not going to use Redeye for that type of mission, you are going to use a more sophisticated type missile. I can't imagine that——

Mr. POOR. I think you are right. I think the follow-on Chapparal system will be more useful. If the Redeye improvement program does result in denying part of the corridors of approach I think it would be useful. I don't think I can say any more than that.

Mr. RHODES. I doubt if you can even say that much now.

General, you mentioned that the Redeye was effective against jet aircraft. Does it have any effectiveness against piston-type aircraft?

General BETTS. Yes; it does, but this changes the range capability characteristics because the heat source is different.

Mr. RHODES. Would you explain that a little further?

General BETTS. There is a higher level of IR output from the hot end of a jet aircraft than there is from a piston aircraft.

Mr. RHODES. So the piston plane would have to be closer to the launcher?

General BETTS. That is correct.

Mr. RHODES. In order for the Redeye to have any effectiveness against it.

General BETTS. It reduces its range from that point of view, but since the piston aircraft is probably going slower you get a tradeoff. I don't have precise numbers as to what this range change is. I would be glad to furnish that for the record.

(The information follows:)

Redeye's range effectiveness against piston type aircraft is, as in jet aircraft, dependent upon the infrared energy radiated by the particular type of aircraft. Four representative types of aircraft and the possible engagement ranges are: L–19 aircraft, ——— intercept range; H–13 helicopter, ——— intercept range; L–20 aircraft, ——— intercept range; PB–44 aircraft, ——— intercept range.

Mr. RHODES. Thank you, Mr. Chairman.

Mr. WHITTEN. Further questions?

SAM–D MISSILE SYSTEM

We turn, then, to the SAM–D program. The Army is requesting $75 million for continued development of the SAM–D surface-to-air missile. The only Army missile program for which more funds are required is the Safeguard ABM. About $135 million has been spent on this program in previous years. The total estimated development cost is ——— million. Describe the capabilities which are sought for SAM–D and compare it with the Hawk and Hercules missiles which it is designed to replace. Those are serious questions and other serious questions have been raised about the program, that its cost may be around $2 billion, that is, in the other body.

Now, what are the facts in that connection?

Colonel TOBEY. The major achievements in increased capability that we expect to get with the SAM–D would be related to the fire power that the SAM–D can generate and its ability to defeat a simultaneous engagement of several aircraft attacking a defended area. As an example, the Hawk system, one battery of Hawk is capable of defeating an attacking force of two aircraft. Anything more than two penetrate the area and have the opportunity to get at the target. The Hercules, on the other hand, has a capability per battery of one attacking aircraft, simultaneous engagement.

By comparison the SAM–D has a capability to simultaneously engage ——— attacking aircraft per fire section. The maximum capability would be to defeat a force of ——— attacking aircraft.

Mr. RHODES. That is, per battery?

Colonel TOBEY. Per battery; yes, sir. The other advantages that would accrue to SAM–D would be its increased capability against electronic countermeasures, its increased mobility, and its ability as a fallout from its other capabilities, of attacking tactical ballistic missiles with a maximum range of some ——— kilometers.

We have in addition considerable manpower saving and material saving. For example, as we pointed out in the opening briefing one SAM–D radar is the equivalent of nine radars doing comparable missions in the Hercules and Hawk systems combined. We have increased the maximum altitude at which we can engage targets from ——— feet in the case of the Hercules to ——— feet in the case of the SAM–D, compared with ——— feet for Hawk.

Mr. WHITTEN. Have you given up on the Hercules and Hawk as being effective weapons, all things considered?

Colonel TOBEY. We are projecting the SAM–D to come into the inventory in ———, that time frame, and by that time we feel that the threat structure is such that the Hercules and Hawk will no longer be able to be upgraded to defeat the threat.

TOTAL PROGRAM COSTS

Mr. WHITTEN. The question is that if you go all-out, what do you plan to spend on this overall program for the SAM–D, including procurement and the whole business? What type of a program is this? How much money are we talking about in the whole area?

Colonel TOBEY. You mentioned a number of $2 billion.

Mr. WHITTEN. I think that was projected in the other body.

Colonel TOBEY. That is our projection of the cost at this time. It will depend substantially on how many units are deployed.

MOBILITY OF SAM–D SYSTEM

Mr. WHITTEN. How mobile will the SAM–D be? What aircraft could transport complete systems, that is, existing aircraft?

Colonel TOBEY. The C–133 can transport the SAM–D system.

Mr. WHITTEN. What major components make up the SAM–D system? How many vehicles are required for a complete unit?

Colonel TOBEY. There are four major components of the SAM–D system. They are the fire control group, one vehicle which mounts the phased array radar, the digital computer, and the operator displays and controls. The launcher control group is a second vehicle. It mounts six missiles in the combination shipping-storage-launcher containers as we showed them in the viewgraph during the opening statement. The missile is a solid propellant missile, using a target-via-missile guidance system as the major component of the system. Of course, it is carried on the launcher control group vehicle. The battery control group which is necessary to coordinate the efforts of the battery is all on one vehicle and it contains displays, communications to coordinate, as I said, the firepower of the battery. This battery control group can coordinate four separate fire sections, when each fire section would be comprised of a fire control group and two launcher control groups.

GENESIS OF SAM–D DEVELOPMENT

General BETTS. Mr. Chairman, I would like to remind this committee that SAM–D in concept went through a long period of what I have called system design analysis, in effect, because back in the late 1950's we recognized that with time both Hercules and Hawk would tend to lose their capability against enemy air attack as particularly the electronics countermeasure capability of the enemy grew with time. We started a development or at least concept formulation aspect of the development in about 1960 that we called field army ballistic missile defense. Because, in addition to the air defense problem, we were then, as we are now, faced with a tactical free rocket and tactical ballistic missile. It became apparent that to do that job we were then trying to defend against ballistic missiles up to about 2,000 miles in range, would require much too costly and complex a system for field army application. So we scaled down our requirements considerably in a program we called Army air defense for 1970. After a couple of years of looking at what kind of system, looking at the kind of subsystem that would be necessary to do that, we scaled down our requirements again and came to the system design we now call SAM–D. But

I might point out the thing that drove the SAM–D system design was this basic requirement that we be able to handle ——— simultaneous engagements. We started out asking for ———, realized that that was going to add cost and complexity beyond that which we felt we could support, and ended up with a kind of an optimum of ——— simultaneous engagements. That isn't a precise number but it does give you a feeling for what we felt this system had to handle. We have, since that time, looked very carefully at what we could do to scale down the cost and complexity of this system because we feel that it is very important that we have an all-weather air defense system that is not saturated by two enemy aircraft attacking simultaneously.

Furthermore, we need flexibility of power to punch through electronic countermeasures when the situation demands. Those two requirements at a crossover point of about ——— simultaneous attacks demand that we go from the old dish radar to phased array. Once we go to phased array, with the automatic data processing necessary to manage the engagement and manage the power budget of the phased array radar, we come to a system of a complexity and cost about that of the SAM–D. The important gain we get from this is the ability to handle the kind of targets that I indicated. I believe in a time frame like ——— or ———, the earliest that we can get this system at levels of funding we are able to give to it, will be faced by at least threats of that capability.

DESIGN CAPABILITY OF SAM–D SYSTEM

Mr. Rhodes. Mr. Chairman, would you yield at that point?

Mr. Whitten. Mr. Rhodes.

Mr. Rhodes. What capability are you really looking for in this SAM–D? Is it capability against high flying aircraft, against low flying aircraft, against all aircraft?

General Betts. All the way from the deck up to high altitude. By the deck I mean as limited by all-weather attack.

Mr. Rhodes. So it has the low level attack capability of the Hawk and the high level attack capability of the Hercules?

General Betts. Exactly, exactly; at a very considerable reduction in manpower because we have reduced the number of radars. With the whole concept of this system we are able to do it with many fewer people.

Mr. Rhodes. Does it have any anti-ballistic-missile capability?

General Betts. As a fallout from the power of the radar as designed for that ——— simultaneous engagement and countermeasures, and the performance of the missile that goes with it, gives it a tactical ballistic missile defense capability. ——— as the enemy range goes up to hundreds of kilometers then his accuracy on target is such that we believe the SAM–D can defend itself from any likely attack by tactical ballistic missiles.

Mr. Rhodes. Can a Sam–D battery engage an incoming tactical ballistic missile and an incoming aircraft at the same time?

General Betts. Yes, I believe it can.

Colonel Tobey. Yes, sir.

General Betts. Yes, it can.

Mr. Rhodes. This is with a conventional warhead?

General Betts. It has both conventional and nuclear capability.

Mr. RHODES. What does it use for fuel? Is it solid propellant?

General BETTS. It is solid propellant. It has one additional feature that we haven't hit on very hard although we have mentioned it. It has a guidance system called target-via-missile that permits us to have the capability in the final engagement that one associates with an active seeker system and yet keeps the complexity of the computer on the ground. It is a new concept and, as far as we are concerned, a very considerable advance in guidance technology.

Mr. RHODES. Can the Sam–D system be jammed?

General BETTS. It would be difficult, because it is inherent in a phased array radar that one can concentrate a lot of power when the circumstance demands it. ———.

It is a very major step forward in ECCM capability.

Mr. RHODES. Is there anything about the Sam–D system which will make it less vulnerable to attack by a missile which homes on the radar?

General BETTS. Since it will have tactical missile defense capability, it should certainly be able to defend itself against that kind of attack.

We think this is one program that, because of our interrelation of concept formulation, has shaken down to a very good design concept. Furthermore, it is one program that is very complex but it is on schedule.

SAM-D TEST SCHEDULE

Mr. RHODES. Have you tested any hardware?

General BETTS. Subsystem hardware. We do not have an all-up system ready.

Mr. RHODES. How soon will you have a system ready for testing?

General BETTS. This fall we will be able to test the target missile guidance by carrying the components in an aircraft and checking out, in effect, a breadboard test. It will be about ——— before we get an all-up system.

PROPOSED LEVEL OF FUNDING

Mr. RHODES. What is your IOC?

General BETTS. At the present projected level of funding, we have talked ——— to ———, but it could go much faster, but not at funding like $75 million a year. It is about a ——— million to ——— million development program, and at this price it just goes on and on because we cannot do the requisite numbers of things in parallel.

For example, we have not even blocked out the design of an independent battery control system because we could not afford it.

For the breadboard testing, we propose to use a modified Hawk launcher, which falls far short of what we think could be provided in a tactical launcher.

Mr. RHODES. What is your capability on the Sam-D for fiscal year 1970 as far as expenditures are concerned?

General BETTS. For 1970, we asked for $75 million, and that is in the President's budget.

Mr. RHODES. How much could you spend economically?

General BETTS. We asked for ——— million, but ——— million would have taken a risk commitment at the beginning of engineering development, and the policy judgment was made that in the present

atmosphere about risk judgments, we would not do that. Having taken that out of it, we backed down to this number of $75 million. It still does work that points toward engineering development.

Mr. RHODES. Thank you, Mr. Chairman.

STATUS OF DEVELOPMENT PROGRAM

Mr. WHITTEN. Has the Sam–D concept already been proven, or are you too early in the development to know? How can you be assured that this system will defend the Army in the field? What is the present state of development and what are your present plans?

Mr. POOR. I think the present state is that on many of the parts of the system about which we were quite deeply concerned as we started to attempt to gain this capability, we are now beginning to get a pretty high level of confidence that it is in fact doable.

The Sam–D critical elements are the target via missile guidance, the rather complicated computer, and the elements of the phased array radar.

One of the things that we were much concerned about was whether it would be possible to package the radar into the very small volume which was required and to cool it properly. The radar antenna array structure has been completed. Over half of the final radiating elements required to go into it have been delivered and are being installed. The beam steering programer, which is a computer that controls this radar antenna, has completed its acceptance test. And some of the higher power radar components have demonstrated that they can be packaged and cooled in this small volume.

Similarly, in the missile a number of the critical pieces have been tested. Static propulsion unit tests have been successfully completed. The weapon control computer, which is a complicated piece of the system, has been fabricated and tested, and the software for it is now being generated.

I think we can say that there were a lot of questions when we started down the line on this, and while we have not answered anywhere nearly all of them, it appears that there are now no major technical uncertainties that say there is a danger the system will not work. It is very encouraging to me to see it coming along as well as it now is.

BACKGROUND OF MAULER TERMINATION

Mr. WHITTEN. How many failures have you had in developing a system of this nature? Is the Mauler the only one?

General BETTS. Mauler is the only one that I would identify as anything like in the area of capability we are discussing here.

Mr. WHITTEN. It failed primarily for what reason?

Mr. POOR. The Mauler history is a funny history. It was a technical success. Mauler finally did exactly what it was supposed to do. It was an economic failure for two reasons.

The Mauler was an attempt to build a system whose capability was not enormously different from Hawk into a very tightly integrated package system. It did not have a phased array technology, which is the thing that makes Sam–D different. It did have all the packaging problems. As a result, it was a very high-cost system.

At about the time Mauler was developed far enough so we could understand it would indeed work as advertised, it became perfectly clear that a large portion of the Mauler mission could be undertaken by very much less expensive heat-seaking missiles of the Chaparral class. Heat seekers could not do the all-weather job, but they could handle the close-in engagements.

So, Mauler, I think, can be characterized as a technical triumph and an economic failure. I think we did exactly the right thing to cancel it when we did.

General BETTS. Mr. Chairman, if we had pursued the Mauler development the way we are now pursuing Sam-D, checking out each subsystem in a hardware sense but not a finished development sense, not trying to solve all the final engineering problems early in the game, it might well be a deployed system today. The real difficulty is back at that time we did not go through this deliberate program we now call the program definition phase, where we try to work out full-system costs from both the development and the production point of view, and we did not look hard enough at what it meant to the unit in the field to maintain such a complex system as that system promised to be.

ASSURANCES THAT SAM–D WILL WORK

Mr. WHITTEN. If it works out theoretically, or in the laboratory, or under ideal conditions, what is there to indicate that it would work under actual field conditions?

General BETTS. Are we discussing the Sam–D?

Mr. WHITTEN. Yes. You can be very optimistic about a system which is still in the concept stage.

General BETTS. The kind of very deliberate program we are pursuing for extensive test and checkout of each of these subsystems while they are still in the eary stages should settle that question long before we commit this full development effort. This is an advanced development at the present time.

Mr. WHITTEN. If you figure on one of those units becoming essential to the whole——

Mr. POOR. Mr. Chairman, I think the kinds of tests that are in hand now and planned for the next several years could hardly be characterized as laboratory tests. The equipments are being built in breadboard kinds of models, but the experiments are experiments in a realistic field environment.

The first step test of the target via missile guidance system involved flying prototype guidance equipment that would be in a missile in an airplane, and making measurements out-of-doors against targets that looked like the kinds of targets that one would expect.

So, it is very far from being a laboratory kind of development. It is one which is field-condition-oriented right from the beginning.

I think the likelihood of ending up with a system that works in a laboratory but does not work in the field is very small indeed.

EFFECTIVENESS OF SAM–D AGAINST FUTURE ENEMY WEAPON SYSTEMS

Mr. WHITTEN. Let us turn to another point. I realize we are taking a good deal of time.

You say this will be ready in ——— under the present schedule, or that you hope so. ———. By that time, the enemy will have made

further progress with his offensive weapon systems. What makes you think the Sam-D will be able to defend against the type of offensive weapons that the enemy probably will have developed by ———?

General BETTS. We have tried to account for that by putting capability in this system concept that is beyond what the enemy has available today, like the countermeasures.

Mr. WHITTEN. In ———, will we still be ——— behind them? In other words, are you developing something which will handle only what they have now.

General BETTS. The system goes beyond anything that they have now. We have tried to project the sort of capability we will expect them to have at that time.

Mr. WHITTEN. What are your plans for the Sam-D?

General BETTS. This system is being developed as a field army, all-weather air defense system.

Mr. WHITTEN. Mobile to the point of following the Army in the field?

General BETTS. Yes, sir. We would hope that it would be effective enough that we could produce the justification to support a deployment in the continental United States and, in the process, therefore, we have placed all of the Nike-Hercules and Hawk systems that are now deployed in the United States.

We also have done extensive studies of the interaction between Sam-D and a ballistic missile defense of the sort provided by Safeguard. The PEMA estimate we gave you earlier of a little under $2 billion is related to ——— batteries. We now have in inventory some ——— Hercules batteries and ——— Hawk. That gives you some feeling for what our planning would be.

We recognize that a single Sam-D battery is more than the equivalent of either a Hawk or a Hercules battery or two of those batteries taken together, but I do not have a detailed deployment plan that far in the future against which we could plan for the full program.

EXISTING SAM-D CONTRACTS

Mr. WHITTEN. What existing contracts do you have?

General BETTS. The major prime is the Raytheon Co. The missile development is with the Martin Marietta Co. at their Orlando plant. And Thiokol has the propulsion subcontract from Martin.

Mr. WHITTEN. I would like you to provide for the record in narrative form the full story of the contract, and what the contract consists of so we can have the whole story.

General BETTS. May I say for your immediate benefits—and we will expand this for the record—our present plan is to go through fiscal 1970 with the kind of efforts we have now, and parallel that testing effort with a very careful system analysis to look at what kind of system we feel this ought to be in a full-scale development effort.

In other words, are there complexities and nice-to-have but not necessary costs inherent in our present design? So, about this time next year we would be in a position to make a firm design commitment that would then go on into a full-scale engineering development effort.

It is a very deliberate approach to avoid all the mistakes in complex system developments that in the past have had overruns and time stretchouts.

I might point out today Sam-D is just about exactly on the cost plan that was designed 2 years ago. Except for a few months in one of the transmitters where a subcontractor was not able to deliver, it is just about exactly on the testing schedule that was laid out 2 years ago.

I think it is a very well-managed program, and one that is very important for the future Army, in my judgment.

Mr. WHITTEN. Of course, this is a complex time in which we live, but in Vietnam and Korea it seems the more complex they are, the less likely it is that they will work. This comes down even to the rifle in the hands of the troops.

We look to other means of defending the continental United States. Do you not think it would be safer to go for a less complex and less sophisticated weapon to deal with this situation? Overly sophisticated systems have not worked very well in the past. Have you seen any place in Vietnam where the Sam-D would have been of any benefit to you?

General BETTS. We have not been subjected to air attack in Vietnam. The Sam-D design was pointed primarily at defense of our Field Army in an environment like NATO.

Mr. WHITTEN. So, you are having not only to guess the type of war, but the type of weapons the enemy will have.

General BETTS. This is the problem.

Mr. WHITTEN. How are you going to spend the $75 million this year?

Colonel TOBEY. The $75 million this year will be spent primarily on the Raytheon contract, with a subtotal of ——— million. This will go to the missile itself, the fire control group and the various groups we have discussed.

To define the engineering development, the next step in the development process, we will spend ——— million in addition to the ——— million.

Those two numbers together, ——— million, would be going to the Rayethon Co., as the prime contractor.

Within the Government we have a total of ——— million spent in-house on the adaptation kit, various portions of the missile, fire control group, systems engineering and management, and for test and evaluation.

Mr. WHITTEN. These contracts sound like an answer you might give to half a dozen other questions I might ask about other things. Are these contracts tied down to the answers that you need for Sam-D?

Colonel TOBEY. The particular engineering data and design data that we need; yes, sir.

Mr. WHITTEN. If you will, provide for the record a breakdown in detail of the $75 million for the various component activities.

Colonel TOBEY. Yes, sir.

(The information follows:)

A breakdown in detail of the $75 million for the various component activities is as follows:

	In millions of dollars
Raytheon contract (AD):	
Missile effort	———
Fire control group	———
Command and control	———
Support equipment	———
System engineering and management	———
Test and evaluation	———
Subtotal	———
ED definition	
Data processor and communications	———
Analysis and specifications	———
Guidance packaging and radome	———
Long lead hardware	———
Subtotal	———
Government:	
Adaption kit	———
Missile	———
Fire control group	———
System engineering and management	———
Test and evaluation	———
Subtotal	———
Grand total	75.0

ENEMY DEFENSE AGAINST SAM–D

Mr. WHITTEN. What do you visualize will be the enemy's reaction to the SAM–D?

Colonel TOBEY. The enemy or the Soviet Union has been very active in air defense work. This does not address his reaction to the SAM–D. I am sure he would follow the development as closely as he could.

It would appear to me that he would be hard pressed to find a single system that would defeat it. It might be, as was suggested by Mr. Rhodes, that he would work toward combinations of tactical ballistic missile defense and aircraft with jammers. He would have to have a very sophisticated, massive effort to defeat the system.

Mr. WHITTEN. I asked you earlier about Vietnam. The Russians have used SAM missiles over there quite regularly, and we have countered them, as I understand it, without too much difficulty.

General BETTS. We have had a very extensive effort to look at exactly what techniques our people use in Vietnam to defeat the Soviet surface-to-air missiles. It is our considered judgment—this is not just the Army speaking, because this was a joint evaluation—that the techniques we used to defeat the Soviet surface-to-air missile system would not defeat either the Nike-Hercules or the Hawk systems currently in our inventory. So, the enemy would have to step beyond the techniques we have developed and used ourselves in North Vietnam.

Mr. WHITTEN. They have ——— in which to do it.

General BETTS. That is why we would want to improve our ability to handle it.

Mr. WHITTEN. Have our Hercules and Hawk missiles become ineffective against aircraft of other countries?

Colonel TOBEY. Not yet. However, we feel that in the post-1975 period there effectiveness will be marginal.

Mr. WHITTEN. How important is SAM–D to the Field Army? Is the primary role of SAM–D to defend the continental United States against air attack?

Colonel TOBEY. SAM–D is urgently needed to provide air defense to the Field Army. The Field Army role is the primary role for SAM–D. This role establishes the requirements that drive the design of the system. The Conus role is a fallout capability of the system once it is designed for the Field Army.

PROPOSED DEPLOYMENT AND COST OF SAM–D

Mr. WHITTEN. Where would SAM–D units be deployed in protecting the field Army?

Colonel TOBEY. Detailed deployment studies for SAM–D have not been completed. SAM–D will be utilized in the Field Army area as a member of a family of weapons (Chaparral, Vulcan, Redeye, or their follow-ons) and would defend the Field Army and selected high value targets in rear areas. It is anticipated that units in the division will be within the effective coverage of the system.

Mr. WHITTEN. What is the estimated unit cost of SAM–D systems?

Colonel TOBEY. ——— million PEMA per battery.

Mr. WHITTEN. What is your best estimate of the cost of defending the continental United States with SAM–D? You may supply that for the record.

(The information follows:)

SAM–D is designed as a tactical air defense system for the Field Army. Therefore, no cost estimate has been made for defending Conus with SAM–D. However, cost estimates have been prepared for varying theoretical deployment levels. Unit costs per battery differ for each level—as the level increases, the cost per battery decreases. However, the level of deployment has not yet been determined. SAM–D system requirements are expected to be reviewed in late August 1969 by the Department of Army Senior Officer Material Review Board. Cost estimates for SAM–D deployment in the Conus air defense role cannot be reasonably projected until the recommendations resulting from this review have been evaluated by the Secretary of Defense and his decisions made.

INTERACTION OF SAM–D AND SAFEGUARD

Mr. WHITTEN. What contracts have been let for studies of the interaction of SAM–D and Safeguard? Do you have any results from these studies?

Colonel TOBEY. The only contracts have been for two studies. One study conducted by Army Air Defense Command (ARADCON) used the services of Braddock Dunn & McDonald ($114,000). This was an operational type interface study. The other study was a technical interface study conducted by the Army's Missile Command and it involved contracts with IBM ($68,000) and Raytheon ($57,000).

We do not have final results from either of these studies, but preliminary indications are that the mutual support gained by using both systems significantly improves the overall defense.

TYPE OF COPTRACTING FOR SAM–D

Mr. WHITTEN. What kind of contracts do you have for SAM–D development?

Colonel TOBEY. The advanced development contract is cost plus award fee. When we enter full engineering development we plan on a fixed price incentive fee type contract.

LESSONS LEARNED FROM MAULER PROGRAM

Mr. WHITTEN. What lessons from the Mauler program are being applied to the SAM–D effort?

Colonel TOBEY. The lessons learned from the Mauler program have been applied to improve our development procedures for all systems. Specific applications to SAM–D are as follow:

First, Mauler did not go through a program definition phase, so costs were continually increased as new requirements were added. Contract definition for SAM–D completely defined system requirements so there should be no program escallation due to unforeseen requirements.

Second, Mauler had no critical component verification phase prior to system development effort. SAM–D has worked in all critical areas, that is, phased array radars, computer and TVM guidance. This greatly reduced risk of entering development of SAM–D system.

Third, the Mauler program entered directly into an engineering development program for tactically configured hardware prior to any hardware verification of the concept. SAM–D in addition to its critical component development phase entered into an advanced development program which had as its objective the demonstration of a low risk engineering development program by functionally demonstrating system performance.

Fourth, Mauler program was initiated without the incorporation of management tools such as pert/cost and configuration management which provide control techniques for keeping program from getting out of hand. SAM–D has these tools and they have been in use from program initiation.

Fifth, the Mauler program used a CPFF type contract which provided no incentive for the contractor to control program costs. As such there were expenditures incurred early for unnecessary items prior to getting a "handle" on some of the more difficult problems. SAM–D uses a CPAF contract which gives the Govrenment unilateral control of fee in excess of 3½ percent based on contractor performance (cost, schedule and technical performance is evaluated monthly).

All of the above plus the fact that SAM–D has evolved from conceptual studies dating back as far as 1960 should preclude "another bad system." SAM–D has been shown to be a cost effective solution to the projected threat. It wasn't until just prior to program that cost effectiveness studies of Mauler were conducted and it was found to be too costly for the defense role for which it was being developed.

SAM–D DEVELOPMENT SCHEDULE

Mr. WHITTEN. When do you plan to enter into engineering development?

Colonel TOBEY. The current plan is to enter engineering development in ———.

Mr. WHITTEN. In November 1967, a contract was signed for design and fabrication of a prototype system to be delivered in September 1969. Will this be performed on schedule?

Colonel TOBEY. The contract signed in November 1967, called for delivery of an advanced development model system. Subsequent funding cuts from that requested coupled with delays in vender deliveries have resulted in a slip from September 1969 to April 1970 for the first integration with software for evaluation.

REASON FOR HIGH COST OF SAM–D

Mr. WHITTEN. Why is such heavy funding of SAM–D requested in fiscal year 1970? Detail the request for $75 million. How much is for each of the major components, for systems engineering, for in-house support, and so forth?

Colonel TOBEY. We are planning to spend ——— on missile effort ——— on the fire control group ——— on command and control and ——— on support equipment. System engineering and management will cost ——— will be used for test and evaluation. In addition we plan on spending ——— on engineering development definition work to prepare for entry into engineering development. Our in-house expenses will be ———.

Mr. WHITTEN. If a SAM system was designed for the field Army role without regard to air defense of the Continental United States, would a less complex and less costly system probably be desired?

Colonel TOBEY. No, SAM–D is not made more complex by a role in Conus. The Field Army role is the primary role for SAM–D, and this role establishes the requirements that drive the design of the system.

Mr. WHITTEN. Any further questions on this?

[No response.]

SURFACE-TO-SURFACE MISSILE AND ROCKET SYSTEMS

Mr. WHITTEN. Turning to surface-to-surface missile and rocket systems, how much of the ——— million requested for "Surface-to-surface missile and rocket systems," is for initiation of an advanced development program to replace Pershing? Is it proposed that Mars will replace Pershing?

MULTIPLE ARTILLERY ROCKET SYSTEM (MARS)

Colonel TOBEY. No, sir. Mars is not a replacement for Pershing. The replacement program for Pershing will not be initiated in the 1970 effort. It will be deferred until ———. We have a program of about ———.

Mr. WHITTEN. Do you mean to say you will not need the ——— million this year?

Colonel TOBEY. No, sir. The ——— million will be devoted to other things, other than the Pershing. You asked the specific question with reference to Pershing.

Mr. WHITTEN. What will it be for?

Colonel TOBEY. Mostly in the Mars program, which is a multiple artillery rocket system. The Mars is being developed as a new weapons system to be effective at a shorter range than the Lance, and to provide antimateriel capability out to a range of approximately ——— kilometers.

This would be to assist the short-range antitank missiles in defeating the massive armor threat that is available in the Warsaw Pact armies.

General BETTS. Mr. Chairman, as a matter of information, in the descriptive summary there is a statement that we would get under way with some of the work on the Pershing replacement effort, but you will recall that was written some time ago, and as we learned more and more about what will be required to do an effective job of concept formulation for the Mars, we felt resources would be more effective expended in that direction.

Mr. WHITTEN. My attention is called to the fact that the Pershing being one of the large missiles, you are probably starting a billion dollar effort if you try to replace that.

Your justification notes that is what you have in mind. Now you have shifted?

General BETTS. We hope to put some resources in that direction.

Colonel TOBEY. The Advanced Research Projects Agency is conducting a study on a tactical interdiction missile system. The purpose of this study is to determine whether or not there is a requirement for a missile system of about a ——— kilometer range that would deliver a warhead of essentially ——— pounds of high explosive.

Pershing, as you know, has only the nuclear capability. If such a weapon is developed as indicated by these things, the Pershing represents an almost in-being capability. The moneys that were intended in this particular program that we have now postponed for a year were the initial moneys to do studies and to get exact facts on whether or not Pershing could perform in this role.

Mr. WHITTEN. You ask for ——— million this year. How much do you contemplate that will grow, year by year, as you proceed?

Colonel TOBEY. We have no projection for the Pershing system.

Mr. WHITTEN. I mean the ——— million, whatever you are going to do with it.

Colonel TOBEY. It will be completely spent for the Mars program, and we are now in concept formulation on that to determine whether this is a feasible system. The Mars is the multiple artillery rocket system, about ——— inches in diameter, weighing about 2,000 pounds, with a ——— pound warhead, with a maximum range of ——— kilometers. It will be highly mobile on either a self-propelled or a tracked vehicle. It will differ from our current types of rockets in that it will have a high firepower capability.

It will have possibly up to ——— rockets on the same vehicle that you can fire very rapidly. It would be used in situations where a high degree of firepower is needed very rapidly.

CONCEPT FORMULATION STUDIES OF MARS

Mr. WHITTEN. When will these studies be completed?

Colonel TOBEY. We have five firms studying the Mars program under concept formulation study. These are Chrysler, LTV, Boeing, Northrop, and Martin Marietta.

Mr. WHITTEN. Over what period of time do you contemplate continuing the study?

Colonel TOBEY. The concept formulation studies are due in to the Army in August of this year. It will take from August to January to analyze these and select them. If there are components that show interest and should be further developed, we propose to explore those with the fiscal year 1970 money.

When these things are done, the Army then must determine whether or not we really want to proceed with the Mars program.

NIKE X ADVANCED DEVELOPMENT

Mr. WHITTEN. Turning to Nike X advanced development, I notice you are requesting $175 million for Nike X advanced development. The April revisions reduced the request to $141 million. What effort was deleted with the $34 million reduction?

General BETTS. The following efforts in the advanced ballistic missile defense program, formerly the Nike X advanced development program, for fiscal year 1970 were reduced by the amounts shown as a result of the $34 million reduction ———.

Mr. WHITTEN. What sums are requested for the various efforts under this heading such as the ———, Upstage, and the solid state phased array radar program?

General BETTS. I have an extensive breakout. The trouble is, it is too extensive. I have not been able to find those items among the breakouts that we have here.

IMPROVEMENTS TO SAFEGUARD

Mr. WHITTEN. Are any of the advanced components under this hearing so significant and so near completion that Safeguard will require alteration in the near future?

General BETTS. It is our arrangement with the Safeguard system manager that our technical people will work very closely with his to identify those aspects of Safeguard that ought to be improved in the future as the enemy threat evolves to greater numbers or greater sophistication.

Recently, we agree with him that we should shift to his program the development of the ——— for the Spartan missile.

There are other things in our program, like the ——— to improve radar performance in an ECM environment, that may be applied fairly early in the cycle of improving the Safeguard radars, but no decision for incorporation has been made at this time.

I am saying that while we have several things that people in technology believe will make a contribution to Safeguard effectiveness, if the decision had been made that they would go on the system and been deployed with it, they would not be in this program.

By definition, our efforts are looking more at advanced technology.

DIFFERENCE BETWEEN NIKE X AND SAFEGUARD

Mr. RHODES. Are Nike X and the Safeguard synonymous?

General BETTS. No. We have used Nike X ever since the original Nike X program to identify the total package of all advanced ballistic missile developments. Actually, we have recently abandoned that as a title in our internal management, and we call this effort the advanced ballistic missile defense program. It is managed by the Advanced Ballistic Missile Defense Development Agency. We do not identify any specific system as Nike X, although you recognize all of the things within Safeguard are fallouts from the originally conceived Nike X program.

Mr. RHODES. Thank you.

NIKE X EFFORT APPLICABLE TO SAFEGUARD

Mr. WHITTEN. Mr. Andrews?

Mr. ANDREWS. General Betts, what part of your program before us is identified with the Safeguard antiballistic missile system?

General BETTS. In terms of early application to that system, we do not have anything in this advance development program.

Mr. ANDREWS. You do not have any R&D?

General BETTS. We have research and development effort that could be applied to upgrade Safeguard capability should the threat later require it. In other words, we are doing the advanced development work that may have potential application to Safeguard but for which no deployment decision is required at this time, based on the current threat.

Mr. ANDREWS. It appears from the information on page 24 you have——

General BETTS. Mr. Andrews, you are aware that General Starbird has R.D.T. & E. money for the development and testing of those elements of the Safeguard system for which he is responsible. That is a separate item in the budget, $400.9 million directly identified with the Safeguard program.

PHASE I OF SAFEGUARD TO PROTECT MISSILE SITES

Mr. ANDREWS. If and when the Safeguard program is deployed, the sites for the Safeguard missiles will be in North Dakota and Montana?

General BETTS. Those are the first two sites, the phase I part of the program.

Mr. ANDREWS. Will those two sites offer any protection to the Southeastern section of the United States?

General BETTS. No significant protection other than deterrence of first strike.

I would have to look at the map again. You remember, those were picked for their primary role of defense of the Minuteman sites.

Mr. ANDREWS. More so than protection of American cities.

General BETTS. That is correct.

Mr. ANDREWS. So, if we expect to get protection in any degree for American cities, principally on the Atlantic and Pacific coasts and

the Southwest and Southeast sections of the country, we would have to deploy more Sentinel or anti-ballistic-missile sites?

General BETTS. That is correct; in phase II of the deployment program as presented by the President.

DEFENSE AGAINST MISSILE ATTACK FROM CUBA

Mr. ANDREWS. What do we have, if anything, to protect against missiles launched from Cuba?

General BETTS. We have nothing, Mr. Andrews.

Mr. ANDREWS. We are defenseless against missile attacks from Cuba?

General BETTS. We have no defense against offensive missiles that might be launched from Cuba.

Mr. ANDREWS. It is not in your area of jurisdiction, but do you have any information about whether or not there are in Cuba at this time any missiles that could be used against the continental United States?

General BETTS. I will check it with the intelligence people, but as far as I know, all of the missiles that we suspected as being in Cuba, Soviet missiles of intermediate range, have been removed.

Mr. ANDREWS. You are talking now about the threat that came during President Kennedy's administration?

General BETTS. That is correct.

Mr. ANDREWS. You hope they were removed. I have not heard any discussion recently about missiles in Cuba.

General BETTS. I said I would check it out with my intelligence friends and make sure that the record is correct.

Mr. ANDREWS. I would like to know, because that poses a real threat against this country if they have missiles down there. It would not take a big missile to reach the southeastern area of America.

General BETTS. That is right. However, I have now been advised that based on current intelligence, there are no offensive missiles located in Cuba.

Mr. ANDREWS. Thank you, Mr. Chairman.

Mr. POOR. Mr. Chairman, should a missile threat from Cuba in the form of very short range missiles develop, I would feel a great deal more comfortable if we had SAM–D in hand, because it would indeed be useful against this class of short-range ballistic missile. We don't. All we have available today is Hawks and the Nike-Hercules system for use against aircraft and certain very low performance cruise missiles.

Mr. ANDREWS. If and when you ever get SAM–D, would you recommend that some of them be placed in Florida?

Mr. POOR. Yes.

Mr. ANDREWS. That is all.

NIKE X EFFORT APPLICABLE TO SAFEGUARD

Mr. RHODES. Mr. Chairman, before we leave this, I think it might be well for you to clarify a statement which you made, General, concerning the fact that the Nike X program for the advanced ballistic missile defense program, as you called it, has some developments upon which there has been no decision to deploy.

The reason I think you should clarify this is that a person who casually reads this record might assume from that that we have something which could be deployed which is greatly in advance of the Sentinel or Safeguard system.

General BETTS. That is a very good point. I will make sure those words in the record explain that what we are doing is looking at technology that could be applied to the systems that are planned for deployment as the Safeguard system.

For example, there are modifications that we might make to the missile site radar (MSR) that would make it ———. We are pursuing it as technology. No decision has been made to include it in the MSR at this time because our investigations have not advanced far enough to make this decision. I will make that very clear in the record. Thank you.

Mr. WHITTEN. There are several questions——

General BETTS. I found the three items you were asking for earlier. The solid-state microwave technology is planned at ——— in fiscal 1970, the Upstage experiment is planned at ——— in fiscal 1970, and the ——— is planned at ——— in fiscal 1970.

RELATIONSHIP OF NIKE X TO ABRES

Mr. WHITTEN. Is there an organizational relationship between the Nike X program and the advanced ballistic reentry systems (ABRES) program of the Air Force?

General BETTS. There is no direct organizational relationship between the Army's Nike X advanced development program, now called the advanced ballistic missile defense (ABMD) program, and the Air Force's advanced ballistic reentry systems (ABRES) program. The Advanced Ballistic Missile Defense Agency manages the Army's ABMD program while ABRES is a national program managed by the Air Force. The ABMD program is concerned with ballistic missile defense technology while the ABRES program is concerned with strategic offensive ballistic missile penetration and with reentry technology. Although there is no direct organizational relationship, there is close coordination and interchange of information between the two programs. As an example, on June 18, 1969 in California, a joint meeting was held at which the two fiscal year 1970 programs were presented to representatives of the two staffs. In addition, ABRES is the agent for ABMDA in the following programs: Terminal radiation program (TRAP), reentry measurements program (RMP) and ———.

NIKE X PROGRAM CHANGES

Mr. WHITTEN. The fiscal year 1969 budget requested $165 million for this program. Only $137.1 million was actually allocated. What program changes took place? Did the fiscal year 1969 estimate include the transfer of Project Defender?

General BETTS. The original advanced ballistic missile defense program fiscal year 1969 budget of $165 million was reduced $57.1 million as follows:

A directed reduction of $37 million in the tactical multifunction array radar (TACMAR) funding when the radar was redesignated as the common aperture multifunction array radar (CAMAR).

A directed reduction of $15 million in the Spartan missile high performance third stage (HPTS) funding.

$5.1 million for operation and maintenance of sensors at the Kwajalein Test Range was transferred to the National Range budget. The fiscal year 1969 budget was subsequently increased by $33.7 million through the transfer of monies from the Advanced Research Projects Agency (ARPA) to support on-going Project Defender programs transferred to the Army when the Advanced Ballistic Missile Defense Agency was organised. This $33.7 million included $4.5 million provided by ARPA to support ABMDA programs at Lincoln Laboratory. Thus, the fiscal year 1969 funds available to ABMDA were $137.1 plus $4.5 equals $141.6 million. Therefore, the fiscal year 1970 funding for advanced ballistic missile defense is approximately the same as fiscal year 1969.

(Discussion off the record.)

Air Defense Control and Coordination System (AN/TSQ–73)

Mr. Whitten. We turn now to "Air defense control and coordination system."

The fiscal 1969 budget justifications did not include funds for the development of a new air defense control and coordination system by the Army. Yet, the fiscal year 1970 justifications state that the program was initiated in fiscal 1969, and that $1.9 million was allocated to this effort in fiscal year 1969.

Under what procedure was this program funded? From what source did you reprogram the funds to start the program?

Colonel Tobey. The AN/TSQ–73 has had a very curious funding history. The $1.9 million reprograming action has been approved by the Office of Secretary of Defense. However, the money has not been released for fiscal year 1969 expenditure.

Mr. Whitten. It has not been sent up to Congress yet?

Colonel Tobey. No, sir; it has not been.

Mr. Whitten. You request ——— million in the budget before us. Do I take it you could get by on the $1.9 million in the event reprograming is approved?

Colonel Tobey. No; that constituted a limited first-year effort.

Reason for AN/TSQ–73 development

Mr. Whitten. How much added capability would the propopsed system add to the Nation's air defense posture? Would it make as much as a 10-percent improvement, in your judgment?

Colonel Tobey. I would think more than that. It is being developed to replace the AN/MSG–4 system now deployed in Europe. The operators report that they are having a great deal of trouble with these systems in maintaining them and keeping them operational.

The AN/TSQ–73 is designed for that role, using modern electronic techniques which would bring us to a greater capability and less maintenance problems.

General Betts. We identified this problem in Europe some years ago. We have a system very like the AN/TSQ–73, called the AN/TSQ–51, that we use here in the continental United States. We had asked for procurement funds to get replacements for the units in Europe.

People who were interested in applying the latest microelectronic technology argued that the AN/TSQ-51 was just not new technology. We could package it in smaller units and make it more reliable if we would convert it completely to solid state microelectronic technology. That sort of debate has been going on for some time.

We have not been able to get the funds to make that conversion, even though it was decided that it would be a desirable conversion to make.

The effectiveness of the AN/TSQ-51 has been demonstrated in test runs. We are sure that this kind of command and control system with microelectronic components can make a very considerable improvement in our air defense in Europe.

PROPOSED DEPLOYMENT OF AN/TSQ-73

Mr. WHITTEN. Where do you propose to locate the proposed Army Air Defense Command Post?

General BETTS. For use of the AN/TSQ-73? This would be each of the group and battalion headquarters in the forces in Europe.

Mr. WHITTEN. What equipment and facilities would be replaced by the new system?

General BETTS. The AN/MSG-4 that we identified.

Mr. WHITTEN. Why is not the Air Force's 407-L tactical air control system adequate for this function?

Colonel TOBEY. The 407-L is a much more complex piece of equipment than we need to do the job that we are talking about. It is quite true that some of the components that have been developed for the 407-L might very well be used in the AN/TSQ-73.

If I might, the 407-L has a much greater capability than we need.

Mr. WHITTEN. How is this mission being performed today?

Colonel TOBEY. It is being performed today by the AN/MSG-4 that we discussed earlier.

PLANNED USE OF FISCAL YEAR 1970 FUNDS

Mr. WHITTEN. I mentioned earlier the ——— million that you requested of the Bureau of the Budget for this program for fiscal year 1970. What do you plan to accomplish with this?

Colonel TOBEY. We would expect to let an engineering development contract which would give us prototypes that would be available late next calendar year. Those prototypes would be placed in Europe and tested in the actual environment in which they would have to operate.

Mr. WHITTEN. Would procurement expenditures be required in this program in addition to the estimated ——— million total development cost?

Colonel TOBEY. Yes.

Mr. WHITTEN. What is the status of this program in the fiscal year 1970 apportionment review?

Colonel TOBEY. I believe I described that, sir.

MISSILE EFFECTIVENESS EVALUATION

Mr. WHITTEN. Turning now to another subject, how firm is your request for $4.3 million for missile effectiveness evaluation?

Colonel TOBEY. We are planning to spend ——— million on a variable speed training target, and ——— on a scaler scoring device which is necessary for our gun systems, and for evaluation of the Chaparral fuze augmentation device, ———, totaling the ——— million that is in the budget.

RELATIVELY LOW-PRIORITY ITEM

Mr. WHITTEN. You requested $6.3 million for this program in fiscal year 1969, and applied only $800,000 to it. Since the program had a low priority in fiscal 1969, is it still a low-priority program in fiscal 1970?

Colonel TOBEY. With the fiscal year 1969 reduced funding, we practically stopped effort in these critical devices that are needed in the future to test our various weapons.

Mr. WHITTEN. You had the same experience in 1968, where you requested $6 million and applied only $500,000. In your our priorities it was funded at that low level in 2 successive years.

Colonel TOBEY. When you are funding support devices as opposed to weapons systems, your priority would go to the weapons system.

General BETTS. That is a good point, Mr. Chairman. These are support efforts and represent thinks that we believe are important. We would like to have them, but when we come down to the point, as we did in 1968, that we were directed to take some $100 million out of the Army R.D.T. & E. budget, we had to look for those places that did not have immediate impact on something that was already on ongoing effort.

I might point out this variable speed training target is something that from recent guidance given us by the Office of the Secretary of Defense is now on a somewhat higher priority than it has been, because they want it to meet not only Army but also Navy R.D.T. & E. requirements.

I suspect we would not have quite the same position with respect to that item this year that we have had in the past.

PLANNED USE OF FISCAL YEAR 1970 FUNDS

Mr. WHITTEN. Break down the request for ——— million to show how much is proposed for each task proposed under this heading.

Colonel TOBEY. The breakdown of the fiscal year 1970 funding of ——— million for the three tasks is:

	Millions
Variable speed training target	———
Scalar scouring device	———
Chaparral fuze augmentation device	———
Total	———

Mr. WHITTEN. What is the development status of each of the items included here and the estimated total development cost of each item?

Colonel TOBEY. The variable speed training target is in the initial phase of contract definition and this is scheduled for completion in December 1969. Contractor selection and initiation of engineering development is scheduled for December 1969. This development effort is to satisfy both the Army and Navy research and development test and evaluation requirements. The total development cost of the variable speed training target is ——— million.

Proposals from industry have been received and are now under evaluation for the scaler scoring device. Engineering development is scheduled to commence during second quarter fiscal year 1970 and to be completed by fourth quarter fiscal year 1971. The total development cost of this program is ——— million.

The Chaparral fuze augumetation device development was initiated in fiscal year 1969 and will be completed in fourth quarter fiscal year 1970. The total development cost will be ——— million.

Mr. WHITTEN. The justification indicates that progress has been made in these developments in fiscal year 1968 and fiscal year 1969 in spite of greatly reduced funding. Has this request been padded?

Colonel TOBEY. No, there is no padding. The progress under the reduced funding was reduced substantially from the progress which is considered necessary in these programs. The progress expected under the requested funding will permit a timely development program.

KWAJALEIN MISSILE RANGE

Mr. WHITTEN. Turning to the Kwajalein Missile Range, you are requesting a $24 million increase for this range in fiscal year 1970; $82.7 million is requested for fiscal 1970 as compared with $58.5 million allocated in fiscal 1969 and $38.7 million in fiscal 1968. How firm is this estimate?

Colonel TOBEY. The estimate is quite firm. We have a detailed breakout of the actual increases totaling that amount, if you care to have it for the record.

Mr. WHITTEN. It may be included in the record at this point.

(The information follows:)

The detailed breakdown of the $82.7 million and the reason for the increase in fiscal year 1970 is as follows:

[In thousands]

Operation	Fiscal year 1969	Fiscal year 1970	Note
Army operation	$10,900	$11,000	
Program management	(1,792)	(2,109)	
Material and supplies	(5,217)	(5,000)	
Support services	(3,891)	(3,891)	
Technical range support (Kentron Hawaii Ltd)	9,409	10,059	1
Logistical range support (Global Associates)	18,045	20,504	2
Discrimination radar and target tracking radar (former Nike radars)	9,575	11,464	3
Kiernan reentry measurement site (former ARPA radars a Roi Namur)	10,606	25,405	4
Communications and instrumentations		4,268	5
Total	58,535	82,700	

1. The $650,000 increase is due primarily to the range assuming funding responsibility for optical data reduction from Safeguard System Command.

2. The $2,459,000 increase is due to increased workload and the fair standards labor law reduction of workweek from 42 to 40 hours.

3. The $1,889,000 increase is due to the transfer of the funding responsibility for the wideband coherent recorder system and the battery control building to the range and a modification to the target tracking radar.

4. The $14.799 million increase in fiscal year 1970 is due to the transfer of the ARPA long-range tracking and instrumentation radar (ALTAIR) radar from ABMDA to the range—$8 million; a full year funding for the TRADEX radar—$4.4 million, and modifications to the TRADEX and ALTAIR radars—$2.399 million.

5. Facility improvements in communications and instrumentation are required to integrate the reentry radars, and furnish support to the strategic offensive and defensive systems.

Mr. WHITTEN. The fiscal 1969 request for the Kwajalein Missile Range was $39 million. The justifications show that $58.5 million has been applied. Is this a real increase, or does it merely reflect transfers from ARPA in order to be comparable to the fiscal 1970 estimate?

Colonel TOBEY. This reflects the transfer of some radar installations to the Kwajalein Missile Range.

Mr. ANDREWS. Does R. & D. pick up most of the check for the operation of Kwajalein?

General BETTS. That is correct. It its managed as a national range to serve not only our own defense programs, but the Navy and Air Force offensive programs.

Mr. ANDREWS. What about the construction of buildings there? Is that charged to R. & D.?

General BETTS. They would be MCA if the item warranted MCA. Minor construction would be charged to R. & D.

PROPOSED FISCAL YEAR 1970 FUNDING FOR KWAJALEIN

Mr. ANDREWS. Could you put in the record at this point the total amount you propose to spend in Kwajalein in 1970?

General BETTS. Yes, sir. You mean all appropriations?

Mr. ANDREWS. Do you have an airstrip there?

General BETTS. Yes; we have three airstrips.

Mr. ANDREWS. Do you plan to build any others?

General BETTS. None is planned now.

Mr. ANDREWS. If you built one, would it be charged to R. & D.?

General BETTS. If we asked for a facility item like that, it would be MCA. Normally Army R.D.T. & E. facilities will be constructed with R.D.T. & E. funds only if the cost is less than $25,000.

Mr. ANDREWS. What about a powerplant?

General BETTS. A powerplant would be in MCA.

Here is the MCA program in fiscal year 1970.

Mr. ANDREWS. I wish you would put it in the record.

General BETTS. We will do that.

(The information follows:)

The total amount of funds programed to be expended at Kwajalein Missile Range by appropriations are as follows:

Appropriation:	*In thousands of dollars*
R.D.T. & E.	$82,700
Military construction authorization, Army	3,273
Military personnel appropriations	427
Total	86,400

GUIDELINES FOR KWAJALEIN FUNDING

Mr. WHITTEN. What is the estimated cost in fiscal year 1970 of the operation of the Altair radar?

Colonel TOBEY. We have $8 million programed for that. We have a breakout; an operation and maintenance costs of $6.149 million, modifications $950,000, and data reduction $901,000.

Mr. WHITTEN. Why was this cost transferred to the missile range from the Army Ballistic Missile Defense Agency?

Colonel TOBEY. As these radars become less developmental items and more items that can support the national range operation, they are transferred to the range and funded by the range.

Mr. WHITTEN. What are your guidelines as to costs borne by the range and those borne by ABMDA?

Colonel TOBEY. The guidelines are furnished by a D.D.R. & E. memorandum. They are essentially as I just enunciated. The range measurement radars should be funded and managed under the national range program element, and the program for radars in development status under the Advanced Ballistic Missile Defense Agency program.

Mr. WHITTEN. That will be all until 2 o'clock, gentlemen. Thank you very much.

AFTERNOON SESSION

INTER-ISLAND COMMUNICATIONS SYSTEM

Mr. FLOOD. Continuing further with the situation at Kwajalein, will you explain the requirement for what you call interisland communications system expansion in 1970? I have a number of questions regarding this system. What is the total cost of the proposed new underwater cable? What is the fiscal year 1970 cost? What communications systems are now available?

You know, we have listened for years here to communications, communications, communications, and communications. Now, is this the "end" or is this more communications?

Colonel TOBEY. This is required communications.

PROPOSED SYSTEM EXPANSION

Mr. FLOOD. First tell us about the requirement for the interisland communications system expansion in 1970. What is so hot about it?

Colonel TOBEY. The present interisland or interatoll communication system has only 48-channel carrier systems.

Mr. FLOOD. Is that bad or good? Forty-eight sounds like a big number.

Colonel TOBEY. It is insufficient, with the expansion in the numbers of missiles and the types of data that they have to have now. These 48 do not have the capacity to transmit reentry radar data between Roi Namur, Meck, and Kwajalein which is required to support the offensive ballistic missile work that is going on there, the Safeguard system test and the reentry discrimination programs. What is required is 120-voice-equivalent channels.

Mr. FLOOD. From 48 to 120?

Colonel TOBEY. That is correct.

Mr. FLOOD. How long have they had 48?

Colonel TOBEY. I think 3 years—is that correct?

Colonel DOSS. Since 1961.

Mr. FLOOD. They have had it since 1961. Is this program going to be so magnified that in 1970 alone you are going to go from 48 to 120 almost overnight as the magnitude of this proposal?

DECISION NOT TO BUILD PERIMETER ACQUISITION RADAR AT KWAJALEIN

General BETTS. May I jump in at this point? You are aware that one of the new elements that was added to Sentinel—now Safeguard system just a few years ago was the perimeter acquisition radar (PAR).

Mr. FLOOD. Yes.

General BETTS. This was to be the alert and warning radar that had not been in the original Nike–X.

Mr. FLOOD. That is the whole thing that is holding up the show, isn't it?

General BETTS. It is at the moment because that is where the argument comes, as to whether or not that should be on site for its testing program. We made deliberate judgement in order to save money that we would not build a perimeter acquisition radar in Kwajalein for a real time system test.

Mr. FLOOD. You made what?

General BETTS. We made the judgment that we would not build the perimeter acquisition radar in Kwajalein for a real time full-system test using the perimeter acquisition radar, because it was argued that we already have at Roi Namur Island in the Kwajalein atoll, the needed UHF frequency radar. Now, we argued that we could take the data from the radar at Roi Namur and in real time plug them into the Meck Island automatic data processing and accomplish the same system test in real time that we might accomplish with the PAR. We felt that was a prudent way to save money. But up to this time we had not been concerned with real time transmission of data from Roi Namur to Meck Island of the many things that one finds. We have radars at Roi Namur and at Kwajalein.

Mr. FLOOD. I asked the colonel this. You have had 48 channels since 1961 and now you are going from 48 to 120?

General BETTS. Right.

Mr. FLOOD. What in the world for?

General BETTS. The decision we made was that we wanted to take data from Roi Namur in real time and feed it into the Meck Island radar.

Mr. FLOOD. That mere decision?

General BETTS. Yes, sir. It becomes a much tougher job then——

Mr. FLOOD. Without more.

General BETTS (continuing). Because what you want to do is carry tracks on every item ———.

Mr. FLOOD. You did not feel that the heat was suddenly on your neck so that you had to do this overnight?

General BETTS. No, no; this was a deliberate judgment reached as a result of a plan that decided not to put PAR at Kwajalein. That would have been a tremendously expensive program.

COST OF NEW UNDERWATER CABLE

Mr. FLOOD. What is the total cost of the underwater cable in 1970?

Colonel TOBEY. $2,586,000.

Mr. FLOOD. What is the total cost?

Colonel TOBEY. That is the fiscal year 1970 cost. The total cost of the program overall is $3,360,000.

Mr. FLOOD. That will be the 1970 total cost? That can't be.

Colonel TOBEY. No, sir. The fiscal year 1970 cost for the 120-channel communications cable——

Mr. FLOOD. The total cost is $3.4 million, and $2.6 million is the cost in fiscal year 1970?

Colonel TOBEY. Yes, sir. Starting with fiscal year 1970 and the 120-channel wide cable, $2,586,000 is the funding for fiscal 1970. In fiscal 1971 an additional $1,175,000 for a total over the 2-year period of $3,361,000.

Mr. POOR. I think perhaps there is something that is not clear here. The $2.186 million takes care of the link from Meck to Roi Namur. There are also required links between Kwajalein, Ennylabegan, and Gugeegve. In fiscal year 1971 this link would require $850,000, and certain maintenance replacement cable, another $325,000. That is the way it goes.

Mr. FLOOD. Did you put another $800,000 in there?

Colonel TOBEY. The numbers that Mr. Poor gave were included in my numbers.

COST OF CENTRAL DATA PROCESSING CENTER

Mr. FLOOD. What is the requirement and the cost of the proposed expansion of the Central Data Processing Center?

Colonel TOBEY. These requirements are as follows: We want to provide real time acquisition data to the tracking cameras and the telemetry systems to tie those in through the Central Data Processing Center to the radars. And all the input and output data for the post-test analysis and preprocessing of data for verification and expedient access by the internal users so they will have real time data to work with.

Mr. FLOOD. We have no quarrel with the requirement. That is, I wouldn't have. What about the cost?

Colonel TOBEY. The cost in fiscal 1970 is $1,2 million.

Mr. FLOOD. Now, I sat here the first day that anybody across the table there talked about a computer. Now, Mr. Andrews was with us. I think we went to the Pentagon the first time when they unveiled the first piece of computer hardware there. It was as big as this room. If you ever saw a piece of Rube Goldberg machinery, this was it; yellow lights, red lights, green lights; it played music; it was a great big massive thing.

Mr. ANDREWS. I remember that.

Mr. FLOOD. Then we started getting new generations and new generations and new generations. It was like the old Army gag that any piece of hardware, any weapon system that works is obsolete. So every time they bought a computer for so many millions of dollars, it became obsolete because the salesman was already outside the door with a new one. They talk about the general pushing that first button, and there is another new one already in the wings—of course, miniaturized, naturally.

Mr. ANDREWS. I often wonder how George Washington won the Revolutionary War without a computer.

Mr. RHODES. The Redcoats did not have one.

General BETTS. He had the most effective one we know how to make; it was between his ears.

Mr. FLOOD. Touché. Now, you are not suckers for a left hook from this salesman, like hundreds of thousands of school districts all over the United States? I know about that as chairman of the Labor-HEW Subcommittee. Here all of these computers, a new computer system for higher education, secondary education, elementary education, and there are schools all over the country with their cellars just jammed with obsolete hardware which cost the school districts, cost the States, and cost the United States hundreds of millions of dollars because of a slick salesman selling the school board something they did not know about, which was obsolete when they bought it.

Now, you are not suckers for a left hook, too; are you?

General BETTS. Not in this field.

Mr. FLOOD. I don't mean the purpose and the idea behind it; I am for that.

General BETTS. We understand. As far as I am concerned with respect to this kind of capability, it has to go from the contractor up through the project manager's office to our office, to the Office of the Secretary of Defense who maintains a range office familiar in detail with what we are doing. They give our proposed costs very hard scrutiny. I believe this has been massaged adequately and is a hard requirement.

NUMBER OF PROPOSED SPARTAN AND SPRINT LAUNCHES

Mr. FLOOD. How many Spartan and Sprint launches are proposed in 1970; how many did you make in 1969, and how many in 1968?

Colonel TOBEY. I will take the Spartan launches in chronological order. In fiscal year 1968 we had two; in fiscal year 1969, seven, and in fiscal year 1970, ——— are planned. The Sprints have not been launched at Kwajalein Missile Range. The Sprints have been fired at White Sands.

Mr. FLOOD. Why the big spread between 1968 and 1969, and the tight spread between 1969 and 1970?

Mr. POOR. The Spartan program is just getting started, just as the Sprint firings at Kwajalein won't start in fiscal year 1970. They are just completing the launchers for the Sprints which will be fired at Kwajalein starting in fiscal year ———.

Mr. FLOOD. You won't fire a Sprint in 1970?

Mr. POOR. Not at Kwajalein in fiscal year 1970. They are being fired here at White Sands, however firings are planned to start at Kwajalein early in fiscal year ———. The load in ICBM/SLBM launches is also going up rather strongly in fiscal year 1970. There were 37 ICBM's in 1968, 44 in 1969 and we expect ——— in fiscal year 1970. That is the kind of thing where they launch from Vandenberg and we get data on our own reentry vehicles to help design the Safeguard system and to develop ——— techniques for our own offensive systems.

Mr. FLOOD. The record should emphasize—and I am doing it for the purpose of emphasis that you do not mean that there will be no Sprints fired in 1970, but you mean no Sprints in 1970 at Kwajalein?

Mr. POOR. That is correct, in fiscal year 1970.

Mr. FLOOD. Now, how many ICBM and SLBM launches are proposed in 1970? Again, how does that compare with 1969 and 1968?

Mr. POOR. I just gave you the numbers, I think, for the ICBM's. In the SLBM's my understanding is there were nine in 1968, none in 1969, and ——— in 1970.

Mr. FLOOD. I think at this point the record should show what is meant by the ICBM.

Mr. POOR. The intercontinental ballistic missile.

Mr. FLOOD. And the SLBM?

Mr. POOR. Submarine-launched ballistic missile.

Mr. ANDREWS. Such as the Polaris?

General BETTS. That is right.

Mr. FLOOD. I believe you have already given us the ICBM figure?

Mr. POOR. Yes. I gave you 37 in 1968, 44 in 1969 and ——— in 1970, which shows a considerable increase in this work on reentry warhead assessment considerable increase in the tasks of the radar complex, at Kwajalein.

TOTAL FISCAL YEAR 1970 COST OF KWAJALEIN OPERATION

Mr. FLOOD. You have a request here for $82.7 million. That is a lot of millions, even for you. Can you give us the various activities which make up the request? Now, you should do that very properly and very thoroughly for the record, but can you hit a handful of high spots now so that we get some idea? This thing should be carefully prepared, by all means, for the record but right now for the committee just tell us something about it.

(The information follows:)

The various activities or operations that make up the $82.7 million for fiscal year 1970 are as follows:

Operation	*Thousands*
Army operation	$11,000
Program management	(2,109)
Material and supplies	(5,000)
Support services	(3,891)
Technical range support (Kentron Hawaii Ltd.)	10,059
Logistical range support (Global Associates)	20,504
Discrimination radar and target tracking radar (former Nike radars)	11,464
Kiernan reentry measurement site radars (former ARPA radar at Roi Namur)	25,405
Communications and instrumentation	4,268
Roi Namur—Meck carrier system	(2,186)
Repair cable for present system	(400)
Telemetry	(1,241)
Photo optics	(441)
Total	82,700

General BETTS. Let me break out the main items and we will fill in the detail. First is for the cost of the Army operation as such, $11 million. These are the operating costs of the Kwajalein facility as such. Then supporting the operating costs—and by operating costs I mean the business of providing the in-house people that support the range—that means we have to reimburse the Weather Bureau for services they furnish to us; we have a couple of million for program management in the in-house staff as such.

Mr. FLOOD. Let me tell you this: As you already know, there is a strong school of thought for an ABM compromise; namely, to run the tests at Kwajalein. Secretary Laird says that can't be done because it is going to cost too much money.

General BETTS. It will, undoubtedly.

Mr. FLOOD. Here you are going to have $82.7 million, and the whole thing is almost all set up. Why can't you take all the ABM equipment out to Kwajalein and test it there? You are going to spend $82.7 million in fiscal year 1970; that is a lot of money. The flyboys will work with you. Why not take it out there and test it?

General BETTS. All of the testing of this system except for the perimeter acquisition radar will be done at Kwajalein as it exists now.

Mr. FLOOD. Then why do you want Montana?

General BETTS. We want the integration——

Mr. FLOOD. If you are all set up at Kwajalein, that is.

General BETTS. We want to integrate the final system to include the perimeter acquisition radar. If we decide to build the perimeter acquisition radar at Kwajalein in order to test the full system there, and its full system integration, it would cost about $200 million.

Mr. FLOOD. Just to set up the PAR hardware?

General BETTS. It is very expensive to do it that far out on the pipeline. Everything we do out there costs more than it would here.

Mr. FLOOD. Merely because it is that far away?

General BETTS. Because of the long logistic tail, that is correct. Beside that, we have the difficult problem of finding a place to live for the people who are working there. There are many people who work on the island now for only 1 year whom we would like to hold for much longer periods but they don't like to be separated from their families. I am talking about the contractor personnel.

We limit our housing at the island to those people that are absolutely essential to the operation and for whom we feel we should provide housing in order to keep them for longer periods than would otherwise be feasible.

Mr. ANDREWS. Do you have contractor operations at Kwajalein?

General BETTS. We do have contractor operations, and the contractor operations would be above this $10.9 million that I identified for Army operations. This was why I used the term "Army," because there are other operations that I can identify with contractors.

Mr. FLOOD. What is the $10.9 million?

General BETTS. You remember, I named the fiscal 1970 Army operation as $11 million even. I was looking at the 1969 column. $11 million breaks out to $2.1 million for program management, $5 million for material and supplies, $3.8 or $3.9 million for support services. Then the technical range support, that means engineers, scientists who run instrumentation related to the exercise under the Kentron contract is about $10 million even. The cost of running the discrimination radar and target tracking radars is $11.5 million. The logistical range support, that is a contract with Global Associates who handle all of the business of maintaining the houses, collecting rents, running the stores, maintaining vehicles operating aircraft, and marine craft, and the powerplant; that entire support exercise is the $20.5 million which I mentioned.

TESTING OF PERIMETER ACQUISITION RADAR

Mr. FLOOD. If the ABM is so absolutely vital, and I mean that with a capital "V," as the proponents say it is, why don't you just shut down everything else you are doing at Kwajalein and do this ABM show?

Mr. POOR. Mr. Flood, I was out in Kwajalein just a few months ago and I can assure you that is what is going on there. It is all devoted to ABM-related research. It is the place where we will be able to test the Spartan missile and associated radar against targets which represent real ICBM targets. It tests that part. What it does not do is put together an integrated system, including a perimeter acquisition radar, all the pieces of a unitized defense, working together——

I think General Starbird has talked to the committee about the plans for phase I. It is to put together integrated systems so that we can make sure there aren't any bugs. It is much better done here because I can assure you that at Kwajalein it would be a most awkward business to put this all together. We are land-limited, we are transport-limited and the problem of putting a complete complex out at Kwajalein would be insuperably expensive and we would not gain the leadtime we can gain by doing it here.

Mr. FLOOD. Now, Mr. Secretary, you have to test the perimeter acquisition radar against an ICBM. Are you firing things out there to test similar equipment at Kwajalein?

General BETTS. Yes, sir.

Mr. FLOOD. You are not going to be able to fire them in Montana and test them.

Mr. POOR. That is correct.

General BETTS. We wouldn't expect to.

Mr. FLOOD. You are not going to fire anything in Montana. How are you going to test this PAR in Montana unless you can fire an ICBM against it?

General BETTS. We can test the PAR on its deployed site in the United States, in the continental United States.

Mr. FLOOD. What are you going to test it against, BB guns?

General BETTS. We can test it against——

Mr. FLOOD. ICBM's?

General BETTS. We don't need to test it against an ICBM in order to conduct a proper electronic analysis of what this will do. We can test it in CONUS against satellites and space debris.

Mr. FLOOD. You are not going to test it. Now, what is the biggest pigeon you are going to test it against at Kwajalein? A slingshot?

General BETTS. The test at the Kwajalein site——

Mr. FLOOD. What is the hottest hardware you will test it against?

General BETTS. We will test it against an all-up Minuteman-III warhead.

Mr. FLOOD. You wouldn't dare do that in Montana.

General BETTS. No, sir.

Mr. FLOOD. Then you have to do your testing of the PAR in Kwajalein.

General BETTS. No, sir; it doesn't work out that way.

Mr. FLOOD. Where else are you going to test it?

General BETTS. Because I mentioned at Kwajalein we have a complex of radar that can feed into the data processor of the Safeguard system.

Mr. FLOOD. And you are going to shoot a Minuteman to test it?

General BETTS. That is right.

Mr. FLOOD. Until you shoot a Minuteman, until you test it with a Minuteman you haven't got a thing, and that you can't do in Montana. So why do you want to put it in Montana until you have tested it out against a Minuteman?

General BETTS. The radars at the tactical sites will be exercised regularly against satellite targets of opportunity to assure high radar detection and tracking performance.

Mr. FLOOD. Now let's go back. I am offstage at the right and I come in and say "Mr. Speaker, here we go again." Until you test the PAR against a Minuteman you have got nothing, and you can't test against a Minuteman in Montana. Until you test the PAR against the Minuteman, you need nothing in Montana, and the only place you can test it against the Minuteman is at Kwajalein.

General BETTS. These are much too simplistic judgments.

Mr. FLOOD. I just asked you.

General BETTS. But this is the whole point: That what the system needs in order to go through the acquisition, the handover, the data processing, the pickup with the missile site radar, and launch the intercept missile, is a proper signal——

Mr. FLOOD. Launch what intercept missile?

General BETTS. The interceptor, either the Sprint or the Spartan, or both, can be launched under control of the missile site radar at Kwajalein. It is that environment, at that site, that we would propose to do the full intercept testing.

Mr. FLOOD. Then what in the world do you want to put anything into Montana for, until you are all set?

General BETTS. Because the time factors are such that we would be far behind the Soviet power curve if we wait until all of the system testing is done at Kwajalein before we start building the perimeter acquisition radar at the sites in the continental United States.

Mr. FLOOD. You are going to build a PAR at Montana, but you are testing something else at Kwajalein. If it doesn't work at Kwajalein, year after year after year like the 3T's in the Navy, all of a sudden you are going to come back and say "Sorry about Montana, it didn't work at Kwajalein."

General BETTS. If we had any concern that we were not well along toward full knowledge of the capability of this system——

Mr. FLOOD. Let me go off the record.

(Discussion off the record.)

General BETTS. The additional element that should enter into this discussion is the fact that the Air Force built a large phased array radar at Eglin Air Force Base called the FPS–85. That is a phased array radar at virtually the same frequency as the perimeter acquisition radar is to be built in the United States. That radar has been extensively, or at least it has been tested to the extent that we know how a phased array radar of that size operates and what its radiation characteristics are. It is for that reason that we say that building a perimeter acquisition radar in the continental United States is not a high risk item by any stretch of the imagination.

Mr. FLOOD. I don't want to shoot you down, but you haven't tested anything against missiles.

General BETTS. We would propose to test missiles at Kwajalein.

Mr. FLOOD. You have not.

General BETTS. Yes, we have had many tests against missiles, many of them, using the old Nike-Zeus, the Nike X systems at Kwajalein. We haven't run the Meck radar against missile test in an all up system sense, but radars at Roi Namur, the upper end of the atoll, and those on the island of Kwajalein itself have been tested extensively. We know what a ——— looks like, what ——— looks like, what ——— look like.

Mr. ANDREWS. How long has the Air Force tested that radar at Eglin Air Force Base?

General BETTS. I would have to get that from the Air Force. It is roughly 2 years.

Mr. ANDREWS. You found it to be perfectly operational?

General BETTS. We found it to be an effective phased array radar.

Mr. ANDREWS. You are telling us that you plan to build that same type radar in Montana.

General BETTS. The same type radar is correct, not precisely the same.

Mr. ANDREWS. You have the bugs out of it with the Air Force experience at Eglin?

General BETTS. I have to qualify that by saying that we feel that the phased array technology at UHF frequency—and that is the frequency band of interest—is well understood. We know what the problems are. We have demonstrated how to solve them. A different contractor won the competition than the one who built the FPS-85 but he has the full benefit of that experience and technology on which to build his new radar.

Mr. ANDREWS. I am trying to determine whether or not this radar you propose to build in Montana is something brand new or is it a duplicate of the one you had at Eglin?

General BETTS. I am trying to be completely honest and objective. As far as we are concerned, it is a state of the art radar. By that I mean that the technology is well known.

Mr. ANDREWS. Like the one at Eglin which has been tested and found to be satisfactory?

General BETTS. That is correct.

Mr. POOR. It is like the one at Eglin but certainly not identical.

Mr. FLOOD. But all you have done at Eglin is look at satellites. The PAR is brand new. This may be the Achilles heel. You have a fantastically sophisticated project here, the whole program is, and the Achilles heel is the inability to tie together the interfaces in this fantastically sophisticated program and be able to test it against an ICBM. You just won't be able to do it. You have this can of worms, you are walking on eggs with all of this highly sophisticated, unbelievable program that you cannot do in Montana, and you cannot do it any place.

Mr. POOR. The radar signal data has been generated and is being generated in Kwajalein using the Roi Namur radars, and the same kind of frequencies are being used as those at Eglin field radar, and they do give us the signature data required for designing the computer software for handling the output of an UHF radar similar to the perimeter acquisition radar.

Mr. RHODES. Mr. Chairman, may I ask a question?

What is your time frame here? When are you going to begin these

tests in Kwajalein on the phased array radar?

General BETTS. At Kwajalein we will have the missile site radar, a radar that is in the safeguard system.

Mr. RHODES. That is not the only radar that you were going to use in Montana?

General BETTS. That is one of two radars we will use in Montana. One is for controlling the missiles and controlling the engagement. The other is for acquisition, the PAR.

Mr. RHODES. Are you ever going to test a phased array radar against an incoming missile at Kwajalein?

General BETTS. We will test it with the missile site radar which is a phased array radar, but not the perimeter acquisition radar at Kwajalein for reasons of costs and the time factors that I mentioned.

Mr. FLOOD. But you have no perimeter acquisition radar at Kwajalein. That is the thing we are discussing.

General BETTS. We do not. We do not propose to do that because we feel we can generate the exact same radar signals using radars that are already there.

Mr. FLOOD. Now, what is that? You can do the same thing as the perimeter acquisition radar with what you have? Then what do you want with a perimeter acquisition radar?

General BETTS. The exact same signals, as produced by the perimeter acquisition radar, can be generated using the radars already at Kwajalein; that is perfectly feasible, Mr. Flood, it really is. This is not such a great bid deal. This has all been reviewed by experts outside the Army——

Mr. FLOOD. Now, that leaves me cold. You know what an expert is?

General BETTS. All right; but it has been looked at very carefully by the Defense Science Board. The Defense Science Board has reviewed this, the President's Scientific Advisory Committee has reviewed it, and no one questions it.

Mr. RHODES. The point I am trying to make, General, is that your tests in Kawjalein will have been greatly advanced before you ever put any hardware on the ground in Montana or in North Dakota. Now, you do have a time frame involved here?

General BETTS. We do.

Mr. RHODES. Except for this perimeter acquisition radar, which worries the gentleman from Pennsylvania—and I must admit it worries me a little bit—is what you say here. Now, I just assumed that all of this would have been tested as a system somewhere before you put it on the ground. You have a weak case here as far as the Safeguard system is concerned because of this fact.

Mr. FLOOD. Yes.

Mr. RHODES. Now, we had been led to believe, and I do believe that the Safeguard system is supposed to test out the concept as a unit.

Mr. POOR. That is right, for the Safeguard systems.

Mr. RHODES. The state of the record is that you cannot test from Montana or from North Dakota, so that you probably never will be able to test out this system unless you build it at Kwajalein. Now, do you want to address yourself to this dilemma?

General BETTS. In terms of a full-scale intercept we cannot test at Montana. However, as I stated earlier, the radars at the tactical sites will be exercised against targets of opportunity to assure high radar detection and tracking performance.

Mr. RHODES. That's right.

General BETTS. That will always be the case. But in terms of tying the two together——

Mr. RHODES. One of the strong cases that has been made for the so-called deployment is that we will be able to see this system and see whether or not it will work. Now, it seems, this is not true.

Mr. POOR. No. It is true, Mr. Rhodes. Let me try this.

Mr. FLOOD. But you see the point. If this is what everybody says it is, if this is the end of the world, then you can't worry about the cost at Kwajalein, if that is true.

Mr. POOR. That would certainly be true except it would take longer.

General BETTS. I think the taxpayer deserves this kind of prudence.

Mr. POOR. And it is not necessary. Let me try it again.

The kinds of radar signals that the perimeter acquisition radar will receive can be measured by the equipment that exists at Kwajalein, the Roi Namur radars. It does not do the whole job. These radars are dish radars, they are not phased array radars, they can't look in many directions at once, so they are limited in the sense that they can't do the search job, the early warning look-around job.

However, they can and will generate the kinds of radar signals that one would expect to get from that portion of the PAR capability that is following an incoming missile. Therefore, we can make tape recordings that show the kinds of signals that will come in and put these into the integrated system at the Montana site and work the whole problem, the whole computer and everything on what is called a simulated engagement. Similarly, the PAR's performance can be tested, its ability to detect targets at very long ranges and track them by testing on satellite systems, targets of opportunity that go every day. So the Montana site is the first completely integrated test bed for the system.

I have every reason to believe that that is the most prudent and most rapid way of getting the system integrated. If we had to build an experimental PAR, take it out to Kwajalein at enormous expense, create the land for it, create a place for the people who are required to maintain it and operate it to live on, we would use up a great deal of time and a great deal of energy which, in my opinion, could far better be placed on the test integration here in this country.

COST AND TIME FACTORS INVOLVED

Mr. MINSHALL. Will you yield? You have given us words here. You say it will be at great expense and a great deal of additional time. Can you give us some dollar and time figures?

Mr. POOR. I cannot. General Starbird has testified on this.

Mr. MINSHALL. Can you give us a ball park feel for this? You said great expense. You must have some idea how much it is, Mr. Secretary.

General BETTS. It seems to me that the time from letting the PAR contract to the time it goes on the air is over 4 years.

Mr. MINSHALL. What about the "great expense?" What are we talking about? "Great" means a lot of things.

General BETTS. We are talking about $200 million at least.

Mr. ANDREWS. Is that what you are going to spend in Montana?

General BETTS. No. In Montana it will be less.

Mr. ANDREWS. But it is the same type radar?

General BETTS. Yes, sir.

Mr. MINSHALL. Here you are going into Montana without ever actually testing the entire system, whereas if you spent another $200 million on strictly R. & D. out at Kwajalein, you would be able to give this system an actual test on an incoming bird, would you not?

General BETTS. We would be able to.

Mr. FOOD. Wait a minute. You are never going to test this system until you push the panic button.

General BETTS. In a real sense that is true, although one can test all the elements of the system all the way up to the nuclear warhead.

Mr. MINSHALL. Don't you feel that would be the better route to follow?

General BETTS. Really, I do not. The Meck data processor that runs the engagement, that is the important item that has to be integrated with everything else.

It does not care that the signals coming in to it are from a tape or from another radar or from the PAR or what. It would be just a foolish waste of money to build a perimeter acquisition radar out at Kwajalein when we already have radars that can create radar signals in real time exactly like those that the PAR would create.

Mr. MINSHALL. Would your thinking change if the other body should come up with an amendment to the ABM program saying R. & D. only—period?

General BETTS. It would not because during the period before there was any commitment to deployment, I was involved in the decision that we would not build the perimeter acquisition radar at Kwajalein, and I think it was the right decision then and is the right decision now, and will be the right decision in the future.

Mr. ANDREWS. Are you telling us you can do the same thing at Kwajalein with the type radars you have there that you hope and expect to do in Montana?

General BETTS. We can do the same type of thing, that is true.

Mr. ANDREWS. In other words, you will have a radar in Montana similar to the one which has been tested at Eglin; and you have on Kwajalein today different radars that will do the same thing as the one to be installed in Montana.

Mr. FLOOD. Simulation.

General BETTS. That will create the same kind of radar data. It is not simulation, Mr. Flood. It is taking data off the ——— and producing exactly the same radar returns that you would get if you had a PAR. You go about it in a different way, but it produces the same signal.

Mr. FLOOD. What is simulation?

Mr. ANDREWS. You have radar that will permit you to identify an incoming warhead and shoot it down with your missiles.

General BETTS. That is right.

Mr. ANDREWS. Isn't that the same thing you say the radar you propose in Montana will do?

General BETTS. That is right.

Mr. ANDREWS. That is the same thing, but it is done in a different way.

General BETTS. Except one must recognize the radar we are putting in Montana is much more capable and will go far beyond.

Mr. ANDREWS. If you say that and you base that statement on the experience you have had with the radar down at Eglin——

General BETTS. We do.

Mr. ANDREWS (continuing). Then you are telling us you will have in Montana with the newer, different type radar a better capability to track and shoot down the incoming warhead.

General BETTS. Yes.

(Off the record.)

General BETTS. It is a very complex picture, but I think we are taking the prudent course of action.

(Clerk's note: The following additional information was provided subsequent to the hearings by the Army.)

In summary of the preceding perimeter acquisition radar (PAR) testimony, it is my judgment that the big expense of approximately $200 million to build a PAR at Kwajalein could not be justified to the taxpayers. The complete Safeguard system (missile site radar, missile site data processor, perimeter acquisition radar, Spartan missile, and Sprint missile) with the exception of the PAR per se will be tested at Kwajalein against intercontinental ballistic missiles and intermediate range ballistic missiles. The purpose of the PAR is to furnish long-range surveillance, identification and track data to the missile site data processor (MSDP) at the missile site radar (MSR). The UHF radar on Roi Namur Island in the Kwajalein Missile Range will furnish this data (identical to PAR data) to the MSDP.

The PAR per se is not required for the Safeguard system test at Kwajalein. The technology involved in the PAR has been operated successfully for approximately 2 years by the Air Force FPS 85 phased array at Eglin Air Force Base. The PAR will be tested at the deployed site against satellites and space debris with known position and velocity parameters to verify the PAR's capability to provide long-range surveillance, identification and track data. The PAR data processor will be tested further by inputing into it taped ICBM data from the reentry radars at Kwajalein. The PAR will continue to be exercised regularly against satellites and space debris to assure high-radar detection and tracking performance. If we delayed the phase I deployment until a PAR is built and tested at Kwajalein, it would delay completion of the deployment until the end of the 1970's, a time frame far too late in relation to our current estimates of the threat.

GLOBAL ASSOCIATES LOGISTICS SUPPORT CONTRACT

Mr. FLOOD. How much is proposed to be spent under the logistical support contract with the Global Associates in 1970, and how does that compare with 1968 and 1969, that one outfit?

General BETTS. I have the figures available for 1969 and 1970. It is $20.5 million for 1970, and it was $18 million even in 1969. That reflects the increased scope of activity.

KENTRON HAWAII, LTD., TECHNICAL SUPPORT CONTRACT

Mr. FLOOD. How much do you propose to spend for the technical support contract with Kentron Hawaii, Ltd.?

General BETTS. $10 million even in 1970. It was $9.4 million in 1969.

MILITARY PERSONNEL ASSIGNED AT KWAJALEIN

Mr. FLOOD. You talk about the number of people on the island. How many Army military personnel are assigned to the Kwajalein Missile Range? Give me the figures for 1968, 1969, and 1970.

General BETTS. May I turn to Colonel Tobey?

Mr. FLOOD. What will the approximate cost be for these military types?

Colonel TOBEY. There are 31 military types assigned to the Kwajalein Missile Range for 1968, 1969, and 1970. The funding is $427,000 each year.

NUMBER OF CIVILIANS AT KWAJALEIN

Mr. FLOOD. Do the same thing for civilians on the test range.

Colonel TOBEY. For 1968, the figure for civilians was 70; 1969 it was 103; and for 1970 it is projected as 126. We do not have the exact figures or their pay, but we have inexact figures of about $1,800,000.

NUMBER OF CONTRACTOR PERSONNEL AT KWAJALEIN

Mr. FLOOD. Contract employees are mixed up in this. What are their figures for 1968, 1969, and 1970, and what is the cost of their salaries for each fiscal year, and what is the average salary?

Colonel TOBEY. I have no strength for fiscal year 1968, but Global in fiscal year 1969 employed 1,300 people, and in 1970 will have 1,250 people, a drop of 50 people. Kentron in fiscal year 1969 employed 250 people, and in fiscal year 1970, 280 people.

We would have to furnish the average salary for the record.

SALARIES FOR CONTRACTOR EMPLOYEES

Mr. FLOOD. What is the cost of contract employees' salaries for 1969 and 1970? Then supply the average.

Colonel TOBEY. We do not have that figure.

Mr. FLOOD. Supply that, too.

Colonel TOBEY. Yes, sir.

(The information follows:)

The direct labor cost for contract employees' salaries in fiscal year 1969, the fiscal year 1969 average salary, and projected salaries for fiscal year 1970 are as follows:

[In thousands of dollars]

	Fiscal year 1969	Fiscal year 1970	Fiscal year 1969 average salary [1]
Global Associates	$17,200	$16,860	$7,712
Kentron Hawaii, Ltd	3,035	4,300	10,285
Radio Corp. of America (full-year operation of Trade TRADEX operation)	1,673	3,346	23,900
Lincoln Laboratory, MIT	800	1,020	27,600
Bell Telephone Laboratory	3,142	3,000	20,826
Sylvania Electric Co., Inc. (operation of ALTAIR radar)	0	1,880	0

[1] The fiscal year 1969 average salary was obtained by dividing the total direct labor costs by the total labor hours and multiplying by 2,496 hours per year.

Mr. ANDREWS. What type employees are they? What do these people do?

Colonel TOBEY. They range all the way from native Marshallese to Ph. D.'s who are over there to operate the radar, from laborer right up.

TOTAL MILITARY PERSONNEL AT KWAJALEIN

Mr. ANDREWS. While you are putting in the number of civilian contract employees, put at this point in the record the number of all military personnel over there.

(The information is as follows:)

These are a total of 53 military personnel stationed at Kwajalein. These personnel are assigned to the following organizations: Kwajalein Missile Range—24; CONARC Central Training Facility—2; Air Force liaison officer—1; resident engineer, Honolulu Engineering District—1; Safeguard System—25.

Mr. FLOOD. By the way, we know the expression "hazardous pay" for different operations, and "combat pay." What is the additional pay given to the personnel, both civilian and military, because they are at such remote locations as Kwajalein?

Colonel TOBEY. For the civil service people, there is a 25-percent increase in pay over the normal basic pay; and the contractors have arrangements to pay their personnel more to get them to work in this remote location, but we have not the precise numbers associated with that.

Mr. FLOOD. Do the military or civilian personnel have their families out there?

Colonel TOBEY. Yes, sir.

General BETTS. There is no differential for the military.

WHITE SANDS MISSILE RANGE (WSMR)

Mr. FLOOD. Let us talk about White Sands Missile Range (WSMR).

The fiscal year 1970 request for the operation of the White Sands Missile Range is $84 million. This compares with $77.7 million in fiscal year 1969 and $75.1 million for fiscal year 1968.

Suppose you tell us what are the major projects at White Sands.

Colonel TOBEY. We have a listing of 10 major projects at White Sands.

MAJOR PROJECTS AT WHITE SANDS

Mr. FLOOD. You do not have to detail the 10 now, but pick out 3, the ones that you think the committee would like to hear about right now, and then supply the rest in detail.

Colonel TOBEY. The Army has there the Safeguard program, the Sprint firing, the Shillelagh, the Redeye, and the Pershing.

Mr. FLOOD. Give us 3 and define each missile as you tell us about it, and put the rest in the record.

Colonel TOBEY. The Sprint missiles that are fired at White Sands Missile Range are a portion of the Safeguard system, very high-velocity interceptor missiles.

The Redeye is at the opposite end of the spectrum. It is a shoulder-fired, air-defense weapon. They are doing the production testing at White Sands Missile Range.

The Pershing is an operationally deployed surface-to-surface missile system, and the tests that are done on the Pershing are the troop tests returning from Europe, actual combat units.

Mr. FLOOD. These are all Army missiles?

Colonel TOBEY. The three that I gave are Army missiles. I have some Air Force and some NASA work, also, in the top 10 programs.

(The information follows:)

There are a total of 133 programs at WSMR. The top 10 programs, ranked by the total effort required to support them are as follows:

1. Firefly. This is an Air Force program for the development of a special purpose aircraft which will be air launched to fly a preprogramed profile. Parachute recovery will normally occur in the 50-mile impact area with midair retrieval being conducted on some flights.

2. Modified bombing system. The objective of this Air Force program is to test various modified bombing systems to determine the improvement in the weapon delivery capability of high-performance aircraft. These systems may include a laser bombing system, or an advanced kinematic bombing system and/or others. The workload on this program is very unpredictable. Where the average number of bombs dropped have been about 250 per quarter, there was an average of over 550 per quarter during the last two quarters. All of these operations are conducted in the north end of the range.

3. Safeguard. The objectives of this Army program are to conduct testing and evaluation operations necessary to the development of the Safeguard antiballistic missile system. Principal test item is the Sprint missile.

4. Athena. The objectives of this Air Force program are design evaluation of penetration aids and reentry bodies, feasibility testing for various concepts, and reentry physics measurements. The 114th round was fired on March 27, 1969 and the 115th and 116th rounds are scheduled for June 5, 1969.

5. Shillelagh comparison. The objectives of this Army program are to provide continuing assessment of the quality of the Shillelagh missile and detect significant degradation caused by production variances. This program is being tested on our small missile range.

6. Hirewimp. The objective of the NASA high resolution wind measurement program is to obtain detailed wind profile measurements using the FPS-16 radar/jimsphere method to establish time variability of small-scale motions to determine the nature of turbulence as related to space vehicles. This program operates both on range and in the Green River area.

7. F-106 SET. The objective of this Air Force system engineering test is to evaluate the modified fire control system for F-106.

8. Redeye. The objective of this Army program is to conduct firing tests of production Redeye missiles against aerial targets. This is a relatively high-firing rate program of a small surface-to-air missile system.

9. Asrov. The Aerospace sounding rocket vehicle is fired by the Army to gather data on properties and environment of the upper atmosphere and near space. A variety of meteorological rockets are used to gather this data.

10. Pershing. This Army surface-to-surface missile is usually fired from the Utah launch complex into White Sands Missile Range. It provides data for weapon system improvements in addition to supporting unit service practice requirements.

MEASURE OF WORKLOAD AT WHITE SANDS

Mr. FLOOD. Our big problem for years and years—and it is your phrase, so we borrow it and now throw it back at you—has been how do you measure the workload—the sacred term—at White Sands? What do you use as a yardstick, the number of missiles launched or what? What is your projected workload for fiscal year 1970? You should not use those terms, because we remember them.

Colonel TOBEY. We have several measures of workload at White Sands. One indicator of the workload is the number of hot firings.

Mr. FLOOD. What is a hot firing?

Colonel TOBEY. A hot firing is defined as an operation that includes a launch or a drop, such as a bombdrop, or ejection from an aircraft, and requires range instrumentation. That is differentiated from a test, which is defined as any operation requiring range schedul-

ing, but is not classified as a hot firing. For example, dry runs would be a test but would not be a hot firing.

Another indication of the range effort is called the range effort equivalent, and this is an index only which represents the direct support effort of the White Sands Missile Range to support the various user projects and activities.

The range effort equivalent includes a direct support effort indicator for data collection, data processing, recovery, meteorological support, and other direct range support activities.

This index was developed with the fiscal year 1961 being the base year, and is one means of evaluating the level of the White Sands Missile Range workload.

We have the history of the range effort equivalents, the REE's, for the period 1961 through 1969 and forecast for fiscal year 1970. That shows an increasing trend over that period of time.

PLANNED MODERNIZATION AT WHITE SANDS

Mr. FLOOD. I was out at White Sands when they opened it. It seems 100 years ago now. What modernization do you plan for 1970, and what will it cost?

Colonel TOBEY. The modernization program has as its objectives increased accuracy of the data obtained, faster test results to get them to the man who has to use the test results much more promptly than has been done in the past, and to utilize the resources of the range more efficiently.

The fiscal year 1970 program related to modernization, as I have it on this paper, is $17,518,000 total.

Mr. FLOOD. How much was spent for the same thing in 1968 and 1969?

Colonel TOBEY. In 1968, $15.767 million; and in 1969, $15.212 million.

NUMBER OF EMPLOYEES AT WHITE SANDS

Mr. FLOOD. You tell us 1,800 military and 4,294 civil service personnel are required to operate White Sands. Have you made any effort out there to reduce the number—have you made any strong effort—I suppose you have made some sort of effort, but have you made a strong effort to reduce the number of personnel at White Sands? Do they get in each other's way out there? That is a lot of people.

Colonel TOBEY. Efforts have been made to reduce the numbers of people.

Mr. FLOOD. I asked somebody that last year, and I got the same answer. You are still making efforts.

Colonel TOBEY. The White Sands Missile Range folks actually feel they need more people to operate the range effectively.

Mr. FLOOD. I am sure of that.

Colonel TOBEY. Those requests have not been approved.

Mr. FLOOD. Good. I am sure they want more.

General BETTS. The workload has been steadily increasing. That is the problem.

Mr. POOR. I think the most promising aspect of this is through the modernization program we are getting gradually an integrated sys-

tem of central computer control that will read out or make available data from all of the different radars and optical tracking devices so the business of data reduction, which has plagued the missile range from the day you first saw it, will be simplified and will have less man-hours per unit of data put out.

This does not necessarily mean we will be able to cut down the people very much, because the demand for work at White Sands from our own programs and from the programs of our sister services is pretty big.

ANNUAL COST OF EMPLOYEES AT WHITE SANDS

Mr. FLOOD. What is the annual cost of the 1,800 military personnel, and what is the cost in salaries and expenses for the 4,294 civil service personnel, the total for the military and S. & E. for civilians?

Colonel TOBEY. We have that data, sir. I would prefer to supply it for the record.

Mr. FLOOD. Would it take long to present that?

Colonel DOSS. The military pay in fiscal year 1969 was $12,194,000, and in fiscal year 1970, $12,805,000.

For the civilian personnel that we have there, the fiscal year 1969 salaries were $28,342,000, and the fiscal year 1970 pay is predicted to be $28,999,000. This increase is due to a 5-percent increase for wage board employees, and a within-grade step increase of $0.278 million for the civil service people.

Mr. FLOOD. Those are mandatory.

Colonel DOSS. Yes, sir.

Mr. FLOOD. That is no little league ball game, is it?

Colonel TOBEY. Before leaving the range operations and the number of people involved in it, it should be pointed out that operating a national range is a 24-hour-a-day——

Mr. FLOOD. What is a national range?

Colonel TOBEY. The White Sands Missile Range is a national range. The Eastern Test Range is one. It is a range operated for all of the national effort, including NASA.

Mr. FLOOD. It is not strictly an Army show.

Colonel TOBEY. No, sir.

We have 24 hours' worth of operation. At White Sands they have only essentially one shift of people. They stagger the workload of those reasonably large numbers of people, looking at it here, but relatively small by comparison with the work effort.

A man can go into the office or the instrument that he mans and he reads the hours he works for the next week. He might work from midnight until 8 o'clock in the morning today, and tomorrow he might work from 4 in the evening until midnight, because of the reduced numbers of people who are available to do this work.

We fire at White Sands Missile Range around the clock. Certain of the tests have to be fired at night. I have fired missiles there where we needed a night condition.

Mr. FLOOD. I saw one.

Colonel TOBEY. We just sat there all night and tied up the whole range all night long, waiting for the cloud cover to lift at White Sands so we could fire this particular test.

Mr. ANDREWS. Mr. Flood was there 100 years ago when you opened it up. That range will be with us from now on; will it not?

Colonel TOBEY. Yes, sir.

Mr. ANDREWS. And so will Kwajalein.

General BETTS. As far as I can see into the future.

Mr. ANDREWS. And so will Canaveral and Vandenberg.

Mr. FLOOD. And so will the Army.

Mr. ANDREWS. I am trying to find out how much longer we are going to have these missile ranges. As long as we have missiles, you have to have these test ranges.

Colonel TOBEY. That is right.

Mr. FLOOD. You use the phrase "Descriptive Summary," and it states on page 164 that 1,100 military and 4,000 civilian personnel are at White Sands. The justification book on page 43 shows 1,800 military and 4,294 civilian personnel are at White Sands, as we just mentioned. What is the matter with this? Which figure is correct?

Colonel TOBEY. There is a difference in the interpretation.

Mr. FLOOD. There is a difference in the figures.

Colonel TOBEY. But it is interpreting the figures. At page 43——

Mr. FLOOD. There is a difference in the figures. My question is: Which figure is correct? Now, go on from there.

Colonel TOBEY. Both figures are correct. The man-years represent——

Mr. FLOOD. That is what I want to hear. Those are your figures.

Colonel TOBEY. That is correct. Both are correct. In the big book these are numbers of people who are authorized——

Mr. FLOOD. By the "big book"——

Colonel TOBEY. I mean the descriptive summary. These are the numbers of people. The justification figures are man-years of effort. This is the numbers of people times the 8-hour workday.

Mr. FLOOD. He did prove it.

Mr. ANDREWS. I have been hearing that for years.

Mr. FLOOD. So have I.

Mr. ANDREWS. I am interested in how many people you have working and you are paying.

Coloney TOBEY. The numbers here of 1,100 military and 4,000 civil service are the correct numbers.

Mr. ANDREWS. When you mix them up and work some of them at night and work some of them double time, you come up with man-years?

Colonel TOBEY. That is correct.

Mr. ANDREWS. I have been hearing that for years.

Mr. FLOOD. Sure you have. That's it.

Mr. ANDREWS. That still does not make those figures the same.

Mr. FLOOD. You cannot be a purist here.

DIFFERENCE BETWEEN KWAJALEIN AND WHITE SANDS OPERATION

Why is it the policy of the Army to operate White Sands primarily with Government personnel and Kwajalein primarily with contractor personnel? Which came first, Kwajalein or White Sands?

Colonel TOBEY. I suppose this grew. White Sands grew up as a military installation with military people operating as much of it as they

could, and they grew toward more and more civilians. On the other hand, the Army took over the Kwajalein Missile Range which the Navy had operated as a Government-owned, contractor-operated facility, and that has gone the other way under Army management.

ANNUAL COST OF CONTRACTORS AT WHITE SANDS

Mr. FLOOD. That is a good answer.

What are the annual payments to the principal White Sands contractors?

Colonel TOBEY. We presented that.

Mr. FLOOD. Give me the big one, and then you can provide the rest.

General BETTS. We haven't provided that.

RCA for operation and modification and complete maintenance of multipulse tracking and instrumentation radars, $2.561 million.

Colonel TOBEY. That is for 1969. The bottom number is the 1970 figure.

General BETTS. I do not have the 1970 figures. I have 1969.

Mr. FLOOD. Let me have 1969, and supply 1970.

Colonel TOBEY. We have them both. RCA in fiscal year 1969 was $2.561 million, and in fiscal year 1970 is programed at $2.570 million.

Dynelectron in fiscal year 1969 was $8.157 million; and in fiscal year 1970 is programed at $8.2 million.

IBM in fiscal year 1969 was $524,000; and in 1970 is programed at $467,000.

Philco-Ford in fiscal year 1969 was $1.050 million; and in fiscal year 1970 is programed at $1.054 million.

New Mexico State University in fiscal year 1969 was $1.297 million; and in fiscal year 1970 is programed at $1.3 million.

Mr. FLOOD. You may supply the rest for the record.

(The information follows:)

PRINCIPAL WHITE SANDS MISSILE RANGE CONTRACTORS AND FUNDS PAID IN FISCAL YEAR 1969 AND ESTIMATED FOR FISCAL YEAR 1970

[In thousands of dollars]

	Fiscal year 1969	Fiscal year 1970
1. Radio Corp. of America Operation, modification, and complete maintenance of Government furnished monpulse tracking and instrumentation radars within boundary of WSMR and off-range sites. Technical skills required would necessitate long-range recruitment efforts and extensive training extending beyond a permissible time frame.	2,561	2,570
2. Dynaelectron Install, operate, maintain, improve and modification of Government range instrumentation and equipment for test and development programs at or for WSMR, high speed track, aerial space medical lab and Utah test site. Provides data collection through the operation of the above-mentioned equipment.	8,157	8,200
3. International Business Machines Provides manufactured special maintenance on approximately 40 pieces of Government-owned equipment.	524	467
4. Philco Ford Instrumentation and calibration of electronic, electrical, and mechanical equipment plus installation. Development of calibration procedures and maintenance of Government-furnished equipment. Manpower resources not available at WSMR.	1,050	1,054
5. New Mexico State University For data reduction services. Reproduction of data reports. Technical skills required would necessitate long-range recruitment effort and extensive training extending beyond a permissible time frame.	1,297	1,300
6. Lockheed Technical skills required would necessitate long-range recruitment efforts and extensive training extending beyond a permissible time frame. Engineering services, engineering and technical service design fabrication, install and check out modified or experimental instrumentation and engineering studies.	1,344	1,700
7. Page Aircraft Maintenance, Inc Range recovery in New Mexico, Colorado, and Utah provides pilots and aircraft to effect search and recovery operations in support of missile firings and test activities.	721	800
8. Computing & Software, Inc Install and maintain and modify data reduction equipment, computer programing, data analyses, digital data progress report, preparation and reproduction. Technical skills required would necessitate long-range recruitment efforts and extensive training extending beyond a permissible time frame. Contract with above company was for 36 months.	1,872	2,320

WORK AT WHITE SANDS INCREASING

Mr. FLOOD. In the past 2 years, the Air Force people have made substantial reductions—and I mean substantial—in the number of military personnel at the Eastern Test Range. They made quite a cut of their uniformed people, and they did not increase the contractor personnel and did not increase the civilian personnel.

Why in the world hasn't the Army been able to reduce military personnel at White Sands?

I know you say it just grew like Topsy. It just grew up. Why can't you cut the military personnel at White Sands the same way the flyboys did?

Colonel TOBEY. The Air Force military workload at the Eastern Test Range we find to be decreasing. The NASA workload is increasing, but the military testing, as we understand it, at the Eastern Test Range is decreasing as the Western Test Range develops more firings.

This, we think, would explain the reduction of Air Force personnel at the Eastern Test Range, whereas at White Sands Missile Range our Army programs are on the increase.

Mr. FLOOD. Mr. Andrews?

Mr. ANDREWS. No questions.

Mr. FLOOD. Any questions to the left?

(No response.)

MILITARY ASTRONAUTICS AND RELATED EQUIPMENT

Mr. FLOOD. We go to "Military Astronautics and Related Equipment."

The fiscal year 1970 request for military astronautics and related equipment totals $14 million, an increase of $3.4 million over the fiscal year 1969 program.

First of all, define military astronautics, and then tell us the reason for the increase.

Colonel TOBEY. Military astronautics as it applies to us relates to the use of satellites for communications where we, the Army, have the ground support station, and it has some applications in mapping, charting, and geodesy whereby the satellite provides data for this kind of information.

Mr. FLOOD. You have a problem. Does anybody else want to volunteer, or have you learned better?

General BETTS. I would just as soon simplify it to the application of space technology to military needs.

Mr. FLOOD. I was looking at it backward; what is military astronautics insofar as what the Army does, which is what he was talking about?

General BETTS. I was identifying the whole program, the application of space technology.

Mr. FLOOD. I doubt very much if you can go further than that. If you did, you would get trapped.

REASON FOR FISCAL YEAR 1970 INCREASED FUNDING

What about the increase? What about the money?

Colonel TOBEY. We have several programs here. Heavy and medium

transportable satellite communications terminals in fiscal year 1969 was about $2.2 million, and in fiscal year 1970 went up to ——— million. This is an increase of ——— million of the ——— million increase, the bulk of it.

Then the other increases were work in support of the terminals. The big bulk of the ——— million is for the development and procurement of one heavy transportable and one medium transportable communications terminal to work with the satellites.

Mr. FLOOD. What is a terminal?

Colonel TOBEY. It is a van with an antenna that receives and transmits signals to the satellite.

Mr. FLOOD. Mobile?

Colonel TOBEY. Yes, sir; transportable.

Mr. POOR. I believe one of our terminal systems is now on its way to Alaska so the people in Alaska will be able to see the television coverage of the space launch day after tomorrow.

Mr. FLOOD. That is only fair, for the biggest State in the Union.

Mr. POOR. We are able to use some of the bands in the Defense Communications Satellite System to make it available.

Mr. FLOOD. The natives of the second biggest State, Texas, will be able to see just as though they were in the United States.

Mr. POOR. It is an interesting little sidelight.

Mr. FLOOD. That does not explain all of the increase, does it?

Colonel TOBEY. Yes, sir. Of the ——— million, ——— million is in the terminals.

Mr. FLOOD. The terminals are the cause of the increase in cost?

Colonel TOBEY. The development and the procurement of one each of these R. & D. prototype models is the bulk of it.

STRATEGIC ARMY COMMUNICATIONS

Mr. FLOOD. The next item is "Strategic Army Communications."

Of the ——— million requested in fiscal year 1970 for military astronautics, ——— million is for the strategic Army communications, known as Starcom. Your fiscal year 1969 program was only $6 million. Will you explain the accomplishments last year in the Starcom area?

Colonel TOBEY. In 1969, the Army accomplished the following:

Completed the modification to the 14 heavy transportable terminals (AN/MSC46) which increased the terminal's capacity from five to 12 channels.

Improved the reliability of the highly transportable terminal by making modifications.

Completed the detailed specifications for the new heavy and medium transportable terminals for phase II of the Defense Satellite Communications System (DSCS).

Issued a request for proposal to industry for the development of one each heavy and medium transportable terminal. The proposals will be submitted to the Army in early August. The contract is expected to be awarded in October 1969.

Completed design studies and awarded contract for two development models of spread spectrum modulation equipment.

DEFENSE COMMUNICATIONS SYSTEM

Mr. FLOOD. Why is a ——— million increase required in fiscal year 1970, and what do you hope to accomplish with the ——— million?

Colonel TOBEY. The increase is required to fund the development of one each heavy and medium transportable satellite communications terminal and the associated equipment. The Army plans to award a contract in October 1969 for the development of these two terminals. Other contracts are expected to be awarded to develop and procure time division multiple access equipment and R. & D. terminal components such as the wide-band amplifier, modulation equipment, sequential encoders/decoders and high-power klystron.

Mr. FLOOD. Page 166 of the justification book indicates that "The objective of this program is to provide for the development and improvement of the defense communications system (DCS) in response to R. & D. requirements placed on the Army by the DCA." What kind of R. & D. work do you conduct for DCA?

Colonel TOBEY. The Army is responsible for developing and testing individual items of communications equipment for the defense communications system (DCS). For example, in the defense satellite communications system, the Army develops and tests all of the ground terminals.

DCA SYSTEMS ENGINEERING FACILITY

Mr. FLOOD. DCA is in the process of establishing a systems engineering facility/laboratory allegedly for use as a test bed for systems and equipment. Is this DCA facility/laboratory being established because the Army and/or the Navy and Air Force were unable to respond to the R. & D. requirements placed on the military services by DCA?

Colonel. TOBEY. Reviews and studies on this subject by the Office of the Secretary of Defense have concluded that a capability does not already exist within the military departments and that it is more efficient and economical to provide the proposed new facility. The Army could respond to the requirements of DCA for an engineering test facility provided the Army increased its laboratory facilities and personnel.

VARIOUS ARMY COMMUNICATIONS ACTIVITIES

Mr. FLOOD. The Army has the Army Communications Systems Agency, the Army Communications/ADP Laboratory, and the Army Satellite Communications Agency, all at Fort Monmouth, as well as the Army strategic communications command, Fort Huachuca, Ariz., and the Army electronics command. How many military, civilian, and contractor personnel are involved in each of these agencies and commands, and how many communication research and development laboratories and facilities are available to the Army?

(The information follows:)

NUMBER OF PERSONNEL WORKING IN EACH OF THESE AGENCIES AND COMMANDS

	Military	Civilian	Contractor	Total
Army Communications System Agency	64	175	0	239
Army Communications/ADP Laboratory [1]	(32)	(380)	0	(412)
Army Satellite Communications Agency	140	168	0	308
Army Strategic Communications Command, Fort Huachuca, Ariz.	371	881	79	1,331
Electronics Command	1,592	12,239	236	14,067
Total	2,167	13,463	315	15,945

[1] The Army Communications/ADP Laboratory is an organization in the Electronics Command and these figures are included in the command figures.

Note: The communication R. & D. laboratories and facilities available to the Army are Army Test and Evaluation Command, Aberdeen Proving Grounds, Md.; Army Satellite Communications Agency, Fort Monmouth, N.J.; Army Communications/ADP Laboratory, Fort Monmouth, N.J.; Army Electronics Component Laboratory, Fort Monmouth, N.J.

ARMY CAPABILITY TO PROVIDE SYSTEMS ENGINEERING

Mr. FLOOD. It is difficult to understand why DCA must create another major organization with the facilities available to the Army and the other military services. Are there any areas in the mission for this new DCA facility/laboratory to which the Army could not respond, if tasked, by utilizing existing resources and capabilities, or minor expansion thereto if required?

Colonel TOBEY. The Army could respond to the DCA system engineering requirements for those functions of the DCS which it has primary responsibility by a relatively minor expansion of its laboratories and other facilities. However, to meet the system engineering facility requirements for the complete DCS would require a major expansion.

Mr. FLOOD. Will you provide for the record the Army capabilities to provide DCA with system engineering and other R. & D. support, if asked to do so by DCA?

Colonel TOBEY. The R. & D. communications laboratories and facilities available to the Army are:

Army Test and Evaluation Command, Aberdeen Proving Grounds, Md.

Army Satellite Communications Agency, Fort Monmouth, N.J.

Army Communications/ADP Laboratory, Fort Monmouth, N.J.

Army Electronics Component Laboratory, Fort Monmouth, N.J.

TACTICAL SATELLITE COMMUNICATIONS

Mr. FLOOD. That takes us to Tactical Satellite Communications.

Your fiscal year 1970 program includes ——— million for Tactical Satellite Communications. How was the $4.6 million provided in fiscal year 1969 utilized? What did you do with the money?

Colonel TOBEY. We developed in fiscal year 1969 an operational concept plan in response to the Deputy Secretary of Defense.

We prepared a joint, triservice, technical development plan which was submitted in May of this year. We have received some alert receivers and some quarter-ton mounted terminals that were shown in the initial opening statement, and ton-and-a-quarter truck receivers. These are the kinds of things we are working on.

Mr. FLOOD. What will you do with the money in 1970?

Colonel TOBEY. We will continue the work in this area, testing the tactical satellite, the Tacsatcom I, which has been placed in orbit, using the terminals that we built in fiscal year 1969 ———.

DIFFERENCE BETWEEN TACTICAL AND STRATEGIC SATELLITE COMMUNICATIONS

Mr. FLOOD. You tell us you are doing work on these satellite communication ground terminals under both Starcom and Tacsatcom.

First of all, suppose you translate Starcom and Tacsatcom from their gobbledygook.

Colonel TOBEY. Starcom is Strategic Army Communications, and it would be in general the communication, from an active theater back to the Conus.

Tacsatcom is tactical satellite communications and it would be within the theater, within the field Army, from division to corps, corps to field Army.

The difference in equipment, of course, is in the degrees and numbers and complexities of the terminals at the various levels.

Mr. FLOOD. Can you explain to us why we must have separate communication satellite systems for so-called strategic and tactical communications?

Colonel TOBEY. We feel that the two, Tactical Satellite Communications and Strategic Communications, will be able to merge in about 1975.

The initial Defense Satellite Communications system, Starcom, which was initially put into operation, became operational when it was in the R. & D. phase.

Mr. FLOOD. That is what I said about tobacco ads on TV. You are going to do it in 5 years. Why not now?

Colonel TOBEY. It has to do with the technical equipment that is in orbit now on the satellites.

Mr. FLOOD. In other words, you cannot do it now?

Colonel TOBEY. You can do it partially but not completely.

Mr. FLOOD. It should not be done now?

Mr. POOR. It should not be done with the equipment currently in orbit.

Mr. Chairman, the problem here is that for a tactical communications satellite, one wants an antenna on the satellite to concentrate the communications energy on the region in which the fighting is going on. For strategic communications you have to cover a whole section of the world.

Mr. FLOOD. But how can you draw the line between strategic and

tactical communications when you are talking about communications in the satellite area?

Mr. POOR. The satellite in orbit can have an antenna that focuses on Europe, talk from Europe to Europe, back and forth. It provides ——

Mr. FLOOD. How do you draw a line between strategic and tactical? There it is.

Mr. POOR. The satellite looks different in this sense: For the tactical problem, you are very concerned about security of communications within the theater. For the strategic problem, you are concerned with very long-haul communications as from here to Vietnam. The design of the satellite's antenna system is quite different in the two cases. In the one case, the Tactical Satellite Communications System, you wish to focus the energy on the tactical area so things outside the area in which you are working do not get into the link and interfere with it. In the case of very long distance communications, you have to light up half of the world with the satellite.

Mr. FLOOD. That is pretty good. Even I understood that.

Mr. POOR. In these satellite communications programs, of which I am reasonably proud, I think we have done something right. These satellites are ones which involve all three Services. We have put together tri-Service executive groups which have been doing the system design together—Army, Navy, and Air Force people walking in step and coming up with the systems and sharing the workload, I think with very satisfactory results.

We have been able to get together in this important area of the use of satellites for communication purposes. I think the work is something of which we can well be proud.

PROPOSED USE OF TACTICAL COMMUNICATIONS SATELLITE FOR STRATEGIC PURPOSES

Mr. FLOOD. The committee has already been advised that ——— will be provided with equipment which will permit their use of the TACSATCOM satellite. They will be able to use the satellite. The Navy people told there is a lot of talk about providing the same advantage for ———, to give them the same capability. Did you ever hear of that?

Mr. POOR. Yes, sir.

Mr. FLOOD. This all constitutes the use of a tactical communications system for strategic purposes. That being so, how can you draw a line between tactical and strategic communications, even though I understood what you just said, and how can you justify the need for two such separate communications systems rather than the one end-to-end communications system, to serve all users? End-to-end communications has been the big deal here for years.

Even after your excellent explanation of the distinction, how can you draw the line and why do you need two separate communications systems rather than this one end-to-end communications system to serve all users?

General BETTS. It really stems from Mr. Poor's discussion of the joint management program. When we talk about satellite communica-

tions as a system, it goes all the way from the terminal to the satellite back to another terminal. If the terminal is on the ground and, therefore, does not have the size, weight, shape and restrictions inherent in putting a terminal on a vehicle somewhere, it is clearly the Army's responsibility.

If it is going up in the air on an airplane where it does have size, weight, shape, and power restrictions, it is clearly an Air Force responsibility.

If it is going on a ship where it has shipboard high cost and corrosion problems that are related to that environment, it is the Navy's responsibility.

But since we are doing this systems design in a joint environment, whatever technology is available to one is available to the others. We have been very careful to avoid any unwarranted duplication.

USE OF SINGLE SATELLITE FOR COMMUNICATIONS AND NAVIGATION

Mr. FLOOD. Take a look at page 28 of your statement. The language on page 28 of your statement bears out exactly the thoughts of this committee. Here is what you say:

It is becoming increasingly evident that one satellite can serve many purposes. . . .

Does that mean that one satellite can be used for both communications and navigation purposes?

Mr. POOR. Yes.

General BETTS. Ultimately, and it is. That is the essence of my comment that the Army is not responsible for that satellite that stays up there in space. That is the Air Force piece of this joint development program.

The thing we were pointing out here is that as technology advances, these differences that Mr. Poor described between a satellite that pointed to a tactical application and one that pointed to a strategic application—these differences will ultimately disappear and one design can satisfy the whole family of users.

Mr. FLOOD. I told you about some of us in the subcommittee sitting here year after year, all through over two decades of this business. We went through the Army Jupiter missile and the Air Force Thor missile, you know.

You fellows came up with Jupiter. This drove the Air Force people to drink. They had to get something. They came up with Thor and elbowed you out of the field. That is when the Army was low man on the totem pole. I was the only friend you had, I think, including half the Army, who did not stand up and fight, either. They chickened out.

General BETTS. I think it is a very well balanced joint effort. The satellite that is up there serving us all is the same satellite.

Mr. ANDREWS. Who put it up there?

General BETTS. The Air Force put it up there.

ARMY INTEREST IN NAVIGATION SATELLITES

Mr. FLOOD. Along the same line that we just touched on, on navigation, the Navy and the Air Force are both pursuing navigation satel-

lite programs. What is the Army doing in the area of navigation satellites?

General BETTS. Our interest is in a small receiver that is either transportable or man-portable for application to the field Army so we can use the advantages of having that satellite available for the solution of navigation problems.

Mr. FLOOD. What navigation problems do you have with a squad?

General BETTS. We are very much aware, in a jungle environment like Vietnam, that it is virtually impossible to furnish a long-range patrol adequate maps to keep them sufficiently well aware of their position, at all times, so that when they call for artillery support from an artillery base, we can put it out there with impunity. Navigation is a very important problem in that kind of situation.

It would be just as important if——

Mr. FLOOD. Do you have a navigator in a tank?

General BETTS. No; I did not say that. I was talking about a long-range patrol in a jungle environment where maps are important to their use.

Mr. FLOOD. He calls the artillery in.

General BETTS. He calls the artillery in.

Mr. FLOOD. But you mean the Red Legs have navigators on them?

General BETTS. No. The long-range patrol wants to be able to tell the artillery base where they are with respect to that base.

Mr. FLOOD. You mean you have to have a topkick who can navigate?

General BETTS. He has to know where he is.

Mr. FLOOD. That is not what I asked you. I am talking about satellite navigation.

General BETTS. In effect; yes. He has to be able to find himself in the middle of a jungle.

Mr. FLOOD. Won't they be surprised when they hear that.

General BETTS. We are doing it now by other techniques that are not as versatile.

Mr. POOR. Mr. Flood, you asked what the Army is doing. In addition to developing equipment to use the navigation satellite——

Mr. FLOOD. Why do you want to navigate?

Mr. POOR (continuing). It can be used to determine position location on the ground, using the same kind of data, if it is available, that a ship can use. It is a means of answering the question, "Where am I"?

NAVIGATION SATELLITE STEERING COMMITTEE

In this sense, the Army does have a real need. I was going to say in a navigation satellite system the Army is actively engaged, as in the case of communications satellite systems, in helping design the whole system. We have a member on the Navigation Satellite Steering Committee, and he is actively participating in the engineering.

Mr. FLOOD. That within itself would be an answer.

Mr. POOR. Just as in the communications satellite criteria.

Mr. FLOOD. You have two good answers. Where am I, and you are helping the other people.

Mr. MINSHALL. Who is on the Navigation Satellite Steering Committee?

Mr. POOR. A man from my office named Victor Friedrich, an experienced electronic engineer originally from the Electronics Command.

Mr. MINSHALL. How many from the other services? Does the FAA have a man on it?

Colonel RUSSELL. No, sir. This is a tri-service committee. There is one secretarial member from each service and one military member from each of the military services. A total of seven people, four military, including the Marines.

Mr. MINSHALL. This is solely for surface navigation on the ground?

Colonel RUSSELL. No, sir.

Mr. MINSHALL. It includes aircraft?

Colonel RUSSELL. Yes, sir.

Mr. MINSHALL. Why don't you have somebody from FAA on it? They are very much interested in satellite navigation to take care of the tremendous congestion problems we have on our airways.

Mr. FLOOD. I guess it is just a military show; is that it?

Mr. POOR. This is primarily a DOD show. I am sure the output of the studies is made available to FAA.

Mr. FLOOD. The question is good, but I can see what you mean.

Mr. POOR. There are some different considerations about a military electronic navigation system. One of the things one might consider is to make it secure so the enemy cannot make use of it. That would not be very helpful to FAA.

Mr. MINSHALL. What about the effect of jamming one of these satellites or even knocking it out of the sky?

Mr. POOR. We have given a good deal of thought to that.

Mr. MINSHALL. I think you should.

Mr. POOR. In particular in case of ———. I am told that ———.

Mr. MINSHALL. From the layman's point of view, what would prevent a potential enemy from putting another satellite up there somewhere near ours and not turning it on until the appropriate time?

(Discussion off the record.)

NUMBER OF SATELLITES REQUIRED FOR GLOBAL COVERAGE

Mr. MINSHALL. How many communications satellites you have been describing would we have in the foreseeable future up there at one time?

General BETTS. Could I turn to Colonel Russell for that answer?

Colonel RUSSELL. It would take approximately ——— satellites to give global coverage. At the present time our plans are for separate systems, and there would be ——— satellites in each of the systems.

Possibly by 1975, the two systems would come together. At that time there probably would be ——— or possibly ——— satellites, depending on whether we use all one type of satellite or two different types.

Mr. MINSHALL. What is the useful life of one of these satellites?

Colonel RUSSELL. They are designed for ———.

Mr. MINSHALL. Thank you, Mr. Chairman.

QUESTIONABLE NEED FOR CERTAIN TACTICAL SATELLITE COMMUNICATIONS

Mr. FLOOD. One last question on what we are talking about just now, and then we will adjourn for the day.

Look at page 29 of your statement. That indicates that Tacsatcom I will "provide the tactical user with a reliable advanced communications system, whether it is 1 mile over a mountain, or 9,000 miles across oceans and continents."

You know what the question is. How can communications 9,000 miles across oceans and continents by a tactical user be considered tactical communications? What in the world will that bull sergeant with that platoon out near that dugout have to do with that?

General BETTS. You remember we remarked that we thought in the time frame like 1975 and later, it would be possible to merge the two requirements for strategic and tactical communications so that a system could serve either application. I consider a corps headquarters or an Army headquarters a tactical headquarters. Communications from corps down to the division is tactical. The same communications center in the corps might be communicating back to a support based in the continental United States.

Mr. FLOOD. From the corps back to the continental United States?

General BETTS. One could find that.

Mr. FLOOD. What Army is that? What corps is that? From the corps to Washington? In what war?

General BETTS. To some supply depot. It is perfectly feasible. Or a command like the STRAC Command—that is a better example—would be in a field situation half way around the world and want to communicate back to his headquarters. The same communications center is just as interested in short-range communications to a division. We were merely——

Mr. FLOOD. There won't be many communications like that.

Mr. POOR. It would take very severe communications discipline to keep it down.

Mr. FLOOD. It is because of the other discipline that there won't be very many communications like that. Can you imagine a guy at the corps calling up the Pentagon and saying, "Good morning. I have a problem."

General BETTS. When we get into the logistic support business with modern data processing techniques, routine working level communications from the theater back to depots in the United States is already a fact of life, and it will get to be even more important.

This is not a wild conjecture. It is something that you will see as a matter of routine in another 5 or 6 years.

Mr. MINSHALL. How far down do you plan to carry this chain of command, down to the division or maybe down to a regiment or combat team? It may even go to the platoon?

General BETTS. I do not think we have really worked that out, since this is highly developmental in nature.

Mr. FLOOD. You are not serious, Skipper? You are kidding us.

General BETTS. I am not. I am certain we would want tactical satellite communications capability at the division level.

Mr. MINSHALL. You would do away with the generals. You would need only one back here.

General BETTS. That is an attractive possibility.

Mr. FLOOD. All right, gentlemen.

TUESDAY, JULY 15, 1969.

Mr. SLACK. The committee will please come to order.

When the committee adjourned yesterday, we were discussing tactical satellite communications and the Army's participation in that program.

How can you justify the expensive development of a family of five tactical ground terminals, including a man pack, a team pack, a jeep terminal, a shelter terminal, and an airborne terminal, for use with tactical communications satellites?

Mr. POOR. I think in a qualitative sense, I can answer that.

The demands placed on the Satellite Communications System by any given ground station depend on two things: One, the amount of information that has to be transmitted from the ground station or received by the ground station through the satellite link; and, two, the size of the antenna that the ground station has.

So, with very large antennas, you can make a very efficient system that puts very little demand on the satellite. As the ground station antenna gets smaller and smaller and lighter and lighter, you have to use more of the satellite power capability to communicate with the system. So, it is logical that there should be a family of different ground stations so as not unnecessarily to overload the communications channel and make reasonably efficient use of the radio frequency energy available.

Mr. SLACK. What is the total estimated cost of developing each of these terminals, as well as the number of production models of each required, and the total estimated procurement cost of each such terminal?

Mr. POOR. I do not have the cost available or really definitive numbers on requirements. However, estimated requirements are something like this: About ——— of the man pack terminals, about ——— of the jeep-sized terminals, about ——— of the 1¼-ton truck, something like ——— of the big 2½-ton truck, and something like ——— of the airborne ones.

You understand the big ones that work on the 2½-ton truck are the kind of thing that can work for a headquarters where there is a great deal of traffic and a relatively big antenna. The man pack is just one or two channels.

Mr. SLACK. You will elaborate for the record.

Mr. POOR. Very well, sir.

(The information follows:)

The five different models of advanced development terminals, shown in the film, are being used to conduct technical feasibility tests and to develop operational procedures. The total development costs, in millions of dollars, of these terminals are:

	Number of terminals	Total cost
Airborne	———	———
Alert receiver	———	———
Teampack	———	———
¼ ton	———	———
1¼ ton	———	———
Total	———	———

In ——— the Army plans to develop engineering models to conduct complete engineering/service tests. The total estimated development costs, in millions of dollars, for these terminals are:

	Number of terminals	Total cost
Manpack	———	———
¼ ton	———	———
1¼ ton	———	———
2½ ton	———	———
Total	———	———

The airborne terminal will be developed by the Air Force.
Total estimated procurement costs, in millions, are as follows:

	Number	Unit cost	Total cost
Airborne	———	———	———
Manpack	———	———	———
¼ ton	———	———	———
1¼ ton	———	———	———
2½ ton	———	———	———

The purpose of each of the five types of production terminals is as follows:
Airborne: To be used in command helicopters.
Manpack: Used by patrols and at platoon level.
One-fourth ton: Used in radio nets at all echelons.
One and one-fourth ton: Used at Brigade Headquarters and above for medium capacity tactical trunking circuits.
Two and one-half ton: This terminal has not been developed yet but would be used at Corps Headquarters and above for tactical trunking circuits at high capacity.

Mr. SLACK. Are there questions? Mr. Minshall?
Mr. MINSHALL. I have no questions, thank you, Mr. Chairman.
Mr. SLACK. Mr. Davis?
Mr. DAVIS. No questions.

SHIPS, SMALL CRAFT, AND RELATED EQUIPMENT

Mr. SLACK. The next item is entitled "Ships, Small Craft, and Related Equipment."

Your fiscal year 1970 program for "Ships, small craft, and related equipment," is $500,000. You were provided $600,000 for this purpose in fiscal year 1969, but the justification book shows a fiscal 1969 program of only $133,000. What happened to the $467,000?

General BETTS. The $600,000 originally approved for this program in fiscal year 1969 included funds to initiate development on a small harbor and inland waterway tug to replace old tugs in the Army

inventory. This program was decreased because the requirements for this new tug were not defined and approved in time to initiate development in fiscal year 1969. The requirement for the tug was just recently approved and initiation of development is programed for fiscal year 1970.

Mr. SLACK. What have you accomplished with the $7.4 million funded for this purpose through fiscal year 1969?

General BETTS. The following are the significant accomplishments in this program through fiscal year 1969: Development of the Lighter, Amphibious, Resupply, Cargo (LARC) family of lighters (LARC–5, LARC–15, and LARC–60); designed, prepared, and maintained technical data package for an improved beach discharge lighter (BDL); studies completed on "marriage" of the BDL with various roll-on, roll-off ships and with the fast deployment logistics (FDL) ship; designs and tests on various shallow-draft boats were completed, and completed studies on hydraulic jet water propulsion system for shallow-draft boats.

Completed studies on unconventional propulsion systems for shallow-draft boats, that is, paddle wheels, stern drives, and special weedless propellers. Completed remote area mobility study and developed marginal terrain-type craft having potential adaptability for use in Southeast Asia. Conducted military potential test on the marsh screw amphibian. Conducted investigation and concept evaluation on plenum air tread amphibian.

Investigated and evaluated various air-boat designs for use in Southeast Asia. Performed preliminary development work on small harbor tug. Prior to fiscal year 1968 all studies, investigations, and exploratory development efforts as well as engineering (hardware) development for marine craft was accomplished under this program element. Exploratory development effort has now been separated from engineering development in this area.

Mr. SLACK. How was the $133,000 utilized during fiscal year 1969?

General BETTS. The fiscal year 1969 money was utilized to maintain the procurement package and improve design features for the BDL pending availability of PEMA funds for procurement. Also, studies were conducted in the area of "marriage" of the BDL with various cargo vessels. Preliminary investigations were begun on a new harbor and inland waterway tug.

Mr. SLACK. How do you propose to use the $500,000 during fiscal year 1970?

General BETTS. The fiscal year 1970 R. & D. effort is primarily directed toward development of a small harbor and inland waterway tug. Tugs in current Army inventory are underpowered and lack the desired degree of maneuverability, and are fast becoming obsolete and uneconomical to maintain. The new tug will provide the Army with an improved craft for performing required port and terminal missions. Also, effort will be directed toward maintaining the procurement package for a beach discharge lighter (BDL) in state of readiness for initiation of procurement. The BDL was designed under Navy contract and will be procured by the Navy when funds are available.

Mr. SLACK. Why can't the Army use small harbor tugs of the Navy, instead of designing new ones?

General BETTS. The Army's tug requirement is for a small tug for operating in congested harbors, or inland waterways and between ports operated by Army transportation terminal units. It must be capable of being transported overseas on decks of and delivered by military and commercial ocean vessels having a heavy lift capability. The tug will be approximately 60 feet in length. The smallest Navy tug that could be considered for Army use is a 115-foot tug. This Navy tug is too large for the operational concepts and restrictive area functions required to support the Army's port, terminal, and inland waterway missions. However, the Army will take advantage of the larger Navy tugs should there be a future Army requirement for such a larger craft.

Mr. SLACK. How does your mission or program for marine craft and amphibious lighters to support logistical operations differ from that of the Navy and Marine Corps?

General BETTS. The Navy and Marine Corps use marine craft and amphibious lighters to sustain initial supply support operations during amphibious assaults. The personnel, cargo and equipment transported during the assault phase are needed specifically to support the landing phase and initial operations ashore. The Army's use of marine craft and amphibious lighters is for transfer of large volume, heavy cargo to support the rapid buildup and sustained operations of land combat forces over an extended period of time and to support other operations within Army ports and terminals. These operations include transfer of supplies and equipment from ocean-going transports anchored off-shore to lighters, followed by movements of this cargo to Army terminals, over-the-shore to inland transfer points and over inland waterways when fixed port facilities are not available or inoperable.

ORDNANCE, COMBAT VEHICLES, AND RELATED EQUIPMENT

Mr. SLACK. The next item is entitled "Ordnance, Combat Vehicles, and Related Equipment."

The fiscal year 1970 estimate for "Ordnance, combat vehicles, and related equipment," totals $193.1 million, an increase of $22.4 million over the fiscal year 1969 program. Generally speaking, in what areas are these increases?

General BETTS. The increases are generally reflected by the requirements for continuation of the development of the main battle tank, advanced development effort for mine warfare, artillery weapons and ammunition, and artillery development for infantry support, wheeled vehicles, tracked and special vehicles.

There have been partially offsetting decreases in effort on the Sheridan, Shillelagh, and Medium Antitank Assault Weapons, Dragon Programs, but those were not enough to completely offset the other increases.

GENERAL PURPOSE FORCES

SHERIDAN WEAPON SYSTEM

Mr. SLACK. Development of the Sheridan weapon system began in September 1959, and it was scheduled to be deployed in early 1964.

What was the original estimated total cost of developing the Sheridan weapon system?

General BETTS. I will have to furnish that, Mr. Chairman. I do not have it with me.

(The information requested follows:)

The original cost of development of the Sheridan vehicle was estimated to be $31.3 million for the vehicle including night vision equipment, $37.1 million for a pro rata share of the Shillelagh development and $2.9 million for a pro rata share of the 152-millimeter ammunition development. The total original estimated development, that can be logically attributed to the vehicle is $71.3 million.

SHERIDAN PROJECT MANAGER

Mr. MINSHALL. Who is in charge of the Sheridan program, General?

General BETTS. The Sheridan program has moved over into the production area. We do have a project manager.

Mr. MINSHALL. Who is the project manager?

General BETTS. The project manager now is Colonel Mathias.

Mr. MINSHALL. Where is he located?

Colonel LAMB. Rock Island, in the Weapons Command.

Mr. MINSHALL. How long has he been project manager?

Colonel LAMB. About 2 years, sir.

Mr. MINSHALL. Who had that job before he took over?

Colonel Lamb. I do not know.

Mr. MINSHALL. Could you find out, please, and find out also where he is located and what his rank is now?

Colonel LAMB. We will supply that information. We do not have that information now.

Mr. SLACK. Supply it for the record, please, General Betts.

(The information follows:)

The former Sheridan project manager was Col. Paul A. Simpson. He is now assigned to MAAG Korea in the same rank, colonel.

CURRENT SHERIDAN DEVELOPMENT COST

Mr. SLACK. What is the current estimated cost of the entire Sheridan weapon system development, including the Shillelagh missile and the 152-millimeter gun subsystem and its ammunition?

Colonel LAMB. We have the exact cost of the Sheridan, and we can add the Shillelagh to it.

The cost of the Sheridan is $34.7 million. The Shillelagh R.D.T. & E. through 1968 was $152.2 million. We have $5.7 million in 1969 and $3.6 million in 1970. $3.4 million of the $3.6 million is for 152-millimeter ammunition.

The total estimated to complete the Shillelagh is $158.1 million from the beginning until it is completed.

Mr. SLACK. Then you would add the $158.1 million to the $34.7 million to get the answer to the question, is that correct?

Colonel LAMB. That is correct.

Mr. SLACK. What about the ammunition? Does that include the ammunition?

Colonel LAMB. We have some additional for ammunition.

Mr. MINSHALL. Let me get something straight before you go further. The figures you just gave us total approximately $190.3 million, Was that for research and development only?

Colonel LAMB. That is research and development.

Mr. MINSHALL. For the Shillelagh missile system?

Colonel LAMB. The Sheridan.

General BETTS. The Sheridan vehicle and the Shillelagh. We are adding two programs.

Mr. POOR. And test and evaluation.

Colonel LAMB. For ammunition, we expect the maximum additional cost to be ——— million to get a satisfactory round.

Mr. SLACK. Then the total would be approximately $200 million?

Colonel LAMB. That is about right, sir.

MODIFICATION OF SHERIDAN

Mr. SLACK. There are no R.D.T. & E. funds requested in fiscal year 1970 for the Sheridan weapon system. Yet there are many problems to be solved with the Sheridan itself, the Shillelagh missile system, and the conventional consumable ammunition. Where are the funds to complete these developments?

General BETTS. We mentioned the funding for further improvements of the ammunition. The modifications to the Sheridan would be handled in the PEMA account, the procurement account.

Mr. SLACK. What do they amount to?

General BETTS. In the PEMA account you will find $5.5 million for modification to the Sheridan, but we do not see any indication of fiscal year 1970 money.

There is no money allocated in the fiscal year 1970 PEMA account for modification of the Sheridan vehicle. All modifications were accomplished with fiscal year 1968 and fiscal year 1969 money. This includes those modifications recommended as a result of the Vietnam evaluation.

General TAYLOR. We will have to vertify if that is available for 1970.

(Off the record.)

ARMY TANK MODERNIZATION PROGRAM

Mr. SLACK. Will you tell the committee how the Sheridan was proposed to fit into the Army's tank modernization program established in August 1959?

General BETTS. You recall that in that time frame there was considerable emphasis on lightening our equipment for airborne operations. We had not then advanced as far as we have today in airmobile operations that depended for its air mobility largely on the helicopter. That is why part of the generic name of the Sheridan is the use of the two words, airborne assault.

It is also a scout vehicle in that it has a cavalry reconnaissance role. But some of the design constraints were related to the requirement that it be airdroppable for the airborne assault role.

Mr. SLACK. Then can you tell us what the original requirement for the Sheridan was, and has this requirement been changed in any way since 1959?

Mr. POOR. That goes pretty far back in history. I think the concept of the vehicle has not changed in any important respect since 1959. At that time the idea was to build a lightweight vehicle, not a tank, which was suitable for reconnaissance and assault purposes. I think that concept has been held right through.

As far as detailed numbers on military requirements statements, I suspect that has been changed. I do not have that information.

General BETTS. The important capability we were looking for was to have a vehicle that was airdroppable or would be airdroppable, to go along with the airborne assault unit, and have an effective antitank capability.

ARMORED RECONNAISSANCE SCOUT VEHICLE

Mr. SLACK. You referred a moment ago to the scout vehicle. I note one page 28 of the justifications that for the armored reconnaissance scout vehicle there is an estimated appropriation of ——— million for fiscal 1970.

General BETTS. That is correct. We see that as complementary to the Sheridan. Remember, "Airborne Assault" was the name given to this vehicle along with armored reconnaissance. That is the full title.

The point is that we wanted something more than just an armored scout vehicle. We wanted something that had assault firepower and antitank capability. That dictated the need for something as big as 152 millimeter for the gun, as well as the Shillelagh missile for the long-range, tank-killing capability.

The Armored Reconnaissance Scout Vehicle that we now talk about as a new requirement is a smaller and lighter vehicle, the role for which would be solely a scout role, and it would not presume to carry anything like the 152-millimeter gun that we have on the Sheridan.

Mr. SLACK. What weapon will be on this vehicle?

General BETTS. It has not been finally determined, but it probably will be the Vehicle Rapid-fire Weapons System that is to be developed in the next year or two.

HOUSE ARMED SERVICES COMMITTEE STUDY OF ARMY TANK PROGRAM

Mr. SLACK. A House Armed Services Committee investigating subcommittee conducted a review of the Army tank program. At this point, I would like to insert in the record the findings and conclusions in this report, dated July 9, 1969.

(The information follows:)

FINDINGS AND CONCLUSIONS

1. In 1959, the Army's principal rationale for a new antitank weapon system incorporating a guided missile capability was an alleged "quantitative and possible qualitative superiority" of the armored units deployed by the Communist bloc countries. The preponderance of evidence assembled by the subcommittee, however, raises serious doubts as to the immediacy of any threat which would justify the development of the Sheridan/Shillelagh system on a "crash" basis.

2. Since 1959 the M60A1 main battle tank has been the mainstay of the Army armored units in Europe and the Army currently considers this tank equal to or superior to Soviet-designed tanks.

3. Had an adequate rate of production of the M60A1 been maintained, the Army would have had an even less "urgent requirement" to justify the production of the inadequately-tested Sheridan/Shillelagh system.

4. Not only did the Army fail to maintain an adequate production rate of M60A1's during the 1960's, but they slowed down the production line and even closed it in 1967 to produce the M60A1E2, which still cannot be deployed because of deficiencies.

5. U.S. armored capability was further degraded by the sale of M60A1's to countries other than NATO allies between fiscal year 1964 and fiscal year 1969.

6. In its rush to develop the Sheridan and M60A1E2 tanks equipped with the Shillelagh guided missile, the Army ordered mass production of these weapons and their related equipment before there was adequate assurance that the designs were suitable, and, in some cases, even before the production or fund requests had been officially approved. The fear of a loss of program funds appears to have been the principal reason why the Army's top management level approved this mass production against the advice of qualified user and testing agencies and personnel who had persistently attempted to convey the true facts of their sadly lagging development efforts.

7. Misleading reports and unwarranted overconfidence of Army developers also influenced these decisions to produce these various articles.

8. Despite continuing development failures, production decisions on almost every one of the items covered by this report were made so that an appearance of satisfactory program progress would lessen the chance for searching and critical reviews by "those who control funds" in the Office of the Secretary of Defense and the Bureau of the Budget.

9. When the Army requested funds to procure additional missile trainers, Congress was informed that the trainers were satisfactory and were "in the hands of the troops right now." In actual fact, at that very point in time the trainers had proved entirely unsatisfactory and were about to be returned to the contractor for a major redesign effort.

10. Every major item discussed in this report was mass produced and then later, millions of dollars had to be spent to reconfigure and modify the equipment in order to achieve, even partially, the design goals.

11. Despite inherent design defects in the Sheridan weapon system, the Army hurriedly modified a small number of Sheridans and released the vehicles to Vietnam in early 1969 to demonstrate the Sheridan's value as a weapon as soon as possible. This release was made on a conditional basis because known safety hazards and performance limitations had not been eliminated. Upon arrival of the Sheridan in Vietnam, crew and maintenance personnel were hurriedly trained in the combat theater, spare parts shortages became severe, and maintenance facilities were limited. Actually the subcommittee found no urgent requirement to justify this expedient action and no need to involve the troops in Vietnam with the problem of solving continuing development failures on the Sheridan.

12. Ten years of effort and some $1.2 billion have now been committed to the Sheridan/Shillelagh effort. Yet there is no convincing evidence that the system represents enough of an improvement in combat capability over existing weapons (used in a proper mix, or appropriately modified) to justify any such expenditures of time and money.

13. Not one Sheridan as originally designed and produced was suitable for combat use without extensive and costly retrofits. A few, so modified, were sent to Vietnam for test purposes under combat conditions, but hundreds of defective Sheridans remain in storage.

14. Although caseless 152-mm. ammunition is being supplied to Vietnam, it is still unsatisfactory and has impaired the Sheridan's effectiveness. Misfires, broken rounds, and other serious defects, have produced situations in which casualties have occurred which, to some degree, have shaken the crew's confidence in the weapon. Vietnam commanders are urgently requesting a more satisfactory main gun round, but apparently there is none to be had now or in the near future.

15. The facts as developed by this subcommittee make almost unavoidable the conclusion that so much time and money had been spent in developing the Sheridan/Shillelagh system that the developers felt irrevocably committed to production. Under such circumstances the project manager became more of a captive than a manager of his project, and might understandably feel that a failure of the project to reach fruition could be interpreted as demonstrating his own lack of managerial skills and thus affect his Army career. Such a condition must inevitably result in management of doubtful quality and questionable management concepts.

DEVELOPMENT OF COMBUSTIBLE CARTRIDGE CASE

Mr. SLACK. According to the report, the Army initiated exploratory development of a combustible cartridge case 20 years ago. How much has the Army spent in the development of combustible or consumable cartridge case ammunition through 1969, and how much is in the Army budget for fiscal year 1970 for this purpose?

General BETTS. I do not have with me the information that goes all the way back to the beginning of that development effort.

Mr. SLACK. Will you please supply that for the record at this point?

General BETTS. I will supply it for the record.

(The information follows:)

Through fiscal year 1969, the Army has spent approximately $20.6 million in the development of combustible cartridge cases. An additional ——— million is requested in fiscal year 1970 for continued development of 152 millimeter ammunition employing this type of case.

Mr. SLACK. How much is in the Army budget in fiscal year 1970 for this purpose?

General BETTS. ——— million of the fiscal year 1970 budget is planned to complete the improvement of the ammunition to a satisfactory level.

I might add, that represents development of this particular approach to the combustible cartridge to satisfy this requirement. We do have additional supporting effort in effect that will go on to look for improvements that can capture the advantages of this general approach to ammunition and negate its disadvantages. That total program is expected to go on for roughly another 5 years. Presently we are estimating ——— million spread over that period.

Mr. SLACK. Will the above costs include money spent on open and closed breech scavenger systems, the nylon and neoprene bags for the ammunition, and testing?

General BETTS. I believe costs for that kind of modification are in the Pema budget. It is not identified in the R.D.T. & E.

Mr. SLACK. Will you include those costs at this point?

General BETTS. I will confirm that for the record.

(The information follows:)

The ——— million of R.D.T. & E. funds requested for fiscal year 1970 will all be expended on improvement of the 152-millimeter low-pressure cartridges, except for ——— which will support improvements to the nylon and neoprene bags. None of this money will be expended in further development of the scavenger system, development of which is now considered complete. No Pema funds are to be used in support of development work in this area.

Pema costs for the following product improvements were:

(1) Open breech scavenger	$90,000
(2) Closed breech scavenger	655,000
(3) Nylon protective bag	30,000
(4) Neoprene cover	225,000
Total	1,000,000

Testing of these components was done concurrently with ammunition testing and no additional test funds can be identified.

(Clerk's note: The foregoing costs do not include the significant Pema funds involved in engineering change proposals to incorporate first the open breech and then the closed breech bore scavenger systems on Sheridan vehicles; the costs involved in renegotiating the Sheridan

contract; or the costs involved in retrofitting the closed breech system to those Sheridans having the open breech system.)

IMPROVEMENTS IN COMBUSTIBLE CARTRIDGE CASE

Mr. SLACK. Reportedly, in May 1967 the Army initiated a program to develop a second generation combustible case, predicting it would be available for production in 24 to 30 months. What is the status and cost of this development effort?

General BETTS. That backup effort is the full ——— million that I mentioned. The status is that the program is looking several different ways to solve the difficulties that we have seen.

We are now in the very early stages of design concept and test.

Mr. MINSHALL. I do not understand that, General. You started this backup some 2 years ago, stating it would be ready in 25 to 30 months, and now you say it is in the very early stages of development. What have you been doing for over 2 years?

General BETTS. We have been trying different approaches to try to get a handle on which one of them would be the best. It takes time and ammunition firings to work out these approaches. We are just not ready to settle on any one of the three and say this is the way we ought to go.

Mr. MINSHALL. When do you think you will be ready to settle on any one of these projected systems?

General BETTS. I am not prepared to make an estimate.

Mr. MINSHALL. Who are some of your backup experts? Do they know?

General BETTS. We sent Colonel Heistand out to check on the costs. Colonel Lamb?

Colonel LAMB. We have really two programs going on the 152-millimeter ammunition case for the Sheridan weapon system. The first one is a product improvement of our present combustible case. It will continue to be a combustible case. It is a program to increase the density of this case so it will not be as susceptible to a casual flame such as a cigarette or something of this nature. It will also be less likely to absorb moisture. It will still burn. However, it has considerable improvement over the present round.

It will also be less frangible. In the same program the method of fastening it to the projectile will eliminate part of the problems that you have read about, that we have had some separation of the case from the projectile when the Sheridan hit a mine. This may not completely solve the problem as far as running over a large mine is concerned, but it will eliminate the problem of any separation from normal handling and riding in the vehicle. That is a product improvement of the present combustible case.

SECOND GENERATION COMBUSTIBLE CARTRIDGE CASE

In the second generation case that we are referring to, we are looking at 3 approaches. We have yet to demonstrate complete feasibility of any one of the three. This would be a case that in some manner followed the projectile out the bore. It would not be combustible. It would be consumable or disposable. As you fired the round, the case would

follow it to some point downrange, either frangible, breaking up into a powder, or deforming and just going out and harmlessly falling aside some distance downrange.

Those programs are still in the early stages, and we do not and cannot make an estimate at this time whether any one of the three will be successful or exactly when.

Mr. MINSHALL. Who made the prediction, though, in May 1967, that to develop a second generation weapon system combustible cartridge case would take 24 to 30 months? Who made that prediction?

Colonel LAMB. I will have to supply that for the record.

Mr. MINSHALL. Somebody in your shop must have done it.

Mr. POOR. There must be an attribution in the material quoted.

Mr. MINSHALL. I am asking the question. I want to know who made the prediction.

Mr. POOR. I did not ——

Mr. MINSHALL. Will you find out who did?

Mr. POOR (continuing). And I have been associated with this program for some time.

Mr. MINSHALL. How long have you been associated with it?

Mr. POOR. Peripherally, about 4 years, something like that.

Mr. MINSHALL. You must have been aware of the prediction that was made.

Mr. POOR. I am not. I am sorry. That is why I asked. The backup effort is, as Colonel Lamb has said, a multipronged thing. I have been following in particular the second generation case approaches, having reviews in my office on roughly 3 to 6 months' intervals. I was unaware of a prediction that that effort could have been completed in 2 years from May 1967. I am startled that such a prediction was made.

Colonel LAMB. Sir, as far as I know—and I came into the program in midsummer of 1967, after the May date you used—the first indication that I knew that we were really considering or looking at the feasibility of a second generation case is, as Mr. Poor says, later in the fall of that year. There was a backup perforated metal case under consideration about the time that you referenced in your question. This perforated case would be similar to the case used in a recoilless rifle. It would not provide the full protection that you would get from a solid metal case round. It would have worked toward the fragility problem.

That was abandoned at a later time. That could have been here in about 2 years, but I do not know the basis of an estimate that the second generation consumable case could have been available in 2 years.

Mr. POOR. If it be that part of the program, I believe I very fully and energetically supported the cancellation of that effort. It would not result in a good solution. The perforated metal case is inadequate protection against ignition and results in a considerable penalty in weight in the ammunition system.

Mr. MINSHALL. Mr. Poor, have you had a opportunity of examining the House Armed Services Committee report entitled, "Review of the Army's Tank Program"?

Mr. POOR. I have had an opportunity of just glancing at it. I have not had an opportunity to examine it.

Mr. MINSHALL. If there is something wrong with this statement on page 20 of that report, let us find out. I will read it to you.

"In May 1967 the Army initiated a program to develop a 'second generation' combustible case. The objective of this program was to develop a case which improved characteristics in the areas of rough handling, performance in adverse environments, susceptibility to accidental ignition, and elimination of residue, while at the same time retaining the advantages of the first generation case. The Army optimistically predicted that the second generation ammunition would be available for production in 24 to 30 months, but delivery is still uncertain today"—as you have just demonstrated.

Mr. POOR. I do not know who "the Army" is in the sentence. I think it entirely possible that people involved in the program would have predicted 24 to 30 months' development time—in my opinion, that was a terribly optimistic prediction—as a reasonable goal to impose, in the hope that you will be able to get the work done energetically.

In fact, it is quite possible that I might personally have set a goal as close in as that, but not a prediction.

Mr. MINSHALL. Why would you set a goal that close in if you knew you were not able to accomplish it?

Mr. POOR. In any of these development programs, there is always the possibility that one of the things you try will work out quite well.

I can be specific in this case. In a much smaller caliber, a plastic case adequately fireproof and quite strong had been demonstrated by one of the west coast contractors. I am not quite sure of my dates on this, but it was during this time frame. It would follow out the muzzle and be deformed into small pieces and provide adequate protection and leave no residue. That was done in about a 20-millimeter size, I think, by a west coast contractor.

Mr. MINSHALL. That is all well and good, Mr. Secretary——

Mr. POOR. The hope was that it could be simply scaled up to this larger diameter system. However, there are enough differences in the design of the breech mechanism and the details of the gun so that the first attempt to do this, which might have been successful, proved to be unsuccessful. Therefore, there is a great deal more work to be done to establish whether or not that system would work.

Had it worked the first time, we might have been sooner than 2 years to a producible case. It is simply an unknown.

OPTIMISM OF MILITARY IN PRESENTING PROGRAMS

Mr. MINSHALL. What concerns me is that it is not just this program but so many programs, whether it be in the Army or whether it be in the Navy or the Air Force. They have come up time and time again with overly optimistic estimates of the capability of a new weapons system and the cost of it and the time frame, all of which later have proved to be wrong. I am getting a little gun shy, very honestly, about a lot of these programs.

If you come up with a lot of optimistic promises just to get a program funded, we will have to take another look at the entire system.

Mr. POOR. I certainly would agree that there has been a great deal of optimism over the years. In a sense, I hope there still will be. I think this program, we would all agree, is of sufficient importance

that an energetic approach to alternative ways of getting the properties that were hoped for with the combustible case and, in fact, have been demonstrated with the combustible case, without its disadvantages, is worthwhile.

While we cannot say when it will be done, I think and hope you will agree that it is the kind of thing that certainly should be done.

SECOND GENERATION COMBUSTIBLE CARTRIDGE CASE

Mr. MINSHALL. The point is that you are not much closer to a solution in July 1969 than you were in May of 1967.

Mr. POOR. I do not think that is really true, because we have eliminated a number of what appeared on the face of them to be moderately promising approaches. We have shown they are not good ones. We have narrowed down and are concentrating on a few that seem more promising.

Mr. MINSHALL. Would you make a prediction today as to when you are going to come up with the final answer to this problem?

Mr. POOR. I think that would be grossly imprudent. I hope we will come up with a final answer in perhaps a year, perhaps sooner. It may take much longer.

Mr. MINSHALL. That covers the waterfront.

Mr. POOR. Yes. The point is that if we do not know, the best thing to say is that we do not know. We have competent people working hard on it.

Mr. MINSHALL. You do not know the time frame any more than you did 2 years ago.

General BETTS. I think the important thing is the comment Mr. Poor made, that we have eliminated fairly firmly one approach, the perforated case, that did look promising then. We have since done enough testing of it that we do not consider it promising.

In working in the areas of unknowns, it is inherently difficult to predict. There is an old saying in this R. & D. business that one must never try to put a time frame on invention. That is what we are faced with. We try to give you, as we try to give our own superiors, the best estimate we know how to make at the time we are called on to make it, but in these new programs it is a very difficult problem to be precise about something that is full of unknowns.

Mr. MINSHALL. How long would you recommend that this committee continue funding this development program?

General BETTS. I think it important that we continue to fund a strong program in advanced research.

Mr. MINSHALL. This is supposed to be an ongoing program though.

General BETTS. This is correct. Because of our own feelings about the urgency of need of the Sheridan-Shillelagh system, we made a risk judgment early in the program that we would go ahead with what amounts to three major efforts: ammunition, Shillelagh missile, and Sheridan vehicle.

The ammunition has lagged the other two elements of this total weapons system in its success. Nevertheless, ammunition that is now available is doing a satisfactory job and one that is acceptable to the user with the things that we have done to make it acceptable—putting

a nylon protection around it so that its vulnerability situation in the tank is comparable to the brass cartridge case, and also putting the closed breech scavenger system on the thing so we get away from any possible residue problem.

In the meantime, it is important to go ahead with advanced development activity looking at backup approaches that will end up providing a better ammunition capability.

It is not all negative, Mr. Minshall. There are at least nine men living today who we are virtually certain are alive because they had combustible cartridge ammunition and not brass cartridge, because under certain circumstances——

Mr. MINSHALL. How many have lost their lives because of this?

General BETTS. I do not think we can identify one. There is one possible because of a mine accident that split the hull of the vehicle. There was an ensuing fire. It is very likely that he would have lost his life, whatever ammunition was in the vehicle.

I am saying that there are circumstances under which this ammunition will burn, whereas brass cartridge ammunition explodes. It is well known when the enemy hits you in the ammunition, you have had it.

Yet, we have at least as many instances as I indicated where there is at least some reasonable evidence that those men lived because the ammunition burned and did not explode.

BACKUP EFFORT TO DEVELOP METAL CARTRIDGE CASE

Mr. MINSHALL. I do not want to belabor this question any more this morning, but in October of 1967 the Army initiated a program to develop a metal cartridge case for the 152-millimeter ammunition. General Betts, a year later you discontinued this effort. Why was this done, especially after 18 fruitless years on the development of a combustible case?

General BETTS. At the time in October 1967, we were beginning to be really discouraged about solving the problems of the combustible cartridge, and we began this particular metal case backup.

By 6 or 8 months later, we were convinced that we had provided a satisfactory combustible cartridge and, therefore, did not consider that the metal case backup we had started was worth pursuing further. We considered that it was more important to look for longer range solutions, such as those described by Colonel Lamb.

Mr. MINSHALL. How long do you think we should go around the barn on this combustible case?

General BETTS. I think we should pursue the program that Colonel Lamb described.

Mr. MINSHALL. For how long?

General BETTS. I think the point is that the combustible cartridge is in inventory, it is in these vehicles, and it is working well. We do see improvements that can be made through advanced development efforts. I think we should continue those advanced developments for some years, the kind of 5-year program I talked about, to see if there are significantly better ways to go about this kind of ammunition.

Mr. MINSHALL. Thank you, Mr. Chairman.

SHERIDAN PURCHASED BEFORE TOTAL SYSTEM DEVELOPMENT COMPLETED

Mr. SLACK. General Betts, the Sheridan weapon system was type classified standard A on May 21, 1966, which did not include the ammunition nor the gunner's periscope, both essential to the Sheridan weapon system, but unsatisfactory and not completely developed and tested. Why was this done?

General BETTS. The Sheridan vehicle and the Shillelagh missile, as subsystems of this total weapons system, were both in limited production at the time frame of this decision you discussed. There are certain fairly routine administrative procedures that naturally follow from putting the label type classified standard A on any program.

It was the considered judgment of the staff that those two subsystems were ready to be type classified standard A, and it was appropriate so to classify them.

The fact that the ammunition was not ready for a similar classification was well understood, and it was accepted that in the remote event we could not work out the problem of the combustible cartridge ammunition, the Sheridan vehicle with the Shillelagh as antitank capability represented a considerable tactical capability. We were confident in our own minds that we could, through the mechanisms we have used—the closed breech scavenger system—and by providing protection to the ammunition, solve the problem of providing an adequate ammunition capability to the system in the time frame that we felt was reasonable to project from the point of that decision.

SHERIDAN PURCHASED BEFORE TESTING COMPLETED

Mr. SLACK. Would you tell the committee how the Army can justify the award of a 4-year multiyear contract to General Motors for production of the Sheridan in April 1965 when it was not type classified standard A until May 1966, which was more than a year later?

General BETTS. We have authority within the Army to use the designation "limited production" to take account of situations where we feel it is prudent to put a system into production, even though all of the testing has not occurred or there may be other reasons why we are not prepared to call it standard A.

In this case, we had another effort that was ready for production, the M–109, and it was our judgment that the Government would get a better program from the economic standpoint if we combined the two competitions, the M–109 and the Sheridan, so we could better distribute the overhead of the tank plant in which we expected to have both of these systems produced.

You will recall that at that time the Sheridan vehicle had undergone extensive testing, and even though there were modifications to it that we saw necessary as a result of that testing, it was our technical judgment that those modifications could be made in the course of advanced production engineering and we put on the vehicles that would come off the production line under the limited production authority. We felt that it was prudent to put the two programs together to save cost to the taxpayer.

SHERIDAN MODIFICATIONS COST EXCEED CONTRACT TERMINATION COST

Mr. SLACK. General Betts, according to a recent GAO report, the awarding of that contract resulted in the following, and I quote:

In spite of the problems being experienced with the ammunition, the Army continued full-scale production of the Sheridan until December 1967, when the third year buy (fiscal 1968) was reduced from ——— to ——— units. As of mid-September 1968 the Army had produced about ——— Sheridans, of which ——— were stored in depots and at the production site.

General BETTS. That is right.

Mr. MURPHY. Why didn't the Army discontinue the production until these problems were worked out?

General BETTS. Because of the cost of discontinuation. We would have spent a great deal more money to have stopped that production line and start it up again later than it cost us to store the vehicles, a great deal more. Furthermore, we are now ready with relatively simple effort involved in the modifications that come out of this testing program to turn out those vehicles in a combat-ready shape at the rate of about ——— per month for just the cost of the modification. If we had turned off that production line, gotten rid of the skills that were developed, I believe that the May 1966 estimate was that it would have cost us $3,500,000 to have terminated at that point. The storage costs have been nothing like that.

Mr. MURPHY. The modification costs for fiscal 1968 and 1969 totaled $10.1 million.

General BETTS. I am not sure that those modification costs wouldn't still have been required later in the program as we learned things from the testing that required modification.

OPEN BREECH SCAVENGER SYSTEM PRODUCED BEFORE TESTING COMPLETED

Mr. SLACK. After producing several hundred Sheridans in February 1967 the Army introduced the open breech scavenger into those on the production line before testing had verified that the open breech scavenger created more safety hazards than it eliminated and was completely unsatisfactory. In about April 1967 the Army initiated development of a closed breech scavenger system while Sheridans continued to be produced with the ineffective and dangerous open breech scavenger system. What is your explanation for this complete waste of taxpayers' money in this manner?

General BETTS. Since I had no direct connection with the production program at that time that related to that decision, I will have to supply that for the record, Mr. Chairman. I don't know.

(The information follows:)

In 1967 at the time that the open breech scavenger system was committed to production, the test agency (TECOM) had issued a safety release based on temporate zone testing. Subsequently, tropic tests uncovered the inadequacy of the scavenger in removing residue. Although the other functions were satisfactory, the Army desired to develop a closed breech scavenger for full resolution of the residue scavenging. By the time the inadequacies of the open breech scavenger system were discovered and conversion decisions made, the funds for open breech scavengers had been committed and no savings were available. Further, the open breech system was an acceptable interim solution for the temperate climates.

NEEDS TO STRENGTHEN PROJECT MANAGER SYSTEM

Mr. MINSHALL. That is why I am interested in finding out who is the project manager on a lot of these programs, because not only in the Army but in the Navy and the Air Force they get on a job and after 3 years, "You have to have a new assignment." Now, in my opinion, you ought to have a look at this whole system. Until a program is developed I don't know why they have to have new project managers.

General BETTS. We are in the process of a major management review, and one element of that review is a look at the whole project manager system and what we can do to strengthen it.

Mr. MINSHALL. It certainly needs strengthening, and quickly.

General BETTS. I will have to get some numbers on that one. I was not directly involved in that.

Mr. MINSHALL. If that man happened to be in the civilian community they would "can" him right away. I think the same should go for a man in the service. If he doesn't do a good job, he will know it is going to be his neck.

General BETTS. I understand that in the course of routine production of the automobiles which you and I drive there are thousands of modifications made in the production line of each car every year. The engineers are just not completely smart enough to do everything right the first time. You know, we try the best we can to do the best we can but it is a very difficult and complex business.

Mr. MINSHALL. That is all very true, but they are usually minor modifications that they are able to correct right now. That is not so with the service. Those are major modifications that they are not able to accomplish.

General BETTS. There are instances like that.

Mr. MINSHALL. I know there are.

DELAY IN STOPPING PRODUCTION OF OPEN-BREECH SCAVENGER

Mr. SLACK. Why did the Army take from April 1967 until October 1967 to stop the installation of the ineffective and dangerous open-breech scavenger system in the Sheridans on the production line?

General BETTS. That is still the same general question that was in the PEMA area. I had no direct connection with that. I will have to research it for you and give you an answer for the record. I do not know.

(The information follows:)

Although the inadequacy of the open-breech scavenger system became apparent in April 1967, the extent of the inadequacy and our inability to adjust the system to fulfill the scavenging function was not conclusively established until just prior to the combat vehicle program review in October 1967. The decision to cease production and insert a closed-breech scavenging system was made at the combat vehicle program review.

COST OF STORING AND MODIFYING SHERIDANS

Mr. SLACK. Can you tell the committee how many hundred Sheridans were produced and stored at the contractor's plant, and at the Anniston and Letterkenny Arsenals, until the ammunition deficiencies could be overcome and a suitable scavenger system developed?

General BETTS. I think you read it in the report just a minute ago. The GAO report is correct.

Mr. SLACK. Were those figures correct, insofar as you know?

General BETTS. Yes.

Mr. SLACK. What was the cost of storing Sheridans and modifying those produced with the open-breech scavenger system?

General BETTS. I will have to research that cost of storing. I do not know. The modification numbers were those that were read out of the PEMA budget in 1968 and 1969.

Mr. SLACK. We want the cost of storing and also the modifications.

General BETTS. I will fill in the record at this point and give all of those figures.

(The information follows:)

The funds for modification are the fiscal year 1968 and fiscal year 1969 funds of $11.1 million PEMA. The funds expended for Sheridan storage as of the end of fiscal year 1969 total $102,210.

SHILLELAGH MISSILE SYSTEM

Mr. SLACK. The Shillelagh, a line-of-sight weapon, reportedly is degraded by trees, smoke, heavy rain, blowing sand, hills, darkness, and other conditions which might obstruct the gunner's vision of the target. What other deficiencies does this missile system have which could not be discussed in the House Armed Services Committee's report?

General BETTS. I don't consider the items that you mentioned as deficiencies. There are conditions of visibility obstruction that will always give difficulty to a tank gunner, whether he is firing a missile or a gun. At the long ranges where we would expect to use the Shillelagh missile instead of the gun, given the option to use either, the range is the important capability and it is a range that will not be available to the gun in anything like the same first hit probability, under any circumstances. So one must look at it from the standpoint of what we gain from that system. Now, it is possible that an enemy is very clever and knows the system in detail and has the right kind of equipment, countermeasure equipment, very closely within the line of sight of the missile so that he can jam the system. But he has to have all of these things going for him at the same time. It is our judgement from a tactical point of view that this is not a significant deficiency in the system. Nevertheless, we are doing work to make the modification further down the line that would remove even that possibility.

Mr. POOR. I have been reading this report. I would like to comment on the view of the Shillelagh missile system that seems to be reflected in the report.

The Shillelagh missile system is, in my very considered opinion, a great advance in antitank warfare. It is performing under test very nearly as expected when the design was initiated many years ago. At that time it was predicted that against stationary targets at all ranges beyond about ——— meters the Shillelagh system would outperform any known tank gun, outperform in the sense that in a duel between two tanks, one equipped with a gun, one equipped with a Shillelagh, that the Shillelagh would get a killing hit on the enemy

tank before the enemy tank gunner could do that to the Shillelagh. Now, that is a function of range. At very short ranges guns outperform missiles. At very long ranges this missile spectacularly outperforms guns. Recent tests have done nothing but confirm those properties.

I read in the report on page 26:

The Sheridan hit record.

On some specific tests, I assume

was far less than anticipated and could hardly be pointed to with pride or used to support an argument that the cost of the Sheridan was a justifiable and worthwhile expenditure.

The most recent tests I have seen do indeed support the spectacular improvement in combat effectivenes that comes from the Shillelagh missile system. I would like the committee to understand that we feel the Sheridan-Shillelagh guided-missile system, is indeed a major development of which we are indeed very proud. Now, in any of these things, complicated systems, deficiencies will be uncovered, and they have been. In those same recent tests it was determined that there was a ———.

The tests confirm the performance in every important respect and they had the benefit of showing this ———.

So I think it is important that all of us realize that the Shillelagh system can do, is doing the job it was intended to do.

Mr. SLACK. The Shillelagh missile system has a reliability design goal of 95 percent. What is the current reliability of the Shillelagh missile system?

General BETTS. Colonel Hiestand.

Colonel HIESTAND. At the present time the Shillelagh missile is firing at a hardware reliability of approximately ——— percent.

Mr. SLACK. Is it true that the Shillelagh missile cannot be fired from a moving vehicle nor can it be effectively deployed in darkness or under conditions of limited visibility without directing searchlights onto the target?

General BETTS. That is essentially true; yes.

Mr. POOR. May I comment on that? At the time the Shillelagh system was developed for installation on the Sheridan a deliberate choice was made not to provide the vehicle with a stabilization system that would permit firing on the move. In the design studies for the new main battle tank and in the experiments on the sighting system for that tank we have established that it is possible, using recent state of the art in stabilization systems, to build a stabilization system that could be applied to other vehicles, that would permit firing the Shillelagh on the move. Whether that is desirable depends on the cost effectiveness ratio. The cost will clearly be very high. It takes very good gyro stabilization to do the trick. We have developed such stabilization systems in the demonstration of the TOW system on the UH–1 helicopter and one that works sufficiently well, I think, for tank installation also in the AH–56 TOW installation project.

The decision not to put it in was an economic decision coupled with the fact that we did not know how to make stabilization systems that good that long ago.

General BETTS. Also, Mr. Chairman, we might add that the likely ranges of engagement under night conditions, the gun is a better mechanism anyhow under those conditions. The gun is available, the night vision capability is available.

SHERIDAN 152-MILLIMETER GUN RECOIL

Mr. MINSHALL. With respect to the gun, I have heard reports that crews have been instructed to brace themselves whenever they fire it. It sometimes displaces the tank up to 3 feet. Is this tank overgunned, considering its light weight? What is the problem?

General BETTS. I think the best way to answer that question, and a question that is undoubtedly in the minds of all of the members of the committee, would be to ask Colonel Ireland who is with us today and has been in command of a unit in Vietnam until a very recent time.

Mr. MINSHALL. Stand up and speak out, Colonel. That statement that I just made; is that a correct statement?

Colonel IRELAND. Yes, sir; essentially, that is correct. This system does have a reasonable recoil to it. Any tank, when it is fired though, of course, does have a good deal of recoil.

Mr. MINSHALL. You said reasonable or unreasonable?

Colonel IRELAND. Reasonable, sir. I have fired this system myself on a number of occasions. It is true that you should, in fact, brace yourself. This is nothing unusual, though, in firing a tank gun.

Mr. MINSHALL. Is it normal for a tank to jump around 3 or 4 feet every time you shoot the gun?

ADDITIONAL ARMOR ADDED TO BELLY OF SHERIDAN

Colonel IRELAND. I suspect those figures were based on the vehicles tested here in the United States. The Sheridans that I had in my squadron in Vietnam had come to us equipped with a ——— belly plate of armor in the front portion of the vehicle. This was designed, of course, to decrease the mine hazard. However, a corelated advantage of this was that it put a good deal of the weight forward on the vehicle and, as a result, in Vietnam we did not get the tremendous jumping around that you described.

Mr. MINSHALL. How much jumping around did you get with this?

Colonel IRELAND. Very little, sir. The vehicle was not noticeably displaced to the rear. It rocked, but rocked back forward again into its original position.

Mr. MINSHALL. How much weight did you put on the tank by installing this plate?

Colonel IRELAND. I don't know the exact weight of that belly armor.

General BETTS. About 1,600 pounds.

Colonel IRELAND. Yes. I think that is about right.

Mr. MINSHALL. In other words, you get away from a lightweight tank configuration when you put this 1,600 pounds on it?

General BETTS. It is still a pretty light weight vehicle to begin with.

Mr. MINSHALL. Why didn't you put this on to begin with?

General BETTS. It was something we learned about as we got closer and closer to the problem and more and more experience in Vietnam with mine warfare.

With 20–20 hindsight we can say we should have. But remember, originally we were pressing toward an airdrop-airborne assault capability. There were design judgments made that kept this vehicle light. In the Vietnam environment that has not been the mode of use. So the extra 1,600 pounds has not been a problem.

SHERIDAN LOSSES IN VIETNAM

Mr. MINSHALL. Colonel, how many of these tanks do you have in Vietnam?

Colonel IRELAND. I had 27 in my squadron, sir.

Mr. MINSHALL. How many over there all together, if you know?

Colonel IRELAND. To my knowledge, sir, there were 60; 27 in my squadron, the 1st Squadron of the 11th Calvary.

Mr. MINSHALL. How many of those 60 have been lost because of combat?

Colonel IRELAND. I believe this is covered thoroughly in the final report from the Army concept team in Vietnam. In my squadron, at the time I left we had lost one. I do not know of any subsequent losses in my squadron.

Mr. MINSHALL. How about the other 33-odd tanks?

Colonel IRELAND. There were 27 in the 3d Squadron, 4th Cavalry of the 25th Division.

Mr. MINSHALL. You don't know how many of those were lost?

Colonel IRELAND. Not specifically, sir. Again, these figures are covered in the active final report.

Mr. MINSHALL. Where is that final report?

Colonel IRELAND. I believe it is available. It may even be in the room.

Mr. MINSHALL. Do you have it, General?

General BETTS. We are looking at it now, sir. It is about 10, but we will have to correct that number, that were damaged enough to be pulled out of combat. Most of these were fixed up.

SHERIDAN MAINTAINABILITY RECORD

Mr. RHODES. How did you find the maintenance of the Sheridan in combat, Colonel? What percentage, if you remember, of the 27 vehicles assigned to your squadron did you usually have in commission?

Colonel IRELAND. Let me answer it this way: When the vehicle was issued to my squadron I was told that an 85-percent availability was desirable. This meant to me that I could not have four or more of these vehicles down at any one time. During the time that I commanded this squadron after the vehicles were issued, which was about 2-plus months, I don't believe we ever dropped below that level. In other words, of the 27 that I had, you might find two or three, but I don't recall an instance in which we had more than four down. In actual fact, to perhaps further clarify, the Sheridan is an easily maintainable vehicle. Mechanically it is extremely sound and we were delighted with it.

SHERIDAN MOBILITY

Mr. RHODES. What about the mobility of the vehicle? Did you find it suitable for the type of action which it was intended for in Vietnam?

Colonel IRELAND. Absolutely, sir. The vehicle that the Sheridan replaced in my squadron was the M-113 personnel carrier which we called an armored cavalry assault vehicle or ACAV, because it was modified to add some additional machineguns. The M-113 is probably familiar to you. It has excellent mobility characteristics in that type of terrain. The Sheridan, I believe, will go any place an M-113 will go, and probably will go in places where an M-113 will not.

Mr. RHODES. I take it you were quite well satisfied with the performance of the vehicle in combat.

Colonel IRELAND. I was extremely well satisfied, sir. I was delighted with the vehicle.

SUGGESTED IMPROVEMENTS TO SHERIDAN

Mr. MINSHALL. What are your chief complaints about the Sheridan tanks that you had in Vietnam, if any?

Colonel IRELAND. No major complaints.

Mr. MINSHALL. What improvements would you suggest?

Colonel IRELAND. Many of the ones, in fact all of the ones, that are covered in this report to which I referred, the ACTIV report, of course, were made by me and members of my squadron and members of the other squadron as well. These were reasonably minor things. For example, there is on the rear of the vehicle—and I can point this out to you on this model in front of Mr. Poor.

Mr. MINSHALL. Yes; but use as many words as you can because we cannot put a picture of that in here.

Colonel IRELAND. Yes, sir. On the rear of the vehicle there is a rack which we call a bustle rack. This is used for storage of additional equipment, equipment belonging to the personnel, possibly even ammunition. This bustle rack we found to be inadequate. That is, as to size and generally as to the shape of the thing. It is made of tubular metal and the spaces between the metal supports were too long. That is, if you put something in without an additional item in there it might well fall through.

To correct this, a sort of fishnet had been placed in the bottom of this to prevent items from falling through. However, we discovered that this was inadequate and would very likely be torn off. We simply modified it. We added on to it, made a larger bustle rack and covered up some of the spaces between the angle iron.

The other modifications were modifications which we suggested for ease of maintenance, particularly in that terrain and particularly during the wet season when there is very, very little hardstand and very little level ground in Vietnam on which you can perform your maintenance. Usually in the wet season you are performing maintenance in lots of mud. These were simple items that we had requested be placed on the vehicle as modifications. Other than that, I don't think of anything.

Mr. MINSHALL. Aside from the little niceties, were there any major objections to this vehicle?

Colonel IRELAND. I had none, sir.

Mr. MINSHALL. You had none. Did anybody else have some?

Colonel IRELAND. No, sir. No one in my squadron that I know of had any objections to the vehicle that were of major significance.

Mr. MINSHALL. What was your experience with the scavenger on the gun?

NO PROBLEMS EXPERIENCED WITH AMMUNITION OR GUN

Colonel IRELAND. We had no difficulties at all with it. I understand this combustible case ammunition has been quite a problem. However, we did not have any problem with it.

Mr. RHODES. Colonel, during the time that you were in command of this squadron were you in engagements most of the time? Were you in bivouac? What type of 21½ months' tour did you have?

Colonel IRELAND. We were out fighting the VC's, sir.

Mr. RHODES. All the time?

Colonel IRELAND. Yes, sir.

Mr. RHODES. Firing how many rounds of ammunition per vehicle per day?

Colonel IRELAND. If I had known my assignment was going to be Washington, sir, I think I would have kept a little black book on these figures. I suspect, however, that this ACTIV report to which I keep referring is very complete in this respect. I think it tells in there the number of rounds that were fired by the two squadrons and perhaps even breaks it down. I do know that in one 6-hour engagement that we had on the 23d of February in the vicinity of Long Binh, we pretty well fired up the basic load of the Sheridan vehicle. We were carrying ——— rounds at the time. There were approximately 18 Sheridans involved.

Mr. MINSHALL. Did you have any loading problems; any firing problems?

Colonel IRELAND. None whatsoever, sir.

Mr. MINSHALL. How was the accuracy of the gun?

Colonel IRELAND. Terrific, sir. You understand, we were firing at reasonably short ranges.

Mr. MINSHALL. At what ranges?

Colonel IRELAND. Usually not to exceed 200 to 300 meters, very often much closer than this, in which case we used the round that was applicable to the situation.

Mr. MINSHALL. What kind of targets?

Colonel IRELAND. They varied, sir. We had two types of ammunition available to us on the Sheridan in Vietnam. One was called a high explosive antitank multipurpose round. This heat round we used to get at people that were in bunkers, in trench lines, things of this sort. It was used in an antipersonnel and antimateriel role the standpoint that you could demolish a bunker with one. The other type round we had is called a cannister round. This is very much like a shotgun round inasmuch as when you fire it, ——— of these ——— flechettes are fired out the muzzle in a shotgun-like pattern. This round we found to be extremely useful. We used this round more than we did the heat round simply because of the circumstances. This is purely an antipersonnel round. When we used this it meant we were shooting at people. We found this to be terribly effective and an absolutely devastating round.

General BEITS. The active report says slightly under 2,000 rounds were fired among all the 60 vehicles in 3 months.

Mr. MINSHALL. Colonel, you spoke of 2½ months' tour as a commander of this squadron.

Colonel IRELAND. In actual fact, I commanded the squadron for a longer period of time.

Mr. MINSHALL. How long were you in combat?

Colonel IRELAND. For the entire time, my entire tour in Vietnam.

Mr. MINSHALL. What was that?

Colonel IRELAND. Slightly over 10 months.

Mr. MINSHALL. You were in command of this tank squadron?

Colonel IRELAND. No, sir. I took command of the squadron in late November of last year.

Mr. MINSHALL. How long were you in command of the tank squadron?

Colonel IRELAND. Five months.

Mr. MINSHALL. During that period you were in almost daily combat?

Colonel IRELAND. Yes, sir.

Mr. SLACK. How many days of actual combat engagements did the 27 vehicles have?

General BETTS. 520 combat missions were involved in the evaluation.

Colonel IRELAND. We received the Sheridan in my squadron at the end of January and I left the squadron in mid-April.

Mr. MINSHALL. You were in M–113 tanks, were you, before that time?

Colonel IRELAND. We had in the reconnaissance platoon, sir, only M–113 personnel carriers. We traded in two of these and received three Sheridans.

Mr. MINSHALL. Thank you, Colonel.

RELIABILITY DEFICIENCY WITH M–44E1 NIGHT VISION SIGHT

Mr. SLACK. What are the deficiencies with the M–44E1 night vision sight?

General BETTS. There is a reliability deficiency. It functions adequately to meet its design requirements but it has reliability problems in the vibration environment. It is my understanding that this has been corrected.

Colonel Hiestand?

Colonel HIESTAND. Sir, there are two types of deficiencies with respect to the night sight and associated night firing fire control searchlight. The 44E1—I have it.

General BETTS. The difficulty is that the reports that we do have did not specify specific items and say this part of the periscope design is no good and has to be changed.

Mr. SLACK. If you don't have the answer right at hand then you can supply it for the record. Do you have it there now?

Colonel HIESTAND. Yes, sir, I do. General Betts is correct that there is no specific internal component or module or other piece of the M–44E1 night sight that was identified as the specific cause of the trouble. There were random failures throughout the sight.

The particular problem was identified because the night sight, once it went down, required a great maintenance effort to repair. The repair procedure was to replace the sight and then try to fix it in the rear.

As the sights went down we ran out of replacement sights. That became the problem. But that problem of supply has been cleared up. Additional maintenance for those items is being forwarded to the theater and the quality control which was the general identification of the problems associated with the sight, have been improved in considerable extent with the new ones going over.

REJECTION OF SHERIDAN BY THE AUSTRALIAN ARMY

Mr. SLACK. In March of 1969 the Australian Government, after subjecting the Sheridan to tropic tests, rejected the Sheridan because it did not meet Australian Army requirements. Why was the Sheridan rejected by the Australian Government?

General BETTS. I don't know the answer to that. Colonel Hiestand?

Colonel HIESTAND. The report was although the vehicle and the weapon system were satisfactory, it was too expensive for the usefulness and purposes which they had in mind. They preferred a weapon system which was less expensive to perform the tasks they identified.

Mr. POOR. I wonder if with respect to the discussion of the night sight I might read a report of action which I think shows the utility of the night sight in Vietnam. I will put the whole thing in the record.

(The information follows:)

On March 1, 1969, A Troop, 3/4 Cav, was employed in an ambush patrol night defense position just south of GO DA HA in the 25th Division area of operations. The troop was in a wagon wheel perimeter, had put out listening posts (LP's), erected barbed wire and RPG screens, plotted artillery concentrations, and dug positions near each armored vehicle. At 2300 hours, the LP's detected enemy movement and reported this to the troop commander, who immediately put his unit on full alert and withdrew the LP's. At 2315 hours, a Sheridan crew using the XM44 periscope observed nine enemy approaching their position at a distance of 150 meters. They received permission to fire and with one canister round killed all nine personnel. The troop then executed all its defense fires. The fight lasted sporadically for the next 3 hours before the enemy withdrew. A sweep of the terrain at first light revealed 40 enemy killed and secured one prisoner. The troop had only one man slightly wounded. The 25th Division Commanding General stated that this particularly successful mission was one of the finest examples of a small unit night engagement ever conducted in his division. The Sheridan played a significant role during this action.

PROBLEM WITH NEOPRENE BAGS CORRECTED

Mr. POOR. We get lots of reports like this. The troops like this thing. They are very glad to have it.

Mr. SLACK. During Army tropic tests in 1968 the neoprene bags for the combustible case ammunition were found to become tacky when hot and stuck together and tore when handled. When cold, the bags were unpliable and had to be cut from the case. What are you doing to correct this situation?

General BETTS. The point of that kind of testing is to determine just what we did discover. We made appropriate corrections to the material that we are using. We have no problem with that now in Vietnam.

SHERIDAN EVALUATED IN EUROPE

Mr. SLACK. The Sheridan was developed primarily for use in Europe. In May 1968 the test center reported that in view of the

deficiencies noted during arctic tests and the temperature limitations of the Shillelagh missile, the Sheridan was not suitable for use under arctic winter conditions. Does this mean that the Sheridan weapon system is unsuitable for use in Europe which has severe winters?

General BETTS. We have just completed an evaluation in Europe and, fortuitously, we have a message from General Polk which just came to us. He says simply that the conclusion he reaches as a result of his exhaustive evaluation is that the M–551 Sheridan is a ———. That is the prudent course of action.

He said in summary his evaluation disclosed a highly mobile, responsive basic vehicle and a very accurate long-range missile system. These constitute major tactical improvements. On the other hand, there are still features which require correction. Following the deployment of the M–551 to the division cavalry squadrons this headquarters will gain much practical experience in the areas of support, training, tactics, and general techniques. Careful, deliberate approach to full-scale deployment taking full advantage of this experience is considered mandatory.

So he says, on balance, that he ———.

PROBLEMS EXPERIENCED WITH SEARCHLIGHT

Mr. SLACK. While the Sheridan was being tested in Vietnam under combat conditions, reportedly a manufacturer's representative was continuously required at the site to see what could be done to make the untested, unproven searchlight operable. Why were the searchlights on the Sheridan unreliable and what were the specific problems?

Colonel HIESTAND. Sir, the searchlights that went to Vietnam were early production models, and, as a result, they fell heir to a number of deficiencies that occur in all early models.

Second, the searchlights were subject to traveling through jungle and other environments which, in fact, beat them up to a far greater extent than anyone had expected, and therefore required additional guarding to insure that they would not be torn and beaten by the jungle as they passed through. So we have taken action to improve the guarding of the searchlights so that they can resist the jungle and, secondly, proper production items are now being sent over there to replace the early production item.

The new items are far more reliable than those that were originally there.

REASON FOR SHERIDAN DEPLOYMENT TO VIETNAM

Mr. SLACK. The report further indicated that despite the Army's original requirements in Europe, the Sheridan was deployed to Vietnam where there was no significant armored threat and where it is being used primarily as an antipersonnel weapon, whereas this capability was already available in Vietnam in both the M48A3 tank and the M113 personnel carrier. According to the report:

The subcommittee examined requirements, searched records, and questioned witnesses to determine why this deployment was made. There was no evidence of an urgent demand from Vietnam.

What was the urgent requirement to deploy the Sheridan to Vietnam?

General BETTS. As far back as 1966 the records that I have in personal notes of a meeting with the vice chief of staff and major elements of the Army staff, it was stated to the vice chief that there was then a requirement for a ——— of these vehicles in Vietnam to explore their combat effectiveness in that environment. The staff has searched the records for an action paper from Vietnam that supports the notes I had from that meeting and we were unable to find it. Nevertheless, I am sure that those on the General Staff who were there at that meeting I cite had the feeling that there was considerable urgency in getting this capability to Vietnam. Now, with respect to the application of the vehicle for a solely antipersonnel role, I believe Colonel Ireland's comments would apply in terms of the ability to break up bunkers, in terms of the very considerable increased antipersonnel capability available from that flechette round. But I might ask him to expand on that answer, if he will.

Colonel IRELAND. Sir, the integration of the M–551, the Sheridan vehicle, into my platoons, for example—and I would like to make this sort of a two-part answer, if I may—first of all, as I previously explained, the Sheridan replaced the M–113 personnel carrier in my platoons. I lost two of these and received three Sheridans for them. This immediately gave me a tremendous increase in fire power. Previously the largest caliber weapon that I had had at my disposal in a platoon was a 50-caliber machinegun. This machinegun is not capable of getting to the man in the bunker, the man in the trench line, or the man standing behind the heavy rubber tree.

As a result, the addition of the 152-millimeter gun gave me the capability of getting to this man and killing him.

It also increased night fighting capabilities inasmuch as prior to this time the only night sighting devices I had were starlight scopes which have relatively limited range when compared to the night sighting capabilities on the M–551.

Additionally, in increased mobility, not so much in my squadron but certainly in the squadron in the 25th Division, third squadron of the Fourth Cavalary. They, instead of replacing the M–113, had originally a slightly different organization which they were using three M–48 tanks in the platoon. These M–48's were replaced by the M–551.

Now, it is true that the M–48 because it weighs a great deal more will break down jungle more satisfactorily than the Sheridan, no one will deny that. It is also true that because the M–48 weighs a great deal more it is more likely to be able to withstand mine damage or at least withstand it in a better fashion than a lighter vehicle. But at the same time in the rainy season in Vietnam, which lasts for approximately 6 months out of the year, the M–48 cannot get off the road. If that squadron did not have M–551's today they would be sitting in ——— without the use of their M–48 tanks. There is no question in any of our minds, who have served in Vietnam, that the Sheridan vehicle, the addition of it to our squadrons was a distinct advantage.

Mr. MINSHALL. In November, 1968, a member of the staff of the Sheridan project manager recommended against deploying the Sheri-

dan to Vietnam, stating "I do not believe that a combat situation where mission and lives depend so heavily on equipment reliability is the test environment to question and resolve these problems." Do you agree or disagree with that theory, General Betts?

General BETTS. I disagree. And I did at the time.

SHERIDAN GUIDANCE DOCUMENT LAGGED VEHICLE DEPLOYMENT

Mr. MINSHALL. The Army sent ——— Sheridans to Vietnam in January of 1969; however, an Army document entitled "Guidance for Units With M-551 Armored Reconnaissance/Airborne Assault Vehicle (General Sheridan)" for Sheridan crew members was not published until March 17, 1969, almost 2 months after the deployment. This document contained only the safety aspects of the Army Test and Evaluation Command release, but not the performance limitations for troop information and guidance which was also a condition of the release by the Army Test and Evaluation Command.

What is the explanation for this situation?

General BETTS. The explanation is that when sending out new equipment of this sort we send out a new equipment testing team. That team has all of the documentation necessary to do an adequate job of training the new operators, in depth. It is true that the formal documentation to accompany the vehicle lagged the vehicle. Yet, in informal documentation that went along with the new equipment training team, all of the information was available that they needed to do an adequate job of training.

I might ask Colonel Ireland if he felt that he was denied adequate information when he was first issued these vehicles.

Colonel IRELAND. The answer to that is, certainly not, sir; we were not denied information. The new equipment training team that came to my squadron consisted of—it varied somewhat between seven and nine individuals. These were officers and enlisted personnel who had previously worked with the Sheridan during the test phase and also some of the enlisted personnel, I understand, were from Fort Riley where there is a troop unit equipped with these vehicles. In addition to this, there were technical representatives, manufacturers' representatives, people who were involved in actually building the engine or the turret components, or whatever. They were there to tell us all there was to know. These were the experts in the field. I think your question is probably related primarily to the safety aspects. There are, of course, particularly with combustible ammunition, safety aspects which should be well known to the soldiers that are going to use the equipment. I can assure you that they knew everything there was to know, and they were always aware that there was a safety problem with this.

I might also add, because I think it might be of interest, in the entire time that we had the Sheridans in Vietnam I never had a man injured because of the safety aspect which had either not been told to him or that he had ignored, particularly as it relates to the combustible ammunition. There simply were no accidents.

Mr. MINSHALL. Colonel, before you sit down, the last part of my question stated "but not the performance limitations for the troop information and guidance which was also a condition of the release

by the Army Test and Evaluation Command." You have spoken to the safety aspects; how about the performance limitations?

Colonel IRELAND. Sir, the only thing that I can say to this is that during our training period we continually had instructor personnel riding on the vehicle, pointing out various possibilities of what might happen. I don't recall specific performance limitations. I don't quite understand this terminology as to how this would affect the individual in the crew.

General BETTS. I might add before the subcommittee of the House Armed Services Committee the Army testified to the fact that all of the information that came out of the Testing and Evaluation Command testing effort, the limitations that were placed on the vehicles, was made available to the new equipment training team and through them in their training program to the units that received these vehicles.

NEWS REPORTS ON SHERIDAN DEFICIENCIES

Mr. MINSHALL. General and Colonel, while we have you here, there have been numerous stories in the news media, public, press, about the failures of the Sheridan tank. Several of the faults were as follows: Overheated engines, jammed cannon, periscope failures, structural weaknesses, and recoil mechanism breakdown. Would you care to comment on that from the field point of view?

Colonel IRELAND. Sir, we had a situation develop which is called hang out of battery, in which the gun in recoil comes out of battery, so to speak, and does not go back into its original position. This was determined to be a seal which had been faultily manufactured. This, I understand, has now been corrected. It was simply a matter of the shape of the seal. It was an incorrect shape. This has been replaced with a proper one. This corrected these deficiencies.

I recognized prior to my departure that there was an overheating problem with these vehicles as there will be with many vehicles traveling in that type of terrain. Overheating is a function in that terrain at least of extreme ambient temperatures and, in addition to this, passing through the jungle very often you have leaves, branches, things falling down and blocking air intakes. This is a matter of sweeping them away. I believe this is addressed in the ACTIV report and I understand also that steps are being taken to make a simple modification to prevent this from happening.

Mr. MINSHALL. What do you mean by ambient temperatures?

Colonel IRELAND. The outside temperature of the air, sir. It, of course, runs 90° and over on an average day in Vietnam almost all year round. Plus when you get into the jungle where you are fairly closely confined, these temperatures can go up even higher.

SHERIDAN TESTED IN THAILAND PRIOR TO VIETNAM DEPLOYMENT

Mr. SLACK. The subcommittee report also pointed out that the Sheridan was tested in Vietnam during extremely dry weather and trafficability was at its best, but it has yet to prove its value in a rainy environment where critical deficiencies such as the humidity absorbing ammunition and electrical power failures are recognized as potential serious limitations. Does the Army still plan to deploy additional Sheridans to Vietnam?

General BETTS. We do plan to deploy additional vehicles to Vietnam, but I might point out that long before we deployed any vehicles to Vietnam there was an extensive mobility test in Thailand that exposed the Sheridan vehicle to heavy going and typical, very wet tropical weather, and it proved to be an outstanding performer under those conditions. Colonel, did you have any experience with wet weather at all?

Colonel IRELAND. None whatsoever.

General BETTS. Colonel Lamb.

Colonel LAMB. Wet weather, rain itself is not a real danger to the ammunition and the ammunition picking up moisture. It is more likely to pick up moisture when you have high humidity, warm temperatures. Every night I spent in the jungle I found the humidity to approach 100 and the temperature, where you get no outside air, is also up around 100. I can't imagine the humidity being much different from that in the rainy season. I suspect it might be low and it might even be less as far as the ammunition is concerned.

Mr. MINSHALL. When you are operating out in the sun what is the situation? Can you button up without roasting to death?

Colonel IRELAND. There is no denying that it is hot in Vietnam, uncomfortable everywhere you are. The same is true of an M-48, however, or an antipersonnel carrier when you are required to button up.

Mr. MINSHALL. What does the inside temperature get to?

Colonel IRELAND. I have no way of telling you, although I know it gets darned hot. I would not begin to tell you it is not uncomfortable in these vehicles.

Mr. MINSHALL. You don't need any sauna baths over there?

Colonel IRELAND. No, none whatsoever.

General BETTS. The shipment to Vietnam was in response to MACV's specific request that we equip all the armored squadrons in that theater with the Sheridan vehicle.

DEFICIENCIES NOTED DURING SHERIDAN TESTING IN VIETNAM

Mr. SLACK. According to the subcommittee report, the 3-month test in Vietnam disclosed (a) the Sheridan was vulnerable to mines and had the side applique already developed for use on the Sheridan been installed the death of a crewman on the first mine incident may have been avoided; (b) a total of 41 conventional ammunition misfires were recorded during combat and the report from Vietnam recommended that priority engineering effort be given to the production of a lesser vulnerable, stronger, and more reliable second generation 152-millimeter round which has been so often repeated since 1967; (c) 25 engines had to be replaced because the overheating had resulted in loss of power, and in 10 of those instances Sheridan's had to be withdrawn from combat due to this deficiency; (d) there were 125 recorded turret electrical power failures; (e) there were failures in the gun's recoil system, fragile grenade tubes were damaged in combat, sprocket wheels were worn out at an unusually high rate and searchlights and periscopes were highly unreliable; and (f) the closed breach scavenger system did not work satisfactorily and one vehicle had never had an operative scavenger but it was ordered to extended combat twice.

General Betts, will you place in the record at this point a copy of

the final overall report prepared as a result of the testing of the Sheridan in Vietnam under combat conditions, together with all recommendations and comments contained therein?

(The information follows:)

DEPARTMENT OF THE ARMY, ARMY CONCEPT TEAM IN VIETNAM

FINAL REPORT M551 SHERIDAN (U)—ACTIV PROJECT NO. ACC-2/601—MAY 10, 1969

AUTHORITY

Message, 24844, COMUSMACV, August 24, 1968. Subject: MACV Staff Study Sheridan Weapons in Vietnam (U), Confidential.

ACKNOWLEDGEMENTS

Deep appreciation is expressed to the officers and men of the 1st squadron, 11th Armored Cavalry Regiment and the 3d squadron, 4th Cavalry, 25th Infantry Division whose professionalism, spirit, and cooperation were fundamental to the conduct of this evaluation. The Army Concept Team in Vietnam is also indebted to the following for their invaluable help in the evaluation:

U.S. Army, Vietnam, 725th Maintenance Battalion, 25th Infantry Division, 185th Ordnance Battalion.

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Lt. Col. Robert J. Washer, armor.

EVALUATORS

Maj. Richard T. Rushton, Armor; Maj. Alan R. Zarch, Armor; Capt. Tim L. Minnich, Armor; Capt. Robert L. Wantland, Armor; Capt. Philip H. Kimerer, ordnance.

ABSTRACT

The purpose of this evaluation was to analyze the tactical employment of the M-551 Armored Reconnaissance Airborne Assault Vehicle (AR/AAV) Sheridan and to determine its suitability in the combat environment of the Republic of Vietnam. The M-551 was designed to replace the M-41, M-48, and M-60 tanks currently employed in armored cavalry platoons, and the M-56 airborne assault weapon. In Vietnam, the Sheridan was also to replace those armored cavalry assault vehicles (ACAV) which were substituted for tanks by earlier modified table of organization and equipment (MTOE) action. The Sheridan is a key part, along with the ACAV-mounted rifle squad and armored personnel carrier (APC) mounted mortar, of the combined arms team in each cavalry platoon.

The evaluation was conducted from February 8, to May 8, 1969 in the 1st Squadron, 11th Armored Cavalry Regiment and the 3d Squadron, 4th Cavalry, 25th Infantry Division.

The M-551 was employed in nine types of missions which included reconnaissance in force, night defensive perimeter/ambush patrol, and road clearing. The vehicles accumulated 39,455 miles, 16,930 hours of operation, and accomplished 520 combat missions.

The conclusions of the evaluations were as follows:

1. The M-551 is an effective and suitable vehicle for use in armored cavalry platoons in Vietnam.

2. Sixteen problem areas and 25 shortcomings requiring modification detract from the effectiveness of the M-551.

3. The M-551 can be maintained and supported to sustain an 85-percent operationally ready rate.

It was recommended that:

1. Department of the Army make CONUS application of those modifications indicated as essential before deploying additional vehicles to Vietnam.

2. Department of the Army deploy sufficient M-551's to equip all cavalry squadrons in Vietnam.

3. The U.S. Army Materiel Command take necessary action to correct identified problem areas.

SECTION I

INTRODUCTION

1. References

(*a*) Message, 24844, COMUSMACV, August 24, 1968, subject: MACV staff study Sheridan weapons in Vietnam (U), confidential.

(*b*) Disposition form, AVHOG-OC, U.S. Army, Vietnam, G3, August 27, 1968, subject: M-551 Sheridan.

(*c*) Disposition form, AVIB-GCD, Army concept team in Vietnam, September 2, 1968, subject: M-551 Sheridan.

2. Purpose

The purpose of this evaluation was to analyze the tactical employment of the M-551 Sheridan and to determine its suitability in the combat environment of the Republic of Vietnam (RVN).

3. Objectives

(*a*) Objective 1.—To determine the effectiveness and stability of the M-551 in armored cavalry platoons.

(*b*) Objective 2.—To determine the vulnerability of the M-551 to mine and rocket damage.

(*c*) Objective 3.—To analyze the maintenance and logistical support for the M-551 Sheridan.

4. Background

(*a*) There has been a long-existing requirement in armored cavalry squadrons for an amphibious vehicle with effective long-range armor-defeating firepower. The M-551 Sheridan was designed to meet these requirements and to replace the M-41, M-48, and M-60 tanks currently employed in armored cavalry platoons, and the M-56 airborne assault weapon. In RVN it was also to replace the M-113A1 armored personnel carrier (APC) with .50 caliber machinegun cupola (locally termed the ACAV) which was issued in lieu of tanks by earlier modified table of organization and equipment (MTOE) action. The Sheridan is to be a key part, along with the ACAV-mounted rifle squad and APC-mounted mortar, of the combined arms team in each cavalry platoon.

(*b*) On August 22, 1968, the commander, U.S. Military Assistance Command, Vietnam (COMUSMACV) approved the requirements, configuration, and distribution of M-551 weapon systems in RVN and tasked the U.S. Army, Vietnam (USARV) to submit an outline evaluation plan for the first 60 vehicles. On August 27, 1968, the Army concept team in Vietnam (ACTIV) was tasked by USARV to conduct this evaluation.

5. Scope

The limited number of Sheridan vehicles (60) precluded full evaluation in all environmental conditions and operational situations that may be encountered in RVN. The evaluation of the Sheridan did not interfere with the assigned missions of the cavalry squadrons in which the vehicle was evaluated. The vehicle was used under combat conditions at the discretion of commanders in a variety of missions. All vehicles were equipped solely with the conventional 152-millimeter gun system; the Shillelagh missile system was not evaluated. Acknowledged limitations of the evaluation were that the sample was not representative of all combat environments in RVN and that the weather during the evaluation was dry.

6. Description of equipment

(*a*) General.—The Sheridan possesses greater firepower, mobility, maneuverability, radius of operation, and versatility than the M-41, M-48, or the M-56. It is light weight—less than 17 tons—and is air transportable and air dropable. In the RVN environment, the Sheridan was equipped with added belly armor, ballistic protection for the commander, and a Xenon searchlight.

It has an inherent swimming capability using a flexible barrier of neoprene-coated nylon which is stowed in a trough along the top edge of the vehicle.

(*b*) *Chassis.*—The power package consists of a water-cooled, turbocharged, 300-horsepower diesel engine, and a newly developed cross-drive, torque converter transmission. An aluminum engine block provides a weight-to-power ratio of 3.6 pounds per horsepower. In the suspension system, a single pin track is used which also serves as a means of propulsion in water. This chassis system provides a low ground pressure of 6.8 pounds per square inch, an operating range

in excess of 350 miles, a maximum speed of 43 miles per hour, and a water speed of 3.6 miles per hour.

(*c*) *Armament.*—The M–81 152-millimeter gun launcher can fire either conventional ammunition or the Shillelagh missile. The gun tube, which has a 600-round life, is rifled to provide spin for the conventional ammunition. There is a groove the entire length of the tube for orientation and stabilization of the missile. The gun launcher employs a lightweight separable breech which is electrically actuated and semiautomatic. In the RVN environment, two types of ammunition were available for the gun—XM–625 canister and XM–409 HEAT–MP. The turret armament system also includes the cupola-mounted M–2 .50-caliber machinegun and the coaxially mounted M–737.62-millimeter machinegun. A grenade launcher system is used primarily to provide a protective smoke screen for the vehicle. It consists of an internally mounted firing panel and eight externally mounted launchers. Each launcher contains one special purpose canister consisting of a standard M–8 white phosphorous grenade and an M–34 smoke grenade.

7. Approach

To satisfy the purpose of the evaluation, three categories of operational variables were investigated. They were mission, environment, and vehicle capabilities Each of these variables was characterized by several performance factors as shown below. The measurement of these factors constituted the data collection phase.

(*a*) *Mission.*—(1) Limitation and type. (2) Reliability and maintainability (vehicle and weapons system). (3) Vehicle availability. (4) Casualties (friendly and enemy). (5) Number of enemy engagements, mine and RPG incidents. (6) Weapon system effectiveness. (7) Tactics employed.

(*b*) *Environment.*—(1) Enemy threat. (2) Weather. (3) Terrain. (4) Support facilities. (5) Initiation time and mission duration. (6) Parent organization for mission.

(*c*) *Vehicle capabilities.*—(1) Materiel (hardware, components, subsystems). (2) Vehicle performance (range, speed, mobility). (3) Personnel (training, experience). (4) Operability (handling, firing, sighting).

8. Environment

The Sheridans were assigned to the 1st Squadron, 11th Armored Cavalry Regiment (ACR) and to the 3d Squadron, 4th Cavalry, 25th Infantry Division. The 11th ACR and 25th Infantry Division areas of operation were in the Mekong Terrace in the northern III Corps Tactical Zone (CTZ). Figure I–1 indicates the areas in which the two squadrons operated during the evaluation. Surface conditions varied from hard packed laterite with little or no plant cover to soft earth with full triple-canopy jungle. For the most part, the terrain was composed of relatively flat dry rice paddies with 1- to 3-foot dikes or scrub brush and rolling hills with moderate to heavy plant cover. Several operations were conducted in rubber plantations and villages. Weather during the evaluation was extremely dry with a few days of intermittent rain. Temperatures ranged from 97° during the day to 75° at night.

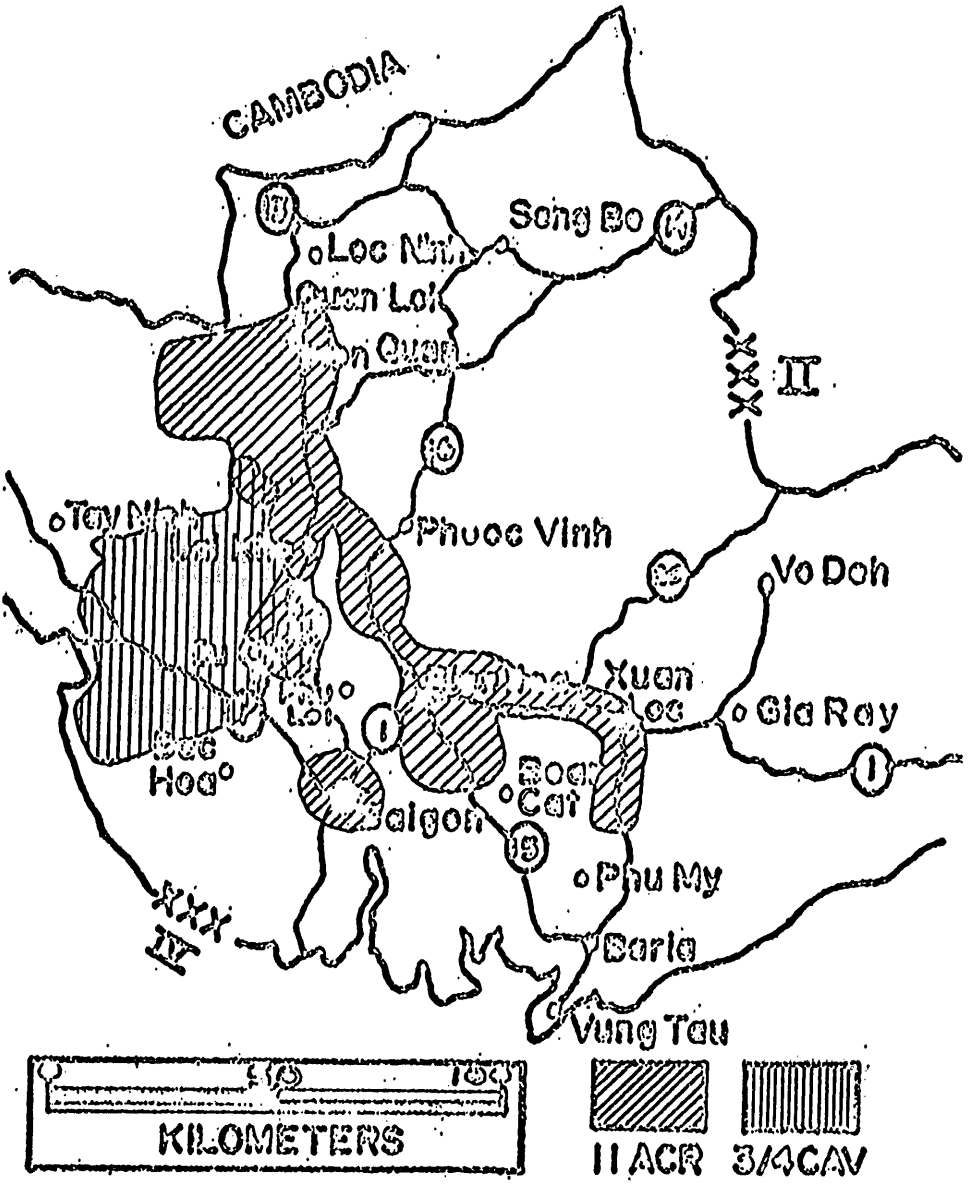

FIGURE I-1. Operational Areas of the 1st Squadron, 11th Armored Cavalry Regiment, and the 3d Squadron, 4th Cavalry.

9. Data collection and analysis

The evaluation team consisted of five officers. Two were attached to each squadron and one collected maintenance and supply information from supporting units and organizational maintenance personnel. Data was collected by interviews, questionnaires, and reviews of unit records and after-action reports. Day-by-day observation of unit operations was made. A listing of data collection forms, data objectives, and collection time schedules is shown in annex B. The evaluation began on February 8, 1969, and ended on May 8, 1969.

SECTION II

OBJECTIVE 1.—TO DETERMINE THE EFFECTIVENESS AND SUITABILITY OF THE M–551 IN ARMORED CAVALRY PLATOONS

This section discusses the combat capabilities, suitability, and effectiveness of the M–551 in the various missions performed in RVN. Problem areas identified during the evaluation are highlighted with appropriate modifications recommended when possible. Training is discussed as it affected combat operations. Finally, the subjective opinions of the officers and men of the two squadrons were analyzed and their assessment provided.

10. Missions

(*a*) Armored cavalry squadrons in RVN are used extensively in roles usually assigned to tank and infantry battalions rather than restricted to the traditional reconnaissance, security, and economy-of-force roles. This method of employment was evolved because of the nature of the enemy and the concept of stability operations. There are no well-defined battlefields in the traditional sense. The enemy avoids contact by moving in small groups and massing only for short-term offensive actions. Consequently, the mission of U.S. forces is to find and destroy the enemy wherever he may be. The armored cavalry squadrons have proved responsive to this concept because of their balanced combined arms structure and inherent capability for quick response and extended independent action. The M–551, with its extensive firepower, mobility, range, maneuverability, and combat power, makes the armored cavalry squadron a well-balanced maneuver battalion.

(*b*) Nine types of missions were performed during the evaluation: reconnaissance in force (RIF), ambush patrol/night defensive position (AP/NDP), road clearing, screen, area reconnaissance, movement to contact, rapid reaction force, security, and cordon and search.

11. Techniques of employment

Of the nine types of missions performed, the RIF, AP/NDP, and road clearing predominated. These missions have also made maximum use of the capabilities of the M–551. For this reason these mission types are analyzed in detail, their characteristics discussed, and limitations associated with Sheridan employment outlined.

(*a*) Reconnaissance in force:

(1) The RIF was the most common mission performed in RVN. In these missions the mobility, firepower, range, and maneuverability of the M–551 were best exploited. Corresponding to zone reconnaissance in conventional armored cavalry doctrine, the RIF allowed the platoon to operate independently over large areas. However, the similarity in doctrine did not apply to the techniques of employment in RVN. Because of difficult terrain (jungle, rubber trees, rice paddies) and the lack of sophisticated enemy weapons systems, techniques of employment were simple and relied on massed firepower. In these operations emphasis was placed on making contact with the enemy.

(2) The characteristics of RIF operations in RVN were:

(a) Reconnaissance by fire.

(b) Continuous movement throughout an area, employing column or line formation.

(c) Maximum firepower applied frontally, using line formation.

(d) Minimum use of fire and movement.

(e) Maximum use of canister rounds for close-in fires.

(f) High suppressive subcaliber firing to minimize RPG attack.

(g) Maximum use of supporting artillery attack helicopters and tactical air strikes against fortified positions.

(h) Sheridans leading the attack through jungle.
(i) After contact, slow methodical closure using maximum suppressive fire.

(3) The M–551 has experienced certain limitations when performing in RIF operations. These have detracted from the vehicles's effectiveness. The limitations were as follows:

(a) Limited fields of fire in jungle terrain thus reducing weapons capabilities.
(b) Limited visibility in jungle terrain especially when the crews were in their assigned positions.
(c) Vulnerability to close range RPG attack in jungle or rubber tree terrain.

(*b*) Ambush patrol/night defensive position:

(1) AP/NDP was the second most common mission for M–551-equipped troops. This type of mission took advantage of the excellent night fighting capability of the Sheridan.

(2) The characteristics of this mission were:

(*a*) Establishment of all-around security.
(*b*) Selection of good fields of fire a minimum of 100 yards from tree lines.
(*c*) Maximum use of night vision devices (XM–44 periscope and starlight scope).
(*d*) Maximum use of IR light before contact.
(*e*) Employment of white light if desired.
(*f*) Use of dismounted listening posts well forward of positions.
(*g*) Installation of RPG screens in front of each armored vehicle.
(*h*) Positioning unit on likely avenues of enemy approach or infiltration.
(*i*) Preparation of defensive artillery concentrations and illumination.
(*j*) A minimum of 50 percent on alert during hours of darkness.
(*k*) Maximum use of trip flares and claymore mines forward of the position.

(3) Limitations in these operations included:

(*a*) Lack of suitable positions within some areas of operation which maximized the mission characteristics.
(*b*) Unreliability of the XM–44 and searchlight.
(*c*) Sacrificing noise discipline when the engine was run to power the searchlight.
(*d*) Difficulty of reinforcement at night.

(*c*) Road clearing:

(1) Road clearing operations included the security given to convoys after the road had been cleared. The mobility, speed, maneuverability, and firepower of the M–551 can be fully exploited. The M–551-equipped unit had a high capability to act as a rapid reaction force along the route.

(2) Characteristics of this type of mission were:

(*a*) Positioning units in selected positions for rapid reaction.
(*b*) Tactical air cover on call and attack helicopters accompanying mission.
(*c*) Preplanned artillery concentration along the route.
(*d*) Mine sweep of road before convoy started.
(*e*) Additional security at critical points.
(*f*) RIF of all critical areas along the route before convoy passage.
(*g*) Escort of convoy by one element.

(3) Limitations in these operations included:

(*a*) Lack of an effective handheld mine-locating device, necessitating reliance on visual detection method.
(*b*) Spreading the unit over a considerable distance because of length of convoy routes.

12. Significant combat operations

Several significant combat examples have been selected to illustrate different types of missions, techniques of employment, and effectiveness of the M–551 in the RVN environment.

(*a*) On March 11, A Troop, 3/4 Cavalry, was occupying an NDP with all-around security. Barbed wire, RPG screens, trip flares, and claymore mines were emplaced forward of the perimeter. Bunkers were dug 10 to 15 feet to the side of each vehicle. Organic radar, night-vision scopes, XM–44 sights, and listening posts (LP) were used. Defensive fires were planned and personnel placed on 50-percent alert. At 2330 hours, an LP 150 meters from the perimeter spotted an enemy squad. Then another LP sighted 40 to 50 personnel moving

toward the perimeter. The troop commander ordered these LP's withdrawn and placed his unit on full alert. At 2345 hours, a Sheridan crew, using the XM–44 periscope made another sighting 150 meters forward of the perimeter, and defensive fires were executed. The engagement continued sporadically for the next 3 hours before the enemy broke contact. A sweep of the contact area at first light produced 38 NVA bodies and three POW's. Three U.S. soldiers were slightly wounded.

(*b*) On March 25, A Troop, 3/4 Cavalry, acting as a reaction force for a road clearing and security operation, was ordered to sweep the area of contact of a convoy ambush. An aerorifle platoon was attached to the troop for the operation. The sweep was conducted with two platoons abreast and one to the rear. When the troop began to receive automatic weapons, small arms, and RPG fire, the A Troop commander returned the fire with all organic weapons. Air strikes, artillery, and a light fire team were called in on the enemy positions. At dusk, flareships were employed to provide illumination and the engagement was continued. At 1900 hours, contact was broken. A sweep of the area that evening and at first light produced 74 enemy KIA and three POW's plus substantial amounts of war materiel. Friendly losses included one KIA and seven WIA.

(*c*) On February 23, following a rocket and mortar attack against Long Binh post, an RIF supported by air and artillery was conducted 1 kilometer south of the post by two troops of the 1st Squadron, 11th ACR. Initially, A Troop made enemy contact and B Troop was deployed to reinforce A Troop. One company of the 1st Battalion, 2d Infantry was also deployed to reinforce. Both troops were brought on line and, employing all organic weapons, completely overran their objective areas. The 1st Squadron was credited with 88 NVA KIA and six POW's plus substantial amounts of war materiel. There was one U.S. WIA.

(*d*) On March 18, the 1st Squadron, 11th ACR was employed in a RIF operation in the Michelin rubber plantation. Two Sheridan-equipped troops and a tank troop participated. The three troops moved in a wedge formation with D Company in the lead, B Troop on the left, and C Troop on the right. After receiving small arms and RPG fire from the plantation, the formation oriented on the NVA force, pushed forward on line, and overran the base camp area. The results were 23 NVA KIA, but no M–551 crew or vehicle losses. On March 19, B Troop, operating alone in the same general area, received fire, deployed on line, and overran the resistance. This troop was credited with 20 NVA KIA and one POW. There were no friendly losses.

13. Night operations

The M–551 has three instruments used to provide an increased night fighting capability.

The starlight scope is also available to each vehicle commander for close-in observation. With these instruments, the armored cavalry platoons have an enhanced capability for long range observation and an increased capability to provide effective long range night firing. The only limitations encountered in using the systems were terrain and noise discipline. To achieve maximum effectiveness, relatively open terrain out to a range of ——— meters is desirable. This was not always available in RVN. Since the searchlight requires operation of the main engine when employed for long periods, a decision must be made whether to capitalize on its increased capability or to sacrifice security. Notwithstanding these limitations, by using the three devices and the M–551 weapons systems, the armored cavalry platoons could deny enemy access to critical terrain, provide security to installations from indirect fire attacks, and bring accurate direct fire at night against attacking units.

14. Noise generation

Several informal experiments were performed to evaluate the noise level of the M–551. The nature of warfare in this environment did not usually require quiet movement during daylight offensive operations. At night, quiet movement to selected positions was often a necessity. It was determined that during daylight hours one complete platoon containing three M–551's and six ACAV's could approach to within about 400 meters of a position without being detected, provided a concealed approach was available. It was thus possible to get well within range of the M–551 main gun without detection. In these tests, terrain was slightly rolling with moderate vegetation. At night, the detection range was increased slightly to about 500 meters for a full platoon. Noise produced by the M–551 was less than or equal to other armored vehicles used

by U.S. cavalry units in RVN. It is recognized that these results are significantly different from previous CONUS tests. However, these experiments were informal, the measurements were estimated, and test framework cannot be documented in detail.

15. Results of combat operations

(*a*) The statistical information gathered during the evaluation is as follows:

	Total	Percent of total
Number of missions	520.0	
Reconnaissance in force	301.0	57.9
Ambush patrol/night defensive position	98.0	18.8
Road clearing	80.0	15.5
Screen	4.0	.8
Area reconnaissance	4.0	.8
Movement to contact	6.0	1.1
Rapid reaction force	9.0	1.7
Security	12.0	2.3
Cordon and search	6.0	1.1
Number of night missions	98.0	18.8
Number of missions in which troop-sized units participated	390.0	75.0
Number of missions in which platoon-sized units participated	130.0	25.0
Hours of actual M551 operation	16,930.0	
Average hours of operation per vehicle	313.5	
Average length of mission (in hours)	9.3	
Miles accumulated in combat operations	39,455.0	
Average miles per vehicle	730.6	
Rounds fired:		
M81 canister	1,461.0	
M81 HEAT-MP	350.0	
M2 .50 caliber	219,590.0	
M73 7.62 millimeter	211,190.0	
Grenades	82.0	

The Heat-MP round proved valuable in both the antipersonnel and antimateriel role. Heat-MP rounds neutralized bunkers consisting of double timber cover, dirt, and camouflaged overburden, with firing ports on all four sides.

(*c*) All missions were successfully accomplished. The trafficability, mobility, maneuverability, speed, range, and firepower of the M–551 can be profitably exploited. Except in heavy jungle, the Sheridan was suitable for missions in RVN.

(*b*) Misfires and extraction:

(1) A total of 41 misfires were recorded. All occurred during combat operations. In almost all cases these misfires were caused by rounds which were carried in the chamber for extended periods while the vehicle was moving. Extreme difficulty was encountered in extracting misfired rounds from the chamber. Apparently electrical contact was lost between the firing probe and the round seated in the chamber while the vehicle was moving. There was probably some expansion of the round while it was in the chamber, making extraction more difficult.

(2) It is recommended that the electrical contact be improved and that a better system of extraction be developed. A second generation round, incorporating strength, reliability, extractability, and less vulnerability should be the ultimate goal in product improvement.

(*d*) Recoil system and hangout-of-battery:

(1) Initially, recoil system and hangout-of-battery malfunctions caused serious concern. There were 49 malfunctions of which 38 occurred in the first 30 days of deployment. The problem was traced to defective recoil seals installed in many vehicles. Since replacement of seals averaged 23 hours each, no large scale in-country replacement was contemplated. No seal has failed after replacement.

(2) It is recommended that strict quality control be instituted to obtain assurance of system reliability. Additionally any follow-on vehicles shipped to RVN, should have the recoil seals checked to insure proper installation.

(*g*) Engine overheating:

(1) The problem of engine overheating appeared after about 30 days of operation. From that time until the evaluation ended, a total of 34 instances of engine overheating occurred. Several times in combat situations overheating caused engine failure. There appeared to be three principal causes.

(*a*) Radiators became rapidly clogged when the vehicles were operating through jungle. Cleaning these radiators was a difficult and time-consuming job. In combat situations it was often impossible.

(*b*) It was necessary to enlarge the bustle rack by local modification. On some of these modifications, the rack was too low and insufficient air flow was available to the radiator (see fig. II–3).

(*c*) Air cleaners became clogged and could not be easily cleaned (see fig. II–4).

(2) It is recommended that the modifications proposed in paragraphs 27 h, n, q, r, s, and t be applied to eliminate the problem.

(*f*) Closed breach scavenger system:

(1) A total of 53 closed breech scavenger system (CBSS) failures were reported. These varied from complete system failure to breakage of hoses and connection. These failures did not prevent firing the main gun in combat operations. There were no recorded instances of burning residue remaining in the chamber, and there were no premature firings of rounds. Although there was never an instance of burning residue in the gun chamber, it must be noted that the weather was dry, and susceptibility of the combustible cartridge case to extreme moisture could not be measured.

(2) It is recommended that connections be examined and strengthened where necessary, and the lines be repositioned to prevent crew damage.

(*k*) XM–44 periscope.—(1) A total of 53 XM–44 failures were experienced. Causes of these failures were not determined and incountry repair facilities were limited. Because of the critical nature of this piece of equipment during night operations, system reliability must be increased.

(2) The only immediate solution available is establishment of direct exchange procedure at the direct support maintenance level. Until the reliability of this equipment is improved, direct exchange is necessary to ensure the best possible operationally ready rate for this vital component.

(*m*) Insufficient stowage capacity:

(1) The factory installed bustle rack is not suitable in the RVN environment. It does not have sufficient capacity or strength for extended field operations. Some type of modification (see fig. II–3) has been made to all vehicles incountry. No standard has been adopted.

(2) It is recommended that an enlarged and stronger rack be designed and placed on vehicles before deployment. The vehicles incountry should be retrofitted with the same rack.

17. Personnel problem areas

(*a*) Habitability:

(1) When the vehicle was moving with hatches open, sufficient circulation was available to keep the crew reasonably comfortable. During contact, when the driver's hatch was closed and the main gun was firing, heat became a serious problem. This was especially true with the air compressor running. In a prolonged engagement under these conditions, the crew would probably suffer heat casualties.

(2) The fighting compartment of the vehicle was cramped. M–551 crewmen (loader and gunner) rode on top of the vehicle when contact was not imminent. In combat, this lack of vehicle space limited the capabilities of Sheridan crewmen. Most crewmen interviewed stated that they became fatigued early, crew efficiency was affected, and the sustained firing rate reduced. During prolonged engagements, transfer of ammunition was slow and often hazardous.

(3) Despite these problems, crews of both squadrons were able to tolerate the situation and remain combat effective. Modifications proposed in paragraphs 27g and h would improve the conditions considerably.

(*b*) Training:

(1) Training began on January 27 in the 1st Squadron, 11th Armored Cavalry Regiment and in the 3d Squadron, 4th Cavalry, 25th Infantry Division. A total of six troops, three in each squadron, were involved. Training lasted 7 days per troop and consisted of the following subjects:

(*a*) Introduction to Sheridan weapons system.
(*b*) Vehicle operation.
(*c*) Amphibious operations and auxiliary equipment.
(*d*) Turret and cupola operation.
(*e*) Gunnery and crew drill.
(*f*) Maintenance.

Concurrent with the training of crews, instruction was conducted for track and turret mechanics at the organizational and direct support levels.

(2) Of the 200 crew members who completed the training, 112 were previously Sheridan-qualified. In most cases, the instruction was excellent and student participation and response were enthusiastic and eager.

(3) Tactical employment showed that this training was sufficient to prepare for chassis repairmen. Turret repair was still a serious problem. The 4-week training period was only marginally sufficient, even for previously trained personnel.

(4) The approach to the training period was significantly different in the two squadrons, and this affected the initial combat experience of each. In the case of the 3/4 Cav, the troop in training maintained its regular combat mission. It was not able to stand down the entire troop for transition to the M–551. Consequently, some emphasis was lost, leaders could not be present, and time was not available to thoroughly indoctrinate crews before commitment. On the other hand, the 11th ACR was able to relieve its troop for a 7-day period. Officers and key noncommissioned officers were present both to supervise and take instruction. Infantrymen, scouts, and mortarmen were indoctrinated and became familiar with the vehicle's capabilities and limitations. When the troops of the 11th ACR were committed to combat they had fewer malfunctions and maintenance problems than did the ¾ Cav.

The initial combat experience in the 11th ACR was highly successful. They had very few maintenance problems and in their first engagement achieved a large body count with only a few minor casualties. It is imperative that transition to the M–551 be initiated with an operational stand down period to insure adequate training for all troop personnel.

18. Users' opinions

Preceding paragraphs have presented factual data and assessment of the Sheridan's effectiveness and suitability. The opinions of the officers and men of the two Sheridan-equipped squadrons were significant and should be considered.

(*a*) 11th Armored Cavalry Regiment:

The 11th Armored Cavalry Regiment had a high degree of success with the M–551. Personnel from the regimental commander down to the individual crewmen were enthusiastic and confident about the performance of the vehicle during combat. They felt that the M–551 replacing the M–113 on a 3 for 2 basis gave the squadron greater mobility, speed, firepower, maneuverability, and night fighting capability. The vehicle was effectively maintained and demonstrated an excellent range of operation. Personnel of the unit recognized that problems existed, but they felt these did not prevent full tactical employment. The overwhelming majority rated the Sheridan a significant addition to the Army's combat vehicle inventory. They stressed that certain modifications were necessary.

(*b*) 3d Squadron, 4th Cavalry:

The 3/4 Cav was initially disappoined in the Sheridan system. The squadron was previously equipped with the M–48 tank as a substitute item for the armored reconnaissance vehicle. The M–48 was an excellent jungle buster and casualties resulting from mines were minimal. They knew the vehicle's capabilities and limitations and had much experience in its tactical use. As a result of later missions which included highly successful day and night operations, this squadron gained increased enthusiasm and confidence in the M–551. Fewer turret problems, incidents which produced no casualties, less difficult terrain, and a high kill ratio were the greatest contributors to this improved opinion of the vehicle. The majority of personnel now feel that the M–551 provides the squadron with greater mobility, firepower, radius of action, and night fighting capability than it previously possessed. They feel that when the significant problems are solved, the M–551 will be an excellent addition to the division cavalry squadron.

19. Findings

(*a*) The most appropriate missions for M–551-equipped units were those of reconnaissance in force, ambush patrol/night defensive position, and road clearing. Six other mission types can be effectively performed (paragraphs 10, 11).

(*b*) The addition of the M–551 has dictated the use of the M–551-equipped cavalry squadron as an effective maneuver battalion in the Republic of Vietnam (paragraph 10a).

(*c*) RIF missions with the Sheridan revealed nine characteristics of employment and three significant limitations (paragraph 11a).

(*d*) AP/NDP missions revealed 11 characteristics of employment and three significant limitations (paragraph 11b).

(*e*) Road clearing missions revealed seven characteristics of employment and two significant limitations (paragraph 11c).

(*f*) The M–551-equipped cavalry troop has a much more effective night fighting capability and greater security than it heretofore possessed (paragraph 13).

(*g*) The main gun rounds are highly effective against both personnel and materiel targets (paragraph 15b).

(*h*) The trafficability, mobility, maneuverability, speed, range, and firepower of the M–551 can be profitably exploited in the Republic of Vietnam (paragraph 15c).

(*i*) (Paragraph 16.)

(*j*) In prolonged combat, the cramped fighting compartment and high turret temperatures did limit capabilities of the M–551 crewmen (paragraph 17a).

(*k*) Transition to the M–551 should include an operational stand down to insure adequate training (paragraph 17b).

(*l*) Using units considered the M–551 an effective and suitable addition to the armored cavalry squadrons operating in the Republic of Vietnam (paragraph 18).

SECTION III

OBJECTIVE 2—TO DETERMINE THE VULNERABILITY OF THE M–551 TO MINE AND ROCKET DAMAGE

20. *Mine damage*

(*a*) A total of 10 mine incidents occurred during the evaluation. Figure III–1 is a summary of these events, detailing the type and size of mines, place of detonation, vehicle damage, and casualties. Annex C contains a detailed synopsis of each mine incident. Although there were only 10 mining incidents, the results appear to indicate that the M–551, in the Southeast Asia configuration, can withstand mine damage better than the M–113. With the exception of the first incident, casualties have been slight. Although there have been four vehicles categorized as combat losses, only the first was totally destroyed. The remaining three suffered warped or ruptured hulls. Sheridan crewmen became confident that their vehicles could withstand mine shock.

(*b*) In the one serious incident, the detonation ruptured the hull and an instantaneous secondary explosion of some main gun rounds occurred. This detonation caused the only serious casualties sustained from mines. The rupture occurred along the weld joining the upper and lower hulls (see fig. III–2). Because this type of rupture did not reoccur, even when large mines were detonated under similar configurations, this first rupture may have been caused by an improper weld. To obtain a high assurance of no secondary explosion, additional belly armor (side applique) has been applied to most vehicles. The belly armor was very effective. It was considered a major factor in limiting damage and minimizing casualties.

21. *Rocket damage*

(*a*) A total of 12 RPG incidents occurred during the evaluation. Figure III–4 is a summary of these events, detailing the types of projectile, place of detonation, vehicle damage, and casualties. Annex C contains a detailed synopsis of each RPG incident. Many enemy RPG rounds were fired at M–551's during the evaluation. The tactics of continual movement, high rate of suppressive subcaliber fire, and use of canister rounds at close range reduced RPG hits.

(*b*) A total of five vehicles were combat losses due to RPG attacks. Four losses were caused by fires in the turrets which eventually reached the main gun ammunition. RPG rounds did not cause instantaneous ignition of main gun rounds when these were properly protected by the OEM ballistic bags. In one case, there was an instantaneous ignition when a round in the chamber with the breech open was struck by RPG blast. It was not known exactly where the other turret fires started. However, 3 to 5 minutes after penetration, the main gun ammunition burned and later some rounds detonated, thus destroying the vehicles.

22. *Findings*

(*a*) The M–551 can withstand mine damage better than the M–113.

(*b*) One mine incident caused hull rupture and an instantaneous secondary explosion. Side applique should prevent this in the future. (Par. 20b.)

(*c*) The effectiveness of belly armor has been excellent and was a major factor in limiting damage and minimizing casualties. (Par. 20b.)

(*d*) Most mine damage was repaired at organizational maintenance level in 1 to 3 days. (Par. 20d.)

(*e*) The tactics of cavalry platoons in continual movement, high volume of suppressive subcaliber fire, and use of canister rounds reduced RPG hits. (Par. 21a.)

(*f*) There were four instances of secondary fires in the turret after an RPG penetration. (Par. 21b.)

(*g*). The M–551 may withstand RPG attack as well as the M–113. (Par. 21c.)

SECTION IV

OBJECTIVE 3—TO ANALYZE THE MAINTENANCE AND LOGISTICAL SUPPORT FOR THE M–551 SHERIDAN

25. Maintenance

(*a*) For the entire evaluation, the ratio of maintenance time to operational time was 0.53. This figure was influenced considerably by almost continuous combat operations conducted by the squadrons. The enemy post-Tet offensive from February 23 until late April coincided with a major portion of the evaluation period. These operations reduced the time normally devoted specifically to organizational maintenance. The maintenance/operations ratio did indicate the excellent maintainability of the M–551.

(*b*) The direct support maintenance units were the 725th Maintenance Battalion for the ¾ Cav. and the 185th Ordnance Battalion for the 11th ACR. The following chart shows direct support maintenance time spent in repair of the M–551 vehicles.

	¾ Cav	11th ACR
Total number of breakdowns	29	49
Total turnaround time (in days)	212	302
Average turnaround time (in days) per breakdown	7.3	6.2
Total maintenance time (in man-hours)	374	672
Average maintenance time (in man-hours) per breakdown	12.9	13.7

Note: These figures included time taken for critical parts to arrive from CONUS.

(*c*) A review of all M–551 job orders at the two supporting units revealed that the Sheridan was effectively supported. The average time spent repairing the M–551 in the direct support facility was better than the average for armored vehicles. In view of the major work performed and the newness of the vehicle, evaluators felt that maintenance personnel did an outstanding job.

26. Supply

(*a*) Supply History.—The supply history for the M–551's was as follows:

	¾ Cav	11th ACR	725th	185th
Number of requisitions	349	555	753	980
Number filled PLL	131	150		
Number filled ASL			342	445
Open requisitions	141	130	188	451
Percentage filled	59.6	76.6	75	54
Zero balance PLL	5	12		
Zero balance ASL			674	405

Depot support filled 307 requisitions.

(*b*) Zero balance and open requisitions.—Figure IV–3 compares the combined number of open requisitions with the zero balances of PLL and ASL. The figure has shown a continual rise and at its present level is unacceptable. A review is now in progress to determine a more realistic PLL and ASL for this environment. Slack decks should be revised to reflect the determined changes. When these changes are made and if the supply system in support of the M–551

becomes more responsive, the zero balance and open requisition level should be lowered appreciably.

(*c*) Procurement time.—The supply system established for the M–551 was very responsive when parts were available incountry as part of the PLL, ASL, or depot stocks. However, requisitions passed out of country as part of the red ball system did not receive rapid service. The average time for procurement based on figures for 10 critical parts was 58.4 days. Furthermore, many parts necessary for the M–551 were not identified in the ASL and consequently not available. Push packages for future deployment should be constructed from the experience gained during the first M–551 deployment. Adequate and accurate assessment of parts available in the PLL and ASL inventories is necessary.

(*d*) Critical supply items.—The following items have a high usage rate. They were or still are in critical supply. Asterisks indicate those still in critical supply.

Air compressors
*Air filters
*Ammunition stowage racks
Cupola box assembly
Elevating motor
Engines
*Fan belt pulleys
Fan tower assemblies
*Fuel filters
*Grenade tubes
Loader's control box
Oil filters
Recoil seals
Recoil valve assemblies
Searchlights
Shock absorbers
Sprockets
*Turret power control boxes
Voltage regulators
*XM–44 periscope

(*e*) Direct exchange items.—Selected items of M–551 equipment should be placed on a direct exchange basis. High failure rates, the need for centralized repair facilities, and the critical nature of the equipment involved necessitates such a system. The items to be included are air compressors, M–119 telescope, searchlights, and XM–44 periscope. Such a system has already been established for the searchlights. It has worked extremely well and has resulted in raising the daily OR rate of these items from 60 to 80 percent or better.

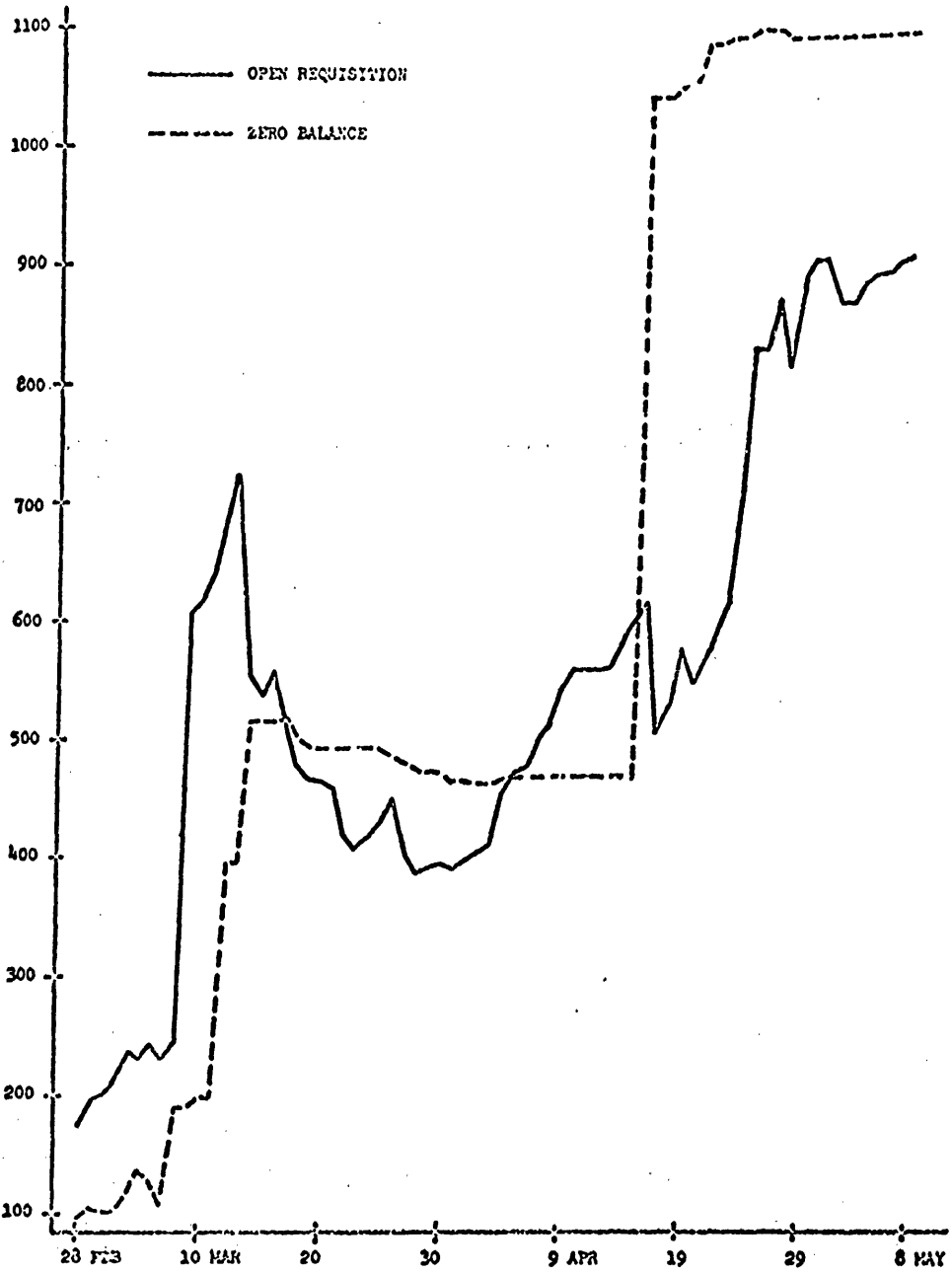

FIGURE IV-3. Zero Balance and Open Requisition

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(*f*) Tools.—The tools available in the OEM have, with a few exceptions, proved adequate. Additions necessary in RVN are:

(1) Cheater bar, larger and longer.
(2) Drive socket set, three-fourth inch.
(3) Funnel with flexible spout.
(4) Oil can, squirt type for filling roadwheels.
(5) Sledge, heavy duty.
(6) Sprocket gage.
(7) Torque wrench.
(8) Track jacks with built-in ratchet, stronger.

Because of the distance between deployed troops and squadron maintenance, and the duration of most operations, one ground hop kit should be provided per troop.

27. Modifications

In section II, the problem areas associated with the M–551 employment were identified and, where possible, recommendations for improvements made. Itemized in this section are those modifications which should be installed or investigated further. Also indicated are those modifications which will further increase the effectiveness of the vehicle but are not specifically identified with M–551 shortcomings. Asterisks indicate those modifications which must be made in Conus before any future deployment.

(*a*) Relocation of the commander's control handle*.—In RVN, the Sheridan vehicle commander rides in a high position in his cupola, either standing on his seat or sitting on the edge of his turret ring. This provides him maximum visibility. He usually remains in this position even during the heat of battle so that he can engage targets without losing sight of them. The turret hatch is seldom closed, and the vehicle commander maneuvers his .50-caliber machinegun cupola, directs the main turret, and fires the coaxial machinegun from this elevated position. The original location of the commander's control handle was unsatisfactory for this configuration. As a result a modification was made to permit relocation of the control handle to a position on the commander's hatch cover. (See fig. IV–4.) It was accomplished by welding a bracket to the right hatch cover. The bracket is notched in such a manner that the control handle may be quickly removed and relocated to its original position inside the turret. It is recommended that all future vehicles have this modification installed before deployment to RVN.

(*b*) Rear ballistic protection for the commander.—There is no protection to the rear for the vehicle commander. Many commanders feel this is an operational necessity. Such a protective device should be easily detachable.

(*c*) .50 caliber ACAV gun shield.—A modification is necessary to replace the M–551 ballistic shield kit with the present ballistic kit used on the ACAV. The ACAV shield provides greater protection for the commander, gives the .50-caliber machinegun better balance, and allows for better ammunition stowage and handling.

(*d*) .50 caliber deflection plate*.—Expanded hot brass from the .50-caliber machinegun frequently fell into the turret. This condition caused turret traversing malfunctions. In several instances, it caused the vehicle commander and gunner to be burned. The installation of a deflection plate on the present mount would eliminate the problem.

(*e*) Turret floor access hatch*.— In the present vehicle there is no provision for cleaning under the turret floor. Expended .50-caliber brass and trash have dropped into this area where it cannot be cleaned out. Serious problems may arise later after extended field operations and firings. A simple floor access plate should be installed to allow crewmen to clean under the turret floor.

(*f*) Driver's external latch.—An external release should be devised to permit the release of the driver if he is knocked unconscious or injured and the hatch is closed and locked. One death might have been avoided had this modification been available.

(*g*) Loader's hatch.—A large loader's hatch is desired. Larger men could enter and exit the vehicle only with considerable difficulty and, in some cases, they sustained minor injuries. The addition of flack jackets and other combat equipment compounds this problem. It is most desirable to enlarge the present hatch and provide padding around the edge of the hatch opening. This modification will also improve ventilation and may reduce turret temperatures.

(*h*) Turret rear access door*.—A door, placed in the turret rear access panel,

facilitating access to the radiator from inside the turret would be an excellent modification. It would allow the radiator to be cleaned rapidly and also reduce the temperature in the fighting compartment. One rear panel on several vehicles was removed and the results indicated that engine overheating was reduced and crew comfort improved.

(*t*) Grenade launcher.—Numerous grenade launchers were damaged. A round collar approximately three-quarter-inch wide to protect the three extending prongs at the open end of the launcher might solve this problem. The launchers should be further strengthened and, if possible, repositioned so that they do not extend over the side of the vehicle.

(*j*) ———.

(*k*) M85 machinegun.—The M85 machinegun should be installed in place of the M2 machinegun. This change will provide a quick-change barrel, higher rate of fire, and preset headspace and timing not available with the M2.

(*l*) M73 ammunition box*.—The installed ammunition box has insufficient capacity and does not feed properly. Both the M48 7.62-millimeter ammunition feedbox and the 20-millimeter shipping container proved to be satisfactory substitutes.

(*m*) ———

(*n*) Bustle rack redesign*.—The present configuration of the M551 bustle rack is unsuitable in the RVN environment because it provides insufficient stowage for subcaliber ammunition, rations, water, and field equipment. The present design will carry only one quarter of this required equipment (see figure II–3).

(*o*) Reverse gear modification.—One reverse gear without pivot steer may be needed. With the present pivot steer in both reverse ranges, drivers must usually back straight out of wet rice paddies and other marshy areas. If a turn is attempted, the vehicle digs into the mud and becomes stuck. Reverse gear without pivot steer will provide greater flexibility and maneuverability in such terrain. The evaluation was not conducted during the rainy season or in heavily inundated areas; consequently, this requirement was not validated. Later deployment may establish a clear need for this modification.

(*p*) Winch kit.—During the dry season, there is little need for a winch. However, commanders feel that during the monsoon season a winch kit would be a valuable addition. It is recommended that several kits be provided to RVN for evaluation during the monsoon season.

(*q*) Backdeck radiator screen.—Vegetation clogging the radiator has contributed to engine overheating (paragraph 16). A backdeck screen of finer mesh would eliminate much of the debris now passed through to the radiator. Investigation of other modifications to prevent clogging is recommended.

(*r*) Air filter*.—The engine air filter was one of the primary causes of engine overheating and later engine failure. This filter could not be easily maintained, was easily damaged during maintenance and required constant cleaning. The only rapid and satisfactory cleaning method is the use of high-pressure air. Other methods attempted included tapping the filter, placing the filter over the exhaust of an M113, and using the CBSS system to blow air through the muzzle with the air cleaner against the end of the tube. The long-range solution to this problem must lie in the development of a filter or filter element which is more efficient and more easily maintained.

(*s*) CBSS air line connection*.—Since a high-pressure air system is already installed in the vehicle, it could be used to assist in maintenance. A simple pressure-reduction device and air lines could be attached to the existing hardware. With such equipment air cleaners could be easily maintained, the radiators could be blown out, and turrets could be efficiently cleaned.

(*t*) Fan belts and fan pulleys*.—The cause of broken fan belts (paragraph 161) was traced directly to the aluminum fan belt pulleys. These pulleys are not strong enough and appear to deform after heavy use. Steel pulleys should be substituted and vehicles now in-country should be retrofitted with this modification.

(*v.*) Searchlight protection, cover and mount.—Because of the heavy underbrush and wooded terrain in RVN, the searchlight must be protected. An external guard of some type is needed to prevent limbs from damaging the equipment. The canvas cover provided for the equipment is also inadequate. Most covers were torn during the evaluation; they should be made of heavier material. Ten mounting brackets have broken while the vehicles were operating in wooded terrain, rendering the searchlight useless. The mounting plate must be strengthened in some appropriate manner.

(*w.*) Roadwheel filler plug*.—Roadwheel filler plugs have loosened after extended operation. The position of these plugs on the inside of the roadwheels has seriously affected crew maintenance. Plugs are difficult to reach and cannot be easily inspected visually. During the rainy season, mud and lack of hardstand will compound the problem. Roadwheel filler plugs should be recessed and relocated on the outside of the roadwheels. Changing the roadwheel lubricant to grease should be considered to eliminate leaking.

(*y*) Fire extinguisher handle protection.—There have been several instances of fire extinguisrer handles being sheared off or bent when operating in difficult terrain. It is necessary to provide a cover of some type to protect the fire extinguisher recess well. A spring-loaded aluminum cover would be a highly satisfactory solution to this problem.

28. *Findings*

(d) The average turnaround time per breakdown in the maintenance battalions was 6.8 days (Paragraph 25b.)

(*f*) The average percentage of requisitions filled for all units was 66.3 percent. (Paragraph 26a.)

(g) The average time required to procure 10 critical parts was calculated and determined to be 58.4 days. (Paragraph 26c.)

(*h*) The parts for both the ASL and PLL should be reexamined and corrected lists prepared on the basis of this evaluation. Future push packages require similar reexamination to determine their proper construction. (Paragaph 26c.)

(i) There were 20 items which had a high usage rate and were or still are in critical supply. (Paragraph 26d.)

(*j*) Selected items of M551 equipment should be placed on a direct exchange basis. They include xxx4 periscope, searchlight, M119 telescope, and air compressor. (Paragraph 26e.)

(*k*) The tools available in the OEM have, with a few exceptions, proved adequate. There are eight additions necessary in RVN. (Paragraph 26f.)

Section V

Conclusions and Recommendations

29. Conclusions

(*a*) The M–551 Sheridan is an effective and suitable vehicle for use by armored cavalry platoons in RVN.

(*b*) Sixteen problem areas and 25 shortcomings requiring modification detract from the effectiveness of the M–551 in RVN.

(*c*) The M–551 can be maintained and supported to sustain an 85-percent operationally ready rate in RVN.

(*d*) The vulnerability of the M–551 to mine damage and RPG hits is not sufficient to bar deployment of the vehicle to RVN.

30. Recommendations

It is recommended that:

(*a*) Department of the Army make CONUS application of those modifications indicated as essential before deploying additional vehicles to RVN.

(*b*) Department of the Army deploy sufficient M–551's to equip all cavalry squadrons in RVN.

(*c*) The U.S. Army Materiel Command take action to correct identified problem areas and improve undesirable design characteristics.

Annex A

Abbreviations

ACAV—Armored cavalry assault vehicle.
ACR—Armored cavalry regiment.
ACTIV—Army concept team in Vietnam.
APC—Armored personnel carrier.
AP/NDP—Ambush patrol/night defensive position.
ARAAV—Armored reconnaissance airborne assault vehicle.
ASL—Authorized stockage list.
CBSS—Closed breech scavenger system.

COMUSMACV—Commander, U.S. Military Assistance Command, Vietnam.
CONUS—Continental United States.
CTZ—Corps tactical zone.
DS—Direct support.
HEAT—MP—High-explosive antitank—multipurpose.
KIA—Killed in action.
LP—Listening post.
MTOE—Modified table of organization and equipment.
NET—New equipment training.
NOR—Not operationally ready.
NORM—Not operationally ready, maintenance.
NORS—Not operationally ready, supply.
NVA—North Vietnamese Army.
OEM—On equipment materiel.
OR—Operationally ready.
PLL—Prescribed load list.
POL—Petroleum, oil, and lubricants.
POW—Prisoner of war.
RIF—Reconnaissance in force.
RPG—Rocket propelled grenade.
RSR—Required supply rate.
RVN—Republic of Vietnam.
USARV—U.S. Army, Vietnam.
WIA—Wounded in action.

ANNEX B

TASKS, DATA SOURCES, AND COLLECTION

1. Tasks

The following tasks were considered a minimum to attain the three objectives.

(*a*) Objective 1:
(1) Record number of M551's available and employed.
(2) Record type of missions.
(3) Document range, speed, and mobility difficulties.
(4) Record number of engagements.
(5) Record terrain and weather encountered.
(6) Record parent organization for mission, its capabilities, and limitations.
(7) Establish reliability and maintainability factors.
(8) Record time of mission.
(9) Record amount and type of ammunition fired.
(10) Record gun malfunctions.
(11) Record ammunition reliability.
(12) Record first and second round hits.
(13) Document effectiveness of fire.
(14) Document fire control system effectiveness (day and night).

(*b*) Objective 2:
(1) Record number of mine incidents.
(2) Record number of casualties.
(3) Document type, location, and size of mine employed.
(4) Describe and document damage to vehicle.
(5) Document effectiveness of added belly armor.
(6) Record number of RPG incidents.
(7) Describe and document damage and secondary effects due to RPG hits.

(*c*) Objective 3:
(1) Review troop/squadron maintenance records.
(2) Compare spare parts issued and on hand with that authorized (prescribed load list (PLL) maintained).
(3) Compute percentage of vehicle downtime for parts (nonavailable days).
(4) Determine personnel maintenance training and experience.
(5) Determine the recurring failures and frequency per vehicle miles.
(6) Determine the average time, in days, from submission of requisition to delivery of parts.
(7) Determine the basic load of ammunition by type and how resupply is effected.

(8) Record RSR and determine adequacy.
(9) Determine the average fuel consumption rate per vehicle.
(10) Determine if POL supply is adequate and how resupply is accomplished.
(11) Determine the adequacy of tools/equipment for maintenance at unit and DS level.
(12) Determine the adequacy and availability of maintenance publications and manuals.
(13) Determine the adequacy of DS maintenance support.
(14) Determine the average turn-around time for repairable equipment.
(15) Determine the adequacy of NET training and effect on maintenance support.

2. Data sources

The following sources of information were exploited to provide the data for analysis purposes and to provide background information.
(*a*) Maintenance manuals, specifications, operator's manual, service school literature.
(*b*) Troop/squadron personnel and maintenance records.
(*c*) DA forms 2404 and 2765.
(*d*) After-action reports.
(*e*) Evaluator's diary.
(*f*) Mission data sheet.
(*g*) Platoon/troop commanders' final structure interviews.
(*h*) Platoon daily structured interviews.
(*i*) Mine incident report.
(*j*) Squadron/troop maintenance interviews.
(*k*) Final report, integrated engineering/service test XM–551.
(*l*) Final report, integrated engineering/service test (desert) of M–551.
(*m*) Suitability for conditional release to troops of Sheridan weapons system M–551.
(*n*) Evaluators' checklist.

3. Collection

The title of the data collection forms, the objectives to which they are addressed, and the collection time schedule are summarized below.

Forms	Objectives	Collection schedule
Mission data sheet	1, 2, 3	Mission.
Platoon daily questionnaire	1, 2, 3	Daily.
Platoon and troop questionnaire	1, 2, 3	Weekly, monthly, and at evaluation completion.
Mine and RPG report	2	As they occur.
Maintenance questionnaire	3	Weekly, monthly, and at evaluation completion.
After-action report	1, 2, 3	Weekly.
DA form 2404	3	Do.
DA form 2765	3	Do.

Mr. SLACK. We will now recess until 2 p.m.

AFTERNOON SESSION

Mr. MAHON. We will resume the hearing.

I have been in and out of this committee room for days now, and I see the same familiar faces here. I would assume that we are hastening toward the solution of all our major problems insofar as the Army is concerned.

SHILLELAGH ANTITANK MISSILE SYSTEM

We will discuss at this time the Shillelagh antitank missile system.

The fiscal year 1970 estimate for the Shillelagh antitank missile system is $3.6 million. Last year, you requested $4.7 million for this purpose, and this year's justification book shows the fiscal year 1969 program was $5.7 million.

(*a*) Why was this program increased $1 million during fiscal 1969, and how was the $5.7 million utilized?

(*b*) Can you detail your accomplishments? For example, were you successful in developing countermeasures hardening for the Shillelagh missile?

(The information follows:)

The $1 million increase was required to support the additional testing necessary to insure that the combustible-cased ammunition was safe for issue to troops. The statistical base needed to establish this level of safety beyond reasonable doubt required an extensive and carefully controlled firing program. Funds for the 152-millimeter conventional ammunition are included in the Shillelagh program element. Other fiscal year 1969 work supported by the $5.7 million included completion of development and fielding of the 152-millimeter rounds deployed with Sheridan to Vietnam (high-explosive, cannister/flechette, and training); product improvement of the combustible case; hardening of the missile system against countermeasures; and improvement of missile flight characteristics. Accomplishments in fiscal year 1969 included the fielding of these 152-millimeter rounds with Sheridan in Vietnam; identification of and significant progress in product improvement measures for the combustible case (the high-density case program); development of an ——— and guidance and control modifications to improve missile ———.

CURRENT DEVELOPMENT COST ESTIMATE

Mr. MAHON. The jurisdiction book indicates that a total of $157.9 million has been funded for Shillelagh development through fiscal year 1969. Yet, a review of justification books as far back as fiscal year 1967 disclosed that the Army has failed to provide Congress with an estimate for total cost of development of this system. What is this total estimate to completion?

General BETTS. The current estimate of R.D.T. & E. cost to completion is $158.1 million.

ORIGINAL COST ESTIMATE

Mr. MAHON. What was the original Army estimate to develop the Shillelagh and what have been the cost increases over the years?

General BETTS. The original estimate was $111.3 million. The $46.8 million difference includes the following additional unforecast development activities: extending the range from ——— meters to ——— meters—$6.5 million; adapting the system to the M60A1E2—$4 million; adapting the system to the MBT–70—$9.6 million; development of the land combat support system—$0.6 million; development of counter-countermeasures $15.3 million; design improvements $9.8 million; and ABCA standardization $0.5 million.

DEVELOPMENT PROBLEMS

Mr. MAHON. What problems have you had in the development of the Shillelagh missile system?

General BETTS. The Shillelagh missile system is the first and only mounted antitank missile system. It is by far the most lethal and accurate long-range vehicle mounted antitank weapon in the world. In view of its uniqueness, there were early problems in realizing the reliability essential in a missile to be distributed to and employed by frontline elements remote from the extensive facilities and highly

trained technicians normally required to support guided missiles. For example, early configurations of the guidance transmitter were not satisfactory, and redesign to the present double xenon sources was required; early onboard gas-generator grains were not satisfactory and required revision; and the onboard thermal batteries gave trouble in the early stages of development. These basic problems, however, were resolved by the end of fiscal year 1962 and the missile system design was frozen in August of that year. Since that time only minor part changes have been required to correct reliability data accumulated by testing and by troop use. Prior to standardization, testing had established that the required levels of durability and reliability could be attained under these conditions. The current Shillelagh missile does have certain limitations inherent in its present design. These were identified, considered, and accepted early in the development program, on the basis that the net capability of the missile represents an invaluable combat capability and a great advance over previous tank weapon systems.

SHILLELAGH MODIFICATIONS

Mr. MAHON. In the last 2 fiscal years, Congress has provided a total of $2.8 million in Pema funds for Shillelagh modifications. What were these modifications and why were they necessary?

General BETTS. In fiscal year 1968, $600,000 was used to modify the deep key missile to change it to a shallow key missile. This change was made to improve tube life of the gun/launcher system. In fiscal year 1969, $600,000 was used for installation engineering for the follow-on xenon beacon program currently under development. One million six hundred thousand dollars for fiscal year 1969 is being held in reserve for installation enngieering, procurement of the technical data package, and test of the final development of the xenon beacon. It is being held back because the beacon had been delayed to get in phase with the guidance and control development. The improvements of which I speak are concerned not with the correction of deficiencies but rather improving the capability of the missile to function against enemy countermeasures. The decision on production and retrofit of the improvements under development on the systems is based on the countermeasure threat at any point in time.

Mr. MAHON. The fiscal year 1970 program, according to p. 173 of the justification, will include, for the Shillelagh missile, development of an improved missile beacon, improvements in guidance and control, and improvements in missile flight characteristics, all of which is a continuing effort. Why should Congress provide $50.5 million in Pema funds in fiscal year 1970 for procurement of ——— Shillelagh missiles when additional development work in the areas mentioned is continuing?

General BETTS. The Army continues to explore possibilities of improving materiel even though a satisfactory item may be in production. The research and development efforts are designed to counter an enemy threat which is forecast for the future. Our development can be considered a hedge against an attempt by our suspected adversary to counter our current missiles. We cannot ignore, however, the immediate requirement to field a workable combat effective system

against a known enemy force nor can we hold production year after year awaiting the next improvement.

Mr. MAHON. When do you hope to complete the development of the Shillelagh missile system?

General BETTS. We expect to complete R.D.T. & E. work on the current Shillelagh missile system during ———.

COMBUSTIBLE CARTRIDGE CASE

Mr. MAHON. Your fiscal year 1970 program for the conventional ammunition is to continue improvements in the current combustible case and development of a second generation consumable case. What problems remain unsolved?

Colonel LAMB. Current work to improve the combustible case will provide a case with greater structural strength, a case which produces less residue, and a case which provides greater resistance to inadvertent and accidental ignition.

Mr. MAHON. What do you estimate the cost will be to complete the development of fully satisfactory and safe consumable case ammunition?

Colonel LAMB. ——— of the fiscal year 1970 R.D.T. & E. budget will complete the improvement of the ammunition to a satisfactory level. It is safe now and has been safe since the decision was made to field the current ammunition. We intend to continue to develop consumable case ammunition through a second generation case product which we expect to be spread over some 5 years and is estimated to have a total cost of approximately ———.

GUN AMMUNITION PROCURED IN QUANTITY UNDER LIMITED PRODUCTION

Mr. MAHON. The ammunition for the 152 mm. gun is not type classified standard A. The XM409 and XM411 ammunition rounds were type classified limited production in December 1964, and it has been extended three times, resulting in the production of more than ——— rounds at a cost of $90 million. The Army planned to buy an additional ——— rounds of the XM409E2 ammunition in fiscal year 1970, but this was cancelled. Why was this done? Why does the Army propose to procure production quantities of the XM657, the XM411E2, and the XM625 in fiscal year 1970?

Colonel LAMB. During a reassessment of assets and requirements at the time of apportionment in June 1969, the Army determined that current assets of the XM409E2 were adequate without the fiscal year 1970 buy. The primary reason for the change in the assets and requirements picture is the delay in fielding the M60A1E2 tank allowing a correlated delay in 152-mm. ammunition production. The Army will procure XM625 and XM657 rounds in support of a Vietnam requirement. The XM411E2 rounds will support the training requirement for Sheridan vehicles now being deployed to Conus, Korea, and Europe.

Mr. MAHON. Are you requesting R.D.T. & E. funds in fiscal year 1970 to buy any of this ammunition for test purposes? If so, how many of each and what is the cost?

General BETTS. We are not buying any rounds of 152-mm. ammunition for test purposes with fiscal year 1970 R.D.T. & E. funds.

Mr. MAHON. How about the Shillelagh missile?

General BETTS. We are buying no missiles with R.D.T. & E. funds for test purposes.

BACK-UP EFFORT TO DEVELOP METAL CARTRIDGE CASE

Mr. MAHON. The Army terminated in October 1968 the backup development of a metal cartridge case for the 152-mm conventional conventional ammunition. How much was spent on that terminated effort?

General BETTS. No funds have been expended on development of a 152-mm metal case. Approximately $265,000 were expended on exploratory efforts for development of a perforated metal case.

MAIN BATTLE TANK

Mr. MAHON. We proceed now to the discussion of a very important and sensitive item.

You are requesting $44.9 million for continuation of the development of the main battle tank in fiscal year 1970. In previous years $184 million has been appropriated in R.D.T. & E., Army, for this program.

This is a program which is, of course, in serious trouble, as is well known to the people who are knowledgeable in this field. It is not entirely unexpected that it would be, since it is one of the few major research and development efforts which have been undertaken with another government as a full and equal partner. Some, but not all, of the difficulties which have arisen can be attributed primarily to the difficulties in managing a binational program of this type. We are not unaware of the difficulties which you have encountered.

Last year, the committee asked its surveys and investigations staff to make a thorough review of the main battle tank program. Such a review was made, and the findings have been reported to the committee. Many of the questions we will direct to you today in this hearing will be based on information included in the report which has been made to the committee.

BACKGROUND OF MBT–70 DEVELOPMENT

By way of background, beginning in 1959, attempts were made within NATO to establish joint development programs for NATO weapon systems. One of the items which it was thought could possibly be developed jointly and used throughout NATO was a new main battle tank. Obviously, this was a very attractive idea, but as is true of many other ideas, working such things out in practice is not always easy. Differences of opinion existed between the NATO Allies to such an extent that this became impossible.

NATO changed its approach of establishing uniform standards for all members, and merely urged members to enter into bilateral agreements for weapons development. In 1963, the United States and Germany entered into an agreement which provided for the development, for production not later than 1970, of 16 prototype tanks with the work divided between the two countries and the cost to be shared equally.

OBJECTIVES IN MBT–70 DEVELOPMENT

Accordingly, we are informed that five objectives were established, as follows:

(1) To gain a significant improvement over existing tanks in combat effectiveness;

(2) To achieve the operational availability of a U.S. production model by 1970;

(3) To maintain system cost at a level which would not offset the increased capabilities;

(4) To achieve reliability and simplicity in operation and maintenance; and

(5) To accomplish the development of a standard tank jointly with West Germany.

The first objective has probably been met in part, but there are still serious difficulties with the tank and with the basic design which indicate that it is too soon to be certain that the MBT–70 will be a significant improvement over existing tanks in combat effectiveness.

The second objective has not been met.

The third objective has probably not been met in that the complexities which have been included in so many of the component systems in the tank indicate that maintenance cost and downtime will be extremely high.

The fourth objective of reliability and simplicity are in direct conflict with the first objective for a significant improvement over existing tanks. It appears that reliability and simplicity have fallen far short. No one would refer to the MBT–70 as simple. Its reliability has not yet been established, but experience to date does not indicate an adequate degree of reliability.

The fifth objective of accomplishing the development of a standard tank jointly with West Germany will at best only be achieved in part in that, except for the hull of the tank itself, many of the components will be different in the tanks of the two countries after the initial production run.

I make this statement for the record. I assume that this would be a good time for you to show us a pictorial of what is involved.

General Betts. I think it would be helpful to start this off with a film which was made to show, as well as we can, the differences in effectiveness between the MBT–70 and the M–60 series tanks, in this case the M–60A1E2. It gives you a feeling for the mobility, the importance of silhouette, and many of the other operational characteristics that are very hard to quantify in a way that will show the effect.

POSITION OF WITNESS ON TANK PROGRAM

At the beginning of your statement you started out "It is well known this program is in trouble." The only trouble of any significance that I know is the Senate Armed Services Committee cut, and they said, in effect, "We don't think you are doing very well in this program."

We think we are doing very well. There have been problems, but those problems are reasonably well in hand from the technical point of view. The big thing that stretched this program out was the decision to go the very conservative route and fly before buy.

What "fly before buy" means is that after you have found problems in the testing program, you make new models that pick up those changes and test those again before you go into production. That is a very conservative approach. It is the approach being taken in this program, and its adds almost ——— to the cycle.

It does not say we are in trouble from the point of view of getting to the end goal. It says we are in trouble because it costs more money and it takes more time to do it the very conservative route that goes simplistically under the words "fly before buy." It is a perfect example of what happens if you try to guarantee that there are no possible problems in getting to the end item for production.

I would say sincerely, in my judgment, if I were making all the final decisions on this tank, I would release this tank to production right now.

When I say release to production, I mean with a year and a half leadtime to get the first tank.

Mr. MAHON. You do not go along with the critics of this program?

General BETTS. I certainly do not. There are all sorts of things to criticize that come back to the joint problems and the difficulties we have gotten into, but I would say that in one sense the joint problems saved us, because the next set of pilots will have a Daimler-Benz engine. We did get into trouble with the American Continental engine. We are able to fall back on the Daimler-Benz engine.

I think we ought to see this comparison, and then let's address questions specifically on those things concerning it to General Luczak. We brought the full knowledge that we have available to us over here to give this committee a chance to see the whole picture as best we can give it to you.

Mr. MAHON. We want you to put your best foot forward, but we do not want you to put it too far forward.

General BETTS. I understand.

I did not give you the Army position with respect to production. I gave you my personal judgment. I feel we are going at a very conservative route.

Mr. MINSHALL. Refer to it as "his neck out."

Mr. MAHON. All right, will you proceed with the entertainment.

(Exhibition of film.)

Mr. POOR. I think those pictures, Mr. Chairman, show you better than any number of words can show that in two very critical areas the MBT–70, with all the time that has been required to get it here, and the fact that the costs have been somewhat larger than anticipated, nevertheless represents a very significant technical advance in tank technology.

The stabilized sight performance is already so great that it indicates we should be able to shoot on the move, using the equipments that are incorporated in the prototype tank, of which the pictures were taken, with a kind of accuracy that will allow us to engage targets with tanks moving at high speed across the terrain, very nearly as well as we can from a stationary tank—a tremendous accomplishment.

The automotive superiority over the best of the existing tanks is, I think, clear cut.

So, it is in that framework of pride in the technical accomplishments that we would like to discuss with you today, the difficulties we

have had in the program, and the reasons we are confident that out of the program, in the long run, will come a very good and very useful military capability.

Mr. MAHON. What is the vintage of the M–60 tank which we saw engage the MBT–70 tank in a drag race in the movie?

Mr. POOR. Currently in production.

Mr. MAHON. That is the latest word?

General BETTS. That is the M–60A1E2 that was released to production with a changed turret back in the middle of 1966. It is now in storage awaiting solution to the stabilization system.

We attempted to put a stabilization system on that tank that, when it works, works very well, but does not maintain a reliable operation. We are in the process of analysis to find out why, and what we must do to correct it.

Mr. MAHON. Where were the tests which we saw in the movie performed?

General BETTS. At Aberdeen.

Mr. MAHON. When were they performed?

General LUCZAK. They were performed in the spring of this year.

General BETTS. General Luczak is the project manager, Mr. Chairman.

POSSIBLE NEED TO DESIGN A NEW TANK

Mr. MAHON. It would appear, in view of the failue of the program to meet all its objectives, and the magnitude of cost increases which have been encountered, serious consideration should be given to discontinuing this program and immediately starting the development of a more simple, practical, and reliable tank so that a useful new tank can be placed in the operational inventory of the Army as soon as possible.

You have expressed yourself somewhat on this question, General Betts. What is your feeling on this question, and what is the feeling of your associates?

General BETTS. We went through this kind of question in some depth last fall as we came to the crucial point of whether or not the Secretary of Defense would support our request for funds for this program.

Mr. MAHON. This was in the Pentagon?

General BETTS. In the Pentagon, in a review of the program by Dr. Foster and his staff.

At that time we asked General Polk to join us, since he is probably the outstanding user we have access to for armored warfare, now in command in Western Europe. General Polk made the point that in his judgment we could ——— of armored vehicles that face us in Western Europe because of the Soviet emphasis on armor. Some ——— tanks is the number that I remember.

His point was that with numbers on our side like ——— we had to concentrate on quality if we were to hope to maintain any kind of parity in a possible war in Western Europe.

For that reason, he very strongly supports this tank, with all its complexity, because from that complexity we gain the operational capability that was illustrated in the film.

Mr. MAHON. Is it true that a great deal of the thrust of the Army is and has been preparation for some type of war in Western Europe?

General BETTS. That has been one of our priority military problems for some years, to maintain a posture in Western Europe that would deter war in Western Europe.

Mr. MAHON. Mr. Secretary, have you anything to add to that?

DECISION TO BUILD MORE PROTOTYPES

Mr. POOR. I would like to add that while I share General Betts' view that it might be possible to commit the MBT–70 to very early production, I think the decision to go through one more round of prototypes is a prudent one. We now have in hand a study called the producibility cost reduction study, the purpose of which is to examine each of the components in the tank with a view to simplification or elimination wherever it turns out to be justifiable on the basis that the savings in costs will not result in a catastrophic loss of capability.

The next round of prototypes will allow us to incorporate some of these changes, should elimination of complexity prove desirable.

There are a number of things about this tank that we are not quite sure about. It has spectacular night-vision capability. I have been out to the manufacturer's plant and driven the tank and looked through the night-vision equipment, and it is very impressive. One can drive the tank almost as if one were operating in daylight. One can pick up targets at long ranges with the night-vision equipment. But the equipments installed are expensive and complicated.

The fire control is extremely complicated. It offers the possibility of first-round hits at very long ranges from a tank on the move. I do not know what the value of that is, but I am sure it is very great.

So, in this program we are attempting to make sure that there are no unnecessary complications and that every feature that we incorporate in the final design can pay its way.

As for its system feasibility, the tank has already demonstrated that most of the technical objectives we set for ourselves can indeed be met.

CRITICISM ON COMPLEXITY OF TANK

Mr. MAHON. There has been concern over the program in Germany as well as in the United States. Much of this concern is that the tank is too complex. To deal with this problem it has been urged that consideration be given to improved torsion bar suspension, returning the driver to the hull, adding the fourth crewmember, and substitution of the automatic loader with a simple semiautomatic loader.

These recommendations amount to a redesign of the tank. Would these recommended changes probably result in a better tank?

Mr. POOR. May I ask General Luczak to comment on that?

Mr. MAHON. Will you speak up, General Luczak?

(Discussion off the record.)

CHRYSLER "K" TANK PROPOSAL

Mr. MAHON. In November of 1968, the Chrysler Corp. made a proposal to the Army for a much simpler tank which is known as the Chrysler K tank. I am not an expert in this field and this does not mean much to me. This new tank would have an improved torsion

bar suspension, semiautomatic launcher, a fourth crewmember, and the driver in the hull. So, evidently serious consideration is being given to a new tank. Is that right?

General LUCZAK. The K tank was a company proposal by Chrysler which resembles the German G tank closer than it does the MBT–70. It was examined by a group within the Army, particularly in the November, December, and January time frame, to see whether or not it would be acceptable.

As I remember the findings of the committee, they stated that it would take about as long to get the K tank into the inventory as it would the MBT–70. The cost was not substantially different. The risks in some cases were just as great or more so. The capability was far less.

They concluded that the K tank was not acceptable, under these circumstances, to the Army.

FUTURE TANK INVENTORY MIX UNDER DISCUSSION

Mr. MAHON. The committee hopes that the Army, in order to avoid the difficulty of an unsatisfactory development program, will not insist on continuing development of the MBT–70 regardless of the costs involved and the chances for eventual success in developing a reliable weapon. If the MBT–70 program has been a failure, we would be much better off to admit it now and proceed as quickly as possible with a new tank, so that the Army can proceed with its long-delayed requirement for a better tank.

Mr. POOR. Mr. Chairman, if I could accept the premise, I would completely agree with the conclusion. I think there is no evidence to support the idea that this tank is a failure. I think we have high confidence that from the work that has been done so far, we can, given time and money, produce a tank that does precisely what the MBT–70 initial objectives required.

Given the assumption that the tank has any significant major failures in it, I would certainly agree that we should terminate it and start over. I cannot find those major failures.

There are still design decisions that will have to be taken to simplify and make more reliable and make more inexpensive the tank, but I feel it would be most imprudent to start over from scratch at this point in time.

Mr. MAHON. Is there some division of opinion among the experts in the Army on this question? You must have had many discussions in which you have pro-and-con views. What degree of unanimity is involved here?

Mr. POOR. About a year and a half ago, I think you would have found that the majority opinion in the Directorate of Defense Research and Engineering was that this program was an incipient disaster. We have had many long discussions with Dr. Foster's people and visits to plants. Secretary Packard went out to look at the program 2 or 3 months ago.

I think the opinion of these technical experts in the Department of Defense is very close to mine, namely, that it is a very significant technical accomplishment. There are bound to be differences of opinion

as to how best to handle the very large number of Soviet vehicles against which we may have to fight if our deterrent in Europe fails. It is quite clear that if a tank costs three times as much and can handle ——— times as many enemy tanks, one at a time, you still may not be able to afford to buy enough of them to handle a massive attack where it becomes an almost 1-on-1 game.

So, the benefit of sophistication may prove too expensive for our whole inventory, and it may be prudent to have two kinds of tanks, perhaps one derivative from the M–60 series, so we can buy large numbers of inexpensive tanks, and complicated, high-effectiveness tanks to mix in with them to get the most economical way of handling the very large masses of tanks in the European threat.

This is still a matter of discussion, argument, and careful thought on the part of the Army and the Office of the Secretary of Defense. With my responsibility for the R. & D. program of the Army, I feel it is essential that we make available the option of an overpowering tank such as the MBT–70 appears to be. The question of how many to buy and with what sophistication on them, and in what mix with cheaper tanks, still needs to be answered.

General Betts. Mr. Chairman, would it help the committee if we asked the project manager to give you a progress report on the testing so you will have a feel for the extent to which this tank has been tested?

CHANGE IN MBT–70 PROJECT MANAGERS

Mr. Minshall. Before you start that, General, have you been on the project since the beginning?

General Luczak. Since July 1, 1968.

Mr. Minshall. Who was on before you?

General Luczak. Maj. Gen. E. H. Burba was on before me, and he succeeded Major General Dolvin.

Mr. Minshall. Why do they keep changing project managers?

General Luczak. I cannot answer that question, sir.

Mr. Minshall. I was complaining about that this morning. They get a guy in and the program starts going bad, and they get him out and promote him and put somebody else in.

General Luczak. I think they have me by the scruff of the neck.

Mr. Minshall. You are just new on board, then.

Mr. Poor. General Luczak is stuck with the job.

Mr. Minshall. He is new on board, though.

Mr. Poor. He is new on board, and he will stay on the program to its completion.

Mr. Minshall. I think that is what is wrong with half our military procurement practices. We keep changing these project men. It is silly.

Mr. Poor. I agree with you entirely. I am doing everything in my power to ask for longer assignments of project managers or the use of civilian project managers, where appropriate, so the man responsible for starting one of these major programs is accountable to us at the end of the program for its status. General Luczak will be in that position.

MBT–70 TEST PROGRAM

General LUCZAK. Insofar as the testing is concerned, there are six research and development prototypes in each country, the United States of America and the Federal Republic of Germany. The total testing to date has been over 37,000 miles on the vehicles, including two test firings. We have fired over 2,000 rounds out of the weapons system. We have 15,000 miles on the Daimler-Benz engine. We have two 6,000-mile tests on the suspension system.

The components you saw being exercised in the automotive phase today are components that have gone through a very long R. & D. test, in some cases longer than previously we required before putting a vehicle like this into production.

CONCEPT OF CHANGING PROJECT MANAGERS

Mr. MAHON. Mr. Poor, do you suppose one of the reasons for the poor showing the United States military has often made in weapons systems is that a project manager stays on the project for a limited period of time and then moves on, and probably does not have the feeling of responsibility that he really should have and he does not go up with the program to success or down with the program to disaster?

Mr. POOR. Mr. Chairman, I am sure that may contribute. Military people, as you know better than I, are trained to assume responsibility and keep it in a system of rotating assignments.

In my experience, the project managers on these projects have brought extreme good will and great dedication to the project, but it is inevitable with this much turbulence in project managers, there will be discontinuities, that people will forget and the programs will suffer.

I think it would be most desirable if we could arrange matters in such a way that it did not unfavorably impinge on a military career for a man to be given project manager responsibility for the duration of a program.

General BETTS. The difficulty from the military point of view is that a program like this may go 5 to 7 years, which gets him out of step with his colleagues in terms of breadth of experience, and his chances for development are thereby limited. Consequently, we have tried to strike a balance in that regard.

Mr. MAHON. We have hurt the programs and we have hurt the cause of defense, other than helping the officers.

General BETTS. I agree with Mr. Poor, we should make a very definite effort to extend the period that a project manager is on the job, but I am giving you the other side of the coin that has driven decisions in the past.

Mr. RHODES. Is that not almost an irrefutable argument for civilian managers?

Mr. POOR. General Luczak is about to become one.

General BETTS. We might point out that all of the project managers have a largely civilian technical team in support. It is not as though

the continuity is dropped like a hot potato when you change from one project manager to another.

Mr. MAHON. You speak almost as though you feel that project management is too important a job to be entrusted to military personnel.

Mr. POOR. I certainly would not agree to that. I think perhaps it is too important a job to be entrusted to short-termers.

Mr. MAHON. That is a good response.

General BETTS. I believe we need continuity in the job.

Mr. MINSHALL. We need continuity in the Congress, too, General.

DEVELOPMENT WORK TO BE DONE

Mr. POOR. Mr. Chairman, I think we may have given the impression that the road ahead in the development of this tank is a very easy one. It is not. There is a great deal still to be done, including the design decision for the next generation of prototypes.

There are still difficult problems with the German part of the design venture in getting agreement on what components go in.

There is a problem on which I will meet with Dr. Herr Wahl, who is Dr. Foster's opposite number in Germany, next month for the selection of the suspension system for this tank. Here both nations design hydrodynamic suspensions that are very good. There is really very little to choose between the two designs. Both have worked reasonably successfully under test.

We think ours is better for a number of reasons in detail. The Germans think theirs is better because they have been working on it and understand it better.

I am hopeful, if we cannot get agreement to use the American suspension, we will be able to standardize on a suspension system that incorporates the best features of both, which would be then produced in both countries identically.

There have been a number of problems of this sort which have made the design choices slower and, therefore, the development more expensive.

It has not all been lost, because the arguments between the two user teams have caused the engineers in both countries much more carefully to assess the merits of the design features that they incorporate into the tank.

So, this tank will incorporate not only a great deal of technical advance, but also the benefit of more thought on military utility than has been given to any combat vehicle up to now in history.

I did not want to leave you with the impression that we had a firm design, a firm plan for production, and that there are not many things left that might still cause us to come back and say we have changed something, because we will be doing that.

SOVIET ARMOR CAPABILITIES

Mr. MAHON. What nations of the world are the most proficient in the production of armor, in the production of tanks? I thought the Germans probably had the reputation of being pretty good in this field. Are the Russians better than the Germans?

Mr. POOR. I find that hard to comment on.

General Luczak?

Mr. MAHON. General Betts, what do you think?

General BETTS. Certainly the Russians pay a great deal of attention to armor, but they also do some things that are completely unacceptable to our users.

For example, they so structure their tanks that the tank must be manned by a man 5 feet 6 or under. We just could not structure our force that way. It is too hard to find the right cross section of people if one limits them in stature.

Also, they tend to deny themselves capabilities that are inherent in modern technology. That is the difference between the capability that goes with complexity and their approach, which is to stress simplicity and numbers.

That does not change my comment that they have accepted stabilization, because I do not consider stabilization a tremendous complexity, even though we have had some trouble in applying it to our vehicles.

Mr. MAHON. Do you suppose that the Russians will move forward with the development of other tanks while we are dawdling about with the M–60 and the main battle tank 1970? - -

General BETTS. I suspect they will keep pushing for development. They have kept a continuing program of adding new capabilities to their force on a fairly regular basis, and I would suspect that they will keep it up.

ESTIMATED UNIT COST OF MBT–70

Mr. MAHON. Mr. Minshall, do you have a question at this point?

Mr. MINSHALL. General, what is the unit cost of the MBT–70 as it was first planned, and what it is today, estimated?

General BETTS. As it was first planned, General Luczak could answer that.

General LUCZAK. Actually, the unit cost, Mr. Minshall, was not arrived at, not looked at very seriously until they decided what kind of a tank they wanted and got the hardware together. At that time the Army made estimates of what the price would be in production, and the estimates ranged from a low of ——— to ——— figure. We are talking about 2 years ago and talking about a period of time when I was not the program manager, but this is in the records.

Recently what we have done to try to analyze this situation is ask "What is the cost of this tank?" and "What can we do with it?" This is with respect to a base line vehicle and we want to price it out in production quantities because it makes a very great deal of difference whether you buy 800 tanks, whether you are buying 8,000 tanks as far as production costs is concerned.

Now, with that production tank, the thing that Mr. Poor and General Betts were talking about, that is the producibility cost reduction study, we are going to take this base line tank and say: Well, the squat feature costs x thousand dollars per unit per vehicle. It is worth that from a combat standpoint?

We ran this through computerized war games to see what the effect of taking that particular capability is on the war gaming of the tank.

Now, in November of this year the Batelle study, which indicates

base line tank, the production figures on the base line tank, will be available to both us and the Defense Department.

Mr. MINSHALL. You had an original production estimate on this tank you just read, of ——— to ———?

General LUCZAK. Yes.

Mr. MINSHALL. Cranking in all the same factors that you cranked in then, the number of tanks you estmiated that you would put into production, what would that cost be now as you look down the road?

General LUCZAK. We can only estimate prior to this study, which should firm up the figure, but I would say in view of the inflation, the rise in price of labor and materials, that price is somewhere around ———, we would guess, at this time.

This represents the top bracket, as we see it now, and we are going to take off from this in order to bring the price down because it represents some things that can be given up.

GERMAN LEOPARD TANK

Mr. MINSHALL. The Germans are having considerable success and getting more enchanted with their own Leopard tank. I have heard reports that the FRG is losing interest in the MBT–70.

General LUCZAK. There is a group of Leopard tankers within the German Army, just as there is a group of MBT–70 proponents within that army. There certainly are political pressures and industry pressures for the Germans to continue the tank that they are now in production on and selling to other European nations.

On the other hand, their developers believe that to take the Leopard and to in effect increase its capabilities to that for the job of a main battle tank would be a very difficult job and it would be better to start from scratch with the MBT–70.

CHRYSLER "K" TANK PROPOSAL

Mr. MINSHALL. In view of these questions and answers, I would like to ask you one more question in view of the rapidly increasing cost of the MBT–70, in excess of ——— per unit cost, the continuing schedule slippage which will probably be at least 5 years and the waning interest of the FRG, shouldn't you be giving consideration to an M–60 product improvement backup program? Our staff has investigated the Army's Engineering Agency contractor's Project K concept, which is an M–60 product improvement program. Are you familiar with that?

General LUCZAK. Yes.

Mr. MINSHALL. That is an M–60 product improvement program. Indications are that this concept will give you almost as good a ballistic protection as the MBT, using the same weapons system, is far less complicated and is estimated at a production cost of under $350,000 or ——— the latest estimated cost we have on the MBT. In view of those statements, shouldn't we be taking a good look at a backup system such as Project K?

General LUCZAK. I am sorry. When you said Project K, I thought you were talking about Project CARE.

Mr. MINSHALL. K like in King.

Mr. POOR. Is that the Chrysler tank?

Mr. MINSHALL. I believe it is.

Mr. POOR. I think, again, if we agreed with the premises we would agree with the conclusion. But our study of the K tank proposal, as General Luczak said earlier, indicates that to get to the full level of capability, comparable capability of the MBT–70 would result in a tank of comparable cost. We don't see any advantage in a new start to try to marry the MBT–70 class of weapon system to a tank which lacks the cross-country mobility, the automotive superiority, and other advantages that are inherent in the MBT–70 design.

Mr. MINSHALL. But many disadvantages as well, incuding ———.

Mr. POOR. I am reasonably confident, Mr. Minshall, that if we incorporate in a tank based on the M–60 series the kinds of power-to-weight ratios that are needed to give the cross-country mobility, fire control system and the armament system required to give comparable fighting capability, that the price differential in the tanks in production would be very small.

Mr. MINSHALL. I am talking about this as a backup system.

Mr. POOR. As for a backup, we do have the M–60A1E2 program which, as you know, is in some considerable technical difficulty at this point in time. The M–60A1E2 is intermediate in its capability between the current M–60 and the MBT–70. I think when that system is debugged it will give us a reasonable good interim capability. The only thing it will lack is the high-velocity kinetic energy round of the MBT–70 and the sophisticated fire control and full night-fighting capability. It will, of course, lack the agility of the MBT–70 but it is a pretty reasonable intermediate tank. Coupled with the conventional M–60, fighting together in an appropriate mix, it will give our forces missile-firing capability and fairly important gun-firing capability.

Mr. MINSHALL. How familiar are you with Project K?

Mr. POOR. I have read the K tank proposal and I have read it in some detail, and seen a mockup of the tank and I have also read Army comments on it.

Mr. MINSHALL. What is your opinion of it, General Luczak?

General LUCZAK. I do not know it, sir.

Mr. MINSHALL. Do you have any comments on it, General Betts?

General BETTS. I might add there was a very careful analysis of the K tank proposal in exactly the context which you have presented it here. The several problems that we had with the proposal as summarized are: First, our analysis would indicate that a $350,000 price tag is unrealistic. We are already over that number on the M–60A1E2. The K cost would be a higher cost than the M–60A1E2. Therefore, that cost figure is rather soft, at best. The second thing is that the kind of torsion bar suspension they are proposing and the up-gunning to put on the K tank, the same gun that is now on the MBT–70, is not a simple problem. There are balance problems that will require some extensive testing and evaluation before we would be convinced that this is a no-risk development. It is not a simple development. That is why the comment was made earlier that in this evaluation of the K tank we felt that it would take us just as long to go through the development and testing cycle for that as it will for us to complete the development and testing of the MBT–70 on its presently planned schedule.

MAJOR MBT–70 PROGRAM REVIEW IN DECEMBER 1969

Mr. MURPHY. The Director of Defense Research and Engineering, Dr. John Foster, has stated in connection with the main battle tank program:

> We reappraised this program last year when the funding ceiling was about to be exceeded. Some of the problems were corrected, but serious new ones have developed. We are again assessing the situation at this time. Basically, we had three problems. The U.S. air-cooled engine did not perform satisfactorily; the German automatic loader has only begun to be tested but appeared to be unreliable; and the tank's unit cost was much higher than our M–60A1E2 tank using the M–60 chassis.

He further stated that a major program review will be held this December at which time relative merits of the current design and an austere version of the MBT–70 will be determined.

How much of the $44.9 million requested for fiscal year 1970 for this program will be obligated prior to the major program review to be held in December?

General LUCZAK. Let me try to refresh my memory. There is less than $20 million on the R.D.T. & E. which will be obligated prior to the December program review. We have examined to see what is the minimal sustaining program that we can go on between now and December, not only in R.D.T. & E. but in other developments that are ancillary to the MBT–70. So that I would say less than $20 million.

Mr. MURPHY. How will that be utilized; in what areas?

General LUCZAK. The $20 million will be for continuation of the General Motors effort, the national water lift effort, continuation of the tank testing of the six pilots that we now have, for the General Motors effort on the automatic loader where we are interfacing the gun-ammo loader. We also have the responsibility in the United States for the integration of the turret. The Germans have the responsibility for the integration of the hull. It would be applied to these efforts. That is the minimum sustaining between now and December which will be the point at which the program will be reexamined.

Colonel LAMB. In addition, there is considerable on the turbine, isn't there?

General LUCZAK. There is some on the turbine on that, and again that is the minimum sustaining between now and the end of the turbine program.

FISCAL YEAR 1970 FUNDING FOR MBT–70 TANK

Mr. MAHON. For the record, detail for the committee the requirement for $44.9 million in fiscal year 1970.

(The information follows:)

The R.D. & T.E. funding requested for fiscal year 1970 will be used as follows (expressed in millions):

Tank Development:	
GM contract	$14.8
In-house support to GM	.5
NWL suspension	.4
Continental Aviation Engineering Co	.3
152KE gun/ammunition	1.6
Engineering and service test	1.9
MBT/Shillelagh	1.5
Turbine development	10.0
FRG prefinancing	5.0
Subtotal	36.0
Unilateral support	1.7
Advanced component development:	
Armor	1.6
Track	1.6
Auxiliary power	1.1
TREE	1.0
Vulnerability	1.0
Subtotal	6.3
Heavy equipment transporter—joint	.6
Heavy equipment transporter—support	.3
Total	44.9

CONSIDERATION OF AUSTERE VERSION OF MBT–70

Mr. MAHON. Why must you wait until December of this year to have a major review of this program? Why couldn't you have done it just as well last December?

General BETTS. You will recall that we had a program for a detailed costing review that will not be available until November. I believe that is a very important input to any major program review. In other words, the production costs, and what can or cannot be done to reduce the final program cost of this tank, is very important to the program review.

Mr. MAHON. You mean, if you are looking at the overall program of expenditures of the Army this would be a very important element?

General BETTS. That is correct, sir.

Mr. MAHON. Especially in the long pull.

General BETTS. That is correct.

Mr. POOR. That is right.

Mr. MAHON. What is involved in the design of an austere version

of the MBT–70? How would you make the tank austere? What are the cost and performance objectives of the proposed austere model?

General BETTS. Can I ask General Luczak to respond?

General LUCZAK. The austere version of the tank is a requirement by the Secretary of Defense as one of the options for the December review. In order to arrive at that point we have taken the study that I mentioned previously which prices out each component and tries to weigh its combat effectiveness down a sliding scale, you might say, of combat effectiveness. At the present time there are five conceptual tanks which depart from what I referred to as the baseline tank which is the upper limit. Concept No. 1 will do such things as eliminate the squat feature, take out the requirement for the driver to have the snorkels erected from within the tank but he will have to go out mechanically and push them back up. The night sight may be degraded to a less powerful, less capable night sight because that is an area where the costs are very high in the fire control area. One of the concepts even gives up the missile system in order to examine what it adds to the war game that is being run on the tank. So this is the sort of process we are going through, Mr. Chairman. The user, both the United States and the Federal Republic of Germany are considering these concepts to try to arrive at an acceptable tank at the lowest possible cost.

Mr. MAHON. You did not answer the question as to the costs and performance objectives of the austere model. What are the objectives?

General LUCZAK. I think that the objective, simply stated, is: What is the least costly tank that we think is an effective tank in battle and what is the crossover point between reducing the costs and then reducing them to a point where the tank really is not cost-effective; it is not enough of a superiority over present tanks to warrant fielding it.

General BETTS. Specifically, Mr. Chairman, we have not set a precise cost goal and said that we must get to $500,000 or $600,000 or some such number. We are going at this incrementally to see what each increment of performance does to the cost pattern.

Mr. MAHON. What efforts are underway which would lead to the development of a new tank if the MBT–70 is terminated?

General BETTS. We do not have any program at the moment that is pointed in that direction.

COST OF DEVELOPING M–60 TANK

Mr. MAHON. How much time and money was spent in development of the M–60 in its original configuration?

General BETTS. I will have to supply that.

(The information follows:)

The M–60 tank was conceived as an evolutionary development, making maximum use of proven components. The two major increases in capability which it provided, in comparison to the M–48-series tanks which it was to replace, were greatly increased cruising range and main-gun firepower. Both of these increases resulted from incorporation of components already well developed and tested under other programs: the diesel engine which permitted the extension of cruising range was a direct conversion of the gasoline engine used in the M–48 tanks: the 105–mm. main gun which increased the firepower was a British development used to up-gun their Centurion tanks and selected about this time by the Germans for their Leopard. Thus, although the nominal R.D.T. & E. costs for development

of the M–60 were $4.9 million, this sum was very much minimized by use of components developed or product-improved under other programs, including that for the M–48 tank.

General BETTS. That was really part of the generic M–48 family and rather grew from that direction. I would have to research that to give you a number.

Mr. POOR. I don't know whether I ought to say this on or off the record, but let me try it off the record.

Mr. MAHON. Off the record.

(Discussion off the record.)

TOTAL COST ESTIMATE TO DEVELOP M–60A1E2

Mr. MAHON (continuing). Will you also tell us how much more has been spent or is being spent in developing the M–60A1E2?

Mr. POOR. Yes, sir.

General BETTS. ——— million R.D.T. & E. is the current estimate to develop the M–60A1E2.

LACK OF RECENT HEAVY TANK DEVELOPMENT EXPERIENCE

Mr. MINSHALL. You said you have had no experience in developing a tank from scratch, Mr. Poor. We had built numerous tanks in this country, the M–42, M–41, 108, 56, even the 114. Granted, these are light tanks, but it is still tank engineering.

Mr. POOR. I think my point was in the heavy tank area we have had no recent experience.

Mr. MINSHALL. What is so different about engineering in a light tank vis-a-vis a heavy tank?

General BETTS. There are tremendous differences, a completely different ball park of power train demands and virtually every subsystem is different. It is a different system, much tougher.

Mr. MINSHALL. It must be, the way you have goofed off on this one.

General BETTS. It is, Mr. Minshall, I assure you.

MBT–70 DEVELOPMENT COST

Mr. ADDABBO. The original estimate of the cost of the bilateral development program for the MBT–70 was $120 million. When this figure was questioned by the Secretary of Defense the estimate was reduced to $80 million. The estimated total joint development cost is now $303 million. How realistic is the $303 million? How likely is it that this amount will be exceeded?

General LUCZAK. The $303 million is what we call a joint program and has a provision by both governments that when an item which is the responsibility of that government exceeds the development cost estimate on the decision sheet—you see, what has happened is that $303 million has been broken out on the decision sheet which parcels out the portion of the funding of the $303 million and also farms out the job that goes with it. Now, if a country does not perform its research and development with the amount of money that has been allocated to it, then it pays unilaterally in order to complete the job. So the $303 million, as far as an international program is concerned, appears to be

sufficient to get us through the R. & D. and through the next set of pilots, when our visibility will be better. Right now the $303 million looks good on the international program.

On the other side, there have been unilateral costs by both countries. An example: We have looked at the turbine program and we said that ultimately for this tank the turbine might offer some promise. So the program to develop a turbine is outside the international $303 million figure. We have a requirement, for instance, for an engineer tank, for an armored bridge launch tank. The Germans do not have this. So this is outside the $303 million program. But to answer you specifically, the $303 million at the present time in developing the international tank looks adequate. There are certain unilateral costs that we recognize right now to the tune of some, I believe it is, ——— million on the U.S. side. But these are unilateral U.S. requirements.

Mr. ADDABBO. Will you itemize those for the record?

(The information follows:)

The United States unilateral requirement for the tank is ——— to be utilized as follows:

	Amount
General Motors contract	———
Engine (CAE)	———
Suspension (NWL)	———
152KE gun/ammunition	———
Engineering and service testing	———
Automatic loader	———
Scavenger testing	———
Comparative evaluation, MBT–70, M–60, A1E2	———
Vulnerability reduction	———
Turbine engine	———
Total, United States unilateral program	———

Mr. ADDABBO. What is the probable total development cost of the MBT–70 tank if its development is continued to completion?

General LUCZAK. I would say the international tank, with respect to that the $303 million is as good a figure as we have now.

Mr. POOR. Do you want to add to that the unilateral costs?

General LUCZAK. Unilaterally-caused costs to the United States, in case some of our developments don't pan out, although right now they look good; I would say we have no better judgment now than the $303 million figure internationally.

Mr. ADDABBO. Right now it would be $303 million plus ———?

General LUCZAK. $303 million plus ———.

Mr. POOR. Plus the German unilateral figure.

General LUCZAK. Plus the German unilateral, which they have to furnish; yes, sir.

Mr. ADDABBO. It soon became apparent that the $80 million estimate made in 1963 was unrealistic. In 1965 a revised estimate was prepared and $138 million was the figure decided upon. One month after the estimate of $138 million was developed the prime U.S. contractor, General Motors Corp., presented a hard estimate of the cost of their effort alone at $88.6 million alone as compared with the $85.4 million that was the entire U.S. share of the $138 million estimate. Why were such unrealistically low estimates made in the early stages of this program?

Mr. POOR. That is a very difficult question to answer, Mr. Chairman.

Mr. ADDABBO. Who made them?

General BETTS. The Joint Engineering Agency was working together to make the estimate that came out at the $138 million. Of course, that $138 million was worked out jointly between the two managers long before the September 1965 date when it was approved at the minister level. But it is perfectly clear that General Motors felt that there was some reliability, design, analysis, and testing that had not been in the original program. Why that did not surface earlier I don't know.

Mr. POOR. May I go off the record?

Mr. ADDABBO. Yes.

(Discussion off the record.)

Mr. POOR. I will give you something for the record with respect to that.

(The information follows:)

In the early phases of the program, the project managers and the senior Army and DOD people involved were heavily preoccupied with working out a viable international arrangement and establishing performance specifications. It is my own impression that, as a result, all early cost estimates were lightly treated. I, personally, feel that credible cost estimates for the development program really first were developed at the time (July 1968) when the joint ceiling was established at $303 million. These estimates have been further improved under General Luczak's management and the intensive review of the past year.

HISTORY OF UNDERESTIMATING PROGRAM COSTS

Mr. ADDABBO. In my short term as a member of this subcommittee and listening to much of the testimony on various programs, it always seems that we come to this one basic failing—a very low original estimate and then suddenly the thing grows.

Now, is this perhaps because if we were given the true realistic figures for the program that possibly the program would not be approved?

Mr. POOR. I am perfectly aware of the fact that there have been a number of programs started that way. What we are trying to do today, and I hope it works, is through insistence on much more careful contract definition efforts with much more hardware in the early feasibility work, to establish a technical and cost base line before we start down the road to completion of expensive programs. Dr. Foster has urged this, I have urged it, the DOD and all three services are trying to do this. I hope that in the future our estimates will be better. We cannot guarantee it, but we are trying very hard.

Mr. ADDABBO. I am going to be honest with you; no one is being kidded except the taxpayer. Actually, you, the Defense Department, and we on this side of the table particularly in many cases receive unnecessary abuse. If we were given a more realistic estimate in the first instance, the newspapers would not have the opportunity to blow the thing up. If we need the armament, whether it costs $1 or $10,000 or $1 million, if it is truly needed, then it must be funded. But to tell us it is only going to cost you $10,000 today, and 6 months from now we find it is going to cost us $100,000, something is wrong some place.

Mr. POOR. Yes, sir.

Mr. ADDABBO. Either we are not doing our job in trying to get the true facts, or we can't get the true facts because you are hiding it from us.

Mr. POOR. Well, that is why we have had a series of reviews of the whole weapons acquisition process using the Defense Science Board, the Defense Industry Advisory Council. Dr. Foster has arranged for a summer study, which is going on right now in Newport under the chairmanship of Dr. Al Hall, to see how we can introduce our decision points, not at the point where a new weapon system is a dream on paper and a hope in someone's mind, but at the point where we know enough about the road ahead so that we can indeed put in much more realistic cost estimates. That we are dedicated to doing. I think we are going to be able to make it.

Mr. RHODES. If the gentleman will yield, actually that, I suppose, is the main reason that the policy of the DOD now seems to be more and more to go toward the development of prototypes.

Mr. POOR. That is correct.

Mr. RHODES. Before you actually go into production, that is, so that you won't, hopefully, have these horrible overruns. We still, I am sure, are going to continue to have cost overruns insofar as R. & D. is concerned—and I am saying your piece for you, general.

General BETTS. This is right.

Mr. RHODES. Because you can't tell what it is going to cost to R. & D. a project or object that nobody has ever built before.

General BETTS. That is right. When you are mixed up with respect to what constitutes invention, you don't really know how to do it.

Mr. RHODES. I do think we can get over the horrible cost overruns in production, which is what the gentleman from New York was talking about, and I agree with him.

Mr. POOR. I fully agree. I think it is essential and perfectly possible to avoid cost overruns in production.

U.S. SHARE OF MBT–70 DEVELOPMENT COSTS

Mr. ADDABBO. The U.S. share of the present official total development cost of $303 million is $173 million. The descriptive summary submitted in support of your request for fiscal year 1970 funds shows that $184 million has already been appropriated for this program and you are requesting $44.9 million in addition in fiscal year 1970. It is, of course, not anticipated that the 1970 funds will complete development of the program but appropriation of the fiscal year 1970 funds would raise the U.S. spending to $228.9 million. What costs over and above the U.S. share of the joint development costs have been obligated in support of the program? What part of the required $44.9 million is for activity not included in the joint development program?

General LUCZAK. I would have to take a few minutes to do some arithmetic, if I may.

General BETTS. We can work it out in the record. Remember, we mentioned ——— million unilateral U.S. figure which goes for the turbine and ancillary vehicles we are developing for the U.S. use, and not as part of the joint program. Now, when we talk about the

U.S. program, it should be the $173 million plus the ——— million we identified earlier. With that background, we will straighten out the arithmetic unless there is something in particular you want to get at now.

Mr. ADDABBO. The descriptive summary shows $184 million. Are there some unilateral funds included in that total?

General BETTS. Yes, I am sure of that. That is why I said it relates to that.

Mr. ADDABBO. Complete that for the record.

(The information follows:)

The total amount appropriated to date, $184 million, includes ——— million for development of the M60 tank incorporating the Shillelagh weapon system. The following is a display of this figure, showing joint and unilateral amounts:

[In millions of dollars]

Title	Total	Joint	Unilateral
Tank	140.2	137.5	2.7
MBT support	8.3		8.3
Advanced component development	———	———	———
Heavy equipment transporter	———	———	———
Heavy equipment transporter, support	———	———	———
Recovery vehicle	———	———	———
Armored vehicle launched bridge	0	0	0
Combat engineer vehicle	0	0	0
Trainers	———	———	———
M60 with shillelagh	———	———	———
Total	184.0	141.1	42.9

ADDITIONAL U.S. UNILATERAL COSTS

Mr. ADDABBO. What is the total estimated cost of additional developments outside of the $173 million U.S. share in the joint development program which are directly related to the MBT–70?

General BETTS. That would be the ——— million General Luczak identified earlier for the unilateral U.S. effort.

Mr. POOR. Can we provide the full detail for the record?

Mr. ADDABBO. Yes.

(The information follows:)

The total estimated cost for unilateral requirements outside the $173 million U.S. share of the joint program which are directly related to the MBT–70 are:

General Motors contract	———
Engine (CAE)	———
Suspension (NWL)	———
152 KE gun/ammunition	———
Engineering and service testing	———
Automatic loader	———
Scavenger testing	———
Comparative evaluation MBT–70/M60A1E2	———
Vulnerability reduction	———
Turbine engine	———
Total additional U.S. unilateral cost	———

General BETTS. Currently that ——— million is not all-inclusive. So we will have to bring in other areas.

MBT–70 RELATED COSTS

Mr. ADDABBO. We have an investigative report that states that ——— million has been programed separately to finance related projects. A list of these separate items is no page 128 of the record.

Mr. POOR. We have not seen the report.

General BETTS. My mistake. That ——— million figure we are using is the unilateral U.S. effort yet to go. I had not added in the unilateral U.S. effort to date. So we will have to add that into the record.

Mr. ADDABBO. In addition, the related programs provided us by our report show MBT–70 support, ——— million; trainers, ——— million; RV, ——— million; AVLB, ——— million; CEV, ——— million; M–60, ——— million; HET, ——— million; JOPIP, ——— million, making a total of ——— million.

General BETTS. That agrees with our assessment of those things we carried as MBT–70-related. The AVLB is the armor vehicle launch bridge. The HET is the heavy equipment transporter. We will identify those specifically in total cost as well as what is yet to be paid for that.

(The information follows:)

Project	Committee figures	Current estimate	Required in fiscal year 1970 and beyond [1]
MBT; U.S. support	———	———	———
MBT; 70 trainers	———	———	———
Recovery vehicle	———	———	———
Armored vehicle launched bridge	———	———	———
Combat engineer vehicle	———	———	———
Heavy equipment transporter joint	———	———	———
Heavy equipment transporter support	———	———	———
Advanced component development	———	———	———
Turbine (separated from advanced component development)	———	———	———
M–60	———	———	———
Total support	———	———	———

[1] Figures in this column are contained in the overall current estimate shown in the center column.

Mr. ADDABBO. In estimates of the total development cost of the main battle tank which have been given to the Congress, did you include the related costs amounting to more than ——— million to which we have just made reference?

General BETTS. Yes, sir.

Mr. ADDABBO. What amounts are included in the fiscal year 1970 budget for the support of the MBT–70 in addition to the $44.9 million in the line items?

General LUCZAK. We have $8.9 million. In addition to the line item of MBT–70 international, there are $8.9 million for some of the items that you mentioned previously.

ADVANCED PRODUCTION ENGINEERING COSTS

Mr. ADDABBO. How much money has been programed to finance advanced production engineering and the facilities and tooling required for production of the MBT–70 tank?

General LUCZAK. It is $20.7 million.

Mr. ADDABBO. Does that include facilities and tooling?

General LUCZAK. There are very minor facilities and tooling involved in this.

Mr. ADDABBO. Will you give us the cost of those items?

General LUCZAK. The facilities and tooling will be out in the 1972 and 1973 time frame. We can give these to you for the record. It will be in that time frame, though.

Mr. POOR. Those moneys in the 1972 time frame for facilities and tooling I trust will be understood as estimates only at this time because they cannot be firm yet.

Mr. ADDABBO. Soft estimates or hard estimates?

General LUCZAK. I think they will be kind of soft, and the reason is, for instance, if we build a Daimler-Benz engine in this country, how will it be built? Will the successful manufacturer put up his own plant or not? It is those kinds of questions that make it soft.

Mr. ADDABBO. How much money has been obligated to date in this effort? Where has this money been budgeted and what is the current best estimate of the total cost of advanced production engineering and facilities both in the joint program and the U.S. share?

General LUCZAK. I would like to provide that for the record.

(The information follows:)

Total advanced production engineering (APE) funds obligated to date are $20.5 million, and no funds for facilities have been obligated. APE funds have been budgeted under activity 5 in the Army budget, on the tracked combat vehicle line, production base support. The MBT is not specifically identified on this line. Under the $40 million joint APE program, the United States is charged with $20 million. The total United States APE effort (joint and unilateral) is $188.6 million. The total United States facilities costs are all unilateral and are estimated at $43.2 million.

Mr. ADDABBO. The staff report states that $45 million of advanced production engineering money will be used for additional engineering by the United States necessary to prepare the German-developed components for production and the fabrication of the four pilot tanks which will contain for the first time all components produced by the United States. Is this expenditure a direct offset to any savings that might result from joint support of the development program?

Mr. POOR. Sorry, Mr. Chairman, I don't fully understand the question.

General BETTS. I don't see how it can be an offset.

Mr. ADDABBO. Will these added costs offset any savings to be realized as a result of the joint nature of this program?

Mr. POOR. You recognize, of course, that any answer to that question is largely in the realm of speculation and must be based on several very rough and uncertain estimates. The cost of bringing these components to a production-ready status on a unilateral basis from the beginning, as opposed to the cost of the actual arrangement in which the FRG performs the development and we perform APE and qualification test, in my judgment would be about equivalent. This is not to say that no advantage has accrued from engaging in a joint program, because many other factors not expressable in terms of dollars must also be evaluated.

FIFTEEN MILLION DOLLARS "BORROWED" FROM GERMAN GOVERNMENT

Mr. ADDABBO. The staff investigators uncovered an example of very peculiar financial procedure. In fiscal year 1966, $19.8 million was programed by the Army for the MBT–70 program but only $18 million became available. The time schedule of the joint development program at that time required the United States to obligate $33 million in fiscal year 1966. Thus, the Army was $15 million short. The R.D.T. & E., Army, funds were obtained by reprograming and no funds were provided from the OSD emergency fund. Rather than requesting supplemental funds from the Congress, the Army borrowed the $15 million from the German appropriation for the program. The $15 million is to be returned to the Germans in $5 million increments in fiscal years 1970, 1971, and 1972. Thus, funds not yet appropriated by Congress have been obligated on the program. This appears to be in direct violation of article I, section 9 of the Constitution. Why did the Army choose to circumvent the appropriation process in this manner?

General BETTS. I can't answer the "why" question. I suspect, but I would have to check this for the record with the project manager's report of that time. I presume that the Germans knew very well that we could make no final commitment to repayment unless the Congress did in fact agree to appropriate money that would be used for repayment. We had the momentum of the program getting underway and the funds were not readily available.

Mr. ADDABBO. Has this been discussed at the OSD level?

General BETTS. Oh, I am sure they were well aware of it.

Mr. POOR. Yes, it has.

Mr. ADDABBO. Was this $15 million approved by OSD and is it included in this fiscal year 1970 budget?

General LUCZAK. Five is included in the 1970 budget for return to the FRG, and five for each of the next 2 fiscal years.

Mr. ADDABBO. Was this borrowing approved by OSD?

General BETTS. There are some things that we will have to explain about that in the record, and it relates to the fact that it gets complicated by the effort to settle with the FRG who does that part of the work. I just don't have enough information here to give you that aspect of the $15 million that was borrowed.

Mr. ADDABBO. Has OSD approved this procedure and the payment of this $5 million?

General BETTS. I am sure they have, because it was explained to them and it has been approved.

Mr. MINSHALL. When was it approved by OSD?

Mr. POOR. May I volunteer a point about the structure of the agreement with the Germans? It does say that upon completion of the work there will be a sort of final balancing out to make the funds come out equitably and 50–50 within the agreement. Now, that is modified somewhat by the production plans which could affect the 50–50 up to 138. But we can provide that detail.

Mr. ADDABBO. Did OSD approve this transaction before or after the fact?

Mr. POOR. I assume before the fact, but I will have to check that.

General BETTS. We would have to confirm that, but all of these international things were handled with full knowledge of the people in OSD.

Mr. MINSHALL. In what calendar year was this funding approved by OSD? Put that in the record.

(The information follows:)

The original transfer of the $15,000 from the Federal Republic of Germany to the United States was accomplished within the provisions of the original joint agreement of August 1, 1963, as signed by the Secretary of Defense. The subsequent repayment of the $15,000 to the Federal Republic of Germany was authorized by OSD in calendar year 1968.

Mr. ADDABBO. What officials of the Department of the Army are responsible for the decision to finance the program with borrowed German funds?

General BETTS. I will have to provide that.

(The information follows:)

Under the terms of the basic joint agreement, the provision of this $15 million by the Germans in fiscal year 1966 did not constitute borrowing, but rather it represented a means by which the Germans could avoid an unfavorable balance at the end of the program. This unfavorable balance was inherent in the unequal distribution of work allocation as opposed to the ultimate equal cost sharing of the $138 million joint cost ceiling. The official of the Department of the Army responsible for the decision to accept this $15 million was the program manager at that time, Maj. Gen. Welborn G. Dolvin, who acted under authority contained in the basic joint agreement. The impression that this transaction constitutes "borrowing" is understandable. However, it must be realized that at the time the $15 million was accepted, neither nation had any ideas concerning subsequent repayment. The joint agreements of that time called for work sharing of $85 million for the United States and $53 million for Germany, while the cost sharing (to be reconciled upon completion of the program) called for equal amounts of $69 million. Thus it was clear that Germany would owe $16 million, and the amount transferred substantially eliminated this unbalance at a time when it was convenient for Germany to provide these funds. In July 1968, a supplement to the basic joint agreement revised the joint cost ceiling and made ultimate cost responsibilities dependent on eventual production figures. Thus the premise on which the $15 million had been provided was changed and it was certain that the Germans would no longer be required to reimburse the United States. It was, therefore, jointly agreed by the two program managers and approved by Mr. Henry J. Kuss, Deputy Assistant Secretary of Defense, International Logistics Negotiations, that the $15 million would be repaid to Germany, as we have already discussed.

Mr. ADDABBO. What will be the result of a refusal by Congress to appropriate the $15 million owed the Germans?

General BETTS. I presume that would be worked out in the final intergovernmental balancing of the program.

Mr. ADDABBO. Are there other instances in this procedure having been followed by the Army?

General BETTS. None that I know of.

Mr. ADDABBO. Will you check your records further and advise the committee if there have been?

General BETTS. Yes.

(The information follows:)

Army records reveal no other instance in which joint programs have involved prefinancing of one nation by the other.

CURRENT UNIT COST ESTIMATE FOR MBT-70

Mr. ADDABBO. The initial estimate of the unit production cost of the MBT–70 was $250,000. At the time, the unit price of the M–60A1 tank was $180,000. Subsequent estimates have varied from ——— to ———. These estimates vary because not all of them include the cost of kits, ammunition, spare parts, equipment, and items of this type. What is your current best estimate of the unit production cost of the main battle tank, including the initial spare parts for the tank?

General BERTS. I believe we answered that in our cost discussion. Would you like to add to that?

General LUCZAK. The figure that I provided to Mr. Minshall of the top of ——— for the base line tank did not include the spares. That was for the production tank. I do not have the figure with me that provides for the production tank under various conditions that we discussed to include spares, and so forth.

Mr. MINSHALL. What would the normal spare expense be?

General LUCZAK. Can I provide that for the record?

Mr. MINSHALL. I mean off the top of your head now. What do you think it might be?

General LUCZAK. Ten or 15 percent of the estimate now.

Mr. MINSHALL. Thank you. Put the actual figure in the record, then.

(The information follows:)

A normal spare parts cost would be about ——— per tank. More refined figures based on projected estimates of parts usage will be available upon completion of the producibility cost reduction study in November this year.

Mr. ADDABBO. In a study by the Army Comptroller in April of 1967 a unit production cost of ——— was established which included the cost of kits and the assembly and overhead cost and profit. This estimate did not include the cost of ammunition and spare parts, and assumed that ——— tanks would be produced over a 7-year period. What more recent estimates have been made?

General LUCZAK. The more recent estimates are the Battelle cost study which will be available in November, and the preliminary results are that the tank under those production figures, around ——— the base line vehicle would cost around ——— and the Army is now examining the tank to see what can be taken off to reduce this cost.

Mr. ADDABBO. What studies of the producibility and costs aspects of the program are being made for the Director of Defense Research and Engineering and the Army? When will these studies be completed?

General LUCZAK. This is a producibility cost reduction study.

Mr. POOR. That is the November–December review that we mentioned earlier.

Mr. ADDABBO. According to current Army plans, what would be the total cost of the MBT program, including all U.S.-financed development costs, preproduction costs, and production costs of the number of tanks which you now plan to procure, including the kits and spare parts necessary for these tanks?

Mr. POOR. We would have to answer that with a range because the number planned for procurement is not firm. There is really no procurement decision at this point in time. So the only way we could

answer that would be by assuming a number to be produced. We will provide it in that form for the record.

(The information follows:)

The total cost of the MBT–70 program including all U.S.-financed development costs, preproduction costs, spares, ammunition, and production of ——— tanks is ——— million. This is based on a unit tank hardware cost of ——— which was selected from a possible range of ——— to ——— associated with the quantity of ———. The ——— reflects an estimate of the most likely configuration, for which a final determination has not been made.

"SAVINGS" FROM JOINT DEVELOPMENT

Mr. ADDABBO. One of the program objectives was to reduce costs to each country by sharing the development costs. In practice, the two countries involved in the program had different views on many things and many components were developed redundantly. This indicates that perhaps the development cost savings were illusory. As you analyze the program now, how much money do you believe that the Army saved on development costs by participating in the joint development programs with Germany? To what extent were the savings offset by cost increases which can be attributed to the joint program?

General LUCZAK. I will try to answer that, sir.

The first part about the duplication in certain components, in some cases, is hindsight, this was very wise, as in the case of the engine where it turned out that the primary candidate was a failure; the suspension system where both systems ultimately proved to be excellent systems. I don't think they would have been, had they not had the very searching examination that resulted from the competition between the two countries. I frankly believe that we probably could have gotten as far as we have now without greatly increasing the cost over what it is in the international field. I believe, though, that we would not have had as good a tank up to this point. Now, there is a crossover point beyond which an international program will cost more than it yields in results. I don't believe that at this time we have reached that point yet. I don't believe we save in actual dollars but I believe we do have a better tank.

Mr. MINSHALL. How close are we to that crossover point?

General LUCZAK. As we discuss and discover differences, and if I may, I will illustrate this with an example which I don't know whether you want on the record or not. But we and the Germans are busily engaged in trying to decide, for instance, how much fault isolation equipment, automatic fault isolation equipment should be in the tank. We are arguing for a lesser degree of fault isolation because of our interest in reducing the production costs, among other things. Ours would cost ———. The Germans, because of the way they constitute their army and the way they do their maintenance, would like to have a higher degree. Theirs would cost ———.

So we are arguing about ——— and when you multiply this by ——— tanks there is an awful lot of money here.

If we are compelled in this instance, or in many instances, to go along in order to achieve unanimity, to compromise in areas like this, then there is a point at which you would say "Well, you break off and you make the tank identical to ours as much as you can and retain the interfaces but you have your MDI system in and we will have our

MDI system in." As I say, that point may not be too far away, depending on how well we get along with the suspension decision, the MDI decision, the secondary decision, and other things in contention between us and the FRG.

QUESTIONABLE VALUE OF JOINT DEVELOPMENTS

Mr. ADDABBO. Going back to a previous question, Mr. Secretary, this might be where we would come to the offset in savings by our developing these four pilot tanks.

Mr. POOR. There is no question we have benefited from the fact that the Germans have built a number of prototypes and are testing them in Germany, using German funds.

Mr. MINSHALL. Would you yield?

Mr. ADDABBO. Mr. Minshall.

Mr. MINSHALL. I think at this point it would be well to put this statement from the report in the record:

> Spreading the R. & D. cost of a weapon system between two or more countries is worthwhile, either because it reduces the "threshold" cost (that is, the minimum expenditure of R. & D. necessary to take the development to production stage) for each participating country, or because it reduces the production cost per unit through a combined order for quantity production.
>
> But there are inevitably "costs of cooperating." Development costs will rise if there are specification changes to accommodate different demands, delays in setting specifications through intergovernmental negotiations, different technical standards and practices between countries or if the R. & D. is divided between several countries. Production costs will rise in a cooperative project if each country's industry has to be given part of the production work, if long journeys have to be made by each subassembly or if there are multiple final production lines. To take the example of a tank, a country such as Germany, with a requirement for about ——— tanks, in trying to cooperate with a smaller country with a requirement for 500 may raise the total R. & D. through accommodating the other country's needs, and fail to reduce the production costs through having to set up another production line in the second country. The saving per tank, if any, will be extremely small.

The only part I do not agree with entirely is that last sentence.

I think it is just the reverse. This has been proven in this case where the cost is to be increased.

Mr. POOR. There are benefits of competition which General Luczak mentioned and I think they are real, but it would be very hard to put dollars on them.

FOREIGN MARKET FOR MBT–70 TANK

Mr. ADDABBO. Early in the program it was felt that some of the development cost of the MBT–70 to the United States and Germany would be offset by sales of the tanks to foreign countries. As of now, what kind of interest is being shown in a concrete way by any foreign countries? Do you predict any foreign sales of the MBT–70?

General LUCZAK. We have inquiries—not inquiries, but desires for information on the tank. The Dutch Government has been interested in the tank up until the time of Czechoslovakia. At that time they decided they could not wait for MBT–70, and instead switched to the Leopard and made a buy of Leopard tanks. We annually brief NATO on the capabilities of the MBT–70. We have just done so. I think we will not know of any concrete interest until a production date approaches.

GERMAN LEOPARD TANK

Mr. ADDABBO. The Government of The Netherlands recently decided to purchase 415 German Leopard tanks rather than wait for the MBT–70. The Secretary of State for Defense of The Netherlands announced that for one-half of the probable cost of ——— MBT–70 tanks they could buy 550 Leopards. Is this an accurate cost comparison?

General LUCZAK. I don't know what the actual cost of the Leopard is, but I would say that is somewhere in the ball park.

General BETTS. I would put it in other words: We have no firm basis to challenge it.

Mr. ADDABBO. Do you know what the costs of the Leopards are?

General BETTS. I don't have that number.

General LUCZAK. We will try to obtain it and provide it.

General BETTS. I am not sure we will be able to obtain it.

Mr. MINSHALL. What kind of a tank is the Leopard? Add that in, if you can. Will you give us some kind of description for the record, too, as to weight, capabilities, and so forth.

(The information follows:)

The Leopard is the current German main battle tank. Its principal characteristics are as follows:
Weight, 44 U.S. tons.
Main gun, 105 mm. (United Kingdom design; same as U.S. M–60 tank).
Secondary weapons, 7.62 coaxial machinegun; 7.62 mm. AA on turret roof.
Power pack, 830 H.P. Daimler-Benz with Renk transmission.
Horsepower per U.S. ton, 19.
Maximum speed, ——— m.p.h.
Cruising range, 350 miles.
Ballistic protection, Hull front: ——— on U.S. M–60A1 tank. Turret front: on U.S. M–60A1 tank.
Unit cost (export price, $287,500).

EXTENT OF GERMAN PROCUREMENT OF MBT–70

Mr. ADDABBO. In the original plans Germany had anticipated the procurement of ——— MBT–70's. In October of 1968 this procurement was reduced to ——— tanks. What was the reason for this change?

General LUCZAK. I am not personally aware of this information, sir.

Mr. ADDABBO. Could you check it out and provide it for the record?

General BETTS. We will put in the record whatever we find out.

(The information follows:)

The Army has not been provided information of the current German production plans for MBT–70. Under the governing agreements for this joint development program, there is no obligation for the provision of this information. Although a specific inquiry has been made through the local German liaison office, a timely and specific reply is not expected. Under joint agreements, the eventual sharing of development costs for the completed program are dependent upon the ratio of actual production, and the German Government may well consider it advantageous from a negotiating point of view that this ratio remain undefined at this at time.

SOME GERMAN ARMY OFFICIALS FAVOR LEOPARD TANK OVER MBT–70

Mr. ADDABBO. To what extent has the German Government become so alarmed by the delays, technical difficulties, and cost increases as-

sociated with the MBT–70 that they are considering substituting procurement of other tanks, possibly their Leopard, for the planned MBT–70 procurement?

General LUCZAK. I think we had touched upon that previously with Mr. Minshall. The side of the German Army that favors a Leopard tank wants to upgun it and to provide the protection of a main battle tank. It does not have that now. The other portion of the German Army and German Government feels that this would not result in a good decision because it requires some very fundamental changes to the Leopard which it is not capable of incorporating very easily.

Mr. ADDABBO. Are there any further questions at this point?

Mr. MINSHALL. No.

Mr. RHODES. No

Mr DAVIS. No.

Mr. ADDABBO. At this point the committee will adjourn until 10 o'clock Thursday morning.

THURSDAY, JULY 17, 1969.

Mr. MAHON. We will resume the hearing.

VALIDITY OF LOCKHEED STUDY LEADING TO MBT–70 DESIGN

The staff report states that the MBT–70 program got off to a bad start in that although two contracts were awarded to the Lockheed Missile and Space Co. to make a study to pick the best design for a tank, weaknesses in the study raise the question of whether it was more misleading than helpful.

For instance, in the study the automotive reliability of the various concepts tested was not taken into consideration. It was assumed that if the tanks could get to the battlefield they would be able to keep going for the 10 minutes that the battles would last. Yet, in World War II tank battles, four times as many tanks were lost in some actions due to mechanical failure than to enemy action.

Further, the computer tank battles which were a part of the tests were not run a sufficient number of times to obtain statistical validity. The Swedish S–Tank, a low silhouette design with no turret and other unique features which proved to be a very successful candidate in every category of evaluation, was eliminated in the computer-simulated tank battles by substituting for it a more vulnerable design with different performance characteristics. Other weaknesses in the simulated tests indicate that they were not really valid tests.

Lockheed was recently awarded a contract for a study of various families of vehicles which will accompany and support the main battle tank on the battlefields of the 1970's. What expertise does the Lockheed Missiles and Space Co. have in the area of tanks?

General BETTS. They have the demonstrated capability of conducting simulated tank battles with a computer model that we consider a good one. They have people who know how to use it and understand what it is we want to get out of such studies.

I would challenge the judgment made that the parametric design and cost-effectiveness study on which we based some of our MBT–70 decisions was particularly weak because the object of the study is not to seek answers of the sort that were discussed in the critical comment but, rather, in the context of the tank battle to try to find out what as-

pects of design—now, I am talking about the more obvious characteristics, such as silhouette, armaments, armor, mobility in terms of speed—what aspects of the design are important to the tank's effectiveness and what aspects are of lesser importance.

The important thing that we got from the parametric design cost-effectivness analysis was information that helped us in our judgment with respect to different candidate subsystems and design characteristics of the tank.

Lockheed did not design the tank. A careful look at that study would indicate that we selected for the final candidate design none of those that were specifically part of the Lockheed parametric design cost-effectiveness analysis. What we did was take from it comparative effectiveness data that helped us in the selection of the final design that we and the Germans considered to be most effective.

NEED FOR OBJECTIVE DISCUSSION OF MBT–70 PROGRAM

Mr. MAHON. General Betts, I would hope that the Army would undertake to give the committee an objective evaluation of this program. If all of this is as perfect as some of the testimony indicates, what are we worried about?

General BETTS. I was attempting to say that the Army was satisfied with the kind of work that was done for us by Lockheed. We felt that they did what we asked them to do and did it with an adequate level of competency that in later similar exercises we went back to them for the use of the computer approach to study relative effectiveness of armored vehicles.

Mr. MAHON. It is pretty obvious to me that the Army is on the defensive and is trying to defend, apparently, the whole package. There are bound to have been some mistakes made in this program. Mr. Poor tended to so indicate, but I don't hear that from the uniformed witnesses.

General BETTS. I am prepared to admit we have made mistakes in this program, Mr. Chairman. I don't think any of us are perfect in this regard, but the indication that we based our whole approach on, in the MBT–70 design, a weak comparative analysis I don't think bears with the facts.

Mr. MAHON. The implication of my statement and my question is not that you based your whole case on a study that was weak, but the implication of my statement and the question was that there were weaknesses in these studies that should be recognized. But you seem to contend that there were no weaknesses in the study.

General BETTS. I would agree we can't expect any computer analysis to give us all the answers with respect to design. The impression I got from the comment that was made was as I had indicated. But let me, if you will, turn to Mr. Trapp who is with us from the project manager's office and who was closer to the design analysis than I was to give you his impression of what we got out of that.

Mr. TRAPP. In the Lockheed study we looked at broad performance spectrums of various major components. Such things as vulnerability relative to armor, placement of ammunition in the vehicle, placement of fuel, it was through this device we attempted to evaluate major

characteristics of various tank configurations. We played this through a computer simulation. As far as Lockheed itself is concerned, they were the management group that put the simulation together. The tactical environment that was played in the war games was provided by the combat development command element of the Army and, as such, they significantly affected the program more than did Lockheed, who was simply the engineering agency to translate performance characteristics into a computer simulation.

As far as the Swedish tank is concerned, the reason that was taken out of the analysis was, the Army looked at that configuration and felt, although the simulation was reasonable, that it couldn't perform the necessary tactical requirements that a tank has to do outside of the simulation, such as in the cities, you have to traverse turrets and do things that this tank cannot perform, as well as work in tactical formations.

We utilized the study in the design, the final design, or the final concept configuration, again to decide whether the military requirements that we had originally agreed to could be performed better with, say, a larger engine versus a smaller engine and take the reduction in performance, and this was the type of assistance the Lockheed study provided. At the same time, it did provide certain cost-effectiveness tradeoffs that assisted in the design.

EXPERTISE OF LOCKHEED IN TANK DESIGN AREA

Mr. MAHON. I asked what expertise the Lockheed Missile & Space Co. has in the area of tanks, and General Betts told me that they have considerable expertise in conducting simulated tank battles. Can you elaborate on that answer?

Mr. TRAPP. They had expertise in the formation of a computer simulation to stimulate the various scenarios to stimulate the characteristics of the vehicles that took place in these scenarios.

Mr. MAHON. How did they get this expertise? I didn't know they were in the tank business.

Mr. TRAPP. Computer simulation has nothing to do with armor versus missiles. It is simply a technical capability. They have a very large computer lab at Sunnyvale in their plant that they utilize in the program.

SWEDISH S-TANK ELIMINATED FROM LOCKHEED STUDY

Mr. MAHON. A representative of the Lockheed Missile & Space Co. advised the staff that the S-tank situation illustrated the fallacy and weakness in the whole study. The validity of the study was dependent upon the data used. He said the Army did not like the S-tank, and did not believe the data supplied by the German creator of the design used in the study, so the data was changed. Is that right?

General BETTS. The S–Tank was in the study. It was a part of the simulation and a part of the final evaluation. However, there are things in the tank that the Army felt could not satisfy their overall requirement.

Mr. POOR. Mr. Chairman, this is a disturbing line of questioning. The Lockheed responsibility in this work was the creation of a com-

puter simulation and running some calculations on this very elaborate computer equipment that were requested by the Army. Now, if a bad job of selection from that computer simulation has been made—and I personally don't think it has—then the person responsible for this judgment, or the people responsible for this judgment are senior Army people. I am disturbed that a statement by a contractor employee, immersed in the business of doing the computer simulation for the Army should be picked out as casting doubt on the validity of those judgments because from the perspective of the men working on the computer simulation, all the rest of the considerations that go into the design of an appropriate tank are simply missing. So I feel it is terribly difficult to respond to this.

I merely question the competence of the man at the contractor's plant to comment on the validity of the selection made by the MBT project office and by the Army staff.

Mr. MAHON. This is just a part of the information provided to the committee and it is up to the committee to evaluate the weight that should be given to it. I realize that everything here is not of the same importance, but it can be evaluated in connection with all the other facts and circumstances.

Mr. POOR. I agree and hope that it will be evaluated in that context.

QUESTIONABLE VALIDITY OF CERTAIN COMPUTER ANALYSES IN PAST YEARS

Mr. MAHON. I think most members of the committee are aware of the problems that have been created over the period of some years with computer analyses. There was considerable attention given a year or so ago to an analysis which "proved" that conventionally powered Navy ships were more cost-effective than were nuclear-powered ships. It was determined, to the satisfaction of some, that the studies which arrived at this conclusion had been tailored by the conditions specified to those who conducted the study by the systems analysts.

In view of the fact there was a Swedish S–tank available to these studies, and without knowing anything of the merit of the vehicle, shouldn't we question whether or not its rejection from the study parallels the rejection of some factors in the ship propulsion studies?

General BETTS. I think it is a perfectly reasonable question, but I think what one must recognize is the nature of the Army's use of the parametric design and cost effectiveness analysis.

We did not use it as a decisionmaking mechanism in the context of: Should we have a new main battle tank or should we not or, is a ——— tank cost-effective, or some of the other more policy-oriented decisions that one has to reach and for which systems analysis has been used in ways that I would agree with you aren't always completely objective?

But let me say this: There is a thesis that I have tried to expound among my own staff and I firmly believe it is absolutely true and can be demonstrated as an important consideration and that is that the effectiveness of systems analysis in the decisionmaking process varies inversely with the square of the distance to the source of the data.

Now, in this case we were using systems analysis in just the way it makes its greatest contribution. Varying the design parameters of the many ideas for tank design that were put into the hopper by both the Germans and the U.S. people, trying as best we could to cost them,

recognizing that it is hard to make a cost projection on something that has never been built. Nevertheless, since the costing was done with a group that was doing the costing of all of the concepts, one could argue that at least from a comparative point of view they were valid for this sort of an analysis. And what we did was to play tank battles in both offense and defense, varying things like silhouette, speed, armament, armor, fire control. All of the parameters that we could crank into the battle model on the computer and have some confidence that, at least for comparative purposes we were getting good answers. From that we began to get a feeling at the project manager's level, where he is dealing with tank designers, engineers, get some feeling of what it was about a tank that made it effective and what it was about a tank that made it costly and perhaps was not worth doing because the costs didn't match effectiveness.

I believe in this case, as has been well carried out and shown in the comparative film that we showed you the other day, that the things that we decided were important to this tank, have indeed proved to be the things that contribute to its effectiveness.

In that context, I believe we used the parametric design cost effectiveness analysis in the way it makes its greatest contribution and we subordinated it to the decisionmaking of engineers and military users who could introduce judgment into the equation. It was judgment which threw the S–Tank out of the picture because it is obvious to any tanker who studies the problem that if he can't fire behind him as readily as he can fire in front of him in all aspects of a tank battle, he is in real trouble, and we believe that except in the defensive role the S–Tank is clearly inferior to any tank in NATO.

LOCKHEED STUDY OF NEW FAMILY OF VEHICLES TO COMPLEMENT MBT–70

Mr. MAHON. What is the Army's plan for a family of new vehicles to accompany and support the main battle tank on the battlefields of 1970?

General LUCZAK. At the present time we are trying to evaluate whether or not it requires that the new family of vehicles be basically an outgrowth of MBT–70; that is, using the same hull, the same power.

Unless it is clear to us that it is cost-effective to go this route, we will examine other means, means within our present inventory expanding it to meet the requirement. In other words, this decision has not yet been made.

NUMBER OF TANKS NOT INCLUDED IN ORIGINAL STUDY

Mr. MAHON. In the original design study, all designs which did not include radiological armor were eliminated. ———. To what extent did the requirement for radiological armor eliminate some tank designs which would have had far more combat effectiveness than the design chosen?

Mr. TRAPP. The essential features, MBT is the capability of fire on the move, the capability of great automotive performance, or good automotive performance; these are inherent in the design regardless of ———. We have recently evaluated further ——— and still feel

both from the engineers' and the Army's evaluation, that the present configuration is the best to provide fire on the move, and the other features that are significant in the tank.

EFFECT OF SMALLER ENGINE ON MBT–70 CAPABILITY

Mr. MAHON. The successful study concept called for an engine with a power-to-weight ratio of 30.6 horsepower per ton. The development concept agreed upon had 22.5 horsepower per ton ratio. To what extent did the lower power-to-weight ratio adversely affect the capability of the tank?

General LUCZAK. I think you saw in the film the great increase in performance over any existing tank at the present horsepower-to-weight ratio.

In the production of MBT–70 it is the U.S. plan to have, if available, the turbine engine. The turbine engine, because of its characteristics will, for the same horsepower, increase the horsepower-to-weight ratio significantly until it will be approaching the specifics set out at the start of the program.

QUESTIONABLE UTILITY OF SHILLELAGH MISSILE ON MBT–70

Mr. MAHON. The main weapon system chosen for the main battle tank is the 152 millimeter missile launcher and gun known as the Shillelagh system. This system has been discussed by the committee in detail earlier so we will not go into it in detail at this time. The MBT–70 study pointed out that the Shillelagh missile has ———. One of the significant increases in capability sought in the MBT–70 was capability of firing on the move. This capability ———. The Shillelagh missile costs about ——— a round as compared with $500 for the conventional round. The Shillelagh missile is regarded as cost effective only at ranges beyond ——— meters, as the conventional rounds are sufficiently accurate and economical for use at shorter ranges. Only about 3 percent of World War II battles were fought ——— meters and 17 percent were fought at ——— meters. This indicated a ———.

General BETTS. I think one must recognize that those battles were not fought at the larger ranges because we did not have the gunpower to fight them at those ranges. It is prefectly obvious in our maneuvers and our exercises to date that Shillelagh will be brought into play on a much broader basis than in the past history.

Mr. POOR. The new kinetic energy round is now incorporated in the MBT and gives very impressive fire-on-the-move capability out to fairly long ranges. That is possible because of the stabilization system. It is probably true that the useful range of the MBT–70 gun will be significantly greater than the useful range of the gun, for example, on the M60A1E2, which has only a low velocity round. All of our recent studies on the utility of the Shillelagh still confirm it gives significant advantages over the M60A1 tank gun beyond ——— meters against large stationary targets. Also, it has significant advantages against smaller targets at shorter ranges and significant advantages against moving targets at essentialy all ranges.

We are now looking at the possibility of providing the MBT with the capability ———.

I think we discussed that somewhat at the last session. It doesn't appear to be very difficult to do that.

Mr. MAHON. It would seem to be a very great ———.

Mr. POOR. It would seem so. I am told that our simulation studies and field experiments indicate that in spite of this disadvantage the Shillelagh-equipped tanks do win, at long ranges. The missile-firing tank gets the kill quicker than the conventional gun tank.

General BETTS. You see, it is a very much longer range. The question of how fast the enemy can pick up the tank doing the firing is much different than it is when the range is at ranges like 500 or a 1,000 meters, where the tank is a lot more vulnerable to the enemy's immediate reaction to his first round.

What we are saying is, at the longer ranges we don't think the fact that ———.

Mr. MAHON. If you are fighting in desert country where you can see for long distances, that is one thing.

General BETTS. It would be a different circumstance, that is right.

Mr. MAHON. But my limited knowledge of western Europe indicates there are a lot of trees, hills, valleys and mountains, and you can't expect to fight on a smoother terrain with an unlimited horizon.

General BETTS. This is correct.

Mr. POOR. Mr. Chairman, some years ago we questioned the utility of the Shillelagh in this role at its originally designed range which was only ——— meters.

The Germans, through their work with us, convinced us that it would be useful in the European terrain to extend the range of the Shillelagh missile to ——— meters. This, was based on terrain studies, war games and maneuvers that they conducted on their own grounds. As a result, we have increased the range of both Shillelagh and TOW to ——— meters at some considerable effort. That effort appears to be justified by the fact that, particularly in a defensive situation, in the European environment one can assume positions which command avenues of approach where the long range of the missiles will be critically useful.

General BETTS. Mr. Chairman, another factor bearing on that same point, the British feel that this increased range is sufficiently useful that they are working on an antitank missile at ——— meters. The terrain doesn't always affect it, but there are many cases where it does.

Mr. RHODES. Is it possible to modify the Shillelagh or the MBT–70 to the extent that ———?

Mr. POOR. Yes, it should be possible. We have studies in hand today to determine how much the cost would be. The evidence of the successful firing of the TOW from a helicopter supports our belief that this can be done. The question facing us now is whether or not the additional complexity in the MBT–70 to ——— is too expensive.

Mr. RHODES. If you ——— while the tank is moving at maximum range, how long would it take the Shillelagh missile to arrive at the target? In other words, how long is the MBT–70 ———.

Mr. POOR. I am not absolutely sure. I think it is about ——— seconds.

Mr. TRAPP. Yes.

Mr. RHODES. Thank you, Mr. Chairman.

RELIABILITY OF SHILLELAGH MISSILE

Mr. MAHON. The report to which we have made frequent reference also points out that the reliability of the Shillelagh is much lower than that of conventional rounds. The conventional rounds have almost 100 percent reliability while the Shillelagh reliability is ——— percent based on the firing of 600 rounds, as I understand. If this statement is in the record I hope you will correct the record at this point.

If the Army designed a new tank today, would the Army include the Shillelagh missile as the main weapons system?

General BETTS. It is probable they would. The next generation of missiles beyond Shillelagh and Tow should have a seeker guidance system so we can get away from the business of having to track the target after the missile is launched. The technology is demonstrated for seekers guidance in a sort of a breadboard sense, but we have a lot of advance development activity we have to do before we would be prepared to start a full-blown development program for that missile approach. It would be a matter of timing.

Mr. MAHON. Is there some quick and easy answer to this question: Why is it that in our space program we can do such marvelous things but in the military field, while we accomplish many things, we seem to find it impossible to contrive weapons of offense or defense that will measure up completely to what we want. It would seem this is a country whose technology can send a man to the moon and return him—which we hope and pray will be the case—would be able to do a better job in developing weaponry in the Army, the Navy and the Air Force.

General BETTS. It is a matter of cost, Mr. Chairman. If we set ourselves a goal as a missile that is 100-percent reliable and spent the money to develop it to that reliability and had checkouts before firing, we could attain that level, but from the point of view of a military weapon it is hard to justify the very high cost of that extreme attention to design and to all the materials and all of the technology that goes into the missile. We are trying to strike a balance between the system cost and the reliability. The number we use now for the Shillelagh is ——— percent reliability.

USE OF BORE SCAVENGER SYSTEM ON MBT–70 GUN TUBE

Mr. MAHON. The difficulties which have been encountered with combustible case cartridges have been discussed earlier. Is it planned to include a scavenger system on the MBT–70 tank similar to the one on the Sheridan in order to remove unburned residue?

General LUCZAK. Yes, sir, it is.

Mr. MAHON. Elaborate for the record.

(The information follows:)

The function of the bore scavenger on the MBT–70 will be the same as that of the scavenger on the M551 Sheridan. However, the higher chamber pressures of the MBT–70 gun make it impossible to use the principle of a closed and locked breech as the Sheridan uses.

The scavenger ports for the MBT–70 gun are cut in the breech coupling, and are exposed as the breech rotates to unlock. At this time, the breech chamber withdraws slightly from the coupling and a two-stage scavenging action begins.

The total time for this scavenging action is 1.8 seconds, approximately the same time required for the complete opening of the breech. The scavenger flow of compressed air, approximately 3 cubic feet, induces a flow of secondary air out of the turret of about 30 cubic feet. This total air movement removes both the noxious fumes and any residue of combustible case from the chamber and bore. When the Shillelagh missile is fired, scavenger action takes place after the aft cap has been withdrawn from the gun chamber.

Development and testing of the scavenger have been in progress for about 1 year. This program has included the firing of more than 400 rounds, some of which were moisture conditioned well beyond typical field conditions in order to get "worst case" testing.

A scavenger will be installed for the engineer design test program on a pilot at Aberdeen in August.

AMMUNITION STORAGE IN MBT–70

Mr. MAHON. How will the conventional rounds be stored in the MBT–70? As now designed, does the MBT–70 include ammunition racks with metal covers for these rounds?

General LUCZAK. Yes; it does for the second generation——

Mr. MINSHALL. Where will these be positioned in the tank itself?

Mr. POOR. They will be in two places. In metal ammunition racks and in the automatic loader which holds some ——— rounds, they will also be protected by metal tubes. We believe that combustible cases in the MBT–70 will be less hazardous than conventional cases in our current tanks because of the way they are stored and because of the protection in the loader.

Mr. MINSHALL. One of the prototypes I observed in Cleveland had storage behind the left-hand seat.

Mr. TRAPP. It is a first-generation prototype but they are stored in a basket area near the driver and also in the loader in the turret bustle and there are ——— rounds immediately behind them.

ANOTHER SET OF MBT–70 PROTOTYPES TO BE BUILT

Mr. MINSHALL. When do you get into the second generation prototype?

General BETTS. I said they were going to build another set of test pilots. That is what he was talking about.

Mr. MINSHALL. Then you are coming up with another tank completely?

General BETTS. Not completely. We are going through the prudent route of picking up the design changes that we have discovered are desirable in our current systems program and create another set of prototypes that will then be tested before we——

Mr. MINSHALL. When will you have these prototypes?

General LUCZAK. It will be in the latter part of 1970.

Mr. MINSHALL. You are talking about calendar years now?

General LUCZAK. Yes, sir.

Mr. MINSHALL. How many prototypes will you have by that time?

General LUCZAK. They will have our first one in the end of calendar year 1970. By the middle of calendar year 1971 we will have six prototypes and the Germans will have five.

Mr. MINSHALL. What extra cost will these entail and how much further down the road will it slip your program?

General LUCZAK. These are included in the present schedule. In other words, these are phased in with our present production rate. We had planned within the past few years to have second generation prototypes.

Mr. MINSHALL. Is that a normal procedure?

General LUCZAK. Not in the tank business. In the tank business the normal procedure is to have a single set of prototypes and then go into production.

Mr. MINSHALL. Why the second set of prototypes in this instance?

General LUCZAK. In this instance, the second set was determined by several considerations. One is the conservative approach that General Betts mentioned where we try to discover all of our possibilities for improvements prior to going into production and rather than making the changes after production we are very, very extensively testing this tank because it is a giant step forward.

Mr. MINSHALL. In 1963 did you figure on having two prototypes?

General LUCZAK. No, sir. In 1963 we didn't even have a tank contract. In 1965 when the first hard design drawings were made, we had figured on one set of prototypes.

Mr. MINSHALL. This is bound to slip the program if you are building a new set of prototypes. How much additional cost will this put on the program?

General LUCZAK. The present schedule is for first production in ———. It includes the time required for the second generation prototype. The international development figure of $303 million includes the second generation prototype on both sides. So the second generation prototype has been in our planning for some time.

I will turn to Mr. Trapp because he has been working with this program through this phase and I will ask him when did we decide with the Germans to go a second-prototype route?

Mr. TRAPP. We signed an agreement on the APE I believe about 2 years ago, sir.

Mr. MAHON. You can put the date in the record.

Mr. TRAPP. Yes, sir.

(The information follows:)

A joint memorandum of understanding on the MBT–70 advance production engineering program was signed by the Assistant Secretary of the U.S. Army for Research and Development on January 20, 1966, and by the German Ministerial Director, Federal Ministry of Defense on June 13, 1966.

Mr. MINSHALL. In other words, you have made so many mistakes on the planning and design concept of this tank that you had to go into a second prototype to correct them, isn't that what it boils down to?

General LUCZAK. I wouldn't put it that way, sir.

Mr. MINSHALL. Put it any way you want to.

General LUCZAK. I would say that 2 years ago we really didn't know what the problems were on the prototype because we hadn't had them built yet, but I think we decided 2 years ago—and I was not there; Mr. Trapp can verify this—was that this was a radically different tank; we did have a different weapons system, we wanted to take a conservative approach and the question was, should we build based on the first generation or should we put in a second generation?

Now, the German practice is to build, say 100 tanks, and test those. Our practice is to go, after the first set of research and development

prototypes, into production. This is sort of a compromise. It reduces the number from what the Germans had been used to going to in their second generation and it put the United States in the process of a second generation and the agreed amount is 11 tanks.

Mr. MINSHALL. How many other programs and systems in the tracked vehicle field have gone to two prototypes?

General BETTS. I don't remember we have ever done it this way.

Mr. MINSHALL. This is brand new.

General BETTS. I will have to research that point.

CONSIDERATION OF A THIRD GENERATION OF PROTOTYPES

Mr. MAHON. Would it probably be wiser to go to a third prototype before you go into production? Then you would have a more fully developed weapon.

General LUCZAK. It may turn out this way, sir, but it is too early yet to say. We were not planning on this route at all. We are planning for four more prototypes that will test the "all-U.S." components. It is our plan to have a tank which can be completely reproduced in the United States and not be dependent upon items of foreign manufacture. We will take four prototypes and use the American-built, U.S.-built, German component and let the user run those through a period of testing in order to prove out the U.S. components.

The first set of production tanks will partially use FRG components.

Mr. POOR. Mr. Chairman, I think that the extra set of prototypes that have been added into the program are clearly a very important contributor to the increase in cost and the increase in time required to complete the program.

On the other hand, we have had some unhappy experiences in the past with tanks which we have put into production too soon and this, I believe, is a prudent extra step to protect us against the mistake of going into production with tanks which have potentially serious difficulties in them. Therefore, I very strongly support the wisdom of the decision of going through the second set of prototypes. We will learn a great deal from the tests on the first set. We could go into production the moment the second set of prototypes are designed and at one point the Army recommended that point of action.

Mr. MINSHALL. With all the design analysis you have had and all the money you have spent, and with all the so-called experts you have had working on this program, your first prototype, aside from very minor changes, wouldn't suffice, but this is certainly not the case in the MBT–70 program. You just came up with so darned many cranked-in mistakes that what it amounts to is you had to start over again.

Mr. POOR. I can't agree to starting over again. It is a matter of design refinement, correcting those things that you can only find in tests. I think that this will prove to be a useful step in the long run in saving money and guaranteeing a better product.

LACK OF METAL RACKS FOR AMMUNITION IN PROTOTYPES

Mr. MAHON. I am not sure that the record makes clear what the answer is to the following question:

As now designed, does the MBT–70 include ammunition racks with metal covers for these rounds? I assume the answer is no, but I am not clear.

General LUCZAK. If you use the word "design," the design provides for metal racks. If you use the word "fabricated," do you have fabrication in your present pilot, the answer is no, we do not. We are putting the metal unit in the second generation.

Mr. MAHON. But it won't be in the first generation prototypes?

General LUCZAK. We will have it in the automatic loader, but not in the turret.

20-MILLIMETER SECONDARY WEAPON FOR MBT–70

Mr. MAHON. It is reported that several unsolved problems relating to the stiffness in the gun mount and to the twisting of ammunition feed belts are existent in the major secondary weapon which is a German-developed 20-millimeter gun. What is the status of the development of this gun? Do you sometime plan to include this gun on the U.S. MBT–70 tanks? What progress has been made in overcoming the problems found with this gun?

General LUCZAK. The secondary weapon is of German design, as you say. It has certain specifications and features which were originally set for it. Since that time there have been problems with the mount of the gun and not with the gun itself; we, the United States, are making a study to see whether we want a 20-millimeter gun on MBT–70.

Mr. MAHON. You may elaborate for the record.

(The information follows:)

The current secondary weapon for the MBT–70 is the German-designed Rheinmetall Rh–202 20-millimeter automatic cannon. This gun uses the same ammunition as the U.S. M–139 cannon recently added to our M–114 vehicle. The gun, however, is a newer design optimized for simplified disassembly and maintenance. It has been under test in Germany for several years and has proved dependable.

We have had problems with the mount adapting this cannon to the MBT–70. The original design called for the gun to stow within the turret armor and to be elevated when firing. In addition, it would be stabilized in elevation and traverse, and would receive ammunition from either side; a belt of high-explosive ammunition on one side and armor-piercing rounds on the other side. In developing the mount, we discovered that these requirements introduced an unfavorable balance condition to the mount, degrading the stabilized performance. In addition, the "pop-up" feature added complexity and could be a source of reliability problems. The United States is committed to the use of the Rh–202 on second generation pilots. ———. These two changes should greatly enhance the stabilized performance and reliability of this secondary weapon.

No decision has been made concerning the secondary weapon to be installed on U.S. production vehicles. The Department of the Army is currently conducting a study on the most appropriate weapon for the tank, from both cost and combat effectiveness points of view.

PASSIVE NIGHT VISION DEVICES FOR MBT–70

Mr. MAHON. In the original plan, both the tank commander and the gunner were to have a passive night vision sight. Because of the lack of turret space, one sight was eliminated and the feasibility of making the commander's sight simultaneously available to the gunner is being studied. What happened in connection with this? What has been the result of this study?

Mr. TRAPP. In the design of the tank we have developed two passive night vision devices. One uses an image intensifier. Another uses essentially a television adaptation. Both are under test. If the television type presentation is finally selected, it would allow both the gunner and the commander to have passive capability in each station. If we utilize the direct view only, only the commander will have the passive in his station.

PROBLEM WITH TURRET STABILIZATION

Mr. MAHON. The MBT–70 is designed so that the tank commander can override the gunner's control of the main weapon and the gunner can also assume control in a limited way over the 20 millimeter auxiliary weapon. These provisions for the interchange of functions raise problems in weapon stabilization. These problems include vibration of the gun, its mount, and the turret and the lack of stiffness in the connecting links transmitting the stabilization commands from the sights to an extent which prevents the exact and the necessary immediate response by the weapons to the synchronization commands from the sights. Modifications which have been made to the main weapon system have reduced the error, but the error is still twice as great as the specifications allow under favorable test conditions. Is that correct?

General LUCZAK. That is not correct under present tests we are doing in Milwaukee. I think we are getting better results. We have solved the problem of the vibration in the turret. The stabilization is very good, as you saw from the movie I showed you the other day.

Mr. MAHON. How recently has this been achieved?

General LUCZAK. I would say the difficulty with the vibration has been solved within a matter of days, really. The difficulty with the response of the gun in moving it to the site has been solved within a matter of 6 months. We finally got the results.

Mr. MAHON. It is estimated that the amount of error existing before this problem is solved reduces the hit probability of the main weapon with conventional rounds by 10 percent. Is that correct?

General LUCZAK. It could reduce it as much as 10 percent, but the present tests indicated we will meet specifications.

Mr. MAHON. Make sure that the record shows the status of your efforts to overcome the stabilization problems and other problems and when you expect the problems will be completely resolved.

(The information follows:)

A thorough analysis of the MBT stabilization concept was conducted prior to completion of subsystem and component specifications. Subsystem testing was accomplished both at Milwaukee and at CATAP (Cleveland) prior to pilot vehicle fabrication. The major problem encountered concerned the gun turret drive performance. High performance is required in the MBT because the weapon is slaved to the sight. The gun turret drive receives its command input from the stabilized sight head via precision synchros and drives the turret and gun into coincidence with the sight. The error resulting from the gun lagging the sight has a direct effect on hit probability and must therefore be minimized as far as possible within practical limits. Testing at CATAP revealed that a load compliance problem existed. The azimuth-mode components needing revision were: traverse gear box and turret ring gear assembly; elevation-mode components were: turret ring gear, turnnion bearings, and gun mount.

Design revisions of the above mentioned components have been accomplished, and modification has been completed for all pilots. Tests of Pilot 4 at Milwaukee have confirmed the adequacy of these corrections, and specification requirements for the gun turret drive system have been essentially met. Final confirmation by

firing tests of the primary sight, gun turret drive system, and main weapon will be completed in November 1969.

Recent mobile testing has shown undesirably high temperatures in the turret hydraulic power system. A heat exchanger module will be added to the R. & D. pilots before they enter engineering test at the end of 1969.

Mr. MAHON. Another problem with the stabilization of the main weapon is caused by insufficient hydraulic power to turn the turret and keep it on target when the hull is making sharp turns or following a turning course. Is that correct?

General LUCZAK. That has been remedied, Mr. Chairman. I tied that in with my statement about 6 months ago. That was part of the problem of getting sufficient power into the turret to provide response when the tank was going an "S" track, to keep the gun in one place.

Mr. MAHON. How did you solve that problem?

General LUCZAK. We increased the turret power. We increased the piping, the plumbing, if you will, to the unit that causes the turret to turn. We put in a larger pump to increase the turret power.

Mr. MAHON. Can the turret now turn as fast as the tank itself can turn?

General LUCZAK. I think what is meant by that question, do we have the ability to keep the tank going on S curves, the answer is with the fix we now have, we can keep the gun pointed on a sinuous route within the hull.

COST OF REDESIGNING TURRET HYDRAULIC POWER SYSTEM

Mr. MAHON. Did you redesign the hydraulic system?

General LUCZAK. We redesigned portions of the hydraulic system.

Mr. MAHON. What did that cost you, probably?

General LUCZAK. Could I review and supply it for the record, sir?

Mr. MAHON. Very well.

(The information follows:)

We had found that the turret hydraulic power system was flow-limited during mobile testing over a serpentine course. This problem was overcome by increasing the hydraulic power supply pressure and volume, while decreasing the displacement of the turret traverse motor valve. These changes rsulted in a doubling of turret traversing speed. Resolution of this problem was verified by a trial installation and mobile testing on Pilot 6. Cost of this redesign and verification testing was $34,500.

STATUS OF AUTOMATIC LOADER DEVELOPMENT

Mr. MAHON. In December 1968, it was decided to have General Motors Corp. test the German automatic loader for the MBT–70 to determine what, if any, redesigns should be undertaken. What is the status of the automatic loader development?

General LUCZAK. We agreed with the Germans to permit General Motors to work out interfaces between the automatic loader, the gun, and the ammunition. ———. General Motors is now in the process of remedying the basic research and development difficulties with the loader, and plan to do the initial firings in the latter part of this calendar year. ———.

Mr. MAHON. In other words, you are having to design a new loader.

General LUCZAK. No, sir, it is not that difficult a job. I can put it in this context. ———.

Mr. MAHON. This is going to cost you timewise and otherwise. Can you estimate the money cost?

General LUCZAK. The money cost for this effort is ———. It will not have an effect on the production schedule.

Mr. MAHON. What problems does the loader have in handling combustible cases?

General LUCZAK. One of the major things that GM is doing is to take the German design loader and make the loader handle combustible case rounds better. What they are doing is substituting rubber for metal where the combustible case is held.

TERMINATION OF CONTINENTAL ENGINE DEVELOPMENT

Mr. MAHON. The original choice of an engine for the tank was a Continental air-cooled engine. This engine had variable compression ratio pistons which were described by one engineer as introducing complexity where it is less desirable. It is understood that you have now given up on the Continental engine. How much money was spent on the development and testing of the Continental engine before you gave up on it?

General LUCZAK. I would say roughly $25 million was spent on the development and testing of the Continental engine.

Mr. MAHON. What were some of the main difficulties encountered in the development of this engine? Supply that for the record.

(The information follows:)

The Continental AVCR 1100 was selected in 1965 as the primary engine for the MBT–70 on the basis of its light weight and high output. At that time, it was expected that 1,250 horsepower would be sufficient power for the tank. As the development of the MBT–70 progressed, it became apparent that 1,500 horsepower would be required.

To meet the 1,500-horsepower requirement, supercharging was added to the original engine. This new engine was tested during 1966 and demonstrated shortcomings which indicated that its design was very marginal at 1,500 horsepower.

Major faults were excessive brake mean effective pressures (BMEP) and unacceptably high exhaust gas temperatures. It was then decided to increase the displacement of the engine to overcome these problems. Development of the higher displacement engine continued in 1967 and 1968. Problems were experienced with the variable compression ratio piston, in metering the oil which controls compression, scuffing of cylinder walls, and durability of the steel piston. Between January and December 1968, the engine failed four successive 400-hour NATO tests. Results of operation in MBT–70 pilots were also disappointing. This engine exhibited unacceptable high thermal loads, repeated turbocharger failures, and fundamental problems in the fuel pump and accessory drive gear train. Although the contractor continued to give assurances that these problems could be solved, their solution had not been demonstrated by December 1968, in spite of nearly a year of intensive corrective action.

Mr. MAHON. As of today, are you continuing the development of the Continental engine?

General LUCZAK. The answer is no, sir.

STATUS OF TURBINE ENGINE DEVELOPMENT

Mr. MAHON. What is the staus of the development of the Lycoming AGT–1500 gas turbine engine? Why are you pursuing this engine development effort? What is the estimated development cost of the gas turbine engine and transmission?

General LUCZAK. The status of the turbine engine is that we have four prototype engines in test. The cost of the turbine is estimated now at approximately $25 million from this point on.

The major reason for going to the turbine is: No. 1, the ease of maintainability in the field; No. 2, it has a lighter weight and we expect to increase the reliability of this engine.

Mr. RHODES. Would you give the names of the four companies that are in this development?

General LUCZAK. The Continental Aeronautical Engineering is one that has worked on the air-cooled U.S. engine. The Lycoming Corp. is working on the turbine engine. Allison is developing the transmission that goes with the turbine and the different type of transmission required for a turbine engine.

Mr. RHODES. Lycoming is working on the gas turbine.

General LUCZAK. Yes, sir.

Mr. RHODES. They have had some considerable background with gas turbine engines.

General LUCZAK. Yes, sir; they build helicopter turbine engines for the U.S. Army.

TERMINATION OF CONTINENTAL ENGINE DEVELOPMENT

Mr. MINSHALL. You talked about a movie you showed us several days ago and bragged about it profusely. I was sitting here thinking that you could make another movie lasting three or four times as long showing all the defects in this program. What kind of engine powered the tank in that movie sequence?

General LUCZAK. It was a Continental engine.

Mr. MINSHALL. It looked pretty good in the movie.

General LUCZAK. It is not a bad engine if you can keep the thing running. That was our major problem. We had defects in the turbocharger.

Mr. MINSHALL. I know you have given up on the Continental engine, but how does the substitution of this engine affect the cost?

General LUCZAK. The International program had decided early in the game to have engine candidates because the CA engine——

Mr. MINSHALL. I know this, but how much did it affect the cost when you had to give up the Continental and go to the backup?

General LUCZAK. We spent roughly $25 million on the Continental engine.

SELECTION OF GERMAN-BUILT DAIMLER-BENZ ENGINE

Mr. MINSHALL. Is that the only additional cost you will have in going to the Daimler-Benz?

General LUCZAK. We will have some minor cost in reconfiguring.

Mr. MINSHALL. Is the present engine cost the same as the Daimler-Benz, as the Continental?

General LUCZAK. It is about the same as the Continental, not the $25 million.

Mr. MINSHALL. The unit cost of the engine is comparable?

General LUCZAK. Yes, sir.

Mr. MINSHALL. What configuration changes will be made in order to accept the Daimler-Benz engine?

Mr. TRAPP. Very minor configuration change to the hull. It will show up in the cooling system.

Mr. MINSHALL. How much additional cost will this be?

Mr. TRAPP. Per unit cost, it will be nearly the same.

DAIMLER-BENZ ENGINE WILL INCREASE WEIGHT OF TANK

Mr. MINSHALL. Does this affect the vehicle weight in any way?

Mr. TRAPP. It affects the weight to the extent of two or three thousand additional pounds. This is the reason the Continental was the primary candidate.

Mr. MINSHALL. What was the original design weight of the MBT-70?

Mr. TRAPP. We have used 48½ metric tons as the maximum.

Mr. MINSHALL. What was the original design weight in 1963?

Mr. TRAPP. In 1963 the design was about 50 metric tons.

Mr. MINSHALL. What is the weight today as you look down the road?

Mr. TRAPP. About 49 metric tons.

Mr. MINSHALL. Pretty much the same.

Mr. TRAPP. Yes, sir.

Mr. MINSHALL. Will the Daimler-Benz engine be utilized in the production models or is this an interim engine until a more suitable one is developed?

General LUCZAK. The U.S. position is that the Daimler-Benz is selected for the second-generation pilot. That is the only U.S. commitment. If we can get the turbine engine developed in time, we would want to use the turbine engine in the production tank. This is the Germans' understanding. If the turbine engine does not pan out then we will use the Daimler-Benz engine in production.

Mr. MINSHALL. I would like to go back to your answer on your original weight design on this tank. I thought the original weight design on this tank was 35 tons.

Mr. TRAPP. No, sir, the weight we gave the Army in 1963 was about 50 metric tons. The desire for ——— metric ton was expressed by both armies. In the course of design the weight remaind nearly constant. I might add that the original weight included ———. So consequently, the weights are nearly the same, although we are now using the heavier engine.

Mr. MINSHALL. ———.

Mr. TRAPP. ———.

SELECTION OF GAS TURBINE ENGINE CONTRACTOR

Mr. RHODES. Did you have any bid competition before you selected the company to make the gas turbine engine?

General LUCZAK. No, we did not.

Mr. RHODES. There are a lot of companies that have been in this gas turbine engine business that are making bigger engines than helicopter engines.

General Luczak. I am sorry. I am wrong. I was not in the program at the start. Mr. Trapp does know.

Mr. Trapp. That program was under one of our commands. There was a competition when they selected Lycoming. This was 4 years ago, I would say.

SIGNIFICANT PROBLEMS WITH VARIOUS MAJOR MBT–70 SUBSYSTEMS

Mr. Mahon. Mr. Poor, as we go through these questions, I find myself impelled toward the conclusion that many of the major components of this tank have not yet been made to work properly.

Mr. Poor. Mr. Chairman, I can understand how you would be getting that impression. Let me say I do not think that is the case at all. In the case of the fire-control system, I have personally been fairly deeply involved in the turret stabilization system design. I would have to provide dates for the record, but some time ago I visited the Allison plant and discussed in depth with the engineers working on the fire control and stabilization system the kind of difficulties that have been alluded to in the questions. These difficulties were the kind of thing that one would expect on the first attempt to put together a very complicated high-gain servomechanism.

As a result of the visit, we arranged that people who have been designing guided missile stabilization systems in other parts of the Allison division would participate in the design. We arranged for much more elaborate simulation of the components for tests which would uncover difficulties early in the program. These tests did uncover those difficulties and they were corrected in the current set of prototype tanks. I submit that this is the kind of difficulty that one does normally get into in developing a new kind of thing.

I submit that I believe that this stabilization and fire-control system does represent an orderly program to get something that works and works well, so I would like to say that while the tank has had growing pains of a significant sort the current test data indicate that the system is working and working well.

Mr. Mahon. It would seem that with the time and money we have spent on this tank, that as of this date the major components ought to be working well, whereas they apparently are not.

Mr. Poor. I would like General Luczak to comment on it. He is much closer than I am to the program. I think in fact the major components with the possible exception of the automatic loader appear to be working well indeed.

General Luczak.

READINESS OF MBT–70 FOR PRODUCTION

Mr. Mahon. We have been going through a series of questions here pointing out various shortcomings. Any weapons system in its early stages—and it would be hard to call this the early stages of the MBT–70 tank program—has problems even after it is put into production and operation. But it seems that you are having more than your share of problems with it. Yet, in spite of all these problems, you seem to be rather enthusiastic about the tank. My spirits were lifted up when General Betts said sometime earlier that he thought we ought to go

right into the production. But, Mr. Poor, you sort of demurred. In view of all these deficiencies we have been talking about, I find it difficult to understand why General Betts wanted to go full-steam-ahead.

General Betts. Let me defend myself, Mr. Chairman.

General Luczak said we are going to come out with another set of pilots, the first of which will appear on the scene at the end of calendar year 1970. That means that we feel that things are working sufficiently well right now, and that we know enough about all of the major subsystems right now, that we are prepared progressively to release design information. In fact, we have been releasing design information to the engineers that will result in a tank by ——— that we consider has picked up all the changes we now can identify. I say as far as I am concerned our normal procedures would put in that kind of leadtime and say this is the first of what I would call advanced production engineering tank. You might go slowly in those first few picking up what changes come out of the very early testing of those pilots. You would correct them as you built the rest of the production line.

The decision that has been made is that because there are so many new systems in this tank—the automatic loader is something we never put in the tank before, the hydraulic suspension system is a new system—because of these new features, we are making the very conservative judgment that we will go through the cycle of the complete test of those next prototypes before we release this tank to production. I say those test prototypes could be early production tanks. It is a matter of judgment. I recognize that I lean on the risk side and other people tend to lean on the prudent side. We are going to have a test pilot at Aberdeen within the next week or so that will pick up all the corrections to date that have come out of the testing, and if any members of this committee or the staff would like to see that vehicle and see why we say we have confidence in all of the subsystems we would be very pleased to demonstrate it.

PROBLEMS WITH AUTOMATIC LOADER

Mr. Mahon. If the loader does not work you are in trouble.

General Betts. The loader works right now. The problem of the loader is related to the fact that there are occasions when you would like to withdraw a round that was not fired. The conventional ammunition is not as strong physically as the metal round and we have had breakage of the lift on the end of the ammunition as the loader tries to withdraw it.

The users have said that in combat if they had a round that was not the right one and they wanted to shift to another round they would fire it rather than take the time to withdraw it. I do not say we will give them a loader that will not withdraw a round, but in the remote event that this continued to be a problem it could be handled. We are planning to go ahead with the kind of modifications that General Luczak mentioned. Those modifications will be picked up in the first of the new set of pilots I was talking about. So the corrections we are discussing are going to be available by the time we produce those pilots.

Mr. MAHON. You may elaborate for the record, if you desire.
(The information follows:)

The U.S. plan to obtain a reliable automatic loader for MBT–70 will be accomplished in two phases. Phase I now in progress at General Motors, has the objective of correcting, as soon as possible, four German-built loaders so that they will perform properly and reliably in engineering tests of first-generation pilots vehicles. This program consists primarily of testing to identify critical areas, followed by corrections as necessary. Although improved design may result, the primary objective is availability of loaders for system testing of R. & D. pilots starting at the end of 1969.

In Phase II of the loader program, we plan to optimize loader design for interface with second-generation pilots, at the same time, possibly accomplishing advanced production engineering for U.S. production. This phase would eliminate the previously planned step of adapting the production-engineered German component to U.S. production methods, ———. Joint agreement on the program outlined above has not yet been reached, and consequently firm contract negotiations have not been completed.

NEW INNOVATIONS INCLUDED IN MBT–70 DESIGN

Mr. RHODES. This may be in the record, but if it is not, I think it would be helpful if you could list in one place all of the innovations that you tried to grind into this MBT–70.

General BETTS. We would be very pleased to.

Mr. RHODES. It strikes me you have bit off an awful big hunk here.

General BETTS. We did.

Mr. RHODES. And we are having a lot of trouble in the digestion process. For instance, when you get the type of mobility which they are trying to get and the fire control system with the type of cartridge which you are trying to use with the combustible case and all, these three things alone are enough to give anybody any amount of trouble. In order to really show what you have tried to do you better put this all in one place.

General BETTS. May I show at the same time the state of testing that establishes our confidence?

Mr. MINSHALL. I think my colleague has just asked that we publish an additional volume.

Mr. RHODES. It may well be.

(The information follows:)

Automatic loader/three-man crew.—The crew for MBT–70 consists of a commander, gunner and driver. The human loader has been replaced by an automatic loader capable of firing an ammunition/missile mix at a rate of ———. This automatic loader is the key to the tank's ability to fire while moving, a major improvement over previous tanks. In addition, by having the three-man crew all located in the turret, the MBT–70 provides a high degree of ballistic protection and a controlled environment to include chemical, biological, and moderate radiological protection. The driver is housed in a counter-rotating station which maintains his directional orientation with respect to the hull, regardless of turret rotation.

152-millimeter kinetic-energy (KE) round.—The 152-millimeter armor-piercing, fin-stabilized, discarding sabot (APFSDS) cartridge is a kinetic-energy armor-defeating round. It consists of a 35-millimeter fin-stabilized subprojectile seated in a full caliber discarding sabot. This round provides the kinetic-energy armor-defeating capability required by an/ main battle tank. The round has demonstrated penetration of ——— inches of rolled homogeneous steel plate at ——— obliquity at ——— meters. The ability of the MBT–70 to fire both the kinetic-energy and the missile/ammunition common to the Sheridan vehicle is obtained by equipping the kinetic-energy cartridge with a long combustible case which utilizes part of the gun bore as a firing chamber. Success of this unique method

of chambering has been verified in more than 3 years and 1,100 rounds of ammunition component testing.

Secondary weapon armament.—The 20-millimeter automatic cannon for MBT–70 is an effective weapon against soft-skinned and light armored ground targets, as well as against low-flying, low-performance aircraft. The weapon is mounted in the left side of the turret and moves independently of the main weapon. The weapon is stabilized and directed by the commander or by the gunner using normal sighting and surveillance sights. Previous U.S. tanks have mounted a caliber .50 machinegun for this role.

Stabilized sight.—The gunner's line of sight is gyrostabilized in azimuth and elevation and can provide stabilized commands to the three weapons of the tank. Similarly, the commander's panoramic sight is gyrostabilized and can control the main gun, secondary weapon, and commander's night sight. This arrangement of slaving the gun to the sight permits either gunner or commander to control the weapons, affords improved fire-on-the-move performance, and permits reloading of the main weapon without line of sight disturbance. The accuracy of stabilization provided for the gunner's sight and main weapon is dramatically improved over that of any previous standard or developmental system.

Spaced armor.—MBT–70 provides frontal and 30 degree flank protection against the ———. The turret, ———.

Hydropneumatic suspension.—The MBT–70 design incorporates a variable-height hydropneumatic suspension system which enables the vehicle to be lowered to a minimum ground clearance of 6 inches or raised to a maximum of 25 inches. The basic reason for permitting higher cross-country speed and better stability for firing on-the-move. A bonus feature is the ability to lower the tank for better concealment or raise it to pass over mud, stumps or other obstacles. Limited comparative evaluation to date against the M60A1E2 tank shows significant improvements in all activities involving the MBT–70 suspension system.

The 1,500-horsepower engine.—The 1,500-horsepower multifuel, liquid-cooled Daimler-Benz engine provides the tank with road speed of better than 40 m.p.h. This power, coupled with the hydropneumatic suspension, provides agility and mobility which far surpasses that of previous tanks, which typically had half this power for approximately the same weight.

ORIGINAL TRANSMISSION

Mr. MAHON. Very well. The model C transmission which was originally selected was too large and heavy and had brake troubles, is that correct?

General LUCZAK. That is correct.

SELECTION OF NEW, LIGHTER MODEL "F" TRANSMISSION

Mr. MAHON. A new, lighter, smaller model F was selected in December 1968, for the next series of tank pilots. The model F was not to be tested for the first time until the middle of 1969. What is the status of the testing of the model F transmission? What costs are related to the development of the model F transmission?

Mr. TRAPP. This has been put into a pilot that has completed that portion——

Mr. MAHON. Will you extend your remarks for the record showing the cost and so on?

(The information follows:)

The Renk "F" transmission differs from the transmission used on the first generation pilots in that internal brakes have been incorporated and the ratio of hydrodynamic to hydrostatic steering has been changed.

Two first-generation transmissions have been modified with internal brakes and are now under test, one in an MBT–70 and one on a dynamometer test stand.

The tank has operated somewhat over 200 miles at the German Government proving ground at Trier with no significant problems associated with test modifications.

Three Renk "F" transmissions are currently under contract, with deliveries to begin in October at the rate of one per month. One will be used for dynamometer tests, one for a spare, and the other for vehicular tests, expected to begin in December.

The Renk transmission effort, including Renk "F" is a FRG assigned responsibility under the joint development program. This effort is financed from the FRG share of the joint ceiling, specifically under sub-decision sheet 008–G. Based on FRG estimates of January 4, 1968, the cost of optimization of the Renk transmission (Renk "F") is $2 million.

STATUS OF GAS TURBINE ENGINE TRANSMISSION DEVELOPMENT

Mr. MAHON. What is the status of the Allison transmission designed for use with the Lycoming gas turbine engine?

Mr. TRAPP. It is under test now with the turbine engine and will continue under test, I would say, for another year or so.

DIFFICULTIES WITH AIR FILTERING SYSTEM

Mr. MAHON. It has also been reported that the Mann and Hummel air filtering equipment lacks the required filtering efficiency critical to the tank engines. Have the difficulties with the air filtering equipment been overcome?

Mr. TRAPP. Mann and Hummel has met the specification requirements. What we were hoping to achieve was to improve requirements over the present generation of air cleaners. We have not increased substantially over our present generation of air cleaners.

PROBLEMS WITH ELECTRICAL DRIVING CONTROLS

Mr. MAHON. Since the tank driver is in a rotating turret, the usual mechanical driving controls cannot be used and electrical driving controls are required. There has been a lack of reliability in the electrical driving controls in tests which have resulted on occasion in the tank going out of control and running into various obstructions.

Have the difficulties with the electrical driving controls been solved?

Mr. TRAPP. The electric driving controls have been redesigned and the present controls are, I would say, a substantial improvement. We have not gone through a complete test to verify it completely.

TURBULENT SUBSYSTEM DEVELOPMENT PROGRAM

Mr. MAHON. This is the point I was making a while ago. It seems that everything has had to be redesigned. This seems rather untypical.

General BETTS. It is typical of a development program. That is what a development program is supposed to do.

Mr. MAHON. Not everything.

General BETTS. That is what you would hope to do, to find out where your original designs were right and where they were wrong. I would not say we have corrected everything. There are aspects that have worked very well.

Mr. MINSHALL. What did all these design analyses do? How can you come up with so many mistakes after all the money we spent with Lockheed?

General BETTS. This relates to conceptual ideas.

Mr. MINSHALL. It is all a part of the package. You have had thousands of people's time and millions of dollars spent on this program and we have nothing to show for it except headaches.

General LUCZAK. Could I comment, sir?

Looking at what we have done in answer to your question, we have a weapon system that we demonstrated in October at Aberdeen firing three different types of weapons, a conventional round, a kinetic round, and the Shillelagh missiles. We demonstrated an accuracy that compelled the FRG to approve of this weapon system for the second generation pilots, even though they were somewhat opposed to it. They did not think we could achieve the accuracy in the kinetic energy round. The weapon system is an excellent weapon system, probably far better than anything existing today and will exist in the next 20 years because of the addition of the kinetic round. It is good. Next, the engine, we did have problems with the Continental engine but the Daimler-Benz engine has proved out in every respect. We are in the last phases of testing it in a desert environment at 120° for its cooling. The reliable engine passed its tests well. It is available.

Mr. MINSHALL. You have not planned to use the Daimler-Benz engine for the production models?

General LUCZAK. We will have if the turbine works out.

Mr. MINSHALL. But you had not planned to use the Daimler-Benz for the production models?

General LUCZAK. We are hoping to have the turbine. If it is not available, we will take the Daimler-Benz.

Mr. RHODES. How much problem will you have to retrofit the turbine engine into the vehicles?

General LUCZAK. You say what problems?

Mr. RHODES. Yes.

General LUCZAK. It is smaller. It weighs a couple of tons less. It will be a far less job than if we had designed for the turbine and put the DB in. It is a much smaller engine. On the suspension system, the suspension system right now is proven. We have gone over 6,000 miles of the worst terrain we could get at Cleveland, and we did the 6,000 miles in about 2½ months. It will work. It does work. We could go into production on the suspension system. Finally, on the fire control: the fire control has been demonstrated. It does work. The stabilization will work. The question is: Is the present configuration the cheapest, all the reliability in it, is the maintainability in it? When you look at it, it is not quite like the impression you get, that nothing has been developed, nothing has been accomplished in the program.

Mr. MINSHALL. You do not have much to show for all the time and money spent.

General LUCZAK. We have six pilots in each country. We have the components that I mentioned that are available, and they are really the heart of the tank. When you take the weapons system, the engine transmission, the suspension, the fire control, that really is most of the tank, sir.

Mr. MINSHALL. I think the record speaks for itself. Thank you, Mr. Chairman.

SEPARATE DEVELOPMENTS PURSUED ON SUSPENSION SYSTEM

Mr. MAHON. The suspension system was considered to be a high-risk item and the United States and Germany pursued separate developments. The approaches of both contractors have been substantially the same and the problems have been almost identical. The MBT–70 has a sophisticated hydraulic/pneumatic suspension system. Two problems have been encountered in both the German and United States developments of suspension system involving a heat buildup in the hydraulic system and wear on the hydraulic pistons from vibration. How successful have the modifications to the suspension system designed to overcome these deficiencies proven to be?

General LUCZAK. They have been proved to be completely successful in the 6,000-mile test.

Mr. MAHON. The German suspension system has exposed hydraulic lines. To counter this vulnerability the joint users group has recommended that ballistic skirts be hung on the sides. How much weight does this add to the tank? Is that to be added?

Mr. TRAPP. The original German suspension system did have one external hydraulic line. That has been redesigned and incorporated internally. The skirting plates that are on the second generation vehicles are there to reduce weight and improve ballistic capability of the overall tank. It reduces the weight of the vehicle by about a thousand pounds.

Mr. MAHON. To what extent has the weight reduction program increased the vulnerability of the suspension to small arms fire?

Mr. TRAPP. No change to the suspension due to the weight reduction program.

REASONS FOR MBT–70 DRIVER BEING IN THE TURRET

Mr. MAHON. The basic requirement in the original design of the MBT–70 was the provision of radiological protection for the crew. This is the primary reason that the entire crew, including the driver, was placed in the turret, is that correct?

Mr. TRAPP. Not the only reason.

Mr. MAHON. I said was it the primary reason?

Mr. TRAPP. No, sir. The stabilization on the move and the protection was the primary reason.

Mr. MAHON. You can clarify that for the record.

(The information follows:)

In selection of the design concept for MBT–70, several considerations led to placing the entire crew, including the driver, in the turret. A major objective in concentrating the crewman was to reduce the volume to be protected. This concentration permitted radiological shielding to be installed around the crew with minimum increase in volume, and it reduced the portion of the tank to be protected with ballistic steel armor. Both of these factors made great contributions toward achieving the desired levels of protection at a reasonable weight. Relocation of the driver to the turret facilitated the MBT–70 capability for firing on-the-move. In conventional tanks, the driver normally must be lowered with hatch closed before the gun is traversed over his head. In a tank which fires only when stationary, there is no significant degradation to the driver's per-

formance. In the MBT–70 the shoot-on-the-move capability as well as its high speed, either backward or forward, dictated that the degradation of driving through periscopes be avoided. In the present design, the driver can operate "head-out," with the associated clear vision, until forced to lower himself due to enemy fire. This elevated position also provides the driver better depth perception of the terrain immediately in front of the tank.

Other advantages gained by location of all crewmembers in the turret include easier chemical/biological air filtration for all crewmembers, improved surveillance for the driver, and a vehicle silhouette some 5 to 10 inches lower than a tank with the driver in the hull.

RADIOLOGICAL PROTECTION FOR CREW

Mr. MAHON. Radiological protection would have to be provided to as small an area as possible. In addition to the radiological armor, a pressure ventilation system, air conditioning, and a crew escape hatch were included for crew protection. ———?

General LUCZAK. I think General Betts answered that question earlier. It was a joint decision.

General BETTS. It was a joint decision. ———.

Mr. MAHON. ———?

General BETTS. That is correct.

Mr. MAHON. The problems created by placing the driver in the turret and by the poor placement of the emergency escape hatch remain ———.

(Discussion off the record.)

Mr. MAHON. Mr. Minshall.

TURRET SPACE PROBLEM IN MBT–70

Mr. MINSHALL. General, there have been many complaints and comments about the turret space problem. Has any pilot tank been fully equipped so the actual review of the space problem in the turret can be made in actual test?

General LUCZAK. Yes, sir; we have six pilots and the Germans have six. Actually, the space in the turret in this tank is probably better than for any previous tank we have had. We have a mockup being made for the next generation pilots where we try to innovate to save space. I do not know if Mr. Trapp will agree with me, but I think this is the best tank that we have ever had insofar as space for the crew is concerned.

Mr. MINSHALL. You just said several days ago that you are going to have to breed a new generation of midgets, something less than 5'8" tall.

General BETTS. That would be if we accepted ———.

General LUCZAK. It is a matter of height. ———.

Mr. MINSHALL. The tank I observed and got into at the Cleveland tank plant, had darn little room for a guy's knees in the driver's seat.

General LUCZAK. That seat is being redesigned. You were in the driver's seat, I believe. That seat was a Federal Republic of Germany development being designed by the United States now. Actually, all tanks are cramped, sir. This does represent a lot of room as tanks go.

Mr. MINSHALL. In view of what I asked prior to this question, it seems the designers did not know how to place all the required equipment in the turret and still leave room for the crew. A review of the

problem was scheduled from April to June of this year. Was such a review made and if so, was it completed, and what are the findings?

Mr. TRAPP. I believe you are referring to the second generation of pilot design. That mockup is under construction. It will be reviewed by September of this year.

Mr. MINSHALL. In view of what I asked prior to this question, it seems to me the answer should be no. You have to change the configuration of the driver's seat. If I remember correctly, they had room for spares and ammunition in back of the driver's seat and they were going to have to relocate spares to give the driver enough room to be able to walk once he got out of the tank.

Mr. TRAPP. No, sir. We have completely stowed the R. & D. pilots. We were able to stow all the equipment that is required into the tank. In the second generation design we ——— have completely re-stowed the sitting compartment and have actually increased the spaces in all of the sitting positions, in the crew positions.

Mr. MINSHALL. It amazes me, starting back in 1963, why in the design concept they could not figure out in a mockup made of plywood or something what room you would need. Was this ever done?

Mr. TRAPP. We built at least three mockups while we were in Germany.

Mr. MINSHALL. I am not talking about the steel types.

Mr. TRAPP. I am talking about a wood mockup. There were three built in Germany and one in the States. In all cases we completely stowed all the materials in the tank. We have endeavored to improve as we have made certain changes to take advantage of these changes, ———.

Mr. MINSHALL. Didn't the space problems occur in the wood mockups?

Mr. TRAPP. The spaces are normally very tight in an armored vehicle.

Mr. MINSHALL. This I know. That does not answer my question.

Mr. TRAPP. Yes; we stowed all the equipment required in all of the mockup reviews.

Mr. MINSHALL. Why didn't you change it in the wood mockup rather than waiting until you got to the prototypes? That is my question.

General BETTS. You recall.

Mr. MINSHALL. Let him answer. Why didn't you do that before you went to all the expense of building these 12 tanks?

Mr. TRAPP. Sir, we made all the improvements we could as we went through the various mockup reviews. The space that was in the eight pilots did include all the equipment that was required and we attempted certainly to achieve the maximum utilization of equipment possible. All the crew stations were designed for a 95 percentile man.

PROPOSAL TO STORE AUXILIARY FUEL TANK IN HULL

Mr. MINSHALL. There has been a proposal that the space ——— be used as storage space for fuel. This would increase the vulnerability of the tank crew so it is proposed that this fuel be used or dumped prior to battle. This proposal was made as an alternative to reducing the road range from the required ——— miles to ——— miles. Has a decision been made on whether or not to store fuel in the turret?

Mr. TRAPP. There is no fuel stored in the turret.

General LUCZAK. Both users are discussing the storage of fuel ——— in the hull. We are examining whether we can utilize that space which adds to our protection for the storage of fuel. If the hull is hit by a kinetic energy round, it has a shock effect transmitted the fuel where it can induce cracks in welding under some circumstances. So the U.S. proposal is, yes, use that storage space for fuel, which will give you added range, and then have a quick dump device if you are getting into a fire fight. Use that fuel first to get where you are going. If you get into a fire fight, dump your fuel, much like the fighter aircraft that carry wing tanks do. They use that fuel first, and dump the wing tanks before going into battle. The German user still has this other consideration. He has not given his consent to this step.

PROPOSED RANGE OF MBT–70

Mr. MINSHALL. Without this auxiliary fuel system that you have just described, what would the range of the tank be?

General LUCZAK. With the Daimler-Benz engine about ——— miles.

Mr. MINSHALL. In other words, some ——— miles short of the original goal?

General LUCZAK. That is right, sir.

Mr. MINSHALL. A tank may hit a mine, be hit by an aircraft or by some other weapon before engaging in a battle; would the storage of fuel in the turret endanger the crew in case of a surprise attack?

General LUCZAK. Not from that angle, sir.

The storage of the fuel in the hull——

Mr. POOR. Excuse me; I think there is a misunderstanding. We are not proposing to store fuel in the turret, but only in the hull.

Mr. MINSHALL. But you do need an auxiliary reserve supply, so to speak, if you are going to get ——— miles out of this vehicle.

Mr. POOR. That is correct.

Mr. MINSHALL. Without it you only get ———. Whether you store it in the turret or in the body of the hull doesn't make any difference.

General LUCZAK. The principal danger is from a kinetic energy round delivered into the hull. Aircraft fire from overhead does not affect this particular problem, nor do mines.

COMPLEXITY OF MBT–70

Mr. MINSHALL. A successful tank must have the ability to be available for battle when needed. The availability of the tank is dependent upon the tank's reliability. The reliability of the tank can be increased by keeping the tank as simple as possible in all of its various components, maintenance procedure, and in the method of operation.

The capabilities desired in the MBT–70 were set so high by the users that great complexities had to be introduced in the tank to achieve the specified capabilities. Industry and Government representatives, in both the United States and in Germany, described the tank to committee investigators as being too complex. Putting the driver in the turret so that a counterrotating capsule was required to enable him to face forward when the turret revolved, the unique weaponry, the increased horsepower to weight ratio, the highly

complex fire control system, and the many fire control options presented reliability problems.

There have been a number of proposals for simplification of the MBT–70. The investigators found that the U.S. participants in the program have generally resisted changes which would delay the program with the result that no significant degree of simplification has taken place. What is the Army's position today? Is it felt that the tank should be simplified? Is it felt that some further delay should not be introduced in the program in order to simplify the tank?

General Betts. I think that was covered in our discussions the other day about the complete review of subsystems we are making that should be completed by December of this year, where we are looking at the relative effectiveness of the major subsystems and whether or not one ought to take them out of the tank to reduce its cost and complexity. In a sense, I addressed it also in giving you General Polk's remarks on that aspect when he was challenged by Dr. Foster with respect to whether or not we wanted a tank of this complexity. It was General Polk's very strongly held opinion since we can ———, that we ought to go all out to have a tank that from a combat effectiveness point of view is superior. I believe the MBT–70 fills that definition.

Mr. Minshall. You will have that decision finalized by December 1969?

General Betts. That is correct.

RELIABILITY AND MAINTAINABILITY OF MBT–70

Mr. Minshall. The Army has had considerable difficulty in the reliability and maintainability of the M–60A1E2. Overall, do you consider the MBT–70 to be more or less complex than the M–60A1E2?

Mr. Poor. I think overall it is somewhat more complicated. That does not mean that if properly designed and built it need be more unreliable. The M–60A1E2, unfortunately, has a large number of unreliable components in its design. They are now being reviewed and fixed. With the very careful design from scratch of the MBT–70, and all of the defect corrections we have been discussing as a possible evidence of difficulty with the program, we have had the opportunity to learn about the critical components which may prove unreliable in the main battle tank, and thus we hope to make it a system very much more reliable than the M–60A1E2.

General Betts. There would be a natural fallout of going through the process of the second group of pilots that gives you all of that additional testing effort to build in reliability.

RATIO OF MAINTENANCE HOURS TO HOURS OF OPERATION

Mr. Minshall. Existing simpler tanks require about 1 hour of maintenance for every 2 hours of operation. No maintenance ratio has yet been established for the MBT–70 nor have the functions to be performed at each level of maintenance been established. Considering the complications of the dual engineering standards based on the inch and metric system, and the sophisticated equipment in the MBT–70, what is your best estimate of the ratio of maintenance hours to hours of operation?

Mr. TRAPP. We have established maintenance hours for hours of operation. The establishment we have used is 1 hour of maintenance for 4 hours of operation.

Mr. POOR. Is that a target?

Mr. TRAPP. Yes, sir.

General LUCZAK. That is a high target that may not be attainable.

Mr. MINSHALL. Was that a realistic target?

Mr. TRAPP. The target was contained in the military characteristics and we have apportioned maintenance requirements throughout the vehicle according to that target goal.

Mr. POOR. Let me say I do not think it is attainable. I am hopeful that numbers comparable to the present tank maintenance can be achieved.

CREW AND MAINTENANCE TRAINING

Mr. MINSHALL. Have plans for the training of the crew and the maintenance personnel for the MBT–70 been completed?

General LUCZAK. No, sir, the answer is that they have not been completed. They are in process. We have maintenance people from time to time—soldiers—in Cleveland. There will be a group Monday, for example. They have not been completed yet.

MAINTENANCE COSTS FOR MBT–70

Mr. MINSHALL. Do the Army studies predict—to go back to one of my previous questions—that the maintenance costs of the MBT–70 will be substantially greater than the maintenance costs of the M–60A1, and M–60A1E2?

General LUCZAK. No, sir, I do not think they would be.

Mr. MINSHALL. Why? You have a much more sophisticated vehicle here. You are bound to have more sophisticated subsystems to take care of and therefore higher maintenance costs.

General LUCZAK. We are making maximum use of onboard checkout equipment. We have the technological progress to go to solid state in our computers and fire control. Our goal of 1 hour of maintenance to 4 hours of operation, while it appears to be unattainable at this time, we are certainly going to get further toward that goal than we have in previous tanks, we feel.

OVERSOPHISTICATION IN MILITARY HARDWARE

Mr. MINSHALL. Lt. Gen. Arthur S. Collins, Jr., stated in an article that technical progress has resulted in an increased tendency toward oversophistication in military equipment. He concluded that "Oversophistication may actually lessen the value of an item to the user." Do you consider his remarks to be pertinent to the MBT–70 as compared with existing U.S. tanks?

General LUCZAK. I think his remarks are a good thing to keep in mind as we go through our considerations in the December review to see what sophistication we have that does not pay its way in both effectiveness and cost.

MAINTENANCE TRAINING

Mr. MINSHALL. What increases in the training times required for maintenance crews are anticipated in connection with the MBT–70?

General LUCZAK. I do not believe we know that yet, sir, until we finally decide what components we will have in this tank.

Mr. MINSHALL. I yield to Mr. Rhodes.

OPINION OF GERMANS ON MBT–70

Mr. RHODES. It was reported in March 1968, that in a conference on the main battle tank, the Germans suggested that they would be happy to continue production of their Leopard tank and were willing to discontinue the main battle tank program. As has been mentioned earlier, the Germans anticipated total production has been reduced from 1,500 to 1,000. It has further been suggested that it is very likely that the Germans will continue producing the Leopard and that the number of MBT–70's in the German operational inventory will be very small. What is the latest information you have as to the intentions of the Germans to procure the MBT–70?

General LUCZAK. The latest information that we have it that they will probably ——— with the MBT–70's. I do not know how many tanks in their Army are in a corps. Insofar as the Leopard is concerned, they are manufacturing the Leopard, which is a medium tank, 45-ton. They are selling it to nations in Europe. But they have given the responsibility for the APE of the main battle tank to the Krause-Mafei organization. The rationale told to us is that they expect to ———. That is the latest information I have.

Mr. RHODES. What is the date of this information?

General LUCZAK. The date of this information is the last PMB, about May 1969.

STATUS OF UNITED STATES-GERMAN AGREEMENT ON MBT–70

Mr. RHODES. It has been further reported that the Germans were not adamant about discontinuing the MBT–70 program because of their agreement with the United States. They recognize the importance of harmony on this international agreement, but that strictly speaking from the point of view of the Germany Army, they do not consider the MBT–70 to be practical and useful. Would you comment on this?

General LUCZAK. Yes, sir, I would like to comment on that because I do not believe the Germans are willing to pay the billions of marks they have set aside or will set aside for the MBT–70 simply to maintain harmony with the United States. Our basic agreements are such that they can pull out of this program any time, and we can pull out of the program any time, as far as we know, without any rancor on anybody's part. This was recognized early in the program.

TWELVE PROTOTYPES CONSTRUCTED

Mr. RHODES. As of today, how many United States and how many German prototypes have been constructed?

General LUCZAK. As of today there have been six United States, six German prototypes, and three test rigs.

Mr. RHODES. To what degree are these complete tanks?

General LUCZAK. In the case of the United States, these are complete tanks with the exception of the automatic loader. In the case of the FRG, I believe there are one or two tanks that are not complete—in fact, none of their tanks have the complete U.S. fire control equipment in them. One set of U.S. fire control equipment is being installed in one of the six German pilots at this time.

Mr. RHODES. You intend to construct an American prototype with everything, including the automatic loader?

General LUCZAK. Yes, sir; at the end of 1970—I mean of the present pilots, we will have complete U.S. pilots with everything including the automatic loader.

PROPOSED FISCAL YEAR 1970 MBT–70 PROGRAM

Mr. RHODES. Detail for the committee the various activities anticipated in your fiscal year 1970 program. You can do that for the record.

(The information follows:)

Various activities in fiscal year 1970 related to the present pilots are—
Completion of engineering design phase of the vehicle program and initiation of engineering tests;
U.S. unilateral loader program (GM) to have usable loader for first-generation pilot testing;
Development of turbine powerpack;
Conduct a comparative evaluation with the M–60 A1–E2 tank;
Completion of engineering development and initiation of engineering tests on gun and ammunition;
Contractor and in-house support to engineering development and engineering tests;
Scavenger testing; and
Vulnerability reduction program.

OTHER FUNDING IN SUPPORT OF MBT–70 PROGRAM

Mr. RHODES. What funds are in the O. & M. and procurement accounts in support of the MBT–70 program?

General LUCZAK. Is that the total program or the fiscal 1970?

Mr. RHODES. What funds are in the O. & M. and procurement accounts in support of the MBT–70 program in fiscal 1970.

General LUCZAK. I do not have the O. & M. broken out. May I supply that for the record?

Mr. RHODES. Yes.

(The information follows:)

There are no O. & M.A. funds programed in fiscal year 1970 or in prior years for the MBT–70. Actual and planned funding thus far in the program has been limited to R.D.T.E. and PEMA for advanced production engineering and facilities only. The budget requests $25.4 million in PEMA funds for fiscal year 1970.

Mr. RHODES. What funds other than the line item for the MBT–70 are budgeted for support of the MBT–70 program in the R.D.T. & E. Army appropriation?

General BETTS. $44.9 million in fiscal year 1970.

General LUCZAK. R.D.T. & E. is $44.9 million, but the question is What other funds?

Mr. RHODES. Other than your line item.

General LUCZAK. Other than the $44.9 million, there is only the $25.4 million in PEMA funds for advanced production engineering in fiscal year 1970.

FUNDS REQUIRED TO TEST MBT–70 THROUGH DECEMBER

Mr. RHODES. How much money would be required in the MBT–70 program in fiscal year 1970 to only continue with the testing of the existing prototype tanks through December of this year when review of the program is scheduled?

General LUCZAK. Approximately $20 million R.D.T. & E. would be required through December of this year.

VARIOUS MBT–70 WEAPON SYSTEMS

Mr. DAVIS. We have three weapons systems to be used in the MBT–70, as I understand it.

General LUCZAK. We have three different kinds of rounds fired through the same tubes. Three very different kinds of rounds, one of which is a missile, one is a family of conventional rounds, and one a brand new kinetic energy hypervelocity round. In addition, we have a machinegun, 7.62 millimeter coaxial as a secondary weapon.

Mr. DAVIS. You indicated that the Germans were testing just one of those.

General LUCZAK. No sir. The Germans are developing the 20 millimeter cannon, another secondary armament system, but we will do the testing on that weapon system. That is our responsibility in the United States. We provide the Germans with the U.S. bill and manufacture the weapons system, including the ammunition, including the missile.

Mr. RHODES. Would it be well to include in the record somewhere an explanation of the kinetic shell?

Mr. POOR. Yes.

Mr. RHODES. So those who read the record will know what we are talking about and what it does that is different from conventional ammunition.

Mr. POOR. You ask that there be a summary of the characteristics of the tank and I think we can well include it there, and so we will do so.

Mr. RHODES. That is all, Mr. Chairman.

Mr. DAVIS. In effect, then, it is the same basic firing system with three different types of ammunition, using it in the broad sense.

Mr. POOR. That is correct.

Mr. DAVIS. Except for the availability of the three different types of ammunition, it does not affect the complexity of the firing mechanism at all.

General LUCZAK. It does, sir, to this extent. You require a different kind of a firing control for the missile per se than you do for the conventional rounds per se, because the missile you have to track after it is fired. The rounds, once they are gone, they are gone.

Mr. POOR. Excuse me, Mr. Davis, I think I agree with you. The fire control system for the MBT–70 is in fact somewhat simplified by the fact that the one system controls all of these kinds of ammunition. So there are gains over putting together an independent computer to

operate the conventional gun ammunition and the kinetic energy ammunition and adding on a separate Shillelagh firing mechanism. I think you are right, there is a simplification through the integration of the three things into one functional package.

Mr. DAVIS. What is the capability now of our present M–60? What do we have in the way of firepower?

General BETTS. It has a 105-millimeter gun in its primary armament.

Colonel LAMB. The M–60 has the coaxially mounted machinegun we are talking about for MBT, it has a 50-caliber where we are talking about the 20-millimeter for MBT; and it has the 105 main armament with two principal rounds, an APDS round and a HEAT round, as well as an antipersonnel round.

General BETTS. The APDS is the same type of round as the kinetic energy round we are talking about.

Colonel LAMB. It gives us a tremendously high probability beyond the range of ——— meters when compared to over the other rounds presently in the M–60 tank.

TANKS TO BE REPLACED BY MBT–70

Mr. DAVIS. As we look down the road can we anticipate annual procurement of the M–60 until such time as the MBT–70 is considered safe to proceed with, and from that time on it will be a gradual replacement of the M–60 with MBT–70?

Colonel LAMB. No, sir, that is not exactly correct. The M–60 will be with us for a long time. We have an authorization in our AAO of ——— tanks. I am rounding off numbers. Against that we have approximately ——— M–60 tanks today. We have ——— tanks of the M–48 vintage, some of them totally unsatisfactory tanks, about ———. Those tanks would be the ones phased out initially as the MBT came into the inventory.

Mr. DAVIS. It will be for a considerable period of time then when we will have both the M–60 and the MBT–70 in our inventory.

Colonel LAMB. Yes, sir.

Mr. MAHON. We have tried to probe as deeply as we reasonably could in the limited time available into the main battle tank program which involves several billion dollars, and has many military implications.

Thank you, gentlemen. We have completed the main battle tank hearing. Those backup witnesses who were here only for that discussion may return to their other duties, if they wish.

TOW HEAVY ANTITANK ASSAULT WEAPON

Mr. MAHON. We will now want to have a period of interrogation in regard to the TOW heavy antitank assault weapon.

The fiscal year 1970 program estimate for the TOW missile is ——— million. Were you able to complete all the fiscal year 1969 objectives for which you were provided $2 million?

General BETTS. Yes. All objectives planned for fiscal year 1969 were completed to include engineering and service testing and first production contract award.

TOW DEVELOPMENT COST INCREASES

Mr. MAHON. A review of prior justifications discloses that the fiscal year 1968 justification book estimated total development cost for TOW to be $94 million; the next year it was shown at $100.8 million, but the fiscal year 1970 book fails to disclose such an estimate. What was the original total estimated cost for TOW and what is the current estimate?

General BETTS. The original cost estimate in July 1963 for the TOW R.D.T. & E. program was $49.3 million. The current program R.D.T. & E. cost estimate for TOW is ——— million.

Mr. MAHON. What are the reasons for the cost increase?

General BETTS. The original cost estimate was based upon the feasibility studies and an austere program. As the program progressed more realistic estimates, unanticipated technical problems, and additional or increased performance requirements resulted in program cost increase.

SLIPPAGE IN TOW DEVELOPMENT PROGRAM

Mr. MAHON. How far has the TOW program slipped?

General BETTS. The TOW program has slipped ——— months since 1963.

TOW MISSILE PROCURED BEFORE DEVELOPMENT AND TESTING COMPLETED

Mr. MAHON. The PEMA justification book indicates that TOW has yet to be approved for service use, yet a total of $86.2 million has been appropriated by Congress in fiscal years 1968 and 1969 for the procurement of ——— TOW missiles. Were these missiles used in your test program?

General BETTS. The ——— missiles being procured with PEMA funding were not used in the R. & D. test program. These funds were obligated in fiscal year 1969 for the first year's buy of missiles. These missiles are scheduled for delivery beginning in ———.

ENVIRONMENTAL TESTS TO BE CONDUCTED

Mr. MAHON. For fiscal year 1970 a total of $156 million is being requested in the PEMA budget for the procurement of ——— TOW missiles. It is noted on page 181 of your justification book that environmental testing will begin using production line missiles. Why is this being done? How many do you need for your testing program?

General BETTS. Environmental testing will be conducted to determine whether the production missile system will perform its intended use effectively in the actual environmental extremes of the desert, arctic, and tropics. These tests will also be used to verify the environmental test data obtained in the engineering tests conducted under controlled environmental extremes. A total of 66 missiles are planned for these tests.

Mr. MAHON. When will the environmental tests begin and when will they be completed?

General BETTS. The tests will begin in May 1970 and be completed in February 1972.

SLIPPAGE IN TOW PRODUCTION SCHEDULE

Mr. MAHON. The committee understands that TOW production slipped about 9 months because it was found the missile had less shelf life than desired. What will you do to correct this problem? How long will it take?

General BETTS. The shelf life requirement for TOW is ——— years without maintenance. Data on environmental stress due to long-term storage conditions are not available at this time. The storage tests are scheduled to begin in second quarter fiscal year 1970 and be completed in second quarter fiscal year 1975. A sample quantity will be withdrawn every 6 months and tested. This depot and field storage data will be evaluated as it becomes available. No shelf life problem has been identified to date and no TOW production slippage has been attributed to failure to achieve the desired shelf life.

ADDITIONAL DEVELOPMENT OF TOW REQUIRED

Mr. MAHON. What else do you need to do to complete development of the TOW missile?

General BETTS. The following work remains to be accomplished to complete the development of the TOW missile system: Conduct arctic, desert, and tropic environmental tests: develop and test the night sight; improve operation in an electronic countermeasures environment.

Mr. MAHON. Why not wait until development and testing is completed before procuring TOW missiles?

General BETTS. Engineering and service tests have been completed. These tests have revealed a reliability (since October 1967) of ——— indicating a low risk in going into production. Although development of a night sight and conduct of environmental tests remain to be accomplished, this work is not essential to the capability of TOW to perform its mission of antitank defense, primarily in the European environment. Delaying production until this work is completed would mean waiting until late fiscal year 1972 or early fiscal year 1973 to make an urgently needed improvement in an antitank defense posture. Such a delay could undoubtedly result also in a production cost increase because of the shutdown and startup of the production line.

Mr. MAHON. What will you do if TOW fails the environmental tests?

General BETTS. TOW has successfully passed controlled environmental engineering tests as well as having undergone early evaluation in the Arctic at Fort Greely, Alaska and under desert conditions at Twentynine Palms, Calif. Because of these tests, we do not anticipate any significant problems with TOW in the environmental extremes. However, should a major failure arise, we would have to accept the deficiency as a limitation of the system or provide a corrective modification. A decision would have to be made on the basis of the merits of the specific case encountered.

REQUIREMENT FOR TOW ON HELICOPTERS

Mr. MAHON. Why do you need a TOW missile on the Cheyenne or Hueycobra helicopters? Do we not have Air Force aircraft equipped with antitank ordnance, such as missiles and bombs, to be called upon

by the Army to knock out tanks? Isn't this one of the reasons we provide large sums for attack aircraft and weapons therefor?

General BETTS. The attack helicopter is a combat vehicle and the capability to engage tanks and other armored vehicles is as essential to it as it is to ground combat vehicles. Army studies indicate that the Cheyenne, with its great mobility and night vision capability will be the most effective anti armor/mechanized weapon in the inventory when equipped with the TOW missile. This capability in the attack helicopter complements Air Force capabilities to destroy armored vehicles in that attack helicopters can operate effectively in the battle area where enemy ground units are being engaged by our forces. This is not usually possible for fixed wing attack aircraft because of their speed and heavy ordnance which makes it difficult to discriminate between friend and foe in a situation where ground forces are in close contact or intermingled. In addition, the attack helicopter is much less restricted by weather and darkness than the fixed wing attack aircraft and can respond more rapidly to enemy threats. In situations where this discrete fire support capability is not required or in the interdiction role, fixed wing attack aircraft will continue to be a vital factor in providing support for our combat forces.

DRAGON MISSILE SYSTEM

Mr. MAHON. You are requesting ——— million in fiscal year 1970 for the Dragon missile. How much was approved by Congress for Dragon in fiscal year 1969; you requested $15 million, but page 183 of the justification book shows the fiscal year 1969 program at only $13 million.

General BETTS. $14.6 million was approved by Congress for Dragon in fiscal year 1969. By reprograming action fiscal year 1969–2 (DOD 69–28), the approved funding was reduced by $1.6 million. This reduction was possible because of delays in the program as a result of reduced advanced production engineering funding in fiscal year 1968.

Mr. MAHON. Were you able to complete all the fiscal year 1969 objectives?

General BETTS. No, guided flight testing and component qualification did not progress on schedule and will continue into fiscal year 1970. Engineering/service tests were not initiated and are being rescheduled to ———. The night sight selection was not completed and is planned for early fiscal year 1970.

SLIPPAGE IN DRAGON DEVELOPMENT PROGRAM

Mr. MAHON. How far has this program slipped and what problems have developed?

General BETTS. The Dragon program has slipped approximately ——— months. Some technical problems have been encountered with the thruster firing switch and thruster propellent configuration and more recently a contractor management problem, growing out of the McDonald-Douglas merger, resulted in a drop in quality control and reliability. Currently, no significant technical problems are without solution and a review of the contractor performance indicates corrective action is being taken on quality control and reliability.

Mr. MAHON. The committee notes that the Dragon program has been funded a total of $54.8 million through fiscal year 1969. When was the Dragon program initiated?

General BETTS. The Dragon exploratory development was initiated in August 1964 and engineering development began in February 1966.

DRAGON MISSILE DEVELOPMENT COST INCREASES

Mr. MAHON. What was the original total cost of development of Dragon and what is your current estimate to complete development?

General BETTS. The original program cost estimate following the exploratory development phase in 1966 was $58.303 million (RDTE). The current estimate to complete development is ——— million (RDTE).

Mr. MAHON. What were the reasons for the cost increases?

General BETTS. The cost increases have resulted from delays in the initial years of the program because of substantial cuts in the funds provided with respect to those estimated as being required (cut 43 percent in fiscal year 1966, 28 percent in fiscal year 1967, 28 percent in fiscal year 1968), from some technical problems encountered in the design stages, and recently from a drop in quality control and reliability attributable to contractor management problems growing out of the McDonnell-Douglas merger.

NUMBER OF ARMY ANTITANK WEAPONS

Mr. MAHON. The justification book indicates that the Dragon missile system will replace the 90 mm. recoilless rifle on a one-for-one basis. Will you compare the weight, reliability, accuracy, and time required to acquire a target and fire the Dragon missile with that of the 90 mm. recoilless rifle? In other words, what do we acquire for this expenditure of funds?

General BETTS. With the acquisition of Dragon, we will be able to provide the foot soldier with a lightweight weapon having a significantly increased accuracy at greater ranges than the current 90 mm. recoilless rifle. A comparison of key characteristics of Dragon and the 90 mm. recoilless rifle is as follows:

Characteristic	Dragon	90 mm. RR
Weight (pounds)	29.2	44.
Accuracy (1st-round hit probability)	——— meters	——— to 225 meters.
Time to acquire and fire at target	5 secs	5 secs.
Reliability	———	99.7 percent.
Penetration 0° (inches) rolled armor	———	———.

Mr. MAHON. How many different antitank weapons does the foot soldier have in the Army inventory and under development?

General BETTS. The following antitank weapons for the foot soldier are in the inventory and under development. The developmental items will replace those in the inventory.

IN THE INVENTORY

M72A1 light antitank weapon LAW
M67 90-millimeter recoilless rifle
M40A1 106-millimeter recoilless rifle
ENTAC 130-millimeter guided missile

UNDER DEVELOPMENT

M72A1E1 LAW (product improvement)
Dragon guided missile (medium antitank/assault weapon)
TOW guided missile (heavy antitank/assault weapon)

COMPARISON OF DRAGON WITH TOW MISSILE

Mr. MAHON. Compare the characteristics of the Dragon with the TOW, including weight, range, accuracy, and mission.

(The information follows:)

CHARACTERISTIC COMPARISON

	Tow	Dragon
Weight	226.4 pounds	29.2 pounds.
Missile	40.5 pounds	13.46 pounds.
Range	——— meters	——— meters.
Accuracy (1st-round hit probability)	——— meters	——— meters.
Crew	4 men	1 man.
Employment	Infantry battalion	Infantry platoon.
Mount	¼-ton truck; ½-ton mule; M113 APC; AAFSS (helicopter).	1-man portable.

SURFACE MOBILITY COMPONENTS AND TECHNIQUES

Mr. MAHON. You are requesting ——— in fiscal year 1970 for surface mobility components and techniques. Why is it that the justification book fails to show funding for this program element prior to fiscal year 1968?

General BETTS. Cumulative prior year data were considered not meaningful for program elements in the research, exploratory development, and management and support areas, as each of these program elements is a grouping of projects with varying levels of effort, and the task content of the projects differs from year to year.

Mr. MAHON. For fiscal year 1969, you requested $4.3 million for this research effort. However, the fiscal year 1970 justification book, page 185, indicates $5.3 million was funded in fiscal year 1969. How was this increased and why?

General BETTS. The amount originally included in this program element for the President's budget was $4.2 million. A combination of congressional action and Army reprograming further reduced this total to $4 million. The total of $5.3 million was attained as $1.3 million was associated with this program element in the statistical application of facilities and installation support costs.

RADIOLOGICAL ARMOR FOR COMBAT VEHICLES

Mr. MAHON. Why are you conducting work on radiological armor for combat vehicles? ———.

General BETTS. ———.

The aim of this project is to develop shielding which requires minimum tradeoffs when included in combat vehicle design. Such material would be particularly valuable for those more lightly armored types which lack the inherent protection offered by the ballistic armor of main battle tanks.

MOBILITY SYSTEMS FOR AUTOMOTIVE VEHICLES

Mr. MAHON. Your total request includes ——— for mobility systems for automotive vehicles. What are you doing in this area?

General BETTS. The major portion of this funding supports early development of suspension systems for new combat vehicles. Examples are the dual-spring-rate torsion bar and active suspensions. This latter system anticipates terrain variations and positions roadwheels accordingly. Additionally, work is being done to extend the service life of combat vehicle track, which currently represents a major element of operating costs for such equipment.

SEA-TO-INLAND LOGISTICS SYSTEM

Mr. MAHON. What is involved in the work on "sea to inland logistics system?" You also have money for this under "Ships, small craft, and related equipment."

General BETTS. This is an effort to conduct exploratory development for design parameters and technological base to support design and development of U.S. Army marine craft, amphibious lighters, and equipment for improved marine logistical transportation from dispersed ocean transports over the beach to inland transfer points, over inland waterways and to Army terminal facilities. Technical and performance suitability is established through experimental model and breadboard hardware investigations. Currently exploratory development efforts are in progress for a silent outboard engine and a ship collision avoidance system. Design parameters and technology acquired in this exploratory development project contribute to hardware development in the engineering development project under the "Ships, small craft, and related equipment" category. Fiscal year 1970 R. & D. effort for engineering development of hardware under "Ships, small craft, and related equipment" will be primarily directed toward development of a small labor and inland waterway tug. Also, effort will be directed toward maintaining the procurement packages for a beach discharge lighter (BDL) in state of readiness for initiation of procurement when funds become available.

OTHER WORK TO BE DONE IN FISCAL YEAR 1970

Mr. MAHON. What other work do you propose for this program element in fiscal year 1970?

General BETTS. In addition to the track and suspension work dis-

cussed earlier, this program element will support continued work in the following areas: laminate armor, spaced armor, transparent armor for cupolas, sealed brakes for wheeled vehicles, water-activated and nickel-cadmium batteries, a 700-ampere alternator, maintenance-free ignition, and water-propulsion kits and systems for combat vehicles. Particular emphasis will be placed on the integration of current componentry into combat-vehicle systems for which development is just being initiated (such as the armored reconnaissance and Scout vehicle and the mechanized infantry combat vehicle).

FISCAL YEAR 1969 ACCOMPLISHMENTS

Mr. MAHON. What did you accomplish with the $5.3 million made available in fiscal year 1969?

General BETTS. The funding made available in fiscal year 1969 was used to support the exploratory development of all the various components enumerated in my explanation of our planned activities for the coming year. As it happened, no new vehicle systems began development during fiscal year 1969; however, those components now sufficiently mature to merit integration into systems initiated in fiscal year 1970 have attained that status through the efforts of the previous year. Other components supported in the previous year are not yet ready for inclusion in vehicle systems and will require further time and funding until they are ready for inclusion in a prototype system. Availability of components such as these for future vehicle systems can be highly effective in reducing the risk and leadtime associated with major system development.

Mr. MAHON. Can you identify any work done under this program element which contributed directly to the MBT–70 program? Give some examples.

General BETTS. The track and suspension items now being tested for MBT–70 received their early exploratory development work within this program. Once the basic merits of these items were clearly established, the projects were transferred to the MBT–70 component program. In addition, early work on ——— ballistic protection is another example of work under this program element which has contributed directly to MBT–70.

CHEMICAL-BIOLOGICAL WEAPONS

Mr. DAVIS. You are requesting $25.7 million in fiscal year 1970 for chemical-biological weapons. What was your fiscal year 1969 program?

Colonel TOBEY. The fiscal year 1969 program was funded at $25.5 million.

Mr. DAVIS. The fiscal year 1969 justification book, page 170, indicates that a total of $203.8 million has been devoted to this work from fiscal years 1963 through 1968. Why does the fiscal year 1970 justification book show funding only since fiscal year 1968?

General BETTS. No prior years funding data is reported this year for exploratory development since this effort is not end item oriented, but applies to many areas of future end item development. Accordingly the accumulation of prior years costs is relatively meaningless.

EFFECT OF CS GAS ON HUMAN SKIN

Mr. DAVIS. Earlier in these hearings, General Betts, you indicated you were unaware of any permanent injury to the skin from exposure to CS. It has come to the attention of the committee that tests completed by the Army in June 1966 disclosed that on most volunteers CS caused immediate skin irritation or inflammation, and 12 to 24 hours later all eight volunteers suffered first- and second-degree burns. Four suffered severe blistering, some required surgery, and three of the eight were hospitalized for a week for treatment of the skin eruptions. These findings were published by the Army Edgewood Arsenal in January 1967 in a pamphlet entitled "The Effects of Thermally-generated CS Aerosols on Human Skins." Are you aware of this report, General Betts?

General BETTS. I was not aware of that report in detail when I gave you my answer, but I can add to my prior answer and put this in somewhat better perspective. A report was issued by Edgewood Arsenal in January 1967. Their technical report 4075. That report stated that at very high concentrations of CS and the number they were using was 300 milligrams per cubic meter of air—and for exposure times greater than 30 minutes under tropical conditions of heat and humidity—97 degrees Fahrenheit; 100 percent relative humidity—with only moderate wind velocity—that is, down to 5 miles an hour—the dosages occur which produce second- and first-degree burns of the skin.

Now, we must put that in perspective. The dosage which produced that is 900 times that which is achieved by the standard Army grenades that are used for riot control, or for tactical purposes. So what we are saying is that although half of the volunteers exposed to those doses developed blisters on the skin, the report provided evidence that while those skin effects can occur under extreme conditions, such effects would not normally be achieved with field aerosols that are generated for riot, or tactical purposes. We feel the difference between any reasonable dosage that is expected in a riot, or tactical situation, and what was achieved under these contrived test conditions would indicate that the safety factor is well in hand.

Mr. DAVIS. You don't think there is any real practical cause for concern based upon the results of this test?

General BETTS. I believe for all practical purposes thermal burns are not a hazard related to the routine use of these weapons.

C/B WORK DEVOTED TO BOTH OFFENSIVE AND DEFENSIVE DEVELOPMENT

Mr. DAVIS. When we speak of this program—the entire CB group for the current fiscal year, are we speaking entirely of offensive capacity?

General BETTS. When we speak of our CB development program, we are speaking about both offensive and defensive development.

Mr. DAVIS. Would you elaborate on the defensive phase of that?

General BETTS. Yes, sir; and may I expand on the pure defensive aspects to this degree: It seems to me that it would be absolutely indefensible for us to cease all offensive lethal weapon development in an international framework that recognizes the Soviets have an extensive operational capability in lethal chemical weapons and they have a very considerable research and development program.

We don't know precisely what agents they have developed and have deployed. It would be foolish if we ceased doing offensive development work that denied us the knowledge of what it takes to defend against any agent that our technology might conceive.

Our national posture is a posture of retaliation only with respect to lethal chemical weapons, or lethal gas weapons. I should qualify that. But it would be foolish if we thought we had a good defensive posture and had not pursued enough offensive development effort to know what kind of capability the enemy could have. We can't hope to get a full picture of this capability from purely intelligence sources.

With that background, I would like to refer to Colonel Tobey for a further discussion of the offensive programs.

Mr. DAVIS. We would appreciate having any comments you care to make on it.

Colonel TOBEY. Our investigations indicated that about ——— percent of the work that we are doing under the CB program is offensive in nature, but it is very difficult to make any clear line of delineation between the two because there is such an intermingling of the two. Most of the offensive-type work we do, or much of it, gives great insight into the defensive equipment that is required to contend with this.

Mr. DAVIS. Do you have any financial breakdown as to the offensive and defensive part of it or are they so intertwined that it is practically impossible to provide that?

Colonel TOBEY. We do have some numbers we could provide for the record on that but, as I indicated, in gross terms it would appear to be about ——— percent.

Mr. DAVIS. And further for the record then, if you would, indicate to us what has been done with the $25 million provided in the previous fiscal year, and the program that you hope to accomplish during the current fiscal year in this area?

(The information follows:)

It is difficult to quantify specifically how much exploratory development work is offensive in nature since much of this work contributes equally to the defensive as well as the offensive effort. For example, chemical agent dissemination and dispersion technology is as important to the study of chemical defensive systems as it is to the weaponeers. But adding all the projects together that could contribute to offensive CB weapons provides a total of ———. Of this total, ——— to incapacitating and riot control agent investigations.

Some major accomplishments during fiscal year 1969 were:

Chemical: Developed a castable, polymer bonded smoke mixture with which to facilitate the production of agent CS pyrotechnic mixes. Selected agent ——— for further development from ———. Developed methods of synthesis for economic production and developed munition design concepts. Developed munition design concepts for an explosive incendiary bomblet suitable for antipersonnel and antimateriel applications. Developed concepts for, proved the feasibility of and fielded a personnel marking and identification system using ———. Developed concepts for and proved feasibility of a retroreflector intrusion detection system using ———. Verified munition design concepts for a number of binary-type candidate lethal agents.

Biological. Established feasibility for a pneumatic feeder for handling dry biological agents. Developed a geomagnetic sensor system for instrumenting and telemetering small biological weapon systems during testing. Identified a tissue cell line for ———.

The fiscal year 1970 funds would be used to accomplish the following:

Investigate potential chemical and biological antipersonnel agents, to determine if they could pose a threat as an enemy system ———. Concurrent with

determining the agent's physical and biological characteristics, and their probable effects upon man, effort is conducted to develop treatment methods, prophylaxis techniques and diagnostic techniques. Investigate the bio degradation of plant control agents with the goal of developing compounds that have little or no residual effects. Investigate the effects upon man of potential riot control agents with the goal of developing an effective agent that has no potentially harmful side effects. Conduct dissemination investigations on chemical agents and biological agents to determine the factors controlling the delivery and dispersion of these agents. The results of these studies will be used to determine the threat potential of these agents and munitions systems and investigate new potential munition designs. ———.

DISPOSAL OF C/B MUNITIONS

Mr. DAVIS. Where do we stand now on the hiatus over the disposal of—I guess nerve gas was the one referred to in the press?

General BETTS. May I refer to Lieutenant Colonel Dismore?

Lieutenant Colonel DISMORE. The National Academy, as you will recall, reviewed the procedures proposed for the disposal of these munitions and made certain recommendations. The latest word on the status of our implementation of their recommendations is as follows:

They recommended that we destroy in place, essentially, the liquid mustard that was stored in 1-ton heavy steel containers. We have made plans to burn this material according to the recommendations of the National Academy.

The burning site and the exact time phasing of this operation is still under consideration.

With respect to the disposal of the M–55 rockets which were filled with agent GB, and were encased in cement inside of heavy steel coffins, each of which contain 30 rockets, the Army convened a committee of technically qualified individuals, including demolition experts, to further consider whether there is any feasible way which is practical to dispose of these items at military establishments. The committee reviewed the various disposal alternatives and has adjourned. The report is being prepared at this moment.

If no method of disposal meeting these criteria is found, then the Army, after coordination with other independent agencies, will consider whether to follow the recommendation of the National Academy, which was to dispose of these by sea dump.

With respect to the demilitarization and detoxification of the Air Force M–34 cluster bombs, a thorough study was commissioned within the Army to determine whether in the interests of safety it was more advisable to perform these processes at Rocky Mountain Arsenal in Denver, Colo., or at Toelle Army Depot in Utah. Both of these locations were recommended by the National Academy of Sciences.

The report has been forwarded to the Secretary of the Army for consideration.

ALLEGED PRODUCTION OF NERVE GAS AT NEWPORT, IND.

Mr. DAVIS. Earlier this week there was a news report relative to the alleged production of nerve gas. One of our colleagues was assuring the public that, based upon a source which had heretofore been reliable in other matters, they were planning to produce nerve gas out at Newport, Ind., and I believe the report said there had been a denial of this, but that this particular representative said that his source was

one that he had found reliable in the past and so he still believes the report was true. Can you clarify that for us?

Mr. POOR. I can categorically deny the report that it is planned to renew the operation of the plant for anything except high explosives.

UNDERGROUND STORAGE OF C/B MATERIAL AT DENVER

Mr. DAVIS. What about the underground storage of some of this chemical biological material out at Denver? Is that currently being planned, or is there some there now?

Mr. POOR. I believe there is no biological material at Denver.

Lieutenant Colonel DISMORE. There is no permanent underground storage at this installation. There are, however, ten 10,000-gallon underground storage tanks used for temporary holding of agent during the manufacturing and munition filling operation.

Mr. POOR. There are chemical munitions stored above ground.

FIREPOWER OTHER THAN MISSILES

Mr. DAVIS. You are requesting ——— in fiscal year 1970 for "Firepower other than missiles." What was your fiscal year 1969 program?

General BETTS. The fiscal year 1969 program amounted to $12.5 million.

Mr. DAVIS. How much has been funded for this program element since fiscal year 1963?

General BETTS. Between $10 million and $16 million a year for an approximate total through fiscal year 1969 of $85 million.

PROGRAM ACCOMPLISHMENTS

Mr. DAVIS. Can you point to specific accomplishments resulting from this program since fiscal year 1963? Provide significant examples.

General BETTS. This program element consists of some 29 projects which provide for exploratory development of new weapons, munitions, and equipment for infantry, artillery, and armor forces. Possibly the best recent example of the contribution this type of effort makes is in the ammunition field. Exploratory development during the late fifties and early sixties led to the marriage of wound ballistic technology, capabilities for miniaturized munitions components, and techniques for delivery of submissiles by artillery projectiles. This has resulted in the recent fielding of a totally new family of antipersonnel ammunition with highly increased effectiveness.

WORK ON WEAPONS FIRING TABLES

Mr. DAVIS. Page 197 indicates you have a project to provide firing tables and associated ballistic data for all land combat weapon systems in which guidance is not incorporated. Will this work be done in-house or under contract?

If under contract, who will do the work

General BETTS. This is primarily an in-house effort by the Ballistic Research Laboratories at Aberdeen Proving Ground. A small contract with Vitro Laboratories amounting annually to about 5 percent of the total effort provides some minor but necessary computer support.

RAPID FIRE DIRECT SUPPORT ARTILLERY WEAPON

Mr. DAVIS. What is the rapid fire direct support artillery weapon referred to on page 198 of the justification book and what was the outcome of work on this system?

General BETTS. Since 1963, the Army has had a qualitative materiel development objective (QMDO) for a rapid fire, direct support, 105-millimeter howitzer. Battlefield experience and computer analysis show that effectiveness is maximized when a large number of rounds can be delivered in a very short time before the target can change its position or seek cover. We are exploring several means of providing this rapid fire capability. Deficiencies exist in all our current concepts. It is these deficiencies that this funding is designed to solve. The major effort, last year and this year, involves effective obturation or propellant gas sealing between gun tubes and different, revolver-type cartridge chambers and magazines.

LIQUID PROPELLANT GUN SYSTEM

Mr. DAVIS. What is the liquid propellant gun system mentioned on page 201?

General BETTS. This refers to an aircraft, air defense or vehicle mounted weapon not exceeding 60-millimeter in size and operating from an attached fluid propellant container. During fiscal year 1970 several fluid propellant compositions will be examined and study will be conducted of devices for metering the propellant into the weapon.

MORTAR APPLIED RESEARCH

Mr. DAVIS. You are requesting funds under this program element for mortar applied research. Reports back from Vietnam indicate some of our men are impressed by the accuracy of the lightweight mortars used by the enemy. Are we doing any work toward the development of a lightweight mortar?

General BETTS. A qualitative materiel development objective (QMDO) is currently being prepared for a lightweight, indirect fire, infantry close support weapon by the Army Combat Developments Command. Nominal development work will be conducted in fiscal year 1970 consisting of conceptual studies and experimentation to determine feasibility in terms of time and cost.

CLASSIFIED PROJECT

Mr. DAVIS. What is the classified project for which you are requesting $910,000?

General BETTS. This project provides for exploratory development of improved conventional munitions. These munitions ——— have significantly improved antipersonnel effectiveness. The first generation of these munitions has been recently deployed. The currently requested funds will provide for investigation of methods for improved ——— improved antiarmor kill mechanisms, and new applications of the technology to area denial operations by the Army and Air Force.

HIGH ENERGY LASER RESEARCH

Mr. DAVIS. A total of $1.7 million will be used for high energy laser research. This is one of many references to laser research throughout the Army R.D.T. & E. program. Will you list for the record the laser research to be done in fiscal year 1970 by program element, subactivity, and project, together with the proposed cost for the entire Army R.D.T. & E. budget?

(The information requested follows:)

Laser research programed by the Army to be done in fiscal year 1970 includes both research on lasers to develop new laser technology suitable for Army applications, and research carried out using lasers to evaluate their use in Army applications. The following is a list of Army laser research planned for fiscal year 1970 together with cost estimates, which totals $7,590,000.

Program element: 6.11.02.A Defense research sciences; subelement: General physics.
Subactivity: 501B.
Project: 20061102B11B Research in experimental and theoretical physics.
Funding: $350,000.
Program element: 6.11.02.A Defense research sciences; subelement: Electronics.
Subactivity: 501B.
Project: 1T061102A31B Night vision device research.
Funding: $600,000.
Program element: 6.11.02.A Defense research sciences; subelement: Electronics.
Subactivity: 501B.
Project: 1T061102A31C Research in quantum electronics.
Funding: $1,444,000.
Program element: 6.11.02.A Defense research sciences; subelement: Electronics.
Subactivity: 501B.
Project: 20061102B31F Joint services electronics program.
Funding: $100,000.
Program element. 6.11.02.A Defense research sciences; subelement: Atmospheric sciences.
Subactivity: 501B.
Project: 1T061102B53A Research in atmospheric sciences.
Funding: $250,000.
Program element: 6.21.02.A Electronic warfare; subactivity: 502B.
Project: 1H062102A218 Electronic warfare components and techniques.
Funding: $30,000.
Program element: 6.26.03.A Firepower other than missiles; subactivity: 552C.
Project: 1T562603A308 High energy laser research.
Funding: $1,700,000.
Program element: 6.27.01.A Communication-Electronics; subactivity: 562A.
Project: 1H662701A448 Information transmission.
Funding: $70,000.
Program element: 6.27.03.A Airborne surveillance and target acquisition; subactivity: 562C.
Project: 1Z662703A186 Airborne image conversion.
Funding: $500,000.
Program element: 6.27.04.A Ground surveillance and target acquisition; subactivity: 562D.
Project: 1Z662704A199 Optical radar and laser techniques.
Funding: $700,000.

Program element: 6.27.05.A Electronics-electronic devices; subactivity: 562E.
Project: 1H662705A055 Thermionic applied research and engineering.
Funding: $75,000.
Program element: 6.27.05.A Electronics-electronic devices; subactivity: 562E.
Project: 1H662705A056 Solid state devices applied research and engineering.
Funding: $1,200,000.
Program element: 6.27.06.A CB defense; subactivity: 562F.
Project: 1B662706A102 Chemical agent warning detection.
Funding: $250,000.
Program element: 6.27.09.A Night vision; subactivity: 562J.
Project: 1Z662709D466 Night vision.
Funding: $200,000.

LARGE CALIBER CASELESS AMMUNITION

Mr. DAVIS. You have ——— in this budget for large caliber caseless ammunition. This effort has been running $1.5 million and $1.9 million for the last 2 fiscal years. What are you doing in this area?

General BETTS. The objective of the large caliber caseless program is to achieve a state-of-the-art capability sufficient to prove the feasibility of a caseless ammunition, automatic, vehicle-mounted, rapid-fire weapon. The program includes the fabrication of sufficient hardware and ammunition for demonstration test. Work has been performed under 18 contracts as well as at four in-house installations. The continuing exploratory development is to develop the required technology for solution to problems of vulnerability, heat transfer, and cook-off. Successful firing of 27-millimeter automatic weapons has been accomplished in test fixtures. The feasibility demonstration is currently planned for fiscal year 1970.

Mr. DAVIS. Will you provide for the record a table showing proposed work to be done in fiscal year 1970 on caseless or combustible cartridge cases by program element, subactivity, and project, together with the cost for each? I want this for the entire Army R.D.T. & E. budget.

(The information follows:)

A total of $5.5 million is programed in fiscal year 1970 for caseless and/or combustible ammunition development as shown below:

6.26.03: A353 caseless ammo for large caliber	———
6.26.04: A522 caseless ammo for small caliber	———
6.36.07: D641 caseless ammo system development	———
2.36.18: D334 Shillelagh (152 mm. ammo)	———
Total	———

MISTIC WEAPON SYSTEMS

Mr. DAVIS. What is the "Mistic Weapons Systems Requirements" project No. A976 under this program element?

General BETTS. Missile System, Target Illuminator Controlled (MISTIC) is a system intended for designating and defeating individual mechanized targets well forward of the FEBA through means of accurate indirect fire on target acquired by scouts, outpost personnel and forward observers. A study of this system is planned under this program element (project A976). Supporting exploratory development work leading to such a system is being conducted under program element 6.23.01.A (Missiles) with respect to terminal homing devices such as laser semiactive guidance and optical contrast seekers.

Army Small Arms Program

Mr. Davis. The Army small arms program is described as a new program element started during the fiscal year 1969 budget cycle. You are requesting ——— in fiscal year 1970, and you indicate that fiscal year 1969 program was $4.7 million. Is this the same effort as last year's "Infantry Supporting Weapons" program element? Where did you get the fiscal year 1969 funds? Has the $4.7 million been approved by OSD? If so, when?

(The information follows:)

No. This new program element is one of three which were initiated to provide visibility to the RDTE task specifically related to the development of small arms. The other two Army small arms program elements cover advanced and engineering development. The source of fiscal year 1969 funds of $4.7 million for small arms exploratory development was from program element 6.21.38.01, "Firepower Other Than Missiles," as follows:

	Millions
A272 Grenades and related equipment	$. 195
A293 Small arms ammunition	.709
A353 Caseless ammunition small caliber	1.100
A304 Small arms armor	2.570
Total	4.664

On July 1, 1968, OSD approved $1.664 million and deferred $3.0 million of these funds. The $3.0 million, deferred funds, were released to DA on December 3, 1968.

Mr. Davis. What did you accomplish during fiscal year 1969 with the $4.7 million? The justification book, page 202, indicates little or no work was done under this program element last year.

General Betts. The major accomplishment was that we were able to fund for exploratory development to provide coordinated support of the small arms development community to the Army small arms program (ARSAP). Specifically, the technique of formation of barrels of coextrusion of two types of materiels is under contract, extensive work on tracer ammunition which had been deferred in previous years was begun, and a comprehensive analysis of the performance of aluminum cases and a compatible breech was conducted.

SMALL CALIBER CASELESS AMMUNITION

Mr. Davis. Your fiscal year 1970 program includes ——— for small caliber caseless ammunition. What are you doing in this area, after the limited success and problems experienced with the larger caliber caseless ammunition?

General Betts. Specific planned goals of the fiscal year 1970 small caliber caseless program are initiation of comprehensive vulnerability studies; intensification of heat transfer and cook-off studies; initiation of comprehensive caseless propulsion research programs; conduct a 3-month test fixture requirements study; and initiate a continuing cost-effective study.

In view of the problems experienced in large caliber combustible ammunition, in April 1969 I appointed a committee to review the Army's caseless ammunition weapons program. This committee assessed the current and proposed research and exploratory programs and has made several recommendations for changes. These proposed changes are being considered by the Army Materiel Command at the

present time. Final action on the committee's recommendations may result in a change in this and other caseless programs.

Mr. DAVIS. What did you accomplish with the $1.1 million in fiscal year 1969 for small caliber caseless ammunition?

General BETTS. Initially $0.5 million for this task was released by OSD. The remaining $0.6 million was administratively deferred until November 1968. During fiscal year 1969 the firing of small caliber caseless ammunition in semiautomatic and automatic test fixtures was accomplished. Contracts with Aircraft Armaments Inc., General Motors, and the Hughes Tool Corp. are weapons concepts studies and ammunition research to solve the problems identified in this area of technology. Major problem areas which require solution are: durability and environmental protection; heat transfer and cookoff, obturation, producibility, erosion and fouling, ignition methods, extraction and misfires, and vulnerability.

POWER SYSTEMS AND CONVERTERS

Mr. DAVIS. You are requesting ——— in fiscal year 1970 for power systems and converters. Your fiscal year 1969 program was $7.3 million. Page 205 of the justification book discloses that a total of $124 million has been funded for this program element since fiscal year 1963. The objective of this program is to provide improved engines, transmissions, and power trains for tactical wheeled and tracked vehicles. What can you show for this effort?

General BETTS. This program element has provided the initial development efforts for a family of high-power/low-weight diesel engines called the VHO (very high output), which are scheduled for use in future combat vehicles. Until its transfer with fiscal year 1970 to the MBT–70 program, development of the 1,500-horsepower gas turbine engine was supported by the program elment. This program element supports those engine and transmission efforts for which there are no commercial counterparts.

PROGRAM CONTRIBUTION TO MBT–70 AND SHERIDAN ENGINES

Mr. DAVIS. You have had severe engine problems, as yet unresolved, with the MBT–70, and the transmission for the tank is overweight. The engine for the Sheridan is too noisy for a reconnaissance vehicle and the rooster tail exhaust can be seen for miles. How has the $124 million for this program element contributed toward the engines for these two vehicles?

General BETTS. The engine problems of MBT–70 are associated with the variable-compression-ratio air-cooled engine, which was the primary engine for the tank until December 1968. At that time it was apparent that this engine was not likely to provide the durability and reliability required for MBT–70 without substantial investments of further time and funding. Fortunately the program had earlier initiated a backup engine development which was able to demonstrate the required characteristics and was therefore selected as the new primary engine for MBT–70. Although the bulk of the development effort invested in the original engine was provided under the MBT–70 program, most of the initial work had been accomplished under this

program element. In general, the reasons for its rejection were concerned with the engineering of the prototype models rather than with the new concepts and basic design approach, which had been examined earlier under this program element. This program element contributed toward the engine of the Sheridan vehicle only to the extent that it monitors commercial engines for possible military application. The Sheridan engine is a modification of a standard General Motors diesel engine. Its exhaust smoke is no worse than that of other contemporary U.S. diesel engines, and its engine noise is no louder than that of similar vehicles and certainly no bar to its employment as part of an armored cavalry platoon.

POWER SYSTEMS, ROTARY AND COMBINED CYCLE ENGINES

Mr. DAVIS. Of the total amount requested for fiscal year 1970,——— is for power systems, rotary and combined cycle engines. Is this work all related to the MBT–70 engine?

General BETTS. A portion of this work is related to MBT–70. Although the development of the 1,500-horsepower gas turbine has been integrated into the MBT–70 program, there are still development projects being completed within this program element for accessories such as air cleaners, electrical accessories, and component testing. The major work accomplished in this program, however, is in follow on turbine engines for other combat vehicle of other weights, which can make use of the development lessons learned on the turbine for MBT–70.

OTHER WORK TO BE DONE IN FISCAL YEAR 1970

Mr. DAVIS. What else do you hope to accomplish in fiscal year 1970 with the total ——— requested?

General BETTS. To summarize the activities supported by this program element, let me list the principal projects: development of transmissions for the VHO family of engines; evaluation of three developmental electric drive systems; work on hydromechanical and hydrostatic power converters; monitoring state of the art in commercial spark-and-compression-ignition engines; gas turbine engines for medium-class vehicles; and monitoring of commercially available gas turbine engines for possible military applications. These are in addition to the previously mentioned work in support of the 1,500-horsepower turbine for MBT–70.

CHEMICAL-BIOLOGICAL WEAPONS

Mr. DAVIS. In the fiscal year 1969 justification book at page 192 it was indicated that the program element under chemical biological weapons was to be funded to a total of $17.7 million through fiscal year 1969. This year's book, at page 209, shows a total funding through fiscal year 1969 to be $31.8 million. How did this program increase $14.1 million in 1 year?

Colonel DISMORE. Sir, that is a very difficult question to answer but I will try to put it in proper perspective.

We are speaking now of advanced development; the reporting of prior years' funds for advanced development is a very difficult thing to do because this development is not specifically end item oriented, as you undoubtedly are aware.

We have investigated this particular deficiency and all we can determine at this point is that last year's report of prior year effort was in error and that the prior year effort shown this year should be taken as the correct figure.

Mr. DAVIS. For the record, would you insert a statement showing the accomplishments in fiscal year 1969 and the proposals for activity for the $4.4 million shown on page 209 of the justifications?

Mr. POOR. We will be happy to.

(The information follows:)

Major accomplishments in 1969 were:

For chemical weapons advanced development: Proved the feasibility of the 155-millimeter ——— and demonstrated the practicality of such a round. Improved the color rendition of certain pyrotechnic colored smoke mixes. Developed production procedures for blending and filling thickened pyrophoric flame agents and applied these procedures to production of triethyl aluminum (TEA) for filling into the warhead of the XM191 multishot portable flame weapon (FLASH).

For biological advanced development: ——— Demonstrated the feasibility of an automatic ——— pilot production plant. ——— Completed engineering studies on cryogenic storage ——— demonstrating the feasibility of long term storage under these conditions. Demonstrated the capability for production of tissue cells in deep tank culture without the use of antibiotics.

Plans for fiscal year 1970 are:

For chemical weapons advanced development: Initiate process scale-up evaluations on two candidate ———. Let an advanced development contract for a ——— flame incendiary module system with a 4-gallon TEA-type warhead. Investigate sound and light for potential in applications ———. Continue investigations of new riot control agents and delivery systems.

For biological weapons advanced development: Continue the development of processes for tissue culture of ——— to demonstrate the potential of such weapons for application to defensive studies. Continue studies to demonstrate if the aerosol stability of agents under adverse environmental conditions can be improved.

WA WEAPONS SYSTEM

Mr. DAVIS. What is the WA weapons system?

Colonel DISMORE. WA is an unclassified symbol for a classified material so may we discuss this off the record?

Mr. DAVIS. Yes.

(Discussion off the record.)

Mr. DAVIS. It was indicated that this program was to be terminated. Yet the justifications indicate ——— to be used in the current fiscal year. Does this fit in with what you have said then about this particular program being terminated, but some related research is to be done on some other things which accounts for the ———?

Colonel DISMORE. Yes, sir; that is correct.

NUCLEAR MUNITIONS DEVELOPMENT

Mr. DAVIS. You are requesting ——— in fiscal year 1970 for nuclear munitions development. One of the purposes of this program is to develop a nuclear capability for the 175-millimeter gun. What has happened to this program?

Colonel TOBEY. Program element 6.36.04.A entitled "Nuclear Munitions Development" has several projects, one of which is nuclear projectiles. Work in this project has been primarily in the development of improved nuclear rounds for the 155-millimeter and 8-inch artillery systems. In addition, minor work was performed in fiscal year 1969 in the areas of ballistic match, layout design, and fuzing optimization in anticipation of reconducting a feasibility study for a 175-millimeter nuclear projectile.

During fiscal year 1969 it became evident that an ———. In consideration of this factor and the ——— years required to develop a nuclear projectile, ———.

Mr. DAVIS. What do you hope to accomplish in fiscal year 1970, and describe your fiscal year 1969 accomplishments.

Colonel TOBEY. Work planned for fiscal year 1970 is predominantly a continuation of fiscal year 1969 effort in anticipation of ——— during this period. Particular emphasis will be placed on continued information exchange and tradeoff studies with the Atomic Energy Commission (AEC), investigations related to high strength-to-weight materials with suitable toughness and ductility, mathematical models and experimental techniques for evaluating interior and exterior ballistic performance associated with ballistic match, rotating band design, fuzing system studies, and safety and reliability studies. Bench tests will be conducted on breadboard designs of key components and a limited number of test projectiles will be fabricated to conduct ballistic match feasibility test.

The primary accomplishment in fiscal year 1969 was the successful accomplishment of two joint phase 2 feasibility studies with the AEC (improved 155mm. and 8 inch projectiles). Both of these studies required significant effort by Army laboratories; this work included preliminary weapon layout, fuzing optimization studies, mathematical model and computer analysis of ballistic matching, key component advanced development, rocket assist application, rotating band design, high strength-to-weight material selection studies, and soft recovery technique investigations.

MINE WARFARE

Mr. DAVIS. You are requesting ——— in fiscal year 1970 for mine warfare, an increase of ——— over the fiscal year 1969 program. What is the reason for this increase?

General BETTS. This increase in fiscal year 1970 will fund efforts on a scatterable mine family that will include antipersonnel, antivehicle, and antitank mines deliverable by air, artillery and ground dispensers.

Mr. DAVIS. The fiscal year 1969 request was $1.3 million, yet page 212 of the justification book indicates the fiscal year 1969 program was $2.8 million. How and why was this program increased last year?

General BETTS. Reprograming actions 67–1 (DOD 69–14) and 69–2 (DOD 69–28) added $1.010 million to this program element for increased work on scatterable mines and to eliminate the guerrilla-counterguerrilla, ordnance demolition task. Another $460,000 was added from fiscal year 1968 funds held in budgetary reserve for development of portable and vehicular mine detectors. Based on a statistical distribution of facilities and installation support costs another $22,000 was added to bring the fiscal year 1969 total to $2.792 million.

AIRBORNE MINING SYSTEM

Mr. DAVIS. The committee notes that about ——— of the fiscal year 1970 request is for Airborne Mining System. This would appear to be an Air Force effort. How much are you duplicating Air Force work in this area and why can't the Army take advantage of Air Force developments in this field?

General BETTS. The Army and the Air Force have been cooperating on the development of Airborne Mining System, using the same mines and delivery cannisters in some applications. In January 1969 DOD tasked the Army as lead service to prepare and staff with the other services a joint requirements document for scatterable mines. This document has been prepared and is presently being staffed for joint services approval.

ARMY SMALL ARMS PROGRAM

Mr. DAVIS. You are requesting ——— in fiscal year 1970 for the advanced development portion of the Army small arms program. What were your accomplishments during fiscal year 1969 with the $4.2 million provided? Were you able to complete all your program objectives?

General BETTS. In fiscal year 1969 we embarked on comprehensive evaluation of 5.6mm. machinegun mechanisms. This evaluation is a joint effort with the U.S. Marine Corps using the Stoner 5.56mm. machinegun as the tool. This evaluation includes a kinematic and dynamic analysis to evaluate future machinegun systems. Special specification and a design related to associated ammunition for future machineguns is being developed concurrently. Work began to solve technical problems associated with the prototype hardware of the special purpose individual weapon (SPIW) (XM19) which were revealed during ET/ST in 1966. The advance development objective for the fiscal year 1969 Army small arms program will have been met, upon competition of fiscal year 1969 funded projects that are now underway.

SPECIAL PURPOSE INDIVIDUAL WEAPON (SPIW)

Mr. DAVIS. Page 214 of the justification book discloses that particular emphasis will continue on making the special purpose individual weapon (SPIW) more reliable. How long have you been working on SPIW, how much has been spent on this weapon development, and what are the problems?

General BETTS. The development of SPIW began in 1962. Concept prototype weapons developed by Springfield Armory and three commercial companies were evaluated in 1964. As a result of this evaluation Springfield Armory and AAI Corp. were selected to develop competing engineering design prototypes. Comparative evaluation of the engineer design prototypes was initiated in 1966 and indicated that there were serious design problems in both weapons. Because of this setback in the SPIW program, and the Army's decision to buy the M–16 rifle, the SPIW was reoriented to an advanced development program as part of a broadened R. & D. effort for a future rifle. The

cost of the SPIW development through fiscal year 1969 is $21.68 million. Problems in the AAI prototype can be placed in three main categories: extraction, feeding, and drive spring life. Problem areas in the Springfield SPIW involve the muzzle brake, friction in the magazine, and premature ignition.

Mr. Davis. Will you describe the other new weapons under development, such as the SPIW, the multiple launched fletchette, and the caseless ammunition and weapon?

General Betts. These items along with the serially fired-fin system are the major contenders for the future rifle. The current AAI (XM-19) developed as part of the SPIW program is an example of the serially fired-in system, that is, a weapon that fires, in response to one trigger pull, a series of cartridges, each of which contains one fin stabilized fletchette. The serially fired-spin system differs from the above in that the projectile (.17 caliber) is spin stabilized, in the same manner as a conventional rifle bullet. The multiple launched flechette system is a weapon that fires a single cartridge containing multiple flechettes. The last system, caseless ammo and weapon, is listed only to give it visibility for the future. This item is not funded under this element in fiscal year 1970, but is listed here only to show where the most promising of the above three candidate systems hopefully will be integrated with the results of the small caliber caseless ammo exploratory development discussed previously under project element 6.26.04.A.

Mr. Davis. How much of the fiscal year 1970 budget will be spent on SPIW?

General Betts. ——— million programed for advance development of the serially fired-spin system in fiscal year 1970. This task is one of several under project D633, Individual Weapons Development.

Mr. Davis. What will the remaining funds be used for?

(The information follows:)

The breakout of fiscal year 1970 request for Army small arms advance development are as follows:

Project No.:

D627, Components development	———
D633, Individual weapons development	———
D640, Crew served weapons development	———
D641, Caseless ammo system development	———
D642, Special purpose weapons	———

Mr. Davis. A total of $26.7 million has been spent on this program element through fiscal year 1969. What can you show in the nature of accomplishments to justify this expenditure of funds?

General Betts. The $26.7 million has been spent over 6 years, fiscal years 1963-69. Approximately $10 million of this amount has been directed toward the SPIW project. Although the SPIW had to be taken out of engineering development and reoriented into advanced development, the concept of multiple, high-velocity flechettes still exhibits the most promise for a future rifle. Work associated with this project will be quite valuable for any future small arms development. Specifically from this program the XM203 40-mm. grenade launcher attachment for the M-16 rifle has evolved. This launcher will soon be classified Standard A, and when issued, will give the infantryman armed with the M16/XM203 combination the capability to engage both point and area targets. The disposable barrel cartridge area target

ammunition (DBCATA), which is a logical future replacement for the grenade launcher, has been demonstrated and is being further developed under this project. Other significant items which have been developed for SEA are signals and illuminating rounds for the 40-mm. grenade launcher, shotguns, and low-noise weapons.

Special Purpose Weapons Project

Mr. Davis. What are the objectives of the special purpose weapons project?

General Betts. To develop a disposal barrel concept using existing 40-mm. warheads. To develop special purpose 40-mm. ammunition, to include: white phosphorus, signals, illuminating, practice, tracer, CS, and multiple projectile rounds. To develop shotguns and low-noise weapons to meet SEA requirements.

Mr. Davis. Were you able to use all of the $1.1 million for special purpose weapons in fiscal year 1969?

General Betts. All of the $1.1 million for special purpose weapons in fiscal year 1969 has been released by USAMC to the appropriate R. & D. agency. The money has been committed to, improvements of the disposable barrel cartridge area target ammunition (DBCATA), 40-mm. signals for SEA, and 40-mm.———.

Advanced Artillery Weapons and Ammunition

Mr. Davis. You are requesting ——— in fiscal year 1970 for advanced artillery weapons and ammunition, an increase of ——— over the fiscal year 1969 level. I note that the 155-mm. medium howitzer project increased about ——— over last fiscal year. Are we developing a new 155-mm. howitzer or improving an old one?

General Betts. We have a requirement to replace currently fielded 155-mm. howitzers when they reach the end of their life cycle about 1978–1979. The ——— increase will, specifically, provide for contract definition during fiscal year 1970 of a new, armored, self-propelled, 155-mm. howitzer with improved firepower, mobility, and armor protection.

ARMORED, SELF-PROPELLED 155-MM HOWITZER

Mr. Davis. The project listing shows that a total of $4.4 million has been spent on the 155-mm. howitzer project during the last 2 fiscal years. How much has been spent altogether on the 155-mm. howitzer project through fiscal year 1969?

General Betts. Today, we have an excellent 155-mm. armored, self-propelled, howitzer in the field. That is the M109. It will complete its lifecycle about 1979 and will require replacement. Our towed 155-mm. howitzers are World War II vintage. They already should be replaced. Exploratory and advanced development over the last few years has led to development of a cannon and ammunition system which promises to extend the range of these weapons from about 14.6 km. to ———. The latter is much closer to the dimensions of an infantry or armored brigade's area of influence. Of this $4.4 million which you mention, $1.5 million has been spent on development of components for the new, armored, self-propelled howitzer. About $1.0 million on components for a new towed weapon. The balance has been spent on more

fundamental research on the cannon system. Altogether, the expenditures for research, exploratory development, and advanced development related to these weapons would total, over the last 4 or 5 years, about $7.0 million.

Mr. DAVIS. What can you show in the nature of accomplishments to justify this sizeable expenditure of funds?

General BETTS. The 155-mm. howitzer is the basic close support artillery weapon of our infantry and armored forces. It is a very high density weapon. The funds expended have allowed us to achieve what amounts to a technological breakthrough with the cannon/ammunition combination which allows extending the range of this weapon from 14.6 to ———. When this capacity is fielded, the force commander will have, for the first time, a responsive and reliable means of attacking targets throughout his area of responsibility.

OTHER WORK UNDER PROJECT

Mr. DAVIS. What did you accomplish in fiscal year 1969 on the other projects?

General BETTS. The other projects in this program element provide for advanced development of fuzes and projectiles with highly increased reliability, functioning accuracy and lethality. This effort is leading us to a capability to develop fuzes with greater than 98 percent reliability and which will be significantly less expensive to produce and to projectiles which may be as much as ——— as lethal as currently fielded projectiles of the same caliber.

Mr. DAVIS. How do you propose to utilize the fiscal year 1970 funds?

General BETTS. During fiscal year 1970, our in-house efforts with respect to fuzes and ammunition will continue. With respect to the 155-mm. armored, self-propelled howitzer, we plan to initiate a competitive contract definition effort during which at least two contractors will develop and provide a detailed, costed program leading to fielding in 1979 of the weapon we require.

HIGH ENERGY LASER PROGRAM

Mr. DAVIS. You are requesting ——— million in fiscal year 1970 for the high energy laser program, speciafically project eighth card. Will you explain this project and program?

General BETTS. The eighth card program is a triservice laser R. & D. program. Details of the program are highly classified. Access to the program is on a limited basis by name and requires special clearance. Details provided in the descriptive summary are necessarily fragmentary and are not fully indicative of the scope of the project. We will be please to provide a special briefing in an appropriately safeguarded facility, on request.

(Discussion off the record.)

Mr. DAVIS. The fiscal year 1970 justification book shows that $2.7 million was programed for this effort in fiscal year 1969; however, last year's justification book fails to list this program. Where were the funds obtained and were they approved by OSD and the Congress? If so, when?

General BETTS. The Army was instructed by OSD, July 9, 1968, to

program $2.5 million for this effort from Army funds. This item was included in the Army reprograming action fiscal year 1969-2 (DOD fiscal year 1969-28), in November 1968. Subsequently in an adjustment of program management support funds, the Army increased the total to $2.7 million.

Mr. DAVIS. Have any of the fiscal year 1969 funds been utilized to date?

General BETTS. All of the fiscal year 1969 funds have been obligated.

Mr. DAVIS. How will fiscal year 1970 funds be utilized?

General BETTS. As previously mentioned the eighth card program is a triservice laser R. & D. program. Details of the program are highly classified. Access to the program is on a limited basis by name and requires special clearance. Details provided in the descriptive summary are necessarily fragmentary and are not fully indicative of the scope of the project. We will be pleased to provide a special briefing in an appropriately safeguarded facility, on request.

ARTILLERY CONTROL SYSTEM

Mr. DAVIS. In fiscal year 1970 you have initiated a new program entitled "Artillery Control System" for which you are requesting ———. What is this program and what do you hope to accomplish?

General BETTS. During recent years great studies have been made in developing new devices for acquiring targets and for exploiting target information by means of computers. Various agencies within the Army and the other services are developing equipments exploiting that technology. We have become concerned that there may be interface problems between these separately developed equipments—that actual incompatibilities may be built-in unless responsibility for examining those interfaces is clearly established. OSD has assigned the Army responsibility and funds to examine fire support as a single, integrated system; encompassing target acquisition, fire control and direction, target destruction and damage assessment. The ——— investigation in fiscal year 1970 should indentify where problems, if any, exist. Future year funding will be for development of hardware to solve those problems, if such development is not, more appropriately, provided for in other DOD program elements.

RELATIONSHIP OF PROGRAM TO TACFIRE AND FADAC

Mr. DAVIS. You mention automation of artillery fire direction and fire control. What relationship does this effort have to TACFIRE or FADAC?

General BETTS. TACFIRE and FADAC are data procesing systems designed to enhance our fire control and fire direction capabilities respectively. This effort is in no way a duplication of these systems but provides for our examination of the interface between these systems and target acquisition means on the one hand and weapons systems on the other. We wish to insure that no incompatibilities exist between the several elements of the total fire support system being separately developed by Army and other Service agencies and contractors.

RELATIONSHIP OF PROGRAM TO DIV-TOS

Mr. DAVIS. Does this effort have any relationship to DIV-TOS?

General BETTS. Yes. One of the outputs of TOS will be evaluated information, in other words, intelligence. Some of that intelligence will be target intelligence or other information essential to fire support operations. This effort will examine inputs to and outputs of TOS from the fire support point of view.

Mr. DAVIS. What is the total estimated cost of developing an artillery control system?

General BETTS. The title "Artillery Control System" is perhaps misleading. What we are trying to fund with this program element is an effort which will insure that nothing is allowed to fall through the proverbial crack—that every element of the total fire support system is compatible with the other elements. As I've already indicated, we are concerned that all aspects of this effort—target acquisition, fire control and direction, target destruction, and damage assessment—are considered as a single, integrated system. In fiscal year 1970, we'll investigate the problem. Whether funds will be required for development in future years will depend on the results of that investigation. We would expect to fund under this program element only those developments which are not appropriate to any other single DOD effort. An example might be in the transmission of intelligence between an Air Force photo reconnaissance installation and the Army's TACFIRE or TOS systems.

INFANTRY SUPPORTING WEAPONS

Mr. DAVIS. The justification book beginning on page 221 indicates that for the engineering development of Infantry Supporting Weapons there is a request for ——— as compared to $4.2 million for fiscal year 1969, representing an increase of ——— in the program.

It is noted that ——— of this total request for fiscal year 1970 is for the vehicle rapid fire weapons system known as Bushmaster. What do you propose to do with ——— in that project in the fiscal year?

BUSHMASTER VEHICLE RAPID FIRE WEAPONS SYSTEM

Colonel LAMB. Bushmaster is the weapons system planned to be used on the Scout vehicle, on the mechanized infantry combat vehicle and we propose to initiate engineering development on the Bushmaster beginning in fiscal year 1970. Actually, we will have a minimum of two contractors to produce prototype hardware. We will test and evaluate hardware to determine which contractor will be selected to produce the vehicle weapons system.

Mr. DAVIS. It has been previously indicated that you would start engineering development in May of next year, but the corrected statement indicates that it will not be started until ——— which indicates that we have some either conflict or revision with respect to the scheduling here. Can you clear that up for us?

Colonel LAMB. Yes. I used the wrong term there. What we are really doing in 1970 is expanded contract definition. Two contractors will be

selected, a minimum of two contractors, to produce prototype weapons and then we will have an evaluation of the weapons produced by the two or three contractors, and after a selection is made, engineering development of one of the weapons will be continued on through and that will begin in ———.

Mr. DAVIS. Will it require ——— for contract definition?

Colonel LAMB. I don't believe the entire ——— is for that purpose. I don't have the exact amount. I can give you the exact amount for rapid fire weapons system for the record.

General BETTS. Mr. Davis, this does reflect what we have been saying about a more conservative approach to new development. This contract definition will probably run for a period like 12 months or more because we want time for each of the contractors to produce hardware, and enough ammunition so that we can make an adequate evaluation of hardware before we select a winner. That way when we select a winner and with that winner negotiate a hard development contract with him and ask him for firm production prices, it will be done on the basis of demonstrated hardware and not on the basis of paperwork as has been the case in some of the total-package procurements where we got in trouble. So it does take longer, there is no question about it, but it is a more conservative approach and it is the mechanism that we see as a way to avoid the kind of difficulties we got into in the Cheyenne program.

Mr. DAVIS. Is it just coincidence that it requires exactly the same amount of money for contract definition as had earlier been indicated for starting engineering development?

General BETTS. That is why the precise amount of money that is allocated to this weapon for the contract definition period is relevant and I just don't have that number immediately available.

Mr. POOR. I would guess if it is the same it is coincidence.

General BETTS. In general it is roughly the same kind of activity. If it had been a full-scale development, one would have tied a contractor down to effort not only for the weapon but for the added effort that would integrate it into particular vehicles. In this competition the more extensive effort that one contractor will have to pursue will come later and each of these contractors, during expanded contract definition, will be doing less work than one contractor would have done if he had been given the whole job of a full development effort.

Mr. DAVIS. Then have we got slippage or a stretchout, or what do we have here?

General BETTS. In effect, the program is stretched out from what we had previously told you, by this decision to go the more conservative route. But it is stretched out at the right end of the program, before we get into the expensive business of maintaining a full-scale development effort.

FUNDING BREAKOUT

Mr. DAVIS. Give us a breakdown of the ———.

General BETTS. We will furnish that, Mr. Davis.

(The information follows:)

The ——— requested for Bushmaster breaks out as follows: ——— for guns and ammunition from two expanded contract definition contractors; ——— for depleted uranium penetrator development work by the contractor; ——— for contractor professional and labor personnel costs; and ——— for in-house support and operation of the project manager's office.

Mr. DAVIS. It is just too happy a coincidence here.

Colonel LAMB. There are several other projects carried under this such as an 81-mm. mortar system where we have engineering services going on for fuses for 81-mm. mortars, counter-guerrilla and other devices, it is not a total amount for just a rapid fire weapon system.

Mr. DAVIS. The breakdown will show each of the items included in the ———. Specifically the ——— that is indicated for Bushmaster program. Now, tell us something about the Bushmaster; its designed purpose and requirement.

REPLACEMENT FOR HISPANO-SUIZA GUN

Colonel LAMB. The Bushmaster is a 20- to 30-mm. automatic cannon to be used on the armored reconnaissance scout vehicle, the mechanized infantry combat vehicle and is the successor to the Hispano-Suiza that is now on the M–114 scout vehicle that we have.

This vehicle is to be used against lightly armored personnel carriers, against personnel, and it has a limited antiaircraft capability.

Mr. DAVIS. What is the time reference with regard to the actual substitution or succession of the Bushmaster?

Colonel LAMB. This weapon can begin coming into the inventory in ———.

Mr. MINSHALL. What is the caliber of the Bushmaster?

Colonel LAMB. Between 20- and 30-millimeter. It has not been determined.

Mr. MINSHALL. We went through this exercise several years ago, if I remember correctly. The Hispano-Suiza gun was a bone of great contention. Now you are going to phase it out. That was one of Mr. McNamara's things.

General BETTS. As you will recall, we bought that specifically for the M–114.

Mr. MINSHALL. That is right; and now you are replacing it. We suggested going the route of the TRW. They have a gun which works and could be put in production in no time. Now you come up with this idea. I am amazed.

General BETTS. We are suggesting here that this be a development that will be pointed to the armament for new vehicles not yet in the inventory, and in that sense it is a follow-on to the Hispano-Suiza 820.

Mr. MINSHALL. What is wrong with the Hispano-Suiza? Why don't you want that all of a sudden?

General BETTS. We don't think it has the necessary effectiveness.

Mr. MINSHALL. We told you that 2 years ago and now you come up with that idea.

General BETTS. I believe the technology is moving fast enough that we can now develop——

Mr. MINSHALL. You are just now catching up with the statements of members of this committee 2 years ago.

General BETTS. I don't think that the TRW was ready for production in that time frame, Mr. Minshall; at least we did not so assess it.

Mr. MINSHALL. Well, you never gave it a chance in the first place.

General BETTS. We were working with the TRW in that time scale.

Mr. MINSHALL. Not very hard, believe me.

General BETTS. Not very hard.

Mr. MINSHALL. You agree with that, don't you?
General BETTS. Yes.

MILITARY POTENTIAL TEST OF TRW 25-MM. GUN

Mr. MINSHALL. The justification book, page 225, indicates that a military potential test was continued during fiscal year 1969 on the TRW 25-mm. weapon which is to satisfy the Bushmaster requirement. What were the results of that test?

Colonel LAMB. The test revealed the weapons system was not suitable for service use in its present form. It must be recognized that the system under test was about 2 years old at the time and that the contractor had made 150 to 200 improvements since the system was purchased. It did not satisfy the stated requirement.

Mr. DAVIS. In what way?

Colonel LAMB. I do not have a specific breakout.

Mr. MINSHALL. Would you supply that for the record?

Colonel LAMB. Yes, sir, we can.

Mr. MINSHALL. Give us all the details.

The TRW 25-mm. gun submitted to the Army for military potential testing did not meet Bushmaster requirements in several areas. In the gun functioning test, 26 malfunctions chargeable to the gun occurred in the firing of 1,101 rounds; 18 parts required replacement. This can be compared to the requirement for not more than one malfunction in 2,000 rounds of firing and no parts replacement permitted at less than 3,000 rounds interval. The contractor has attested that insufficient stiffness (rigidity) of the gun mount at Aberdeen Proving Ground contributed to the malfunction rate. The Army has stiffened the mount and will continue testing in the near future. The 1969 model of the TRW gun is considerably heavier and includes 150–200 engineering changes over the model under test at Aberdeen. TRW attests that the later model should be more reliable and durable than the one delivered to the Army in 1967. The 25-mm. ammunition has also exhibited deficiencies in the area of fuzing, penetration of some likely armor targets, and consistency of performance. Accurate assessment of the military potential of the 25-mm. gun and its Oerliken designed ammunition can be made only after considerable additional testing. Test priority problems (primarily conflict with equipment tests associated with the Southeast Asia conflict) are certain to delay the TRW system tests.

BUSHMASTER FUNDING THROUGH FISCAL YEAR 1969

Mr. DAVIS. It is indicated that you have spent a total of $19 million on Bushmaster through fiscal year 1969. How much of that was spent in fiscal year 1969 and what have been the accomplishments with that expenditure of funds?

General BETTS. Our total expenditure on the TRW—on the Bushmaster concept has been $3.6 million. That would include the concept studies that we have done and what limited amount of hardware support effort we have supported.

Mr. DAVIS. How do we reconcile that with the $19 million that appears on page 225 of the justification book?

General BETTS. That line item goes all the way back through 1968 and prior, and includes work we did on testing the Hispano-Suiza 820 gun. The Bushmaster falls under this and although you see that title in this line item, it is related also to the earlier work for weapons of the same application.

Mr. DAVIS. What have we to show for the $19 million at this stage, General?

General BETTS. We have a deployed 20 mm. gun which for its time frame development is a good gun. It is on the M–114 Scout vehicle. Of course, we have the preliminary concept formulation work that we have done with respect to the Bushmaster.

PREVIOUS PROCUREMENT OF HISPANO-SUIZA 20 MM. GUN

Mr. DAVIS. In previous years there has been considerable discussion regarding the procurement from Germany of the Hispano-Suiza 20 mm. automatic cannon. Has our procurement of this weapon and ammunition been completed, or do we have any funds in the fiscal year 1970 budget for that program?

Colonel LAMB. That procurement was originally planned for 4,600 Hispano-Suiza. It was cut to ———. I do not know if all have been delivered, but there are no more being procured.

General BETTS. We will pin down the production dates for that for the record.

(The information follows:)

PRODUCTION DATES OF M-139 20-MM. GUN

Fiscal yeal	Quarter	Number	Total
1968	2d	———	———
	3d	———	———
	4th	———	———
1969	1st	———	———
	2d	———	———
	3d	———	———
	4th	———	———
1970	1st	———	———

ATTEMPT TO DEVELOP ONE GUN FOR ALL THE SERVICES

Mr. DAVIS. We are looking for a successor——

General BETTS. We had no previous plans to extend procurement of the HS–820 to put it on the new vehicles mentioned, the MICV or ARSV.

The present development effort is timed to coincide with the development effort on those two vehicles so that at the time they are ready for production we should have a new, very effective weapons system for them.

I might also add that the Marines are interested in this VRFWS as a possible application on one of their landing vehicles, one of their tracked landing vehicles, and there is at least some possibility that the Air Force may want this as armament for one of their fixed-wing aircraft.

Mr. DAVIS. Are they doing individual development in this area then or is this all an Army assignment?

General BETTS. It is an Army assignment for the development and we have been discussing the requirement with them to take account of any unique aspect of the requirement that would help satisfy their need as well as our own.

Mr. DAVIS. At this stage we are talking about a common weapon in this category for all branches of the service, are we?

General BETTS. That is the goal.

RELATION TO SIMILIAR SOVIET WEAPONS

Mr. DAVIS. In prior years' hearings it was indicated that the requirement for the new vehicle rapid fire weapon was based on a response to the threat posed by the Soviets' 14.5 mm. weapon. The Soviets have displayed new weapons ranging in caliber from 23 mm. to as large as 75 mm. on their armored personnel carriers, and reconnaissance vehicles.

In your contract definition planning what Soviet weapons are you planning to match or counter with the new weapon?

Colonel LAMB. This new weapon will ———. The vehicle rapid fire weapons system will ———.

The 75-mm. you referred to is on their amphibious tank that might have appeared in Vietnam. That is a different class gun and shooting a shaped charge it will have considerable more penetration than an automatic cannon, but it is not an automatic weapon that can fire several rounds and engage all types of targets.

Mr. DAVIS. In this type of weapon, in seeking to meet the requirements of all branches of the service, are you contemplating a common ammunition for all branches?

General BETTS. That is the designed goal of the program.

I might add though that there will obviously be fusing differences related to the application of the ammunition but within the constraints of the different applications we will try to maximize the commonality of all elements of this total weapons system.

Mr. DAVIS. Where it is used on a ——

General BETTS. Wherever it may be used.

Mr. DAVIS. Including airplanes?

General BETTS. Including airplanes.

CONTRACT DEFINITION

Mr. DAVIS. What type of contract definition are you working on in this area?

General BETTS. The expanded contract definition will, as has been said, pick up at least two competing contractors for the expanded contract definition period. It will give them time to make hardware and actually demonstrate it so that we have a solid basis for selecting a winner from between the two, or among three if indeed the costs that come in as a result of our request for proposal will permit more than two. The question of whether it is two or three will have to turn on response to the request for proposals. The nature of that contract would be a fixed price for the period of contract definition.

Mr. DAVIS. I would assume there would be a large number of potential competitors in this area?

General BETTS. I don't know how to answer that. I know that there will be several because there are several who have expressed very keen interest in it already. What may turn them off is the requirement that they have hardware available. Someone who hasn't already developed hardware will have a hard time being really competitive in this contract.

Mr. DAVIS. How about offshore, foreign competitors? Are you contemplating any of them in this program?

General BETTS. We have no basis to eliminate them other than to respond to the general provisions of ASPR that relate to foreign contractors. We would expect Hispano-Suiza and Rhine Maetel and Oerliken to come in on it; people like that.

Mr. DAVIS. Do you plan getting a technical data package or obtain royalty-free reproduction rights for any weapon developed in this program so that possible second or third production sources could be established without necessitating royality payments?

General BETTS. We would expect to do that in the actual development period. We would not get that out of the contract definition since it will not be possible in the short period of contract defintion to carry development that far.

"DEPLETED URANIUM" ARMOR-PENETRATING AMMUNITION

Mr. DAVIS. What has been done so far with respect to demonstrations of "depleted uranium" armor-penetrators? What is the Army's latest thinking regarding the use of this type of ammunition?

General BETTS. This is a very good technique for a given caliber weapon. In addition to the penetration capability inherent in the density of uranium, you get ———. In other words ———.

WEAPON RELATIONSHIP TO NEW VEHICLES

Mr. DAVIS. Would you relate the development of this weapon to the XM723 mechanized infantry combat vehicle (MICV), the XM800 armored reconnaissance scout vehicle (ARSV), and as secondary armament on the main battle tank we were talking about this morning?

General BETTS. All three of those are candidate applications at this time, yes, sir.

Mr. DAVIS. Is this the only weapon that the MICV and the ARSV would be expected to carry?

Colonel LAMB. The mechanized infantry combat vehicle carries a squad of riflemen. It is employed in a mechanized role. It is a companion vehicle with the main battle tank. This is a primary weapon on the mechanized infantry combat vehicle. However, the members of the squad will be capable of firing their individual rifles from portholes in the side of this vehicle so it could keep up with the MBT and in the case of light resistance would be able to ride right on through and past the objective area.

There will also be a 7.62-millimeter machinegun on the vehicle. The same thing is true with the Scout except that the Scout carries a crew that normally remains with the vehicle at all times. It will also have a lightweight machinegun in addition to the main armament.

GUERRILLA, COUNTER-GUERRILLA, AND ORDNANCE DEMOLITION WEAPONS

Mr. DAVIS. What are you developing in the way of guerrilla, counter-guerrilla, and ordnance demolition weapons?

Colonel LAMB. The development of special and general purpose demolition equipment includes electrical and mechanical timers, detonators, and other activating devices. This development work is not directly related to mine warfare though it is carried in the mine war-

fare program. It is more or less related to special forces and demolitions associated with special forces operation.

Mr. DAVIS. Last year you justified $10.9 million for infantry supporting weapons. Yet it is indicated actually $4.3 million was allocated to the program. How do you reconcile those figures?

General BETTS. We will have to research that and give it to the committee for the record. That is related to a reprograming action that recognizes that we deferred some of the work in pyrotechnic signals and reduced some of the effort on a time fuse for the 81-millimeter mortar, but I would want to look further and expand that if I may.

(The information follows:)

In fiscal year 1969 the Army requested $10.9 million for infantry supporting weapons. This amount was reduced by congressional action to $9.6 million. By reprograming action 69-2 (DOD No. 69-28) the program element was reduced by $5.167 million to a total for fiscal year 1969 to $4.433 million. The reduction resulted from the extending of the contract definition phase of the vehicle rapid fire weapons system and postponing engineering development of fiscal year 1970. In addition, further development of pyrotechnic signals was deferred to fiscal year 1970 and reduction in effort was effected on the time fuze and the 81-millimeter mortar illuminating round and for guerrilla, counter-guerrilla, ordnance and demolitions.

M-72 LIGHT ASSAULT WEAPON (LAW)

Mr. DAVIS. We would like to discuss with you the M-72 light assault weapon (LAW). There doesn't seem to be any place we can find this particularly in the budget request. It was type classified standard "A" in March 1961. Can you tell us what was the total development cost for LAW?

General BETTS. The total development cost for the M-72 LAW was $3.023 million R.D.T. & E. and supporting PEMA.

Let me tell you a little about what happened with this weapon. The LAW is a very useful weapon for the patrol to take along to break up reasonably well fortified positions when they come on them and their small arms can't handle Vietcong who are dug into well-fortified bunkers.

The LAW is a good infantry level weapon to handle that kind of a target. If the target is really tough, of course, we have to call for help further back to bring in heavier weapons.

SOVIET RPG-7 ANTITANK WEAPON

The Vietcong have been furnished a weapon by the Soviets called the RPG-7, which is about four times as heavy as is the LAW and it is a very effective antitank weapon. We have looked carefully at what I would call the possibility of a reverse engineering job, to create a weapon exactly like it for our own troops. There is considerable interest in Vietnam on the part of MACV that we do that. At the same time, the people responsible for the development of the LAW pointed out that the application of the latest technology in warheads within the configuration of the present LAW could raise its penetration capability to that of the RPG-7 and therefore, from the point of view of a squad going out on patrol, they could carry about four of the LAWs for each one of the Soviet RPG-7 systems.

Furthermore, it was apparent that at the maximum ranges available to the RPG–7, in any kind of a cross-wind, its accuracy was rather severely degraded by the nature of the secondary thrust available to the RPG–7. When we weighed all of these factors and the cost of the reverse engineering and production effort to get into production on something like the RPG–7, we decided it would be more useful to go ahead with improvements to the LAW. That is what is reflected in our change in this program from that which we discussed with you in the past. We felt that it then became fairly high priority to get on with the improvements of the LAW.

Mr. MINSHALL. What is the minimum range at which this wind deflection is noted?

General BETTS. Well, it takes effect immediately upon launch.

Mr. MINSHALL. For all practical purposes, what is the minimum range?

Colonel LAMB. When you use the RPG–7 and it is launched, at about 30 feet the motor that propels it on to the target ignites. Until it gets to that distance, it is propelled by the initial charge as fired from the launcher. Whatever the wind has done to that projectile at that very slow velocity prior to the ignition of the motor, if it is blowing against the fins and turns it a little sideways, that effect is present all the way to the target.

The ranges become more effective at about 150 meters.

Mr. MINSHALL. What is the speed you are talking about?

Colonel LAMB. Seven miles an hour crosswind.

Mr. MINSHALL. It affects it that much?

Colonel LAMB. Yes, sir.

Mr. MINSHALL. What is the caliber of the equipment?

General BETTS. About 3.3 inches in diameter on the warheads.

Mr. MINSHALL. What is the armor penetration capability?

General LAMB. Fourteen inches.

Mr. MINSHALL. What do you plan to put on the MBT–70?

Colonel LAMB. Not that much.

General BETTS. This little 5-pound LAW is good to about ——— inches.

The latest technology is making antitank weapons very effective if they can get close enough to the target and hit it.

Mr. MINSHALL. How does this work in a bazooka?

General BETTS. In effect, the LAW is a kind of a great grandchild of the bazooka.

Mr. MINSHALL. How does it work with the LAW?

General BETTS. It works very well, but the LAW doesn't have the range capability that the RPG–7 would have.

Mr. MINSHALL. The Russian weapon can go through 14 inches of armor?

General BETTS. That is right. It will go through about 6 feet of logs and dirt and bunker protection.

Mr. MINSHALL. It will go through about ——— tanks if it gets a good start?

General BETTS. We have some vehicles in Vietnam where it has gone through one side and out the other.

Mr. MINSHALL. I thought its effectiveness was getting in there and banging around though?

General BETTS. Well, this is a jet. In a thin-skinned vehicle it will go in one side and out the other. If nothing happens to be in the way that is all the effect it will have.

M–72A1E1 LAW STILL UNDER TEST

Mr. DAVIS. Is the so-called improved M–72 what you are using in Vietnam right now?

General BETTS. The M–72 LAW is what we are using now in Vietnam. We give it the designation A1–E1, which is the improved model.

Mr. DAVIS. That is the one in use?

General BETTS. It is the standard M–72. The improved model is now in test.

Mr. DAVIS. This is the second improved version.

General BETTS. Colonel Lamb tells me we have some of the improved LAW in Vietnam.

Colonel LAMB. Our LAW that we had in Vietnam, the standard M–72 LAW, we had some complaints about not being rugged enough in the general environment and when we increased the penetration of the LAW we also made it more rugged where it would withstand the environment. It has been tested in this country and completed its test. It has been evaluated in Vietnam, we expect it to be standard —— and we will have the new rugged LAW replacing the other LAW early next year.

EFFECT ON FUTURE TANK WARFARE

Mr. MINSHALL. With this type of weapon aren't you sort of putting the future of tank warfare in doubt? If you can knock out a tank so easily, for example?

Colonel LAMB. No, sir. I think we are going to have infantrymen for a long time to come.

Mr. MINSHALL. I know this. I am talking about tanks now.

Colonel LAMB. Yes, sir. A bullet does the same thing to an infantryman that this does to a tank.

General BETTS. It will increase the environment hazard to tanks, no question about it.

Mr. POOR. Mr. Minshall, the Germans had something to poke a hole in everything we have. And they poked holes in some of our tanks in World War II, but the tanks were useful.

(Discussion off the record.)

Mr. POOR. The tanks were useful vehicles in that war despite the consequences.

I believe they will continue to be useful despite the existence of the RPG–7 and LAW and all the rest of it. The supporting fires of a tank—infantry assault team call for an awful brave soldier to launch a LAW. I think the greater threat may come from the longer range systems like the TOW which are a little safer for the infantrymen to operate.

Mr. MINSHALL. How have you war-gamed the results of a weapon like this on the MBT tank?

General BETTS. I might ask Colonel Lamb to respond to that.

Colonel LAMB. In all of our war gaming in playing our tanks, MB–60 and MBT–70 against our tanks and Russians, we have brought in LAW, RPG–7, known Russian missiles, our own antitank missiles of TOW and Dragon, and we played to the full characteristics of antitank weapons, the tank still serves a useful purpose on the battlefield. We lost tanks to these weapons, there is no doubt about it.

Mr. MINSHALL. Isn't your rate of kill going to be higher because of these weapons than previously?

Colonel LAMB. You mean the rate of tank losses?

Mr. MINSHALL. Yes.

Colonel LAMB. There may be some increase, although MBT–70 does quite well. We have other improvements that make these weapons a little less effective than they might individually appear and that is suppressive fire from artillery. You are able to fire to keep the guy down in the hole or under cover so he cannot aim his weapon as free as he could in the past. There are other offsetting countermeasures.

We expect greater losses than we would have if they did not have these.

Mr. MINSHALL. How much greater?

Colonel LAMB. I do not have an exact figure, but maybe in a run it might average over a hundred runs through the simulation, one tank more out of a battalion.

Mr. MINSHALL. How much penetration of the antitank gun in World War II as compared to today?

Colonel LAMB. The Bazooka, 3.5 inch, developed during the Korean War, will go through any tank that is known.

SOVIET RPG–7 ANTITANK WEAPON

Mr. MINSHALL. The difference is that the RPG has a greater range?

Colonel LAMB. Yes.

Mr. RHODES. What sort of engine would the RPG have—is it rocket propulsion?

Colonel LAMB. Yes, sir.

Mr. RHODES. How long does it take to aim one of them?

General BETTS. It is a line of sight sort of thing. Just a matter of the skill of the gunner. A relatively few seconds under the best conditions or longer under other conditions.

Mr. RHODES. You can undoubtedly do it under 14 seconds.

General BETTS. Yes; no question about it.

Colonel LAMB. It has a maximum effective range of about 250 meters

It will go to 500. It self-destructs around 920 meters, and the real effective range is somewhere around 250 to 275.

(Discussion off the record.)

DEVELOPMENTS IN ANTITANK MINES

Mr. MINSHALL. What have you developed in the way of antitank mines? Have you any radical improvements or changes?

General BETTS. We have some improvements. They are more related to ways of delivery than to any major new approach.

Mr. MINSHALL. You cannot employ this Shape charge technique to antitank mine?

General BETTS. Yes; we can and have.

COST OF IMPROVING M–72 LAW

Mr. DAVIS. Trying to pull this together a little, we started out with the M–72. That revealed some deficiencies and we went to the M–72A1 and that is the one we are using in Vietnam.

Colonel LAMB. That is the one that is in Vietnam now. The M–72 A1E1 is the one that will be going to Vietnam in large quantities next year.

Mr. DAVIS. Give us the funding story on the change from the M–72 to the M–72A1.

General BETTS. I do not have that with me, Mr. Davis. We will have to furnish that.

(The information follows:)

The cost of development to change from the M–72 to the M–72A1 was $0.674 million PEMA under a product improvement program. The further product improvement to the M–72A1E1 required $0.097 million PEMA funding.

Mr. DAVIS. What funds did you use for that; can you tell us that?

General BETTS. I will have to check that out. It may have been done with PEMA funds because it was a product improvement effort. I will have to research that and furnish it for the record.

(The information follows:)

PEMA funds were used in the improvement of the M–72LAW.

Mr. DAVIS. Is your testing completed now on the M–72A1E1?

General BETTS. It is not. As we said, we have sent some of the A–1 models to Vietnam for combat evaluation. Testing is still continuing in this country. It will be next year before we are in production on the improved model.

CONTRACT EFFORT ON AN ADVANCED LAW

Mr. DAVIS. Apparently in January 1969 the Army Missile Command released a request for quotation to industry for a concept study for improved or advanced LAW. It is understood that this request is to be funded under the program element, Missiles Exploratory Development. What is the cost and the purpose of this study?

Colonel LAMB. In looking for a replacement down the road and knowing that the Russians have the RPG–7, which does have a slight range advantage over our 5 pound LAW, in the light antitank weapon that we are looking to for the future we desire characteristics of being able to have a ——— percent probability of a single shot kill at ——— meters. Our present LAW does not have that. The purpose of this study was to go out and probe industry for ideas on how we might achieve characteristics of a ——— percent probability of a single shot kill at ——— meters.

We expect that to cost about ———.

ARMY INVENTORY OF ANTITANK WEAPONS

Mr. DAVIS. Apparently there is in inventory or under development the 3.5-inch rocket launcher, the 90 millimeter recoilless rifle, the 106 millimeter recoilless rifle, the TOW and DRAGON missiles, which are all classified as infantry antitank weapons? Where does LAW fit into this entire group of antitank weapons?

Colonel LAMB. Sir, in looking at what we want in the family of antitank weapons, we have three: We have LAW, the light antitank weapon. It is issued as a round of ammunition to each rifleman and he carries it with him. It might replace the grenadier of World War II in the squad. Then we have the Dragon which is the medium antitank weapon coming along. This will be the replacement for the 90 millimeter recoiless rifle in the rifle platoon. The Dragon is the platoon antitank weapon. We have the TOW, heavy antitank weapon, with a ——— meter range, coming along. This is a replacement for both the 106-recoilless rifle and the ENTAC in the company and battalion.

FISCAL YEAR 1970 PROCUREMENT OF LAW

Mr. DAVIS. Are there any procurement funds in fiscal 1970 PEMA budget for any version of LAW?

General BETTS. Yes, I am sure there are, but I do not have that information with me.

Colonel LAMB. It is issued as a round of ammunition and would be in ammunition. I am sure we have some LAW going to Southeast Asia.

General BETTS. I would have to get that for the record.

(The information follows:)

An Army procurement of ——— M-72A1E1 LAW's has been included in the fiscal year 1970 PEMA budget for $15.3 million. In addition, a Navy procurement for the Marine Corps of ——— the same model LAWS at a cost of $8.7 million has been programed for fiscal year 1970.

REQUIREMENT FOR XM-190 LAW TRAINER

Mr. DAVIS. What is the requirement for a LAW trainer.

Colonel LAMB. The LAW training device is a subcaliber device and the requirement is strictly to reduce the cost of training. Currently we have a training cost of about one and a half million per month, using regular LAW ammunition. Using this trainer we will be able to reduce that cost considerably. That is really the purpose of the trainer.

Mr. DAVIS. You are testing the XM-190 at the present time?

Colonel LAMB. Yes, sir.

FUNDING FOR THE XM-190 LAW TRAINER

Mr. DAVIS. Where will we find the funding for that? It does not appear to be in the project list for either fiscal year 1969 or 1970.

(Discussion off the record.)

General BETTS. I will have to identify that for the record.

Mr. DAVIS. Will you provide that for the record?

(The information follows:)

Completion of the LAW trainer tests is being accomplished using prior year funds (fiscal year 1968). Missiles for the remaining tests will be funded using fiscal year 1969 late start PEMA APE funds ($60,000). The remaining engineering tests will be combined with the initial production tests to prevent duplication and reduce total testing costs.

Mr. DAVIS. Apparently in fiscal year 1968 there were two other LAW training devices that were tested. Can you provide for us the

total cost of developing and testing each of these two LAW training devices?

General BETTS. I do not have that information with me. We will have to provide it.

(The information follows:)

The other two LAW training devices under test in fiscal year 1968 were developments by a Norwegian firm and a Belgian firm. Consequently, there were no developments costs involved from the U.S. standpoint. However, the United States did expend $17,080 in the conduct of military potential tests of these two training devices. Results of the tests indicated that both had some military potential, but required redesign to correct deficiencies and shortcomings in order to meet military requirements for durability, tracer reliability, wind sensitivity, accuracy, ease of operation and maintenance, and reliability. Since the U.S. development was found by using agencies to meet military requirements, no further U.S. action has been taken to develop the foreign devices.

FIELD ARTILLERY WEAPONS, MUNITIONS, AND EQUIPMENT

Mr. DAVIS. You are requesting ——— in fiscal 1970 for field artillery weapons, munitions, and equipment, an increase of ——— over the fiscal 1969 program.

A total of $11.6 million was requested in fiscal year 1969. What was the total program approved by Congress?

General BETTS. The fiscal year 1969 program for field artillery weapons, munitions and equipment as approved by Congress totaled $10.8 million.

Mr. DAVIS. The actual fiscal year 1969 program was $7.4 million. To what programs and projects were the remaining funds reprogramed? Also, through fiscal year 1969, a total of $153.4 million has been funded for this program. What can you show in the nature of accomplishments?

General BETTS. Most of the artillery weapons and ammunition now in the field have been developed under this program element. This includes the 105-millimeter, M102 howitzer which is the backbone of artillery support for airmobile forces in Vietnam; the long range 175-millimeter, self-propelled gun which gives us a capability to provide fire support of forces at distances of up to 32 kilometers; the highly accurate 8-inch SP howitzer with its nuclear capability; and the 155-millimeter, M109, armored, SP howitzer which has had remarkable success not only with our forces but also in the area of foreign military sales. A most significant effort was in the development of the improved conventional munitions for Army, Navy, and Air Force weapons systems which provide antipersonnel lethality which is as much as ——— times greater than earlier standard ammunition. The $2.4 million reprogramed from this program element is reported in DOD reprograming actions numbered fiscal year 1969–28 and fiscal year 1969–11 and was applied to the YO–3 quiet aircraft and other high priority programs.

Mr. DAVIS. Were all program objectives met in fiscal year 1969, and what do you hope to accomplish in fiscal 1970?

General BETTS. Not all objectives were accomplished. During fiscal year 1969 we were working on 16 different munitions developments under this program element. As might be expected in that number of research and development programs there were a few which demonstrated problems during testing which require additional development

or testing during fiscal year 1970. When it comes to ammunition which is fired over the heads of our troops we must assure ourselves that they are not only effective but absolutely safe. In this area we proceed very carefully and, regardless of delays and within reasonable costs, insist on a very high assurance that the newly fielded munition will not cause casualties among our own troops. In fiscal year 1970, we will continue development of new munitions which will provide, for the first time, a capability for effective attack of ———. A major portion of our effort will be directed to the testing of a new mechanical time fuze with highly increased accuracy of functioning, reliability, producibility, and—very important—positive overhead safety to within 2 seconds of set time.

WORK ON CLASSIFIED PROJECT

Mr. DAVIS. The committee notes that ——— of the fiscal year 1970 program is for a classified project. Will you explain this project and advise the committee how much has been spent on this project through fiscal year 1969?

Also, what have you accomplished under this classified project for this large expenditure of funds and how much will be required to complete this classified project? You may supply that for the record.

(The infomation follows:)

Research during the late 1950's and early 1960's resulted in a most fortuitious marriage of wound ballistic technology, capabilities for miniaturization of munitions components, and techniques for delivering submissiles by artillery projectiles and other means. This project has exploited that technology and has provided a new family of improved conventional munitions which has demonstrated lethality ——— times greater than formerly standard munitions. The first generation of these munitions has been fielded. We have not, however, completely exploited the capability represented by this technology. Under development are both antipersonnel munitions with even greater lethality and ———. To date we have spent $78.7 million on this project. Completion of existing tasks will require $13.6 million. It is to be hoped that continuing research will permit us to continue improving our conventional munitions even after these tasks are completed.

FIELD ARTILLERY FIRE DIRECTION CENTER SYSTEMS

Mr. DAVIS. The committee notes you have discontinued funding of the Field Artillery Fire Direction Center Systems. Will you explain this system and advise us of its relationship, if any, to the program element "Artillery control system" on page 220 of the justification book? Why was funding discontinued on FAFDCS and how does this relate to FADAC and TACFIRE?

General BETTS. The project Field Artillery Fire Direction Center Systems provided a nominal amount of money ($25,000 to $35,000 a year) to develop new manual aids—range deflection fans, graphical firing tables—required for existing and newly developed weapons and ammunition. This represents a small, but continuing requirement. Perhaps because of its smallness it was inadvertently omitted from our budget request. It will be necessary for us to reinstate it using authority granted to us. The devices developed under this project provide the manual backup for the FADAC system and are not considered to be of significance in relationship to TACFIRE or the so-called "Artillery control system" program element already described.

Nuclear Munitions

Mr. Davis. You are requesting ——— in fiscal year 1970 for nuclear munitions, an increase of ——— over the fiscal year 1969 program. You requested $2 million in fiscal year 1969; what was your approved program? To what programs were these funds reprogramed and how were the fiscal year 1969 funds used? In addition, why are you requesting an increase of ——— for fiscal year 1970 and what do you hope to accomplish with these funds? You may supply the answers to these questions for the record.

(The information follows:)

The approved fiscal year 1969 program for nuclear munitions was $1.5 million. Congress approved a fiscal year 1969 funding level of $1.9 million. In the omnibus reprograming action (DOD 69-28) submitted by DOD to Congress following apportionment, this amount was reduced to $1.5 million. It is not possible to specifically identify those programs to which the funds were reprogramed.

The fiscal year 1969 funds were used as follows: Fabricated and tested two XM-94 firing device prototypes; completed fabrication and initiated testing of three prototypes of the M-15 command signal decoder; completed testing of two engineering prototypes of the XM-28 remote switching controller; fabricated and initiated testing on three prototypes of the XM-117 remote firing device; investigated improved ammonia-type batteries for use in the firing system; and established operational concepts and completed preliminary design of the command arming device.

Engineering development on this system started in fiscal year 1965 and what should have been a 3- to 4-year normal development program has slipped significantly because of funding reductions in fiscal year 1969 and previous years. The ——— increase in fiscal year 1970 is an effort to overcome the impact of past funding cuts and to get this required program moving. The planned fiscal year 1970 effort includes fabrication and initial testing of five complete prototype systems; design of a type X trainer; updating of engineering drawings and specifications; procurement, test, and evaluation of improved batteries; continue reliability assessment of components and systems; and fabrication and initial testing of five command arming device prototypes.

Wheeled Vehicles

Mr. Davis. We will turn to the question of wheeled vehicles.

Mr. Minshall.

M-151 QUARTER-TON TRUCK

Mr. Minshall. General, there was a press article several months ago concerning the M-151 quarter-ton truck, known as the present-day Jeep. It says, "Army Ford's Jeep is tipsy. Kills and disables 100 GI's." They go on and tell how top-heavy it is and how it tips over at an alarming rate. Are you familiar with that article?

General Betts. I have read the article.

Mr. Minshall. Would you care to comment on it?

General Betts. I have heard my colleagues who are closer to the troop problem than I am sitting in the Pentagon.

Mr. Minshall. Who developed this Jeep? Was this an R. & D. project?

General Betts. This was an Army jeep that came from the Army R. & D. cycle. Indeed, there are circumstances under which it does overturn more readily than the Jeep that it replaced. As I understand it from the operators it is a matter of driver training and drivers who are not traveling at excessive speeds and trying to hot rod this vehicle

don't have any more problem with it than any vehicle. There are improved ride characteristics that go with the change in design.

JEEP ACCIDENT RATE

Mr. MINSHALL. It said, "In fiscal 1967 alone the Army M–151's worldwide had 3,538 accidents with 104 GI's killed and 850 injured. The overturn rate is 36 percent of all M–151 accidents. The domestic civilian overturn rate of all vehicles is 1.6."

That would include passenger cars and everything.

General BETTS. The Jeep has always, because if its very short wheel base and high road clearance had a higher overturn rate than the civilian vehicle. The two are not comparable in any sense. Those numbers are not particularly relevant to the problem as far I am concerned.

Mr. MINSHALL. I am concerned about the 36 percent figure.

General BETTS. We are very much concerned about that 36 percent. I can only repeat the comment I made before, those officers with whom I have discussed this problem, who are closer to it have insisted that it is a good vehicle and the problem is largely related to the matter of driver training.

JEEP REAR WHEEL SUSPENSION SYSTEM

Mr. MINSHALL. Is the problem something to do with the independent rear wheel suspension system?

General BETTS. It does have something to do with the suspension of the vehicle; that is correct.

Mr. MINSHALL. What are you doing to correct this? Increase the driver training period?

Colonel LAMB. May I comment on it, sir?

Mr MINSHALL. Yes.

Colonel LAMB. These wheels are independently suspended, and the thing that makes the difference from our prior jeep is in order to increase the ground clearance so that it can travel over more rutted roads and have better cross-country mobility, which is absolutely essential in a jeep, the axle is up like this at an angle. It is easier to turn over. It has a little more power. This vehicle, if the driver is properly trained, is not any more dangerous than any jeep we have had in the past.

Mr. MINSHALL. You are blaming it on the training program and not the jeep?

Colonel LAMB. I ran a training brigade and I had 180 jeeps and I drove them over all kinds of terrain and I never had an accident.

Mr. MINSHALL. The statistics here speak for themselves. They have had a very high accident rate. I wonder what the Army is doing to correct this, either in the design of the jeep to give it a wider tread or the training of the drivers or both.

Colonel LAMB. I do not know where the statistics are taken from, but I know in 1966–67 they were much higher than they are today and we initiated the training program. In order to maintain the present characteristics for cross-country mobility there is very little that we can do that will make the jeep less susceptible to flipping over if you drive it at 70 miles an hour.

General BETTS. We are outside of our area of responsibility, and I will research this.

Mr. MINSHALL. I wish you would because according to the story there are 90,000 in operation today.

General BETTS. I will give you a much more complete answer than we were able to.

Mr. MINSCHALL. The reason I brought it up here is that it was your shop that originally designed it.

General BETTS. I am sure it was designed and came through the R. & D. program.

(The information follows:)

In the initial years following the fielding of the M151 vehicle, experience indicated a need for a driver training program to acquaint Army drivers with the particular characteristics of this vehicle and the proper techniques for its operation. In common with all jeep-type vehicles, the M151 has a narrow tread, short wheel base, and high center of gravity. Unlike earlier jeeps and most U.S. passenger cars, the M151 over-steers, which means that when skidding first occurs in a turn, the rear wheels slip outward, and the corrective action is to turn the front wheels outward also. A driver accustomed to other jeeps or passenger cars would react as required for understeer and cut his front wheels inward, sometimes overturning the vehicle. A major training program, involving required programs of instruction and specific qualification for M151 operation, has been in effect since this problem was identified, and Army statistics in Europe since 1966 have shown the M151 accident rate to be below the overall average for all types of wheeled vehicles. Pending type classification now is a product-improved M151 which incorporates a semitrailing-arm rear suspension system, which provides a more familiar steering feel to the operator. This change appears to offer the possibility of even further reducing the accident rate associated with the M151.

Mr. MINSHALL. For the sake of the record, I would like to say this article came out of the Cleveland Plain Dealer and that is why I am especially interested.

XM-705 TRUCK

Mr. DAVIS. In the discussion of wheeled vehicles, page 231 of the justification book, you requested $2.3 million in fiscal 1969, yet last year's program is shown on page 232 as $2.5 million. For the record, how and why was this program element increased; and for what specific projects was the $2.5 million spent in fiscal year 1969?

(The information follows:)

The increasee in fiscal year 1969 funding for wheeled vehicles from $2.3 million to $2.5 million resulted from reprograming necessary to provide an appropriate amount for the initiation of engineering development of the XM-705 truck.

GOER VEHICLES

Mr. DAVIS. In listing the fiscal 1968 and prior accomplishments, it is indicated that the tests on the 8-ton Goer vehicle was completed and it was adopted as standard. How much was spent on the Goer vehicles and why are they not being procured in quantities?

General BETTS. That is in another area of responsibility. It is my understanding that we have gone up to OSD asking for authority to buy these and have been denied the funds. I will have to comfirm that. That is in the PEMA area of responsibility.

Mr. DAVIS. At the same time would you also obtain a statement indicating the reason why the procurement has not gone forward?

General BETTS. I will do my best.

Mr. DAVIS. Other than the fact that they just did not approve the funds, there must be some reason in addition to that.

General BETTS. I think it is one of those differences of opinion as to how valuable it would be to have this kind of capability. I will get the best answer I can.

(The information follows:)

The Goer vehicle has not been procured as yet because the Office of the Secretary of Defense has not yet been convinced of its cost effectiveness, particularly in the manpower area. The identification of tradeoffs in personnel requirements possible upon introduction of Goers has not so far been considered adequate to support funding for production. It must be noted, however, that OSD had agreed in fiscal year 1969 to the purchase of 74 Goers for Southeast Asia; however, that requirement was subsequently withdrawn due to overall lack of personnel resources in that theater.

Mr. DAVIS. How much has been spent on those vehicles up to the present time? Can you tell us that?

Mr. POOR. I do not know. May we provide it for the record?

Mr. DAVIS. If you would.

(The information follows:)

Expenditures on GOER's, through the end of fiscal year 1969 are as follows: $1.3 million for RDTE; $13.0 million PEMA; and $622,000 O & MA funds.

M-561 TRUCK KITS

Mr. DAVIS. On that same page relating to the fiscal 1969 program, it is mentioned that the development of the kit for the M-561 truck was continued. Why is it necessary to develop such a kit and what is the cost of that development?

General BETTS. I do not have information on what that kit is. I will have to dig that out and give you the information.

(The information follows:)

The kit development for the M-561 truck in fiscal year 1969 included the arctic kit and the winterization kit. These kits are normally developed for wheeled vehicles so that the basic production vehicles need not meet such a wide requirement for operating temperatures. The kits make it possible to equip trucks only as required and thus to reduce the costs associated with this capability. Costs to support the in-house development of procurement packages for these two kits is $137,000.

XM-705 TRUCK

Mr. DAVIS. In the fiscal 1970 planned program, there is a recitation of continuance of engineering development of the XM-705 under the package procurement multiyear contract. In the PEMA portion of the fiscal year 1970 budget there is a request of $4.5 million to procure 473 such trucks. This raises the question we have asked a number of times before as to the concurrence of the continuance of engineering and procurement in the same fiscal year. Would you comment on that?

General BETTS. Mr. Davis, the problem is that when we went out for this competition on the XM-705, the automotive industry was remarkable in its lack of response. No one was really enthusiastic about committing the extent of engineering effort necessary to do an adequate job on this competition except the General Motors Co. There was a very considerable effort on the part of the Army, as a matter of fact, in the Office of the Secretary of Defense to try to find out why

the rest of the industry did not want to enter this competition, and there were a few arms twisted trying to encourage additional competition. Nevertheless, as it turned out no other manufacturer wanted to enter the TPP competition for the XM–705. After we had gone ahead with the contract definition phase of that program the Kaiser Co. had a change of heart and thought they would like to get into the competition. As you are aware, they were building and are building the M–715 vehicle that is in the same weight class or same payload class. Because they were in that field they came in with a proposal to the Army which said with relatively minor modification to the M–715 they felt that they could compete from the performance point of view with anything that might come out of the XM–705 development.

We suggested, therefore, that they give us a price for an adequate number of the M–715 so modified so that we would have a hardware basis for evaluation against the output of the XM–705 development effort. I will confirm this for the record, but it is my understanding that the PEMA funds you cited are for the purpose of buying those long leadtime items associated with the first production XM–705 vehicles.

May I add to that that the negotiation with respect to modified vehicles for the evaluation has not been completed. Kaiser has not responded and said yes, we will come in.

Mr. DAVIS. Our information had been that the 473 trucks were the first buy on the XM–705s.

General BETTS. I am in an area of the budget that is not my responsibility and I will have to correct that and get the word back to your staff.

INITIATING XM–705 PROCUREMENT BEFORE R&D COMPLETED

Mr. DAVIS. General Miley testified that the $4.5 million in PEMA funds requested in fiscal year 1970 will be used for procurement of 473 XM–705 trucks. This quantity represents the first year of a 4-year multiyear contract for a total of 18,000 of these trucks.

General BETTS. That is General Miley's area of responsibility and I would have to turn to him for review of this information. I will straighten it out in the record. It is not in our budget.

Mr. DAVIS. This gets back to what I asked earlier, as to whether we properly should appropriate four and a half million in PEMA funds for the XM–705 truck when it will be some 14 months before a decision is made as to whether or not the production of the XM–705 will be authorized.

General BETTS. Under the total package procurement multiyear contract the schedule would call for that kind of a commitment. We certainly would not go through with if the testing of the XM–705 as it is produced in the R. & D. program does not provide an adequate vehicle.

Mr. DAVIS. Aren't you really saying that the $4.5 million would be an appropriate item for consideration in the fiscal year 1971 budget?

General BETTS. I would have to go back and take a look in detail at the schedule of testing that I do not have with me on the XM–705. The schedule that was being followed would have required PEMA money in this timeframe, apparently.

Mr. DAVIS. In that connection, we have a memo here from the GAO, paragraph 2 of which reads as follows:

The General Motors contract which is the total package procurement type, the first of this type placed for a truck, provides for three development prototypes to be completed and checked out by March 1, 1971, at which point decision will be made as to whether production of the XM-705 will be authorized.

General BETTS. I do not have the information with me to confirm that date. The first production rolloff is scheduled for March 1971. The results of contract definition—the information I have here is not adequate to give you a full answer to that except to say that the March 1971 date that I have in my backup information says that is first production rolloff. We would have to have evaluation of vehicles and test information long before that and commitment to production. I will have to fill that out for you in the record.

(The information follows:)

The $4.5 million in PEMA funds is required in fiscal year 1970. The contract for the XM-705 to include production of 473 vehicles, requires the obligation of funds in January 1970. At that time, it is necessary that the Government have the necessary funds in hand, even though the contractor will receive payment only upon delivery of trucks, kits, and publications as required by the contract. First production rolloff is actually planned for April 1971, with the production line beginning operation one month prior in March 1971.

MISSION FOR XM-705 TRUCK

Mr. DAVIS. When you have the M-37, the M-715, and M-561, 1¼-ton trucks available to you at the present time, what mission is the XM-705 scheduled to fulfill that is not now or cannot be fulfilled by these other three trucks of the same size?

General BETTS. We limited the buy of the M-561 to what we would call the tactical environment that demands a lot of cross-country activity in an attempt to hold down costs, because we recognized that although the mobility and payload carrying capability of the M-561 is really outstanding, it is a more expensive vehicle. The M-715 was bought as a replacement for the rapidly—I don't know whether the word "rapidly" is right—for the very old M-37's, the fact that these were getting older and older in the fleet and we had to make replacements.

We went into the XM-705 development to see if it is not possible through appropriate attention to modern materials technology, modern lubrication technology, to produce a vehicle that would require a great deal less maintenance, would have a longer life than is inherent in the M-715 that is very little different from ordinary commercial truck technology. It is our analysis that in the total life cycle costs of the two vehicles, even though the XM-705 would end up costing more in investment costs, if it can achieve the goals we set forth in reliability and maintainability and life, it would end up in a total program being considerably less expensive than going the other route.

Our goal was to get a rugged reliable long-life vehicle out of this development effort.

Mr. DAVIS. Is it roughly comparable with marginal improvement of the M-561?

General BETTS. It would be less mobile than the M-561. The M-561 is designed for cross-country mobility, primarily. But it would also be considerably less expensive. So, if anything, it should be considered as a replacement for the M-37 and in some measure for the interim

M–715. The payoff is going to be in testing the product of the development contract that we entered into with GM. If they can achieve the goals that were called for in the design characteristics, it will indeed be worthwhile going into extensive procurement of this vehicle. If they cannot achieve these goals we just won't procure it. It is as simple as that.

STATEMENT OF CONGRESSMAN JOHN BRADEMAS CONCERNING XM–705 TRUCK

Mr. DAVIS. On the 9th of June, Mr. Brademas of Indiana appeared before the subcommittee and registered his conclusions that the Army's decision to procure the XM–705 truck is unjustifiable because it offers only a marginal improvement on overall vehicle performance at a disproportionate increase in cost. We will insert Mr. Brademas' statement before the committee at this point.

(The statement follows:)

STATEMENT OF CONGRESSMAN JOHN BRADEMAS OF INDIANA

Mr. Chairman, I very much appreciate the opportunity to appear before this distinguished subcommittee. My testimony this morning is directed at a problem of growing concern to Members of Congress and to the American people. I refer in general to increasing evidence that the Department of Defense is willing to pay excessively high costs for weapons systems and equipment that often provide only marginal improvements in combat effectiveness.

Mr. Chairman, I know that members of this subcommittee are vitally interested in both our national defense and our national economy. Your concern is to act upon Defense Department requests for weapons and equipment essential to our national defense while at the same time disapproving the expenditure of public tax moneys when not essential to our national security.

I requested the opportunity to appear before your subcommittee, Mr. Chairman, to bring to your attention some details of a Government procurement with important implications for the public interest in terms both of our national defense and our national economy.

Specifically, I intend to demonstrate that the U.S. Army is now procuring a 1¼ ton truck—the XM–705—which will burden the American taxpayer with as much as $150 million in unnecessary expenditures. Yet abundant evidence shows that the XM–705 will produce at best only a modest improvement in combat effectiveness.

Moreover, the Army seeks to buy this vehicle, with all the risks attendant to buying a vehicle that exists only on paper despite the fact that a modestly improved version of an existing vehicle, the M–715, can substantially meet the Army's requirements.

Mr. Chairman, these conclusions are not merely my own. The General Accounting Office, which at my request has undertaken an examination of the XM–705 program, only last week made the following tentative observations:

"It appears that the XM–705 does not represent a real stride forward in terms of combat effectiveness. Rather, it appears to offer only a relatively small increase in terms of combat effectiveness over the XM–715 1¼ ton truck already in the Army system and no clearly significant superiority over the improved XM–715 proposed by the Kaiser Jeep Corp. Accordingly, the XM–705 program appears to represent an excessive expenditure for marginal improvements in combat effectiveness over the improved XM–715."

Moreover, Mr. Chairman, the Army's ill-advised decision to procure the XM–750 flatly and unconscionably contradicts the explicit conclusions reached by the Army's own Army Materiel Command. This report, prepared by the Systems and Cost Analysis Division of the Army Materiel Command, dated July 8, 1968, compares the proposed XM–705 both with the existing and the improved M–715. The report finds:

"The XM–705 has all the uncertainties associated with a vehicle that does not exist . . . With the improvements proposed, an adequate design guarantee and

warranty, and contractor liability established by demonstration to Government test specifications, there are no known performance or effectiveness preclusions to selection of the improved M–715."

With respect to this report the Chief of the Vehicles and Equipment Division, Maintenance Directorate, Army Materiel Command, states flatly:

"* * * we conclude that there is questionable necessity for going through the expense of developing a replacement vehicle at this time."

He recommended that:

"The M–715 series of trucks be considered for adoption as the standard replacement for the M–37 series and that procurement of the M–705 series of trucks be held in abeyance pending the acquisition of more definitive operation and maintenance experience with the M–715."

Thus, Mr. Chairman, the evidence available at this time, developed both by the General Accounting Office and, indeed, by the Army itself militates strongly against procurement of the untested, untried paper XM–705 at an additional cost to the American taxpayer estimated by the Army Materiel Command to be $150 million. Here again is the conclusion from the Army Materiel Command report I have already cited: "Introduction of improved M–715's requires fewer vehicles in the *total fleet* and approximately $150 million less for the total fleet life cycle costs than does the XM–705 . . ."

It is for these reasons, therefore, that for the first time in my 10 years in Congress, I have requested an opportunity to testify before your subcommittee.

Mr. Chairman, let me elaborate:

I first began looking into the Army's procurement of new fleet of 1¼-ton vehicles this past January when officials of the Kaiser Jeep Corp., which has a plant located in the Congressional District which I represent, brought to my attention the Army's intention to procure the XM–705 from the General Motors Corp.

After a period of several months of investigation on my part, which included meeting personally with the Secretary of the Army, Mr. Stanley R. Resor, on February 18, 1969, I became increasingly convinced that the XM–705 program could not be justified. I first transmitted my concern to you and to your committee in a letter dated March 19, 1969. At that time, I indicated my serious reservations about the XM–705 program. Concurrently, I advised the Comptroller General of the United States of my concern about the XM–705 program and requested that the General Accounting Office undertake a thorough investigation.

After several months of continuing inquiry on my part, and on the basis of the preliminary review submitted to me by the General Accounting Office, I am thoroughly convinced that the XM–705 program has not been justified by the Army, and that, as available expert evidence indicates, this program will cost the American taxpayer many millions of dollars beyond what is required for an adequate 1¼-ton truck fleet.

History of the 1¼-ton truck program

Let me briefly summarize the U.S. Army 1¼-ton truck program.

At the present time the Army has about 30,000 M–715 trucks. This 1¼-ton truck is a conventional mobility truck which first went into production in January 1967, at a cost of less than $3,500 apiece to the Government.

Notwithstanding the success of the M–175 in the field, the Army has embarked on a program to procure another 1¼-ton conventional mobility truck—the XM–705. The complete acquisition cost for the first 18,000 of these vehicles is scheduled to be $8,160 per truck, according to data provided me by Army officials.

The Army made this award despite the fact that for more than 6 months, the Army had held in abeyance an unsolicited firm fixed price proposal from the Kaiser Jeep Corp. in the amount of $71 million to produce a like quantity of improved M–715 trucks. The improved M–715 is a modification of a similar and apparently satisfactory M–715 vehicle already in the military system.

Congress has repeatedly cautioned the Army about introducing a new truck into the logistics system. The full House Committee on Appropriations, as far back as June 1963, questioned the Army's continued sole-source procurement of the M–34 ¾-ton truck and emphasized the need to develop the follow-on XM–561 vehicle with competitive procurement at the earliest practical date. (The M–561, known as the Gama Goat, is a high mobility truck now being procured at a cost of about $11,000 each.) The Appropriations Committee, however, approved a limited procurement for ¾-ton trucks for fiscal year 1964 anticipating that these

vehicles as well as existing inventory would be adequate to meet Army requirements until the successor M–561 was ready for procurement.

The Appropriations Committee further noted that the Army was looking into the possibility of utilizing other commercially available trucks that might meet the Army's requirements. The committee admonished the Army that the advantages of competitive procurement must be weighed against the higher costs associated with introducing a new vehicle into the logistics system.

Thus, the Army at present is faced with logistically supporting two trucks of the same class—the M–37 and the M–715—and will soon have a third truck, the high mobility M–561 truck, in its system. Procurement of the XM–705 will add yet a fourth 1¼-ton truck to the system.

The Army Materiel Command itself, in its comparison of the improved M–715 and the XM–705, warned of the additional expense and unnecessary logistical complications that would result from adding this fourth 1¼-ton truck—the XM–705—to the fleet. In its report, the Army Materiel Command emphasized the logistical advantages of retaining the M–715 and rejecting the XM–705:

Selection of the improved M–715 would have the following effects on logistic factors:

(*a*) Reduces the types of major items in the fleet.

(*b*) Reduces the number of new component line items introduced into the system.

(*c*) Avoids increased supply and distribution costs. The X–705 would require complete logistics introduction.

Mr. Chairman, a comparison of initial investment costs for the XM–705 and for the XM–715 is plain evidence of the Army's misjudgment in this matter.

For an initial buy of 18,000 vehicles, the Army estimates that the initial investment cost will be $8,160 for each XM–705. This figure compares with $5,120 for each XM–715. The additional cost, then, is over $54 million for the XM–705. Moreover, based on a projected fleet of 50,000 vehicles, the Army Materiel Command estimated that the total additional cost to the taxpayer would be approximately $150 million.

Mr. Chairman, I have sought time and time again to obtain from the Army satisfactory explanations to questions I have raised about the basis for its determination to procure the XM–705.

Following my meeting with the Secretary of the Army in February, I exchanged correspondence with him. I subsequently met at some length with a team of Army officials dispatched by the Secretary of the Army which included the Army's Director of Materiel Acquisition, Maj. Gen. Roland B. Anderson. I have studied materials thereafter prepared for me by General Anderson. I have reviewed with care the answers concerning the XM–705 submitted by the Army to this subcommittee just 4 days ago.

But, Mr. Chairman, the deeper I look into this matter, the more convinced I have become that the Army's justification of the XM–705 program is not only inadequate, but also misleading.

Essentially, Army officials have attempted to justify their decision to procure the XM–705 by stating that it would result, in contrast to continuing procurement of the M–715 or an improved version, in both substantial improvements in military effectiveness and lower life-cycle costs.

Mr. Chairman, the Army has failed to support either of those contentions. Let me explain.

1. Life cycle costs

Life cycle costs lie at the heart of the issue and draw attention to the questionable accuracy of the Army's method of comparing the real life M–715 and the paperwork XM–705.

I was informed by the Army that its decision to proceed with the procurement of the XM–705 was based on the Army's calculated higher life cycle cost of the improved M–715. In fact, however, as I have indicated, the internal Army study, to which I have already referred, stated in July 1968 that the additional life cycle cost of adding XM–705's to the fleet would be approximately $150 million over the alternative of procuring the improved M–715.

Yet, Maj. Gen. Ronald B. Anderson, who headed up the delegation sent to my office by Secretary Resor, represented this figure to be only $75 million. Moreover, he dismissed the savings which would result from purchasing improved M–715's as unsubstantiated in the eyes of the Army. According to General Anderson, in a document he submitted to me on April 18, 1969:

"A cost comparison study made by the Army Materiel Command Comptroller and Director of Programs did indicate a life-cycle cost advantage of $75 million for the improved M–715 on the basis of a 50,000 vehicle fleet. However, this study was made on the basis of the assumptions that Kaiser Jeep's unsupported claims as to reliability and durability could be attained. For that reason it has never been accepted by the Army. This study was accomplished in July 1968."

General Anderson's letter of April 18 takes the unequivocal position that the Army's life-cycle cost computations showed a lower cost for the XM–705. But the General's assertion is in direct conflict with the earlier determination of the Comptroller and Director of Programs, Army Materiel Command, that the life-cycle cost for the improved M–715 would be substantially lower than that for the XM–705.

2. Contrived cost comparisons

Notwithstanding this Army Materiel Command report, the Army subsequently contrived—and I use that word advisedly—an unrealistic life-cycle cost for the improved M–715 in order to justify procurement of the XM–705.

Let me explain.

The Army has relied heavily on the alleged high life-cycle cost of the improved M–715 as compared to the life-cycle cost for the XM–705. Simply stated, the life-cycle cost is the initial acquisition cost of a vehicle plus the maintenance and repair cost for that vehicle over its expected lifetime.

In calculating a life-cycle cost, the so-called "maintenance index" is vitally important. This is because a maintenance index indicates just how much time a vehicle will be unable to operate because of the need for repairs and other maintenance.

To illustrate how crucially important the maintenance index is, the Army stated that repair parts and maintenance for each improved M–715 would amount to approximately $13,500—over $1,000 each year for each year of the M–715's 12-year life span. At the same time, the Army stated that the repair parts and maintenance for each XM–705, which exists on paper only, would be slightly over $6,000 for the lifetime of each vehicle—or approximately $500 each year.

As a result, the difference in cost as given between maintaining a fleet of XM–705s and maintaining a fleet of improved M–715s, based on Army assumptions is enormous. In fact, that difference, based on a projected fleet of 50,000 vehicles over a 12-year life expectancy for each vehicle, amounts to several hundred million dollars.

And yet, when I sought to learn the basis on which the Army assigned these very different, yet crucially important maintenance indices to both of these vehicles, I was astonished, as I am sure that the members of this subcommittee will be, by the lack of integrity of the criteria the Army chose to use.

What I learned was this:

The Army has assigned a maintenance index for the XM–705 based on conjecture, assumption, and insufficient data. In fact, no XM–705 has ever been built. The index assigned for the vehicle is based entirely on values calculated by the contractor which the Army, after checking, accepted. And yet the vehicle exists only on paper, and I will indicate later in my statement how dangerous this practice of failing to rely on prototype development has been in the past.

Moreover, the very high maintenance index assigned for the improved M–715 is no more supportable than the very low index assigned to the XM–705. The Army has failed, despite my repeated requests to Army officials, to provide me with any explanation of how the figure for the improved M–715 was derived—an index almost three times as high as that for the XM–705. And yet there are at least three compelling reasons which suggests that the maintenance index assigned the M–715 is arbitrary in the extreme.

1. Apparently, the Army used only five of the first M–715s off the production line, tested them, but ignored considerable test data on later M–715s in calculating the maintenance index.

2. At present, approximately 25,000 M–715s are operating in the field, many of these vehicles for close to 2 years. (About 5,000 M–715s are in reserve storage.) Yet neither officials of the Kaiser Jeep Corporation nor I have succeeded in getting any information from the Army which suggests that the existing M–715s have not been performing effectively and economically. In fact, one Army Materiel Command memorandum states specifically that "there are no reports pointing to other than normal maintenance and MWO [Modification Work Order] requirements." Moreover, officials of the Kaiser Jeep Corporation have visited

many field commands where the M–715 is deployed, both in the United States and abroad, and reported to me that the M–715 apparently has received wide acceptance among field commanders.

3. Moreover, two reputable management consulting firms, Harbridge House and Communications and Systems, Inc., conducted studies, commissioned by the Kaiser Jeep Corporation, based on test data made available by the Army. The conclusion of both of these studies is that the maintenance index assigned to the improved M–715 by the Army is much greater—and hence of course much more costly—than is justifiable based on the data used by the Army.

In sum, the Army has chosen to rely heavily on the alleged merits of the paper XM–705. Yet the truth is best stated in the Army Materiel Command's study of the XM–705 and the M–715: "No conclusive difference in estimated reliability can be stated because of the uncertainties involved in both vehicles."

Mr. Chairman, I am convinced that in their assignment to the improved M–715 of a maintenance index almost three times greater than that assumed for the XM–705, the Army has taken elaborate pains to construct a self-serving case.

Combat effectiveness: Unsupported and untested comparsion of benefits of XM–705 and M–715 programs

Mr. Chairman, as members of this subcommitee will all be aware, Army regulations are clear that the bulk of research, development, testing and evaluation funds should be spent on items providing significant advances in combat effectiveness with emphasis on mobility, firepower, and communications. No substantial sums of money are to be spent for small, incremental increases in combat effectiveness with emphasis on mobility, firepower, and communications. No substantial sums of money are to be spent for small, incremental increases in combat effectiveness. Furthermore, regulations specify that the cost of new items must be carefully weighed against expected improvement in operational capability. According to Army doctrine, "improvements of modernization action are avoided," and "unnecessary technical features, over-refinement, and excessive durability must be eliminated."

Army Regulation 11–25, entitled "Army Programs, the Management Process for the Development of Army Systems," (dated April 10, 1968) is clear and succinct: "Priority is placed on new capabilities which provide significant improvement in combat effectiveness."

Yet this explicit mandate has been ignored in the present case.

The General Accounting Office is conducting an extensive study of the Army's analysis and cost comparison of the XM–705 and the improved M–715 programs. As we are all aware, Mr. Chairman, the General Accounting Office was placed in the legislative branch of the Government to provide the committees and Members of Congress with independent reports on the management operations of the executive branch. The unremitting duty of the Comptroller General and the General Accounting Office staff is to serve Congress by searching continually for means of achieving greater effectiveness, economy, and efficiency throughout the Government.

Although the General Accounting Office has not yet completed its review I have been greatly impressed both by their findings to date and by the thoroughness of their investigation.

Mr. Chairman, let me here cite in detail some of the unequivocal, unambiguous findings of the General Accounting Office:

"Based on our review of the XM–705 development and the conclusions of the cost/effectiveness study made by AMC [Army Materiel Command] in July 1968, it appears that the XM–705 does not represent a real stride forward in terms of combat effectiveness. Rather, it appears to offer only a relatively small increase in terms of combat effectiveness over the XM–715 1¼-ton truck already in the Army system and no clearly significant superiority over the improved XM–715 proposed by KJC [Kaiser Jeep Corp.]. Accordingly, the XM–705 program appears to represent an excessive expenditure for marginal improvements in combat effectiveness over the improved XM–715.

"As far as we know, the Army does not accept the July 1968 AMC cost/effectiveness comparison because it was based on unsupported assumptions. It does not seem reasonable to make such a study for the apparent purpose of providing a better basis for decisionmaking, when the input is based on unsupported assumptions that cannot be accepted. Further, the definitive data considered necessary to validate the assumptions was not requested by the Army for about 6 months. It appears that the Army should have taken action to obtain such

data much sooner than it did. Further, we believe the award of the TPP (Total Package Procurement) contract to GM (General Motors) should not have been made prior to receipt and evaluation of the requested definitive data. If the evaluation was favorable to KJC, then it seems the course of less risk to the Government would have been to proceed with development and test of KJC's improved XM–715 since KJC also guaranteed performance and offered a significant saving in cost and time. While there is the possibility that the improved XM–715 would fail during tests to meet the requirements although guaranteed, the same possibility also exists in the more costly current XM–705 program."

Mr. Chairman, having cited the findings of the General Accounting Office, I want, in order to complete the evidence for the members of the subcommittee, to cite several additional points contained in the Army Materiel Command's Comparison Study, to which I have earlier referred.

They are essential points which I have not yet made. The Army Materiel Command report said:

"1. With the improvements proposed, an adequate design guarantee and warranty, and contractor liability established by demonstration to Government test specifications, there are no known performance or effectiveness preclusions to selection of the M–715. Areas in which the QMR (Qualitative Materiel Requirements) are not met are not considered significant. Cost differentials are significant, particularly in the acquisition category (R. & D. and Investment) and are considered to be conservative. The current M–715 is programed in the Army inventory through fiscal year 1978 and further logistics simplification and cost avoidance are factors for M–715 selection. The Government's legal and moral obligations in abandonment of the XM–705 are protectable and/or defensible. Government Rights-in-Data are roughly comparable between the two suppliers. Significant savings are also evident to the M–715 in the ambulance version and high density kits. Other savings, on cost-effectiveness considerations, can be made from the improvements specified in both proposals.

"2. Both the XM–705 and the improved versions of the M–715 are "paper vehicles" in the sense that neither exists or has been demonstrated. The current version of the M–715 does exist . . . and both costs and performances values have some historical documentation. The values (performance and maintenance estimates) of the XM–705 have been derived from quotations and estimates made by the contractor and modified where considered appropriate. These, therefore, are considered to have a greater uncertainty (plus or minus), than for the current M–715 data."

In view of the unrelenting investigative work and the findings to date of the General Accounting Office in the present XM–705/M–715 controversy, and in further view of the devastating Army Materiel Command's Comparison Study, I must conclude that the method used by the Army to procure the XM–705 is unjustifiable and irresponsible.

Based on a careful examination of the XM–705 program, then, I fail to see any justification either for the increased costs or the complication of logistics caused by several equivalent vehicles in the military system. It is my understanding that the M–715, with minimum improvements, can fulfill the system's description of the XM–705. Accordingly, there is no reason for the Department of Defense to incur the additional cost of developing a new vehicle where the capabilities required can be provided through minor modification of the existing M–715. In summary, it appears that, at best, the XM–705 program offers a marginal improvement in overall vehicle performance at a disproportionate increase in cost.

At a time when the Federal Government is trying very hard to limit expenditures and when Defense Department appropriations are approaching $80 billion annually, I respectfully urge the members of this distinguished subcommittee carefully to review the entire XM–705 contract and the manner in which it was awarded.

Naturally, Mr. Chairman, I would hope that your distinguished subcommittee would also insist, in view of the kind of evidence I have here presented, that the Army give satisfactory responses to the questions I have raised, which the Army has up to now failed completely to do.

Mr. DAVIS. General, we ask that you read the statement and insert in the record such remarks as are appropriate.

General BETTS. Thank you.

(Discussion off the record.)

Mr. DAVIS. Does the Army propose to award a contract to build prototypes of a modified M–715 truck to be used for competitive testing with the XM–705?

General BETTS. That is the comment I made before, that Kaiser has not come back, as I understand it, with a firm price proposal on that. I will confirm that in the record, but that is my understanding.

(The information follows:)

The Army proposes to award a contract for an improved M–715 vehicle for comparative test with the XM–705, provided the Kaiser-Jeep Corp. submits a technical proposal in sufficient detail to enable the Army to make a judgment that the improved vehicle has a reasonable chance to survive the stringent test planned, and provided the price proposed for a production quantity of 18,000 vehicles indicates potential cost savings. Kaiser has not yet submitted such a proposal but has promised to do so by September 1, 1969.

The Army cannot agree that the decision to procure the XM–705 truck is unjustifiable because it offers only a marginal improvement on overall vehicle performance at a disproportionate increase in cost. The Army believes the XM–705 offers great increases in reliability and durability over the current M–715 truck, and the extra increment in investment costs will be more than offset by lower fleet operating costs over the 12-year useful life of the vehicle.

In the contract for the XM–705, General Motors has guaranteed a degree of overall vehicle reliability that requires the XM–705 to go an average 7,880 miles before a mission failure occurs. This guarantee will be verified by test of a compliance sample of 16 vehicles over a severe 30,000-mile test course. On the other hand, test experience on the M–715 on a relatively mild 12,000-mile test course indicates it will go an average of only 5,900 miles before a mission failure occurs. The mileage before failure on the severe 30,000-mile course would likely be much less. Also, in the area of component reliability, a comparison of the XM–705 reliability model (supported by engineering data based on guarantees) with actual test results of the M–715 reflects improvement over the M–715 as follows:

	Percent
Engine	100
Cooling system	90
Electrical system	340
Transfer	100
Wheels, hubs, drums	510
Frame and brackets	820

General Motors has also guaranteed that the XM–705 will have a maintenance ratio not to exceed 10.6 percent. That is, maintenance hours will not represent more than 10.6 percent of the operating hours. This guarantee will also be checked by test of a compliance sample of 16 vehicles. In contrast, the M–715 in four successive series of tests, conducted in an effort to qualify the vehicle for unrestricted deployment, has never achieved a maintenance ratio of less than 12.2 percent. More often, the ratio approached 20 percent. As was the case for reliability, the General Motors' guarantee of a maintenance ratio of 10.6 percent for the XM–705 applies to a rigorous 30,000-mile test, while the maintenance ratios for the M–715 were developed from test results over the 12,000-mile course. The M–715 was never subjected to the 30,000-mile test course, as it is a modified commercial 1¼-ton truck and the Army recognized that it could not be expected to survive the longer and more rigorous test. As the subcommittee knows, the Army bought the M–715 because it was prohibited from buying additional M–37 trucks after fiscal year 1965 and an interim 1¼-ton truck was needed to bridge the gap until suitable tactical vehicle replacements for the M–37 could be developed and brought into the truck fleet. A modified commercial truck was procured because this type could be obtained quickly.

As mentioned above, the M–715 truck has performed poorly in repetitive tests. Production deliveries began in January 1967, but it was not until March 1968 after completion of the third series of tests, that it was released for issue to troops and then on the condition that the remaining deficiencies would be corrected. In the period between January 1967 and March 1968, thousands of M–715's had accumulated in depots and all of these had to be reworked by the contractor, Kaiser-Jeep, before they could be issued to troops. Moreover the

last round of verification tests conducted between August 1968 and May 1969 still found deficiencies in the M–715 vehicle and indicated the need for additional corrective action.

When one considers the poor test record of the M–715 and Kaiser-Jeep's previous statements about the XM–705 program, he can understand the Army's serious doubts concerning the validity of Kaiser's claims contained in its unsolicited proposal submitted in May 1968. When solicited for a contract definition proposal on the XM–705 in 1966 and again in 1967, Kaiser-Jeep declined on the grounds that the potential return did not justify the risks and investments involved; that Kaiser did not have the specialized personnel needed for the system analysis and cost trade-off studies required for the contract definition—total package procurement procedure; and that the X–705 requirement could not be satisfied by a normal product improvement program of the M–715 vehicle. Yet in May 1968, Kaiser proposed meeting the XM–705 requirement with a modest improvement program of the current M–715 at the cost of only $500 per vehicle. Kaiser's unsolicited proposal provided no depth of engineering analysis to substantiate its claims. Nevertheless in view of the large cost savings possible if, in fact, the Kaiser claims could be verified, the Army is willing to make a moderate investment in the test of a limited quantity of the improved M–715's, provided Kaiser does submit an adequate technical proposal as described above. In my judgment both the Army and Kaiser-Jeep are aware that the improved M–715 will probably not meet the XM–705 requirements in several respects. Nevertheless the Army has informed Kaiser that if the test data on the improved M–715 meets the requirements in the areas of reliability, maintainability, and durability, the Army then would be in a position to consider design trade-offs for significant cost advantages.

As to comparative costs of the XM–705 and the improved M–715 the Army does not agree that acquisition of the XM–705 will burden the American taxpayer with as much as $150 million in unnecessary expenditures. Apparently the $150 million figure is based on a 50,000 vehicle fleet and an estimated differential in initial investment costs of $3,000 in favor of the improved M–715. Also the figure is based on the assumption that 12-year operating costs of the XM–705 and M–715 will be equal.

The differential in initial investment cost will only be true if Kaiser can prove its claim in its unsolicited proposal that it can substantially meet the XM–705 requirement with a modest improvement of the M–715 at a cost of only $500 per vehicle, and General Motors is unable to better the ceiling price in its incentive contract for the XM–705. The long time (February–September 1969) Kaiser is taking to prepare a definitive technical proposal suggests that the company may be having some difficulty.

In the field of 12-year operating costs, the Army believes on the basis of the data now available, that a comparative test will prove the XM–705 to be about half as costly as the improved M–715. This estimate is based on guarantees contained in the General Motors contract, and the Army's assessment of the probable performance of the improved M–715 on the 30,000-mile severe test course planned for the XM–705. All estimates of 12-year operating costs are subject to confirmation in the comparative test. However in light of the test experience on the current M–715, the Army feels its estimate is far more accurate than one which equates the 12-year operating costs of the XM–705 and the improved M–715.

The results of the comparative test of the two vehicles (provided Kaiser submits an acceptable proposal and the tests are conducted) will be considered in our current and future plan for the procurement of XM–705. The contract with General Motors provides for a checkpoint on March 1, 1971 before production of end items commences. At that time, the Army has the option of proceeding with program, canceling the contract if circumstances so warrant, or taking other appropriate action. In the event cancellation is not indicated but further development work is needed to meet specification requirements, the contract provides for it to be accomplished at General Motors' expense.

At the present time the XM–705 is in the development stage and the contractor is on schedule. First delivery of production vehicles will begin in April 1971, if after completion of tests on prototypes, an affirmative decision is made at the March 1971 checkpoint date to proceed with production. The $4.5 million in the Army's fiscal year 1970 PEMA budget request is for the initial 473 production vehicles. These funds must be placed on contract by January 1, 1970 to provide the required 15 months leadtime for initial production deliveries.

Finally, the Army wishes to state it has made every effort to answer all of Mr. Brademas' questions relative to the XM–705 program. It has presented written detailed answers on a question-by-question basis, and has met with him on two occasions. At the last meeting in April 1969, Army officials explained to him and representatives of his constituent, Kaiser-Jeep Corp., the complete rationale for the decision to proceed with the XM–705 program and the offer to test an improved M–715 vehicle.

XM–705 DELIVERY AND TESTING PROGRAM

Mr. DAVIS. When are the prototypes of the XM–705 scheduled for delivery and testing?

General BETTS. I do not have the testing schedule with me unfortunately. I will have to insert that for the record.

(The information follows:)

The first of nine prototypes of the XM–705 is scheduled for build completion in December 1969 and will be used for Arctic testing and other tests by the contractor. Five additional prototypes will be built during the period December 1969 through April 1970 for contractor-conducted tests. In August 1970, the Government will receive delivery of three prototypes for Government tests. Government prototype testing will begin in August 1970 and end in February 1971. A checkpoint has been established March 1, 1971 for program review prior to release for quantity production. Thirty days prior to the checkpoint, the Government and the contractor will review the status of the design based upon the Government and contractor test results.

XM–705 DEVELOPMENT COSTS

Mr. DAVIS. What costs have you associated with the development of the XM–705 prototype? You will probably want to put that in the record also.

Mr. POOR. We will put that in the record, Mr. Chairman.

(The information follows:)

Costs associated with development of the XM–705 prototype are targeted at $8.4 million, with a ceiling cost of $9.5 million.

TRACK AND SPECIAL VEHICLES

Mr. DAVIS. Turning to the item of "Track and special vehicles," we have the usual questions relating to the use of the funds and what you have done with the funds.

You are requesting ——— in fiscal 1970 for track and special vehicles, an increase of ——— over fiscal 1969 program. What is the reason for this increase? Also, you requested $8.3 million for this program in fiscal 1969. What was the approved program and what is the reason for the decrease?

General BETTS. The ——— increase in funding under this program element for fiscal year 1970 can be associated with the initiation of contract definition for MICV and ARSV. Conversely, the reduction in fiscal year 1969 expenditures of $1.8 million can be traced to delays in the initiation of contract definition for these two vehicles, originally to begin in that fiscal year.

VARIOUS NEW VEHICLE DEVELOPMENTS

Mr. DAVIS. Under this program element you have the XM–723 mechanized infantry combat vehicle (MICV), the XM–800 armored

reconnaissance scout vehicle (ARSV), the adverse terrain and remote area vehicle, and the air transportable multipurpose vehicle family (ATMVF). Will you explain the role and mission of the MICV, the ARSV, and the ATMVF and how they differ from the role and mission of our current armored car, the M–113 armored personnel carrier, the M–114 command and reconnaissance vehicle, and the M–551 Sheridan weapon system?

General Betts. The MICV is intended to be the successor to the M–113 as the combat vehicle for the mechanized infantry squad, and its fundamental roles and missions will not differ significantly from the present equipment. Principal changes will be provisions to allow the squad to fight while mounted in the vehicle when appropriate, and improvements in range, protection and mobility to make it compatible with the main battle tank with which it will be contemporary and with which it will fight in closely integrated formations. The ARSV (or Scout) will be the successor to the M–114 and basically will assume the roles and missions now assigned to the M–114. ARSV will provide a mobility differential over the other combat vehicles with which it must work to permit rapid accomplishment of its missions without unduly impeding the actions of the larger formations for which it works. The M–114 does not currently provide this differential. The ARSV will also incorporate state-of-the-art surveillance devices and sensors to assist its crew in the acquisition of information, as required in the performance of most of its missions. The ATMVF project does not represent a formal development program leading to a new major item of equipment. This project has been used to carry developmental work associated with improvements to the M–113 family of vehicles, as indicated by experience in Vietnam. The R.D.T. & E phases of this work have been completed, and no funding is requested for this project in fiscal year 1970. The Commando vehicle performs route and rear-area security missions, normally in military police units, and as such is not useful in the roles of MICV or ARSV.

TWISTER VEHICLE

Mr. Davis. What is the military requirement for the Twister, and what vehicle or vehicles will it replace?

Colonel Lamb. It has possible application in the role of a scout. It approaches a track vehicle in off-road mobility and if it can attain some of the equality with a track vehicle off road it will have tremendous advantages because a wheeled vehicle will be cheaper to maintain and operate and will be much quieter to operate.

We are giving it a military potential test.

General Betts. It is a logical candidate for the armored reconnaissance scout vehicle competition when we go out for that competition.

Mr. Davis. We do not have anything in the inventory at present that will fulfill a requirement this is designed to meet.

Mr. Poor. We do not have any vehicle that performs anything like the Twister in cross-country mobility. So I think the proper way to look at the Twister is that it is a brandnew idea, a brandnew capability, and we are trying to learn how to use it in our system, or learn whether to use it in our system of new vehicles.

Mr. DAVIS. Can it be said that this is designed to meet some specific Army requirement, or is it sort of a plaything?

General BETTS. No; this was an idea developed by the contractor that looked so promising we thought we ought to give it an adequate evaluation from a military potential point of view.

The remark I made about a candidate for the armored reconnaissance scout vehicle is that we feel that we should develop such a capability, and it is logical that this mobility approach would be a likely competitor. It is not necessarily the winner by any means, but one would go through the expanded contract definition route to try to find the best approach to the armored reconnaissance scout vehicle.

Mr. DAVIS. What do you contemplate doing with the $1.1 million in the current fiscal year?

General BETTS. With respect to the Twister?

Mr. DAVIS. Yes.

General BETTS. The military potential testing.

Mr. DAVIS. Is the $1.1 million entirely for testing?

Colonel LAMB. We are buying three test beds to do a military potential test. The Twister test bed that Lockheed made and submitted to the Army is not in a military configuration. We are building a test bed with a scout configuration, as General Betts said, and this vehicle will be delivered to Fort Knox late this year. We are building another test bed that will have a swimming capability. This vehicle will also be delivered to the Army on November 15 or late this year. This will be tested also against the swimming capability. The other is a mobility open-top test bed. So the $1.1 million completes the buy of the vehicles as well as funding the military potential test of the three vehicles.

INITIAL TWISTER DEVELOPMENT COST

Mr. DAVIS. What is your total estimated cost of the Twister development?

Colonel LAMB. The total cost is about $1.83 million. If it is identified that this vehicle does have military potential and it becomes a primary candidate for Scout and eventually the scout vehicle, of course, that will change.

Mr. DAVIS. Did you use $743,000 in 1969 fiscal year entirely for Twister?

Colonel LAMB. Yes, sir.

Mr. DAVIS. What do you look forward to in the way of procurement requirement and estimated procurement costs for the Twister?

General BETTS. We do not really look forward to anything at the moment other than it is a logical competitor in the ARSV program and it would have to win the competition against whatever other vehicles are submitted in response to our request for proposals.

XM-723 MECHANIZED INFANTRY COMBAT VEHICLE (MICV)

Mr. DAVIS. How much have you funded through fiscal 1969 for the mechanized infantry combat vehicle, and what is the estimated total cost of developing it?

Colonel LAMB. The total estimated cost for the development of the MICV is ———.

This can vary depending on the type development contract. There are three different types of contracts being considered. It would come to a total of ——— and the other is about ——— for a total development cost. What we have expended to date, I would like to provide for the record.

General BETTS. It has been very little, largely on concept formulation. I understand it is $1.6 million that has been obligated to date.

(The information follows:)

R.D.T. & E. expenditures to date are $4.2 million for fiscal year 1968 and prior, and $1.6 million for fiscal year 1969, for a total of $5.8 million.

Mr. DAVIS. For what purpose will the ——— in fiscal 1970 for MICV be used?

General BETTS. It would be the fiscal 1970 commitment to the expanded contract definition. It would take more than that to complete the expanded contract definition.

I will have to confirm this, but it looks as though the 1971 budget would need ——— and the sum of the two represents what we are now estimating for the expanded contract definition. I will have to run that down with additional data but that is what I think is the estimate for expanded contract definition.

ESTIMATED UNIT COST OF MICV

Mr. DAVIS. Do you have an estimated unit cost for the MICV?

General BETTS. Total cost?

Mr. DAVIS. Yes; per unit. How many will you require?

General BETTS. I think we do.

Colonel LAMB. This vehicle has been under considerable review, and the estimated cost in procurement will vary depending on the equipment that winds up on the vehicle.

It can vary from ——— a copy.

We do not have a firm number on our requirement, but it is in the neighborhood of ———.

XM-800 ARMORED RECONNAISSANCE SCOUT VEHICLE (ARSV)

Mr. DAVIS. You have funded the total of five and a half million through fiscal 1969 for the ARSV and are requesting ——— for fiscal 1970. What is the total estimated cost of developing the ARSV?

Colonel LAMB. ———.

Mr. DAVIS. Do you have an estimate of the unit cost and how many of those will be required?

Colonel LAMB. Again the estimate will vary primarily depending on the sophistication of the night vision equipment. The night vision equipment is the most expensive part of it. This is being studied very hard within the Army staff now, and realizing that the role of the reconnaissance vehicle is to acquire and get information, the most likely price is somewhere in the neighborhood of ——— a copy.

ARSV CONTRACT DEFINITION PROPOSED

Mr. DAVIS. Would you insert for the record a statement as to the purpose of the fiscal year 1969 funds and the use to be made of the fiscal 1970 funds?

Mr. POOR. We will be happy to.

(The information follows:)

Purpose of the fiscal year 1969 funds was to complete the concept formulation phase. A parametric design/cost effectiveness study (PD/CE) was conducted under a contract with industry to assist in the determination of an ARSV which will accomplish the vehicle mission. The plans and prerequisites necessary to enter the contract definition phase of the program were finalized during the period. The fiscal year 1970 funds will be utilized to release the request for proposal (RFP) and to initiate contract definition. During this period two or more competing contractors will be selected for extended contract definition effort.

AIR TRANSPORTABLE MULTIPURPOSE VEHICLE FAMILY

Mr. DAVIS. How much have you spent on the air transportable multipurpose vehicle family through fiscal 1969 and what are your objectives for this program?

General BETTS. I do not know what that line item is. I will have to dig it out.

(The information follows:)

The M113 family of vehicles was carried under this project (air transportable vehicle family). Objectives of the program included the XM765 (an improved 113) and developmental work on a bulldozer kit and a recovery kit. Funds expended through fiscal year 1969 were $2,161,000.

Mr. DAVIS. Why are there no funds in the fiscal year 1970 budget for this family of vehicles?

(The information follows:)

Funds are not required for fiscal year 1970 because there are no current projects under this program element.

M–114 RECONNAISSANCE VEHICLES UPGUNNED

Mr. DAVIS. Page 35 of your statement indicates that Soviet bloc nations continue to upgun their lightly armored combat vehicles. To counter this threat, the Army is upgunning the M–114 reconnaissance vehicle with a 20–millimeter cannon and the first units in Europe will be so equipped this summer. What is the total cost of upgunning the M–114?

Why was this effort necessary when you have the Sheridan reconnaissance assault vehicles, with the Shillelagh missile and 152-millimeter gun, being produced by the hundreds during the past couple of years?

Provide these answers for the record.

(The information follows:)

The requirement for a more effective weapon on the present scout vehicle (the M–114) is essentially independent of the availability of Sheridan's. These two vehicles, although both are intended to work together in the armored cavalry platoon, perform different functions in the accomplishment of platoon missions. Wherever possible, platoon combat formations insure that the Sheridan element is able to overwatch the activities of the scout elements to their front; however, many of the missions routinely assigned to these platoon require a wide deployment in which the scout elements survive or die based on their own

inherent capabilities. Such missions would be the delay, screening, economy of force, and, in many instances, area and zone reconnaissance. At present, most M-114-equipped scout elements actually operational in armored cavalry platoons are associated with medium tanks in the role to be assumed by Sheridan; yet the field commander for our forces in Europe, General Polk, has expressed an urgent need for this improved capability on his M-114 vehicles, and from latest reports he is well pleased with the actual performance demonstrated thus far, as these weapons are being deployed to his command. Total program cost to upgun the M-114 with the 20-millimeter cannon is $93.5 million.

Fortifications, Mines, and Obstacles

Mr. Davis. You are requesting ——— in fiscal 1970 for "Fortifications, mines, and obstacles," an increase of ——— over last year. What is the reason for the increase? In addition, I note you requested $5.1 million in fiscal 1969 for this program element, but this year's justification book indicates your fiscal year 1969 program was $6.8 million. Why and how was this increased?

General Betts. The increase of ——— was a result of the Army's assumption of some of the responsibilities formerly exercised by the ———.

The bulk of the increase in this program element for fiscal year 1969 was a result of DOD reprograming action 69-28 which reprogramed $1.005 million into the program to supplement the funding for the scatterable mine system. Smaller increases were affected by a release of funds from the budgetary reserve and a statistical distribution of facilities and installation support costs.

Scatterable Mining System

Mr. Davis. The largest item in this program element is ——— for the scatterable mining system. Will you describe this system and the total development costs through fiscal year 1969?

General Betts. The scatterable mine system is a family of mines that can be dispersed through a variety of means (hand, vehicle, towed dispensers, artillery, and aerial vehicles) over selected terrain. Development costs through fiscal year 1969 were $7.456 million. (Additional classified information has been furnished separately to the committee.)

XM-56 Airborne Antitank Mine System

Mr. Davis. Fiscal year 1969 and prior year funds were used for the XM-56 airborne antitank mine system. How much was spent on this effort?

What has the Navy and Air Force done in developing airborne antitank mines and how much has the Army duplicated this effort?

Has the XM-56 entered production? If so, when and show the quantities and procurement costs by fiscal year. If not, what is the reason it has not entered production?

You may answer these questions for the record.

(The information follows:)

In fiscal year 1969, $443,000 had been spent on the XM-56 system.

The Army, as the DOD designated lead service, has developed a joint service operational requirement for mine warfare that effectively precludes duplicatory

efforts. In general, Army systems are for close-in mine warfare while the Air Force effort is directed toward areas not in close proximity to the battlefield.

The system has not entered production because of difficulties with the carrier/dispenser. Work during the coming year will concentrate on redesign of this portion of the system.

FISCAL YEAR 1970 PROGRAM FOR SCATTERABLE MINING SYSTEM

Mr. DAVIS. How do you plan to utilize the ——— in fiscal year 1970 for the scatterable mining system?

General BETTS. Development of the XM–56 mine dispensing system during fiscal year 1970 and 1971 will continue. Engineering development of the following items will be initiated in fiscal year 1970 and continue through fiscal year 1971:

Mine, underwater XM–91 (Paramine).
Underwater antivehicle mine.
Field marker system.
Area denial artillery munitions.

Mr. DAVIS. You are requesting $4.9 million in fiscal year 1970 for chemical-biological weapons (CBW). What is your program for fiscal year 1970?

You requested $4.3 million in fiscal 1969 for CBW, yet the fiscal year 1970 justification book shows the fiscal year 1969 program at $5.5 million. Why and how was this program increased?

While we are on the subject of CBW, there has been recent publicity concerning proposed nerve gas tests at Edgewood Arsenal, Md., and in other areas of the United States.

The committee recalls that nerve gas tests last year in Utah killed several thousand sheep. Will you provide the details of these proposed tests, the reasons therefor, where and when the proposed tests are to be conducted, the danger to animals and humans, and the safety precautions to be taken.

Provide answer to these questions for the record.

(The information follows:)

The program for fiscal year 1970 includes engineering and service tests on the XM–191 multishot portable flame weapon; initiation of engineering development on the ——— personnel marking and identification system and a weapons system for PG ——— completion of engineering development on the 2.75-inch tactical CS aerial rocket and a modification of the XM–28 aerial CS dispenser which was tested in Vietnam. Engineering and service tests will be initiated on a ———. Engineering development will continue on the ——— cartridge. This was suspended last year in favor of higher priority Southeast Asia projects. Development will also continue on a multiple submunition 155-millimeter CS projectile and the XM–627 soft nosed, riot control, 40-millimeter CS cartridge. Engineering and service tests will be completed on the XM–47 nonhazardous rubber riot control CS hand grenade.

The increase of $1.2 million in the fiscal year 1969 program was due to reprograming actions necessary to fund Ensure requirements from field commanders. The items funded were the multishot portable flame weapon, XM–191; the liquid riot control agent dispenser, XM–32; and the tactical CS rocket, XM–96.

Nerve gas tests at Edgewood Arsenal have been conducted for several years in support of the Army's Chemical Research and Development Laboratories there.

The pursuit of these research and development activities at Edgewood has required experimentation in both the laboratory and the field. In the field the principal areas used for the conduct of lethal and incapacitating chemical agent tests are the Carroll Island and Graces Quarters test sites located on the west shore of the Gunpowder River directly opposite the Gunpowder Neck Peninsula.

Experimentation at Carroll Island and Graces Quarters has involved the

controlled release of small amounts (never over 15 pounds) of chemical agents ———.

Dissemination of lethal agents ——— is based upon considerations of the quantities of agent involved and the various prevailing meteorological factors ———.

Safety procedures in connection with such tests are a matter of continuing review. A detailed review of safety procedures at Edgewood Arsenal was made last year by a group of Army civilian scientists. In addition, Secretary of the Army Stanley Resor has appointed an advisory committee of eminent scientists to review the procedures, equipment, facilities, and safety regulations used at this installation.

All lethal agent open-air testing at Edgewood Arsenal was temporarily suspended by the Secretary of the Army until the review of safety procedures is completed by the scientific advisory committee.

AERIAL CHEMICAL MUNITIONS

Mr. DAVIS. You are requesting ——— in fiscal 1970 for aerial chemical munitions. This would appear to be a Navy and/or Air Force effort. What is involved in this project and what are the Navy and Air Force doing in this area?

General BETTS. This project was established to develop munitions of Army helicopters. Two munitions are being developed in response to Ensure requirements from Vietnam. The major effort, ———, is on the XM–99 2.75-inch aerial folding fin rocket with a CS riot control agent submunition warhead. The other item being developed, ———, is the XM–28 dispenser and bagged riot control agent CS, which is a container that is sling loaded beneath a helicopter and will be used for bulk agent dissemination.

CHEMICAL APPREHENSION DART

Mr. DAVIS. General Betts, page 32 of your statement discusses the development of a chemical apprehension dart to aid in the capture of looters and arsonists during civil disturbances. This does not appear to be anything new. The committee recalls police departments rejecting a weapon of this nature several years ago because of the possible permanent damage if such a dart were to imbed itself in a person's eye. How much has the Army spent in the development, testing, and procurement of this weapon through fiscal year 1969?

How much is in the fiscal year 1970 Army R.D.T. & E. and procurement budgets for this purpose?

How can the Army assure itself this weapon cannot accidentally hit someone in the eye?

You may supply that for the record.

(The information follows:)

It is correct that the chemical apprehension dart is not a new concept for it has been used for a number of years in animal capture. We conducted a feasibility study using available commercial hardware and several incapacitating compounds. This study showed that the system tested did not meet our requirements for time required to incapacitate and system accuracy. Good accuracy would enable a potential user to aim at and hit a target individual in the legs or lower torso. Forty-eight thousand dollars were spent to conduct the feasibility study and associated medical studies. There are no R. & D. funds programed for this project in fiscal year 1970 nor is there any procurement anticipated.

Army Small Arms Program

Mr. Davis. You are requesting ——— in fiscal 1970 for Army small arms program engineering development, a new program element. What was the purpose in establishing this new program element?

UNIVERSAL MACHINEGUN

Of the total amount requested, ——— is for machineguns. Will you explain what new machineguns are involved and describe their characteristics and what weapons they will replace?

How much has been spent through fiscal year 1969 for R.D.T. & E. of machineguns for the record?

(The information follows:)

Program element 6.46.08.A Army small arms program was established as part of the Army's restructuring of R.D.T & E. programs to give visibility to those tasks associated with the development of small arms. Engineering development is planned to begin in fiscal year 1970 in response to the users stated requirement for a universal machinegun (UMG). The UMG is envisioned as a replacement for both the standard ground (M–60) and tank (M–73) mounted 7.62 millimeter machinegun. Regarding R.D.T & E. funds spent on machineguns through 1969, no funds have been spent on engineering development of ground machineguns since fiscal year 1957 when the M–60 was type classified standard A. The only programed advance development funds for that period is $0.385 million for a joint evaluation with the USMC of the Stoner light machinegun. From fiscal year 1963 through fiscal year 1969 a total of $0.6 million has been spent on exploratory development, oriented toward the requirement for a universal machinegun (UMG).

SMALL ARMS CASELESS AMMUNITION WEAPONS

Mr. Davis. In view of your experience on caseless ammunition for the past 20 years, why are you so optimistic that the entire caseless ammunition program will have progressed to the point where some engineering development work can be initiated on the weapon for this system concept?

The committee might suggest that you take a hard look at your experience and progress in caseless ammunition development before initiating engineering development of any such weapon system.

General Betts. Successful firing of semiautomatic and automatic 5.5 millimeter have progressed to a point that a feasibility demonstration can be forecast during fiscal year 1970. If this demonstration of feasibility is successful the funds programed under this program element would be used to initiate engineering development. However, based on our recent experience with other combustible ammunition, the Army will completely review the progress of small arms caseless exploratory and advance development before initiating engineering development of a small arms, caseless, weapons system.

Mr. Davis. Bring the committee up to date on the Stoner weapons' development. As I recall there was a Stoner rifle and a Stoner machinegun, in which both the Army and Marine Corps were interested at one time. How much have you spent on the Stoner weapons, what size ammunition will they fire, and what problems have you had, what are the results of testing, and what is the status of the program?

What weapons or weapon were the Stoner weapons to replace?

(The information follows:)

The Stoner 63 small arms weapons system consist of six separate arms (carbine, rifle, and four machinegun configurations), all built from one basic common group. All these weapons fire the 5.56-millimeter cartridge. The Stoner family of weapons was extensively tested by the Army during the small arms weapons systems study (SAWS) in 1965–66. The study was conducted to determine the small arms weapons with which to equip the U.S. Army. The candidate small arms weapons systems were the Stoner family, Colt family, 7.62-millimeter family (M–14 rifle and M–60 machinegun), the Armalite 18, and the Harrington and Richardson G3. This study revealed no significant difference in performance characteristics between the M–16 and the Stoner rifles. The decision was made to adopt the M–16 based on its lighter weight (6.5 pounds for M–16 versus 7.8 pounds for Stoner) and the fact that the Army had previously procured 412,405 M–16 rifles. This study also revealed that the M–60 machinegun was superior to all other machineguns tested and was retained as the Army standard A machinegun. Cost of Stoner equipment to support SAWS was $0.5 million. Subsequently, the U.S. Marine Corps expressed interest in the Stoner system, to include a 1967 combat evaluation. Currently the Army and Marines are engaged in a joint project of evaluating the Stoner, 5.56-millimeter machinegun (XM207). Engineering testing is scheduled for completion by June 1970. Cost of this test is being shared equally by the U.S. Marine Corps, fiscal year 1969 Army funding was $0.385 million.

Other Equipment

ELECTRONIC WARFARE QUICK REACTION CAPABILITY

Mr. Mahon. You are requesting ——— million in fiscal year 1970 in support of "Electronic Warfare Quick Reaction Capability." To what extent is this effort based on firm requirements and to what extent is it a dollar level sum requested in anticipation of presently unprogramed requirements in this area?

Colonel Lamb. The EW, QRC program is not based on firm requirements. The Army objective is to plan in advance for R. & D. of EW equipment that will be required in future years. When this process falls short of providing adequate equipment because of an unforeseen enemy capability, it is necessary to take extraordinary measures to obtain the required item. The majority of the EW QRC funds have been applied to problems presented in Vietnam. The dollar level sum requested is not based on anticipated presently unprogramed requirements rather it is an estimate based on prior experience.

Mr. Mahon. What quick reaction capability projects were funded under this heading with the $2.5 million made available in fiscal year 1969?

(The information is classified and has been furnished separately to the committee.)

Mr. Mahon. At this point in time, what projects have you identified under this heading for fiscal year 1970?

Colonel Lamb. None at this time. Before a project can be considered for QRC funding it must be approved by the Army electronic warfare board.

Tactical Fire Direction System (Tacfire)

Mr. Mahon. You are requesting ——— million in fiscal year 1970 for the tactical fire direction system (Tacfire). You requested $12.8 million for Tacfire in fiscal year 1969; however, page 247 of this year's justification book indicates the fiscal year 1969 program was $16.2 million. How and why was this program increased?

Colonel LAMB. The $12.8 million was based on estimates prior to award of the contract in December 1967. $2.6 million was subsequently added November 26, 1968 in reprograming action fiscal year 1969-2 (DOD fiscal year 1969-28) to provide for additional funds required in the development portion of the total package procurement contract. The remainder ($750 thousand) was reprogramed within authority in November 1968 for an engineering change to provide for addition of a necessary random access memory.

Mr. MAHON. Please describe Tacfire, what it is and what it will do?

Colonel LAMB. The tactical fire direction system (Tacfire) is an integrated on-line tactical computer system which will be fielded throughout the Army's field artillery units during the time period 1972–74. Tacfire will assist field artillerymen, through the use of automatic data processing; to accomplish those tasks which machines can do faster, more accurately, and with greater effect and economy than is possible with present manual methods. Tacfire will perform the time-consuming burden of field artillery computation and data processing that is now done manually. The objective of Tacfire is to increase the effectiveness of field artillery fire support through increased accuracy, better and more rapid use of target information, reduced reaction time and greater efficiency in the determination of fire capabilities and the allocation of fire units to targets. Specifically, Tacfire is the application of automatic data processing techniques to the seven field artillery functions of technical fire control, tactical fire control, fire planning, artillery target intelligence, artillery survey, meterological data, and ammunition and fire unit status. The system will also provide a back-up capability for the fire support element, which is part of the tactical operations center, for preliminary target analysis, nuclear target analysis, nucler fire planning, chemical target analysis, and fallout prediction.

FIELD ARTILLERY DIGITAL AUTOMATIC COMPUTER (FADAC)

Mr. MAHON. In April 1967, the field artillery digital automatic computer (FADAC) was deployed to South Vietnam and is now in the hands of Army and Marine Corps artillery units. Please describe FADAC, what it is and what it will do for artillery units.

Colonel LAMB. FADAC is a portable all transistorized general purpose computer, ruggedized for the tactical environment. It's principal function is to compute a ballistic trajectory for artillery projectiles. It combines weapon location, target location, meteorological data, muzzle velocity data and a computer program for the equations of motion to compute the basic technical solution for the gunnery problem—the elevation and deflection settings for a given artillery piece to hit a given location. Thus, FADAC replaces only the manual ballistic computations and their associated tools (firing charts, firing tables) within the artillery fire direction center (FDC). It moderately increases the speed of technical fire direction and increases the probability of first round hits when an accurate target location is known. It cannot be considered a system since it serves only individual FDC's and has no digital communications capability. Being a general purpose computer, FADAC can be programed for other applications such as limited weapons effects analysis, sound and flash ranging, survey computa-

tions, meteorological data reduction and tactical imagery interpretation. However, one computer can be programed for only one of these applications at one time and cannot be used for other applications without reprograming.

TOTAL FADAC COSTS

Mr. MAHON. What was the total development costs of FADAC, and total procurement costs through fiscal year 1969?

Colonel LAMB. The total development costs of FADAC was $6.9 million. The total procurement costs through fiscal year 1969 is $54.5 million.

FADAC DEPLOYMENT

Mr. MAHON. Are all Army and Marine Corps units equipped with FADAC worldwide? If not, will they be so equipped with FADAC and what will be the cost?

Colonel LAMB. All Army units are not equipped with FADAC. FADAC was scheduled to be issued no lower than battalion level for 105 mm. howitzer battalions. Due to decentralization of actions in Vietnam, the computers have been issued to battery level. No additional FADAC equipments are being procured for this requirement. All battalions will not be equipped with FADAC since Tacfire will replace FADAC in the active Army. When Tacfire enters the inventory, FADAC will be issued to the reserve components since no Tacfire equipments have been planned for these forces. In the Marine Corps at the present time only those forces in Vietnam are equipped with FADAC. The Marine Corps plans to completely equip their forces worldwide by the second quarter of fiscal year 1970 at a cost of $1,852,300.

FADAC FUNDING FOR FISCAL YEAR 1970

Mr. MAHON. Are there any funds in the fiscal year 1970 Army budget, all appropriations, for FADAC? If so, please identify same.

Colonel LAMB. O. & M.A. only--$987,000.

TACTICAL FIRE DIRECTION SYSTEM (TACFIRE)

Mr. MAHON. The fiscal year 1970 justification book, page 247, indicates the Army has funded a total of $23.3 million for Tacfire through fiscal year 1969. The fiscal year 1969 justification book, page 225, shows that Tacfire had been funded a total of $41.5 million through fiscal year 1968. With the fiscal year 1969 program of $16.2 million, this means that Tacfire has been funded a total of $57.7 million through fiscal year 1969 and not $23.3 million as indicated in the current justification book. What is the explanation for this significant discrepancy?

Colonel LAMB. The fiscal year 1970 justification book, page 247, indicates the Army has funded a total of $33.3 million for Tacfire through fiscal year 1969. The apparent discrepancy in reporting the prior year cost of Tacfire occurred as a result of an attempt to refine the data reported in the descriptive summaries. In the fiscal year 1969 summaries the figure reported for the program element included funds obligated through fiscal year 1969 on the program element

"Tactical ADPS Equipment." Most of these funds related to the Tacfire element. In addition, in the fiscal year 1969 summaries a large portion of the funding history on "ADSAF," automated data systems for the Army in the field was included. The interrelationship between ADSAF and Tacfire was referred to in the "Description" portion of the fiscal year 1969 summaries. In development of the fiscal year 1970 budget, however, funding history at the program element level was confined to the period fiscal year 1963 through 1968, as the element structure was instituted in fiscal year 1963. As a result, the fiscal year 1970 summaries shows only the prior year funding history on "Tactical ADPS Equipment." A more thorough analysis has now been made of Tacfire and specific portions of the two elements relating to Tacfire have been identified. This more accurate estimate is $25.8 million for the period fiscal year 1963 through fiscal year 1968.

TACFIRE DEVELOPMENT COSTS

Mr. MAHON. What was the original estimate for total Tacfire development and what is the current estimate?

Colonel LAMB. The original estimate for Tacfire development, including $17.6 million incentive exposure, was $56.989 million. The current is ———. This includes current Litton request for increased funds. It should be noted that PEMA has been and will be reduced by a like amount of R. & D. increase within the terms of the contract.

SLIPPAGE IN TACFIRE DEVELOPMENT PROGRAM

Mr. MAHON. Have there been any cost increase and/or slippages in the Tacfire development? If so, what are they and reasons therefor?

Colonel LAMB. Yes; in fiscal year 1969 there was a $5.75 million increase over program in R.D.T. & E. costs. Of this amount, $1.42 million was generated by the Government for necessary engineering changes. The remainder was required by the contractor within the terms of the contract with a like decrease in PEMA funds. In fiscal year 1970 ——— million over current program will be required. ——— million of this amount is required to procure necessary engineering service test spares and test equipment. The remainder will be required by the contractor again within the terms of the contract and again with a like decrease in PEMA costs. The Tacfire contract is a total package procurement (development plus production costs) fixed price, multiple-inentive contract. In order to enhance both his opportunity to gain performance incentive as well as his ability to produce Tacfire at a reduced cost within the total overall contract price ceiling, the contractor has chosen to accelerate his funding of the development phase of the contract with a like cost decrease in the production phase. There has been a total of ——— weeks slippage in the program. Less than 15 percent of this ——— week schedule slip can be attributed to resolution of technical difficulties. The majority of this slip occurred prior to November 1968 due to subcontractor negotiation difficulty and delayed management decisions resulting therefrom. Additionally, ——— weeks of this delay is attributable to the addition of secondary drum memory (an engineering change) in the battalion configuration. Only ——— weeks of this delay has occurred in the last 8 months.

TACFIRE DEVELOPMENT ACCOMPLISHMENTS

Mr. MAHON. What did you accomplish with the fiscal year 1969 funding of $16.2 million, and what do you hope to accomplish with the ——— million in fiscal year 1970?

Colonel LAMB. During fiscal year 1969 all major systems design was completed and engineering drawings were released for equipment fabrication. Engineering models were fabricated for most system components. Integration of these models began in late fiscal year 1969. Software (program) design was approximately 70 percent completed and initial testing of the software commenced on a commercial computer.

During fiscal year 1970, the contractor will deliver a program support system (one division and one battalion configuration), a training support system (one division and one battalion configuration) and the FT/ST models (one division and four battalions). All components of the system will begin acceptance testing starting in October 1969. Software is presently being tested using the engineering models. Full system integration will commence in April 1970 with delivery of the engineering test/service test system by June 1970.

As noted earlier, an additional ——— million will be required for fiscal year 1970. Of this amount, ——— million is required by the contractor with a like reduction in PEMA costs and ——— million is required by the government for the procurement of engineering/service tests spares and test equipment.

TACFIRE LEVEL OF DEPLOYMENT

Mr. MAHON. At what levels will Tacfire equipment be used—battalion, division, regiment, or at all levels?

Colonel LAMB. The current procurement will equip all active Army field artillery cannon and howitzer battalions and division artillery headquarters. It is planned to equip corps artillery headquarters and field artillery group headquarters with later procurements.

COST COMPARISON OF TACFIRE WITH FADAC

Mr. MAHON. What is the total estimated cost to equip all Army artillery units with Tacfire and how does this compare with FADAC?

Colonel LAMB. The total estimated cost to equip all active Army artillery units with Tacfire (PEMA only) is ——— million. This compares with FADAC costs of ——— million. However, this is not a proper comparison since Tacfire equipments will be issued to more type units than FADAC; for example, division artillery headquarters and all batteries in addition to providing greater capabilities.

Mr. MAHON. Is any of the FADAC equipment being used in the Tacfire system? If so, in what way?

Colonel LAMB. None of the FADAC equipment is being used in the Tacfire system.

REASONS FOR REPLACING FADAC WITH TACFIRE

Mr. MAHON. What was wrong with FADAC? Have there been any complaints from South Vietnam concerning FADAC?

Colonel LAMB. Nothing was technically wrong with FADAC. The main objection is with its limited application. As shown earlier its purpose was limited in that it performed only one basic function from the broad spectrum of artillery functions which lend themselves to automation.

There have been isolated complaints from South Vietnam concerning FADAC. The chief complaints were excessive downtime on the generators which power FADAC and a lack of trained operators. The first complaint is being resolved by quick reaction training in generator maintenance and operation of field units by an incountry FADAC contact team. The second is being resolved by onsite training of operators by the same contact team and by increased training in Conus.

Mr. MAHON. Explain what Tacfire can do for artillery units that FADAC cannot do.

Colonel LAMB. The Tacfire system of computers will tie together, through digital communications, the division artillery headquarters with all of its subordinate battalions. Tacfire performs automated solutions not only for technical fire control (FADAC's sole function), but for tactical fire control (the coordination of fire units), nuclear and nonnuclear fire planning, survey computations, artillery intelligence analysis, meteorological data, nuclear and chemical target analysis, ammunition and fire unit status and fallout predictions.

TACFIRE TESTING PROGRAM

Mr. MAHON. You state that the fiscal year 1970 program will continue engineering development of the prototype system, which will be delivered in ———, after which engineering and service tests will begin. How long will engineering and service testing take?

Colonel LAMB. Engineering and service testing is scheduled for ——— months—from ——— to ———.

FISCAL YEAR 1970 PEMA FUNDS FOR TACFIRE NOT NEEDED

Mr. MAHON. If engineering and service testing will not be completed until about ——— and it is not scheduled for fielding until ———, why is the Army requesting $6.5 million in the fiscal year 1970 PEMA budget for Tacfire?

Colonel LAMB. The $6.5 million was originally programed for long-lead Government furnished equipment and contractor material. In view of the program slippage to date this requirement is now being reevaluated with a view toward procuring long-lead Government furnished equipment only.

Mr. MAHON. Why should the Congress appropriate PEMA funds in the amount of $6.5 million for a system which is still being developed, the prototype system has yet to be delivered, the engineering/service testing will not be completed until ———?

Colonel LAMB. The Tacfire contract is a fixed price, multiple incentive total package procurement contract for the design, development, testing, production, procurement and 2 years of followon field support after delivery of the first production system. Due to long leadtime requirements for both Government and contractor furnished equip-

ment, funds must be provided approximately ——— months prior to delivery of these equipments at the contractor's facility. This brings about the PEMA requirement in fiscal year 1970 and is necessary to prevent slippage at the beginning of the production phase.

MARINE CORPS INTEREST IN TACFIRE

Mr. MAHON. The committee notes that Marine Corps units have FADAC. Does the Marine Corps have a requirement for Tacfire. If so, what is the possible or potential cost of providing appropriate Marine Corps artillery units with Tacfire?

Colonel LAMB. The Marine Corps is very interested in Tacfire and is planning to participate in the test program. It is the Marine Corps intention, pending successful completion of the test program, to procure Tacfire equipments. Actual Marine Corps requirements must await completion of the test program and Marine Corps evaluation of actual Tacfire capabilities.

DEFENSE COMMUNICATIONS PLANNING GROUP

Mr. MAHON. You are requesting ——— million in fiscal year 1970 for continuation of effort performed under "Defense Communications Planning Group." Submit a listing to the committee of the projects to be undertaken in fiscal year 1970, the amount to be allocated to each project, the sum already spent on that project, the anticipated cost to complete the project, and the purpose of the project.

(This information is classified and was submitted separately.)

Mr. MAHON. What accomplishments can you report from the activities in this area in fiscal year 1969?

(This information is classified and was submitted separately.)

CRYPTOLOGIC ACTIVITIES

Mr. MAHON. You are requesting a large increase in funds for "Cryptologic Activities." ——— million was planned for this area in fiscal year 1969. You are requesting ——— million in fiscal year 1970.

(This information is classified and has been furnished separately to the committee.)

Mr. MAHON. To what extent is your effort under "Cryptologic activities" performed in-house? How much of the in-house effort is at the Electronics Command at Fort Monmouth?

Colonel LAMB. During fiscal year 1970 ——— is programed for in-house effort. Of this ——— will go to the ECOM at Fort Monmouth and the balance is for in-house work by the USASA.

Mr. MAHON. What are the major accomplishments from the funds expended under this heading in the past year?

(Information is classified and has been furnished separately to the committee.)

Mr. MAHON. Describe the major new systems which are included in this activity?

(Information is classified and has been furnished separately to the committee.)

Signal Intelligence

Mr. Mahon. Under "Advanced development in signal intelligence," you are requesting an increase from ——— million in fiscal year 1969 to ——— million in fiscal year 1970. The descriptive summary in support of this item refers to "a new airborne test bed platform to reconfigure airborne equipment for installation in new, larger aircraft." What new, larger Army aircraft are referred to?

(Information is classified and has been furnished separately to the committee.)

Mr. Mahon. What new projects are being initiated in this area in fiscal year 1970?

Colonel Lamb. The project just discussed requiring the ——— enlarged aircraft and an automatic mobile ——— assembly.

Mr. Mahon. You are requesting an increase from ——— million to ——— million for "Engineering development in signal intelligence." List for the committee the projects to be undertaken in this area in fiscal year 1970 and also submit a list of the items on which you worked in fiscal year 1969 and indicate the amount allocated to each.

(Information is classified and has been furnished separately to the committee.)

Mr. Mahon. Describe the ——— on which you anticipate development completion in fiscal year 1970. What capabilities will this equipment have over other equipment?

(Information is classified and has been furnished separately to the committee.)

Mr. Mahon. In the fiscal year 1969 budget you requested ——— million for "Engineering development in signal intelligence." The justifications now before the committee indicate that ——— million was actually allocated to this area. What are the reasons for this increase in fiscal year 1969?

(Information is classified and has been furnished separately to the committee.)

Mr. Mahon. If the ——— set will be completed in fiscal year 1970 as well as ——— assemblies, as referred to in the descriptive summary, we might expect to see a reduction, not an increase, in this area in fiscal year 1970. Why is this not the case? What new projects are entering engineering development in fiscal year 1970?

(Information is classified and has been furnished separately to the committee.)

Technical Sensor Collection

Mr. Mahon. The fiscal year 1969 budget requested ——— million for effort in the area of "Technical sensor collection." The fiscal year 1970 budget shows that ——— million was applied to this area in fiscal year 1969. No funds are requested for fiscal year 1970. Was this effort completed in fiscal year 1969 or has it been transferred to another budget element? What are the results of the ——— effort?

(Information is classified and has been furnished separately to the committee.)

Counterintelligence Investigative Activities

Mr. Mahon. You are requesting ——— million for a new budget element entitled "Counterintelligence Investigative Activities." To what extent is this a new program? Is it merely a reclassification?

Colonel Lamb. This is not a new program. Counterintelligence investigative activities were formally funded under electronic warfare program elements 6.21.02.A, 6.37.11.A and 6.47.07.A. Since the activities are not truly electronic warfare the new program element was formed. It is a reclassification of the effort under one program element.

Mr. Mahon. What are the comparable amounts spent in this activity in fiscal year 1968 and fiscal year 1969?

Colonel Lamb. $1,364,000 and $1,604,000 were funded in fiscal year 1968 and 1969 respectively.

Mr. Mahon. What kind of new agent communications system do you anticipate development of?

(Information is classified and has been furnished separately to the committee.)

Mr. Mahon. Supply for the committee a list of the individual projects which make up the ——— million total request for fiscal year 1970.

(Information is classified and has been furnished separately to the committee.)

Intelligence Data Handling System (IDHS)

Mr. Mahon. You are requesting ——— for work under the heading "Intelligence data handling system." The sum of $200,000 was allocated to this effort in both fiscal years 1968 and 1969. Why are you requesting a ——— in this area in fiscal year 1970?

Colonel Lamb. ——— was requested for fiscal year 1970 to fund adequately a study aimed at defining the interface requirements between the defense intelligence data handling system and planned Army tactical intelligence data handling systems, such as the tactical operations system (TOS).

Mr. Mahon. You did not request any new money for this activity in fiscal year 1969, yet the fiscal year 1970 justification indicates $200,000 was allocated to this effort in fiscal year 1969. Were carryover funds available?

Colonel Lamb. Carryover funds were not available. The $200,000 was allocated to the program by the Office of Defense Research and Engineering during their apportionment review.

Mr. Mahon. Why must an investigation be made into "the interface requirements of the intelligence data handling system and other systems automating intelligence information"? Weren't such interface requirements looked at during the development of the system?

Colonel Lamb. The defense intelligence data handling system, to insure the required flow of information from and to tactical data handling systems must have the proper interface. During development

of the former system, interface requirements were addressed as they were known. However, as new tactical data handling systems progress into development, new interface requirements are generated that must be addressed.

Mr. MAHON. How was the $200,000 estimated for fiscal year 1969 obligated? What work was done, and where was it done?

Colonel LAMB. The $200,000 for fiscal year 1969 was reprogramed to fund work for the tactical operations system (TOS) in Europe. The money was used to partially fund a contract to Bunker Ramo Corp. for development of software for the TOS-Europe. The work was done in USAREUR.

Mr. MAHON. When will this program be completed?

Colonel LAMB. This program should be completed in fiscal year 1970 from a research and development standpoint. Future efforts should be funded from other appropriations.

LEFIRM ARMOR

Mr. MAHON. Describe the new program entitled "Lefirm Armor" for which you are requesting ——— million in fiscal year 1970? What is the total estimated cost of this new program?

Colonel LAMB. Project Lefirm Armor is a highly classified sensitive program. Access to the program is limited. I will be pleased to provide a special briefing in an appropriate safeguarded facility, on request.

(Discussion off the record.)

COMMUNICATIONS-ELECTRONICS

Mr. MAHON. The fiscal year 1970 request for communications-electronics exploratory development is ——— million, an increase of ——— million over the fiscal year 1969 program, according to the justification book. What is the reason for this increase?

Colonel LAMB. A new start was initiated in fiscal year 1969 in this program called tactical radio communications system. This project is for the orderly, coordinated, nonfragmented approach for a system of net communications equipment and also to maintain a concentrated effort in the specific areas of technology required to implement the objectives of a QMDO for a tactical radio communications system. This project was funded at a minimum level with funds from other projects in this program in fiscal year 1969. The proposed funding for this program in fiscal year 1970 is ——— million. Additional increase of ——— million is requested in the radio frequency compatibility program to insure a comprehensive program to cope with the problem of radio frequency interference among electronic equipment and systems. This increase is an attempt to bring the exploratory development back up to the level it was in fiscal year ——— when ——— million were in this program.

Mr. MAHON. How much of the work under this program element is done in-house by the Army and how much by outside contractors?

Colonel LAMB. The present plans call for the utilization of ——— million for in-house effort and ——— million for contractual support.

Mr. MAHON. Will you briefly explain the work being done under this program element? Provide that for the record.

Colonel LAMB. Yes, sir.

(The information follows:)

The program element consist of eight projects:

1. Studies an investigations for communications-electronics: This project provides for continuing studies and investigations of concepts and techniques in support of communcation-electronics research and development.

2. Tactical radio communications system: This project provides for development of a coordinated, nonfragmented approach for a system of net communications equipment and maintains a concentrated effort in exploring specific areas of technology applicable to net radio equipment in the 1980-85 time frame.

3. Information transmission: This project provides for the exploratory development of improved techniques for information transmission.

4. Radio frequency compatibility program: This project provides research and development support for the Army's radio frequency compatibility program, and development of improved techniques and device components for the reduction of electromagnetic interference.

5. Satellite communications: This project provides development of improved techniques and design for ground satellite communication terminals.

6. Information acquisition: This project provides for exploratory development of improved techniques for converting various forms of information into electrical signals and back to their original form. It includes speech printed, and pictorial information.

7. Communications system theory: This project investigates problems in the areas of system organization, system control, and system standards and characteristics to increase utilization of communications systems.

8. Investigation of future communications systems: This project provides contractual support to the U.S. Army Combat Developments Command in the development of qualitative and quantitative requirements for all types of communications-electronics equipment for the Army in the field.

TACTICAL RADIO COMMUNICATIONS SYSTEM

Mr. MAHON. Of the total requested ——— million is to conduct concept formulation in depth on a program for a tactical radio communication system. This appears to duplicate work being done under Project Mallard, a proposed tactical communications system for field armies, which is essentially in the conceptual phase at the present time. Is this so?

Colonel LAMB. The tactical radio communications system is for small, lightweight, single-channel combat net radios for use in brigade and forward areas whereas the Mallard project is primarily for multichannel higher level systems. Although the sytems will necessarily complement each other they will not duplicate each other.

PROGRAM ACCOMPLISHMENTS

Mr. MAHON. What did you accomplish during fiscal year 1969 and what do you hope to accomplish with the ——— million in fiscal year 1970?

Colonel LAMB. The primary accomplishments in this program in fiscal year 1969 were continued operations of the Army radio frequency compatibility program and exploratory development in those technological areas where the state of the art must be advanced in order to improve the ground environment of the defense communications satellite program. In the latter, a parametric amplifier will be tested and evaluated and a breadboard model of an antijam encoder-decoder fabricated. In addition, a program was initiated for development of a coordinated nonfragmented approach for a system of net communica-

tions equipment. Work was continued in instrumentation techniques and fault-detection techniques. Investigations continued in the areas of special recognition and character recognition techniques. In fiscal year 1970 the program will include studies and investigations to emphasize optimized digital modulation and demodulation techniques for troposcatter, line-of-sight, and very-high-frequency communications systems. The RF compatibility program will continue to improve the Army's ability to predict, measure, and reduce electromagnetic interference. Investigations will continue in the area of speech recognition, character recognition techniques, and miniature printer/keyboard devices. Exploratory development will continue in the tactical satellite communications area, focusing on advanced antennas, power amplification, and multiple access techniques. Concept formulation in depth will be conducted on a program for a tactical radio communications system.

SATELLITE COMMUNICATIONS

Mr. MAHON. You propose to spend a little more than ——— million during fiscal year 1970 in the satellite communications area. Will you explain how this work does not duplicate the tactical satellite communications program element under "Military astronautics and related equipment"?

Colonel LAMB. The objective of this project is to conduct exploratory development to improve the state of the art of satellite communications terminal components. The knowledge gained from these developments is used to write specifications for the development of new terminals and improving present terminals in the tactical satellite communications program which is in advanced development. These terminals are used to conduct technical feasibility tests and to develop operational procedures.

REPROGRAMING HISTORY

Mr. MAHON. The justification book shows the fiscal year 1969 program as $4.9 million. The committee has been advised, however, that it was only $3.3 million. How and why was this program reduced?

Colonel LAMB. This program has not been reduced. The fiscal year 1969 funds available to this program were $4.892 million.

Mr. MAHON. How much has been reprogramed away from exploratory development communications electronics during each of the last 3 fiscal years?

Colonel LAMB. In fiscal year 1967 Congress approved $6.2 million and the Army reprograming action raised the program to $6.824 million. In fiscal year 1968 Congress approved $4.5 million and reprograming action reduced the program to $3.2 million. In fiscal year 1969 Congress approved $5.06 million and reprograming action reduced the program to $4.892 million.

IDENTIFICATION, FRIEND OR FOE

Mr. MAHON. You are requesting ——— in fiscal year 1970 for "Identification, friend or foe" (IFF). What are the objectives of this program?

Colonel LAMB. The objective of this program is exploratory development in the field of identification, friend or foe (IFF). This effort consists of studies and investigations of new techniques and application to IFF and includes identification of ground elements on the battlefield (battlefield identification system).

Mr. MAHON. How do you propose to use fiscal year 1970 funds?

Colonel LAMB. The fiscal year 1970 funds will be used to continue development and test of the optical BIFF and to initiate development of synchronous identification system.

PROGRAM FUNDING HISTORY

Mr. MAHON. The fiscal year 1969 justification book indicates that a total of $700,000 had been funded for this effort from fiscal years 1963 through 1967 and that the fiscal year 1968 program was $700,000, for a total of $1.4 million. This year's justification book shows on page 265 that the fiscal year 1968 program was only $200,000. Please explain these discrepancies.

Colonel LAMB. The fiscal year 1968 program was reduced through Army reprograming. The fiscal year 1968 program approved by Congress included only $200,000 for this element. In planning for execution of the fiscal year 1968 program the Army initially planned to increase the funding to $700,000 through reprograming, and this level was reflected in the Descriptive Summaries for the fiscal year 1969 budget. However, during the last half of fiscal year 1968, it was necessary to divert the additional $500,000 to finance Southeast Asia items.

AIRBORNE SURVEILLANCE AND TARGET ACQUISITION

Mr. MAHON. You had requested $5 million in fiscal year 1969 for "Airborne surveillance and target acquisition." How and why was this program reduced to $3.7 million?

General BETTS. The funding in this program element was reduced from $5 million to $3.7 million by instruction from the DOD in response to the Army's apportionment request. This action was necessitated by the requirement to accomplish higher priority tasks.

Mr. MAHON. The fiscal year 1970 request for this program element is ——— million. What was accomplished during fiscal year 1969 and what do you hope to accomplish during this fiscal year?

General BETTS. Some outstanding accomplishments under this program element are the following:

Demonstration of a dual mode radar-radiometric sensor; development of several special purpose flush mounted airborne antennas; completion of a study on a multisensor armed surveillance helicopter; completion of evaluation of proposals for a multisensor drone.

Our planned program for fiscal year 1970 includes the following items:

Continuation of integration of multisensors; completion of airborne clutter penetration radar development; work on helicopter-mounted moving-target-indicator radar techniques with emphasis on detection of moving personnel under foliage; development of improved flush mounted and miniaturized antenna techniques for application to heli-

copters; development of nonlinear signal processing techniques; research in methods of modulating covert laser radiation; development of a photoelectrolyticimaging system; improvement of techniques and procedures for more effective signal processing; fabrication of a weapons location mosaic detector; development of a flash ranging sensor; development of a single axis laser rotational sensor; development of an erbium laser to be used in laser rangefinding and illumination applications; completion of a simulation facility for evaluating intrusion devices and systems; research into methods for processing combat surveillance data.

PROGRAM FUNDING HISTORY

Mr. MAHON. The fiscal year 1967 justification book indicates that a total of $37.8 million was funded for this purpose through fiscal year 1967; the following year's justification book shows that a total of only $36 million had been funded for this purpose through fiscal year 1968. What is happening to the funding for this program element?

General BETTS. The fiscal year 1968 descriptive summaries inadvertently included $7.3 million fiscal year 1962 and prior year funds in the column headed "Fiscal Year 1963 Through Fiscal Year 1966." By deleting the fiscal year 1962 funds the cumulative funding for fiscal year 1963 through fiscal year 1967 would have been $30.5 million, which was the amount shown in the fiscal year 1969 descriptive summaries for fiscal year 1967 and prior years. Major reprograming action 68–4 reduced the fiscal year 1968 program to $4.0 million as reported in the fiscal year 1968 column of the descriptive summaries supporting the fiscal year 1970 budget.

Mr. MAHON. What is the total funding for this program element through fiscal year 1969?

General BETTS. The total funding for this program element for fiscal year 1963 through fiscal year 1969 is $38.2 million. Funding prior to fiscal year 1962 is not identifiable to the current program element structure.

PROGRAM ACCOMPLISHMENTS

Mr. MAHON. Can you cite specific examples where this work contributed directly toward the development of airborne sensors?

General BETTS. The Mohawk aircraft (OV–1) has been fitted with surveillance devices and utilized successfully for a number of years. The sensors utilized provide day/night all weather infrared surveillance; day/night photographic surveillance; and side-looking, moving-target-indicator radar surveillance. Also as a result of this work, the visual airborne target location system was developed and utilized in Southeast Asia. The laser target designation system, now in advanced development, was a result of this program. Another example is the airborne laser equipment realtime surveillance system that was developed as a result of the exploratory development done under this program.

RELATIONSHIP TO JIFDATS

Mr. MAHON. Page 267 of the justification book refers to work directed toward increasing speed and effectiveness in processing intelli-

gence data. Is this where ——— million will be used and does this duplicate the work being done on JIFDATS?

General Betts. The funds you refer to will be used to develop new techniques to meet Army requirements for air-ground data transfer, and for special studies of the flow and handling of surveillance information. Some of this work is expected to support the work in the JIFDATS program. Coordination with the JIFDATS program is accomplished and there is no duplication of effort.

Mr. Mahon. Are any of the fiscal year 1970 funds to be used for YO-3A or ——— aircraft sensor equipment?

General Betts. No funds from this program element will be used for the YO-3A or ——— aircraft sensor equipment.

Ground Surveillance and Target Acquisition

Mr. Mahon. The fiscal year 1970 request for "Ground surveillance and target acquisition" is ——— million. What are the objectives of this program and how are they unlike the program we just discussed?

General Betts. The objective of this program is to carry out applied research and exploratory development to provide the Army with an improved capability for the detection and location of military targets utilizing ground-based systems. Surveillance devices are to be developed with increased range, higher resolution, increased sensitivity, and foliage and weather penetration. Specific applications under this broad objective include improved countermortar and artillery radars; laser rangefinders and target illuminators; passive infrared flash detectors; improved acoustic target locating systems; advanced methods for intelligence gathering; improved seismic and/or acoustic intrusion detection and surveillance systems; and improved methods of image interpretation. This program of work differs from the program we just discussed, in airborne surveillance and target acquisition, in that the airborne systems are intended to maintain a comprehensive surveillance of the battlefield as well as providing for recognition and accurate location of military targets. Airborne systems must be compatible with the aircraft carrying them, to include weight and size and that particular design of antennas, power supplies, and other electronic subsystems. Ground-based systems have somewhat more flexibility in design but must be considered in terms of mobility and other logistics problems.

PROGRAM FUNDING HISTORY

Mr. Mahon. The fiscal year 1967 justification book, page 223, indicates that a total of $42.6 million was funded through fiscal year 1966 for this purpose. The following year's justification book, page 253, shows that a total of $12.7 million had been funded through fiscal year 1966 for this program element. What is the explanation for this discrepancy?

General Betts. The figure of $42.6 million was reported for fiscal year 1966 and all prior years, for which the program could be identified. The figure of $12.7 million was reported for the fiscal years 1963–66 only.

Mr. MAHON. How much has been funded through fiscal year 1969 for this program element?

General BETTS. The funding for this program element for fiscal year 1969 and all prior years for which the program can be identified is $51.9 million.

PROGRAM ACCOMPLISHMENTS

Mr. MAHON. Can you point to any developments which resulted directly from work under this program?

General BETTS. Several small lightweight radars for the detection of personnel and vehicles were developed as a result of this work. Examples are the AN/PPS-4, the AN/PPS-5, and the AN/PPS-9. The development of a ground-based foliage penetration radar resulted from this program. A patrol locator was completed, tested, and put into advanced development. Several mortar and artillery locating radars were developed as a result of this work. Examples are the AN/TPQ-28 and the AN/MPQ-4. An electronic scan pencil beam antenna was developed. This antenna will have application in new mortar and artillery locating system.

Mr. MAHON. How was the $3.7 million in fiscal year 1969 utilized and what do you hope to accomplish with the fiscal year 1970 funds?

General BETTS. Some outstanding accomplishments achieved in fiscal year 1969 include the development of a patrol locator, fabrication of a high resolution moving-target-indicator radar, evaluation of foliage penetration radars, a complete design for an electronic scan pencil beam antenna, demonstration of automatic data processing techniques for sound ranging, development of a variable magnification projection lens for 70 millimeter film, and development of a gallium arsenide laser ranging system. Our plans for fiscal year 1970 include work on new techniques for weapon location, applications of high resolution techniques to various radar problems, improvement of moving-target-indicator radars, improved and lightweight radar antennas, investigations on new and novel optical, mechanical, and cutaneous displays for radar information, improved systems and data processing for infrared flash ranging and acoustic techniques for weapon location and identification, investigation of photographic techniques including gated laser cameras, and development of very lightweight laser rangefinders.

ELECTRONICS AND ELECTRON DEVICES

Mr. MAHON. The fiscal year 1970 request for electronics and electron devices is ——— million, an increase of ——— million over the fiscal year 1969 program. What is the reason for this increase?

General BETTS. To reply I need to give a little background. The funding of this element was reduced by almost 40 percent from fiscal year 1966 to fiscal year 1968, a situation aggravated by inflationary effects. The support in fiscal year 1969 was only slightly increased over fiscal year 1968. Such decreased funding over the years has caused what we feel is a dangerous reduction in the on-the-shelf technology so essential to continued advances in system performance. The ——— million increase in fiscal year 1970 over fiscal year 1969 is to provide for new and improved technology and devices that will satisfy the requirements of future systems.

PROBLEMS WITH CABLES AND CONNECTORS

Mr. MAHON. Why is emphasis being directed toward developing more reliable "connectors and cables"? What were the shortcomings noted in this regard in Southeast Asia?

General BETTS. Reports from Southeast Assia and recent visits to that area indicate there is a continuing reliability problem with cables, cable connectors, and electronic assembly interconnections. This means that there have been numerous instances of broken cables or wires within cables, improper mating or breakage in cable connectors, and like failures.

Mr. MAHON. What did you accomplish during fiscal year 1969 to overcome these problems?

General BETTS. During fiscal year 1969, we initiated effort on reliability of electronic devices, in amount of $250,000. Specifically, our effort was directed toward reliable and long-life components, to include work on reliable miniature rotary switches, snap action push-button switches, rugged interconnecting cable assemblies and connectors, and reliable flat cables and interconnections.

Mr. MAHON. How much of the effort under this program element is done in-house and how much is contracted out?

General BETTS. In fiscal year 1970, we plan that 60 percent of the program or ——— million be done in-house and 40 percent or ——— million be contracted out.

PROGRAM FUNDING HISTORY

Mr. MAHON. Like other program elements noted, the funding picture is rather distorted. The fiscal year 1968 justification book, page 256, indicates a total of $85.2 was funded for this purpose through fiscal year 1967. The fiscal year 1969 justification book, page 244, shows only $81.9 million funded through fiscal year 1967 for this purpose. What is the explanation for this?

General BETTS. The figure of $85.2 million reflected in the fiscal year 1968 justification book was accurate at the time the book was prepared. As a result of reprograming prior year funds, a current reading for the period fiscal year 1963 through fiscal year 1967, would be $84.4 million. The figure of $81.9 million reported in the fiscal year 1969 justification book was understated; in developing the data one project was omitted from the fiscal year 1966 cost.

PROGRAM ACCOMPLISHMENTS

Mr. MAHON. What did you accomplish with the $13.9 million in fiscal year 1969 and what do you hope to accomplish in fiscal year 1970 with the ——— million requested?

General BETTS. The following are some recent accomplishments under this element. A miniature 15-volt thermal battery was developed for high "g" and spin applications such as the 30-mm. gun. Modification of the thermal battery used in the 2.75" rocket fuzes, resulted in doubling its active life. An improved lead-acid battery for artillery fuzes was developed. A high temperature acid fuel cell, using advanced design electrodes, was successfully demonstrated. A 500 watt fuel cell,

using normal leaded gasoline, was demonstrated. A silent 300 watt thermo-electric generator was developed. A water-activated, throw-away type zinc-air battery and a mechanically rechargeable zinc-air battery were developed. A picture tube was developed to display navigational data and radar data in real time. A high efficiency infrared source for electronic warfare application was developed. Avalanche transit time diodes were developed that have direct application in the Army hand-held radar (PPS–9) development. Electroluminescent diodes, suitable for application in solid state display panels, were fabricated. A new design was achieved for a high power microwave ferrite latching switch, essential to phased array radar development. A seven-fold improvement over the broadband electronic jammer now in use was achieved. Testing of a portable atomic frequency standard was completed and all specifications were met. The aging of quartz crystals was traced to three sources: particle impurities in processing; mechanical strains; and oxygen absorption. Corrective development programs are underway. A new frequency tuning device, a silicon "tunistor," compatible with integrated circuit (IC) concepts was developed. An IC electronic subsystem was developed to meet an urgent avionics laboratory application.

Our planned program for fiscal year 1970 includes the following items. Miniaturized power supplies are to be developed, using fuzed salt, fluoboric acid, and liquid ammonia based systems. A prototype thermal battery design is to be developed for applications of increased environmental stress and power density. Work will continue on electrolyte storage (plastic or metal ampoules), release (activation techniques), and distribution system (design) of liquid reserve power supplies. Limited evaluation of pneumatically driven electromechanical generators will be made. Simulation and analyses will be made of electrical system components such as turbo-alternators, cyclo-converters, inverters, and electric-drive wheels. Development and testing of advanced generation systems will include improved electrode materials and catalysts, new electrode structures, improved fuel cell systems and novel batteries. An 8 kilowatt superconducting generator will be tested. Evaluation of silent, multifuel thermoelectric power generators will be accomplished. Development of high performance, high power microwave devices will continue, to obtain broadband, lightweight noise generators for electronic warfare; low-noise, high efficiency tubes for communications; and electronic switches for use with modulators or as protective devices in high-power radar, communications and electronic warfare equipments. Development of millimeter wave components such as generators, amplifiers, and duplexes for radar and communications will be undertaken. Development of pickup, display, and storage devices for command and control, and combat surveillance and target acquisition applications will continue.

High resolution tubes, flat panel displays, and large area displays will be emphasized. Higher frequency, higher power, and more reliable transistors will be developed to meet the requirements of future electronic equipment. Quantum electronic devices will be developed that include erbium—"safe"—lasers, laser detectors with high sensitivity and low-noise factors, and laser modulators and Q-switches for application in communications and surveillance. Microwave semiconductor devices—both bulk effect and avalanche types—will be developed with

emphasis on improving frequency response, noise figure, bandwidth, power, and reliability. The goal is all-solid-state tactical microwave equipment. Four-year exposure data on various electronic parts and materials will be analyzed to determine fungi resistance. Development will continue of ultracompact components such as filters that are compatible with integrated circuits, and of microwave devices such as delay lines, filters, electronic tuners, mixers, and antenna phase shifters. Development will be undertaken of extremely stable and reliable miniature crystal units and advanced crystal technology for future avionics and communications equipments. Reduction in size and cost of atomic and molecular frequency standards for precise frequency and time control requirements of communications, navigation and station-keeping equipments will be undertaken. Research in nuclear radiation effects and hardening of electronic components will continue. Development of reliable cables, cable connectors, and interconnection on techniques will continue.

Chemical-Biological Defense

Mr. Mahon. You are requesting $15.9 million for "Chemical-biological defense." This compares with $16.7 million in fiscal year 1969 and $14.5 million in fiscal year 1968. What are the major projects included in this area?

General Betts. Biological agent warning and detection technology; protection for personnel working in the biological programs (safety); chemical and biological physical protection investigations; medical defense aspects of biological agents; medical defense aspects of chemical agents; and chemical agent warning and detection technology.

Mr. Mahon. What part of this work is performed in-house and what part by contract?

General Betts. Of the $15.9 million programed for this element; $5 million is for contract work. These contracts are in the areas of biological agent detection, physical protection investigations, medical defense aspects of biological and chemical agents, chemical agent detection and warning investigations and chemical and biological detection analysis studies. The in-house effort at Edgewood Arsenal is programed for $6.1 million to conduct exploratory development on chemical and biological physical protection, the medical defense aspects of chemical agents, and chemical agent warning and detection techniques. Fort Detrick in-house effort is programed for $4.8 million to conduct work on biological agent warning and detection techniques, protection for the personnel working in the biological programs, and the medical defense aspects of biological agents.

PROGRAM ACCOMPLISHMENTS

Mr. Mahon. What accomplishments in this area can you report during fiscal year 1969?

General Betts. The following developments were achieved in this chemical and biological defense element: the research on a sorbent chemical decontamination system was completed moving the effort to advanced development for fiscal year 1970, a new technique of protective mask production employing the simultaneous molding of two dif-

ferent types of silicone elastomers was successfully achieved, a producible tedlardacron laminate fabric was developed for chemical and biological protective shelter systems. The chemiluminescent biological agent detector and alarm system was breadboarded and the principle proven, thereby progressing the effort to advanced development in fiscal year 1970. Research has indicated that a pyrolizer air inlet can be added to the M–8 automatic chemical agent detector and alarm to provide an incapacitating agent detection capability. Infra red—IR—spectral studies were completed on long path IR chemical agent detectors which predict that these systems can operate in dusty and high humidity environments. Laser technology was shown to be adaptable to IR chemical detection devices. A principal chemical reaction for the detection of chemical incapacitating agents was developed. A breakthrough has been indicated for an effective prophylactic against anticholinesterase agents—nerve agents and a specific treatment for poisoning by oxime-resistant anticholinesterase agents has proven successful in initial experiments.

TOTAL FISCAL YEAR 1970 FUNDING FOR CHEMICAL AND BIOLOGICAL WARFARE

Mr. MAHON. Insert at this point in the record a listing of the various program elements and amounts involving chemical and biological warfare efforts which are included in the R.D. & E. Army appropriation.

(The information follows:)

[In millions of dollars]

Program element and title	*Amount*
6.26.02.A C&B weapons	25.7
6.27.06.A C&B defense	15.9
6.36.03.A C&B weapons	4.4
6.37.05.A C&B defense	4.9
6.46.07.A C&B weapons	4.9
6.47.18.A C&B defense	4.0
6.57.04.A Deseret Test Center	18.4

The following basic research element contains project tasks in the chemical and biological fields:

[In millions of dollars]

	Amount
66.11.02.A Defense research sciences	3.9

M–8 AUTOMATIC CHEMICAL ALARM

Mr. MAHON. What is the status of the development of an automatic alarm for chemical incapacitating agents?

General BETTS. The effort to add an incapacitating agent detection capability to the M–8 automatic chemical alarm is in exploratory development. Work is also being conducted to develop a simple field detection device for this class of chemical agents.

MAJOR CHEMICAL/BIOLOGICAL DEFENSE PROBLEMS

Mr. MAHON. What are the major defensive problems on which you are working?

General BETTS. The rapid detection, warning, and identification of biological agent, the long-range detection of chemical and biological agents, the protection of individuals against liquid, skin-penetrating, lethal chemical agents, the prophylaxis and treatment for chemical and biological agents, the collective protection of groups of people against lethal and incapacitating agents, the rapid detection of incapacitating chemical agents, and staying abreast of the rapidly advancing technology of new chemical compounds and biological organisms manipulation to determine if any new warfare agents may be developed by potential enemies.

MAPPING AND GEODESY

Mr. MAHON. You are requesting ——— million for "Mapping and geodesy" as compared with $3.1 million in fiscal year 1969. The fiscal year 1969 budget indicated a request for $4.5 million for this activity. What items were deleted in the $1.4 million reduction in fiscal 1969?

Colonel TOBEY. No exploratory research effort was actually deleted by this reduction. The military geographic analysis project was, in part, transferred to "Program Element 621.12A, Terrestrial Investigations Analysis," to place it in the proper exploratory development category. The other portion of the project was moved forward in the development cycle to "Program Element 6.37.12A, Mapping and Geodesy (Advanced Development)," as military geographic systems.

Mr. MAHON. How long has the Army performed research and development in the area of mapping and geodesy?

Colonel TOBEY. The Army has performed research and development in the area of mapping and geodesy for approximately 40 years. The first known Army R. & D. effort was performed by an Engineer Reproduction Plan Detachment at Wright-Patterson Air Force Base. The effort was to use aerial photography for mapping. In 1941, the Engineer Board was established and a cartographer was included as a member of the board to advise on R. & D. for mapping. In 1947, the Engineer Research and Development Laboratories was established and a Division of Surveying and Mapping which later became a department was included. This department provided the nucleus for the establishment of the Geodesy, Intelligence, Mapping, Research and Development Agency—GIMRADA—in 1960. In 1967, GIMRADA was renamed the U.S. Army Engineer Topographic Laboratories—USAETL.

PROGRAM ACCOMPLISHMENTS

Mr. MAHON. What were some accomplishments in this area in fiscal year 1969?

Colonel TOBEY. Major accomplishments in the mapping and geodesy area in fiscal year 1969 include:

Development of a prototype automated point transfer instrument. This instrument measures exact coordinates of points from an aerial photograph.

Completion of the joint Army/Air Force test on the rapid combat mapping system. The system is designed to provide the Field Army with a capability for the rapid production of 1:50,000 scale contoured orthophotomaps, mosaics, and revised maps from optical and radar

aerial photography. Results of the tests are currently being analyzed and the final report is now being prepared.

Completion of the first phase of an all-weather mapping system. Using equipment and techniques developed in this phase, two 1:250,000 scale maps of the Darien Province of Panama were produced. This effort is unique in that all previous attempts to photograph this area have failed due to perennial cloud cover. This system, when completed in 1975, will provide an all-weather—radar—topographic mapping capability for 1:50,000 scale maps.

Development of equipments such as a device for automatically digitizing elevation from maps and a prototype device for automatically identifying selected man-made features from aerial photography for incorporation into the pilot semiautomatic cartographic system. This system will provide automation of many manual drafting and interpretation techniques currently required for mapping.

Tests were conducted to determine the feasibility and practicality of mapping from SR–71 optical and radar materials. Initial results indicate the system, with minor modifications, is well suited for mapping and further tests are being conducted in coordination with the Air Force.

Development of prototype small north orienting device that is now being tested. This 3-pound instrument will provide true north to an accuracy of 3 mils. It will replace most of the magnetic compasses now in the Army inventory.

Completion of a feasibility-model laser velocimeter will now allow work to proceed on a highly-mobile, all-inertial position and azimuth determining system (PADS). The PADS will enable field units to determine their geodetic position and to measure azimuth without interference from natural forces (weather, magnetic fields) or from enemy jamming. It is designed as a completely passive, self-contained, nondetectable geodetic positioning system for use by field army units.

TOTAL DOD EFFORT IN MAPPING, CHARTING, AND GEODESY

Mr. MAHON. What is the total Department of Defense effort proposed in fiscal year 1970 in the area of mapping, charting, and geodesy?

Colonel TOBEY. The total Department of Defense R.D.T. & E. effort proposed for mapping, charting, and geodesy for fiscal year 1970 is ——— million.

LUNAR BASE RESEARCH

Mr. MAHON. Describe the program element entitled "Lunar base research" for which you are requesting ———? How long has the Army been spending money in this area, how much has been spent, and what accomplishments have been achieved?

Colonel TOBEY. The title of this project, "Lunar base research" is misleading. A more appropriate title would be "Extraterrestrial Research" in that they are engaged in all aspects of extraterrestrial research. It is an in-house research and development activity that was established by the Chief of Engineers to support NASA. The charter for the agency was coordinated with and endorsed by NASA. Their past activity has been directed at supporting NASA in their efforts to land a man on the moon; however, recently their efforts have been

directed toward planning in support of the President's post-Apollo space plan. ———. In addition, they maintain cognizance of extraterrestrial programs which may be of concern to the Army research and development community. The program was initiated in fiscal year 1965. Research and development expenditures for fiscal years 1965–69, inclusive, total $712,000.

Accomplishments of this project include:

Assisted NASA in extraterrestrial program development. All direct expenditures reimbursed by NASA.

Provide technical data in connection with current national planning of U.S. space programs for the post-Apollo period.

Provided a clearinghouse for extraterrestrial engineering spin-off applicable to terrestrial military problem solving.

Provided technical data in connection with the ———.

Identified the areas of potential contributions of extraterrestrial systems technology to military functions.

Combat Support

Mr. Mahon. Under the program element "Combat support" you are requesting ——— million as compared with $8.5 million in fiscal year 1969. The fiscal year 1969 budget estimate for "Combat support" was $4.8 million. What programs which were not included in the fiscal year 1969 budget program were added and what were the sources of the funding for these programs?

General Betts. Three actions modified the fiscal year 1969 funding level. The first was an increase of $0.894 million that resulted from the statistical distribution of facilities and installation support funds to all program elements. A reprograming action debited the program element $0.225 million to support the silent aircraft program. A subsequent reprograming action put $3.07 million into this program element for the purpose of increasing the effort on guerrilla countermeasure techniques. This was the omnibus reprograming action 69–2 (DOD Number 69–28) which totaled $74.1 million.

PROGRAM ACCOMPLISHMENTS

Mr. Mahon. What achievements can you point to in this area in fiscal year 1969?

General Betts. In fiscal year 1969 we achieved the following: Conducted comparative evaluations of United Kingdom and German bridges. Conducted feasibility studies of protective devices for bridges. Conducted exploratory development of a variety of prefabricated building materials. Investigated the use of a reverse osmosis process for water purification. Conducted experiments on the use of hypervelocity water jets and explosive techniques for rapid excavation in earth. Established design criteria for variable body armor. Determined quality parameters for dehydrated, formulated, compressed, and synthetic foods.

Guerrilla Countermeasures Techniques

Mr. Mahon. The fiscal year 1969 budget indicated a program of $220,000 for "Guerrilla countermeasures techniques." The fiscal year

1970 budget indicates that $2.4 million was allocated to this program in fiscal year 1969 and you are requesting ——— million in fiscal year 1970. What items are included in this line item in fiscal year 1969 and in fiscal year 1970? How is this effort related to the work of the Defense Communications Planning Group?

General BETTS. In fiscal year 1969 the following tasks were included: An airborne metal radar (METRA), trace gas detection techniques, an airborne magnetic detector, studies into detection of command wires used with mines, cargo and checkpoi. ' search detectors, use of METRA or microwaves or infrared techniques for booby trap detection. In fiscal year 1970 work will continue on METRA techniques for personnel and munitions detection, trace gas techniques for personnel detection, booby trap detection, and cargo inspection methods. Techniques used in this project are in some ways similar to those used by DCPG in remotely emplaced sensors. Thus, there is a considerable exchange of information between the two programs.

FIRE PREVENTION

Mr. MAHON. What kind of effort is included in the line item "Fire prevention" for which you are requesting ———?

General BETTS. This effort is aimed at the development of a helicopter transportable air crash and rescue fire system.

BARRIER COUNTERBARRIER

Mr. MAHON. You are requesting ——— for a program entitled "Barrier counterbarrier." Describe this program to the committee.

General BETTS. The general objectives of the barrier-counterbarrier projects are to provide a fundamental technological capability to support the on-going mine warfare and countermine warfare hardware development programs; and to initiate and pursue research (fundamental and applied) and exploratory development programs over a broad scope of new and novel phenomena and enemy forms for application in new and controlled barrier and counterbarrier systems for the time period ———. A few examples of work in this project include research on ———.

FOOD PROCESS PRESERVATION TECHNIQUES

Mr. MAHON. You are requesting $1,535,000 for "Food process preservation techniques." Provide a list of the activities included in this heading for the record.

(The information follows:)

The following is a list of activities included in this project directed toward establishing, advancing knowledge of and gaining control over food processing, preservation and packaging techniques to meet new combat feeding requirements and radically improve the effectiveness of the operational ration structure.

Establish quality parameters in dehydrated foods.
Establish quality parameters in formulated, compressed and synthetic foods.
Establish quality parameters for foods processed by combined methods.
Establish design parameters for ration miniturization.
Establish techniques of fabricating foods.
Development of radiation sterlized meat, poultry, and marine products.

Mr. MAHON. When we discussed military sciences, we discussed a program entitled "Radiation preservation of food" for which you are requesting $1,270,000. What is the relationship between that program and the "Food process preservation techniques" program we are discussing?

General BETTS. The "Radiation preservation of food" program is applied research to establish the technological feasibility of preserving foods of Army interest by means of ionizing radiation. This includes research and investigations applied to foods in such areas as physics, microbiology, chemistry, wholesomeness and radiation dosimetry. Knowledge gained in this applied research effort is applied toward the development of radiation sterilized foods for adoption as standard components of the military feeding system, which is part of this "Food processing and preservation techniques" exploratory development program.

FOOD PROCESSING WORK BY OTHER GOVERNMENT AGENCIES

Mr. MAHON. What use is made of research performed by other Government departments and agencies in the area of food processing? For instance, NASA has spent a lot of money in developing and packaging various kinds of processed food for utilization in spaceflight. Of what use is NASA's work in this area to the Army? What Department of Agriculture effort in this area has been useful to the Army?

General BETTS. There is close coordination between the Army and other Government agencies involved in food processing. Any knowledge from these agencies which has application to the requirements of DOD is incorporated into the Army program.

As to the NASA feeding program, I think the advantages actually accrued to NASA. Much of the technology from the Army program was directly usable in the space feeding program.

The following examples illustrate useful USDA contributions to the Army food program:

Vacuum dehydration of fruit juices.
Stabilization of fats and oils.
Cooking loss studies.
Studies on the stabilization of frozen foods.
Pasteurization of liquid whole eggs.
Tables of nutritional value of foods.

RELATIONSHIP TO FOOD TECHNOLOGY PROGRAM

Mr. MAHON. What is the relationship between the "food technology" program for which you are requesting $209,000 under "Military sciences" and the "food process preservation techniques" program?

General BETTS. The food technology project actually supports the more advanced food processing and preservation techniques project. The food technology project is concerned with food deterioration as it affects storage life. This project involves types of deterioration and the characteristics of each, identifying the causes of deterioration, and establishing techniques for processing to prevent deterioration. The food processing and preservation techniques project extends the

more elementary knowledge on prevention of deterioration to techniques which can be used in larged scale or commercial processing and preservation applications.

Army Materiel Command Engineer Handbook

Mr. Mahon. Describe the "Army Materiel Command Engineer Handbook" program for which you are requesting $260,000? The justification shows that $993,000 was allocated to this program in fiscal year 1968 and $313,000 in fiscal year 1969. What is the total amount which has been allocated to this purpose and what is the total requirement as now seen?

(The information follows:)

In 1950, it became evident considerable technical and scientific skill was being lost to the Army at an alarming rate, since much of it had been documented in informal records and notes which were lost to the Army laboratories upon retirement and/or departure of technical personnel. To prevent the increasing loss of this technical and scientific know-how, the idea was advanced and approved that current as well as new technology should be properly documented and brought up to date as required. Such a systematic technique would advance the state of the art as well as provide an essential springboard for future R. & D. The handbook program has been in continuous operation since its inception. To date, approximately 100 handbooks have been completed and approximately 35 are in various phases of preparation. The total amount allotted to the program is approximately $7,275 million. To assure a sound balanced program, a minimum of $600 thousand per year is required to review all the scientific disciplines and to keep the engineering handbooks up to date. The effort is a continuing one since scientific knowledge and technology are constantly on the move and new technological frontiers are being discovered.

Night Vision

Mr. Mahon. The fiscal year 1970 requests for "night vision" exploratory development is ——— million as compared with $3.1 million allocated to this effort in fiscal year 1969. The fiscal year 1969 budget request for "night vision" was $4.2 million. What part of the effort was deleted or delayed by the $1.1 million reduction in fiscal year 1969?

General Betts. This reduction delayed our work on the development of higher resolution second-generation image intensifier tubes, smaller and more efficient laser diodes, and improved infrared transducers.

Mr. Mahon. What would be the effect of continuing the program at the 1969 level?

General Betts. The amount of $3.1 million represents a sustaining level for this effort. In the years to come it will be desirable to increase the effort in this area as new technologies are uncovered.

Mr. Mahon. In your apportionment review for fiscal year 1970, what amount has been allocated to this effort?

General Betts. ——— million.

Limited War Laboratory

Mr. Mahon. You are requesting $6.8 million for activity under "Limited War Laboratory" in fiscal year 1970 as compared with $7.5 million in fiscal year 1969. What have been your major accomplish-

ments in this area through funds provided under this line item in fiscal year 1969?

(The information follows:)

The Limited War Laboratory response to requirements from Vietnam has made significant contributions in support of the Army. The Laboratory sent a total of 20 different items to Vietnam for test and/or evaluation. Some items that have completed a successful evaluation and have been requested for operational use are:

1. Adjustable ranging telescope,
2. Landing zone directors signal kit,
3. Retransmission device,
4. Tunnel explorer, locator, and communicator.

Some items currently being evaluated have every indication of being successful. Most notable is the scout dog platoon trained by new techniques to detect mines, booby traps, and tunnels.

Mr. MAHON. What is the estimated cost of salaries and expenses for the 128 civilian scientists and engineers assigned to this effort?

(The information follows:)

The current authorized civilian strength of Limited War Laboratory is 126. The breakout is: 60 professional scientists and engineers, 21 technicians, 11 wage board (machine shop) personnel, and 34 secretarial and administrative support personnel. The estimated salaries and expenses for the 60 professionals is $1,290,000. The estimated total laboratory payroll is $2,007,626.

MAJOR CONTRACTS

Mr. MAHON. Provide the committee with a listing of the major contracts currently in being under this line item, indicating the purpose of the contract, the contractor, and the total amount of the contract.

(The information follows:)

Firm	Purpose of contract	Total funding
Behavior Systems, Inc	Training mine-detecting dogs	$555,000
Delco Radio	Improved radio retransmission device	269,000
Resources Planning & Control Corp	Detection of personnel by biochemical luminescence	248,000
Syracuse University Research Corp	Foliage penetration radar (man-pack and fixed installation).	996,000
Westinghouse Electric	Improved position locator	382,000
Franklin GNO Corp	Explosives detection	131,000

RELATIONSHIP TO ARPA'S PROJECT AGILE

Mr. MAHON. The goal of the laboratory to develop knowledge and explore potential military needs peculiar to remote areas of the world other than Southeast Asia seems to duplicate the goal of Project Agile in the Advanced Research Projects Agency. How is the decision made as to whether the Army or ARPA will engage in this kind of activity in a specific area?

(The information follows:)

The mission of Limited War Laboratory is to react rapidly to meet the Army needs for research, development, test and evaluation requirements relating to limited war, particularly to war of low intensity in underdeveloped or remote areas of the world. ARPA operates on a project basis. These projects fall into three general categories:

1. Research not identified with a specific military requirement.
2. Research which relates to the primary functions of two or more of the military services.
3. Research which, for specific reasons, is better handled by an agency other than one of the military services.

FUNDING OF FISCAL YEAR 1970 TASKS

Mr. MAHON. To what extent is the fiscal year 1970 program under this heading firm and to what extent is it based on a need for the flexibility to fund presently unforeseen efforts the requirement for which may arise in fiscal year 1970?

(The information follows:)

The Limited War Laboratory program for fiscal year 1970 contains 119 separate tasks, 19 are new tasks to be started this fiscal year. After reserving funds for fixed costs, carryover tasks, and new tasks the laboratory reserve is $307,500 to meet unplanned requirements from Army operational areas.

Mr. MAHON. Submit for the committee a listing of the individual activities under this heading which are considered firm for the fiscal year 1970, indicate the contractor involved, and the sum related thereto.

(The information follows:)

The following lists some new tasks firm for fiscal year 1970

Tasks:	*Funds*
1. Patrol communications	$35,000
2. Ambush light	35,000
3. Reticle illumination adapter	28,000
4. Lightweight flotation gear for the individual soldier	30,000
5. Five-pound brakish water purifier	60,000
6. Small unit river crossing equipment	30,000
7. Improved ration heater	15,000
8. Explosive detection	240,000
9. Personnel detection program	360,000

No contractors have been selected for the new tasks. Some will be done in-house, others by other Government laboratories, others will be competitive bids for contracts.

ELECTRIC POWER SOURCES

Mr. MAHON. The fiscal year 1970 request for "Electric power sources" is ——— million as compared with $3.866 million in fiscal year 1969. The fiscal year 1969 budget indicated a requirement for $2.2 million for this activity. Was there a reclassification of this program or has there been a real increase? If there has been an increase, discuss the requirement for the increase?

General BETTS. There was an increase in fiscal year 1969. This was done to meet a requirement from Southeast Asia for generators which operate at lower noise levels, and to do some work on increasing the reliability of our present generators.

MOBILE ELECTRIC POWER PROJECT

Mr. MAHON. The fiscal year 1969 budget indicated no requirement for funds in that year for "Engineer powerplants" and showed an allocation of $993,000 in fiscal year 1968. The fiscal year 1970 budget shows that $2,158,000 was allocated to "Engineer powerplants" in fiscal years 1969 and $2.1 million was the actual amount allocated in fiscal year 1968. Please discuss this change.

General BETTS. These changes reflect the interest of Department of Defense and the Army in the electric power generator area. To this end a DOD project manager for mobile electric power was chartered. Specific development efforts relate to standardization of generator sets, and to the requirements for high reliability and silent power previously mentioned.

DEVELOPMENT OF FUEL CELLS

Mr. MAHON. Is the Army utilizing fuel cells in any operational combat systems today?

General BETTS. No.

Mr. MAHON. What sums are being spent on the development of fuel cells throughout the Defense Department?

General BETTS. The Army spent $2.711 million in all phases of fuel cell R. & D. in fiscal year 1969. In fiscal year 1970 we have requested ———.

AUTOMATIC DATA SYSTEMS

Mr. MAHON. The fiscal year 1970 request for automatic data systems for the Army in the field is ———. What was the fiscal year 1969 program, $3 million or $3.4 million?

Colonel LAMB. The fiscal year 1969 program was $3.5 million, $3 million was originally approved, $500,000 was reprogramed within authority for development of an intelligence functional area for application to the tactical operations system.

PROGRAM JUSTIFICATION

Mr. MAHON. The justification book, page 292, indicates that the objective of this program is to provide first-generation ADP systems for the Army within a 4- to 5-year period, which is what you have been saying since at least fiscal year 1967. This program goes back at least to fiscal year 1963 when it was known as "CCIS for Field Army." With all the ADP firms available, together with their hardware, why is it necessary to develop such ADP equipment?

Colonel LAMB. Army efforts in tactical automatic data processing (ADP) systems began in 1956 with the preparation of a large number of combat development studies. These studies indicated that significant improvement could be realized by the application of ADP techniques to the combat tasks falling in the general functional areas of the four principal staff sections. From these studies, requirements evolved for five ADP systems within the command control information system—1970 (CCIS–70) framework. These systems were fire support, logistics, personnel and administration, operations, and intelligence.

In February 1965 the Chief of Staff directed revitalization of the command control information system, 1970 program which despite 7 years of effort had not resulted in fieldable systems. The DA prepared, and in May 1965 the Vice Chief of Staff approved, the automatic data systems within the Army in the field (ADSAF) study which reoriented the old CCIS–70 effort, defined three related but semi-independent tactical automatic data systems, and established schedules and resource allocations for their fielding. The three systems are tactical fire direction system (Tacfire), a system to increase the effectiveness of artillery fire through improved response time, better and more rapid use of target information, and greater efficiency in the use of fire support

resources; tactical operations system (TOS), an information system focused on G–2 and G–3 items which will provide commanders and their staffs, at the division, corps, and Army echelons, with timely and accurate information on which to base operational decisions; and the combat service support system (CS–3) which is designed to increase the responsiveness of combat service support (logistics, personnel and administration, financial, and civil affairs) within the Army in the field.

The reference to "first-generation ADP systems" should have more appropriately read "first-generation militarized ADP systems." Militarized ADP systems are required to meet the operational and environmental constraint of the tactical battlefield. Army experience in SEA has confirmed earlier studies that off-the-shelf commercial ADP equipment will not meet the long-range needs for automation in the Army in the field.

Militarized ADP hardware is presently being developed for the tactical fire direction system (Tacfire) of the ADSAF program. It is expected that the general-purpose nature of the major components of the Tacfire system can be adopted or adapted for use in the tactical operations system (TOS).

Available ADP equipment, both commercial and militarized, was considered during the Tacfire procurement. The requirements of the qualitative military requirement (QMR) for the Tacfire system could not be met by available ADP hardware, and therefore development of militarized ADPS was initiated. Operational and environmental constraints for the TOS are similar to those of Tacfire.

Due to the length of time required for the development of militarized ADPE and the urgent requirement to provide ADP support for combat service support functions, the combat service support system (CS–3) of the ADSAF program is currently undergoing field testing using ruggedized off-the-shelf, third-generation, commercial ADP equipment. The primary objective of the CS–3 test is to achieve, quickly, important improvements in support of deployed Army units rather than to test ADP hardware. It is expected that as a fallout of this test, a determination could be made as to the adequacy and acceptability of the use of ruggedized commercial ADP equipment in certain combat service support operation and physical environments, particularly at the theater level. DA currently envisions the need for militarized ADP equipment for ADP support of tactical combat service support functions. Tacfire militarized ADPE, when available, will be evaluated as to its adequacy to support, at least partially, CS–3 ADPE requirements.

PROGRAM ACCOMPLISHMENTS

Mr. MAHON. What have you accomplished with the $55.8 million funded for this program element through fiscal year 1969?

Colonel LAMB. The $55.8 million has been used for systems engineering, development of software, standards and integration, procurement and testing of tactical ADP development. Functional areas and systems receiving support included the following: The tactical operations system (TOS); tactical fire direction system (Tacfire); the combat service support system (CSSS); and logistics areas; intelligence

functional areas; command, control, standards, and integration. Work was carried on within two general time frames: prior to fiscal year 1966 and fiscal year 1966 to the present. Efforts prior to fiscal year 1966 were accomplished primarily at Fort Huachuca, Ariz., in support of the command control information system—1970 (CCIS-70). Feasibility studies, documentation, and software were developed in personnel, operations, logistics, and fire support areas; experience and lessons learned provided the basis for subsequent developments within the Tacfire, TOS, and CSSS areas. The intelligence effort provided some input to the TOS Europe concept and allied intelligence applications. Programing, documentation, and testing of developmental efforts validated Tacfire and CSSS concepts and contributed significantly to their development. In addition, this funding supported the TOS Europe project which demonstrated TOS concept feasibility in 1968 and successfully tested its functional system design in June 1969. A final report on this project will be submitted to the Department of the Army by December 31, 1969. Funds were expended through fiscal year 1969 as follows: TOS Europe, $15.6 million; CSSS and logistics areas, $7 million; Tacfire and fire support, $12.6 million; intelligence functional areas, $9.8 million; command, control, standards, and integration, $10.9 million.

Mr. MAHON. What is the specific requirement for this ADP program and how close are you to the stated objectives?

Colonel LAMB. The purpose of the USAREUR tactical operations system (TOS) was to develop a provisional tactical operations system to accomplish the following:

Identify areas through field development where ADP can assist commanders in the conduct of tactical operations.

Obtain military and scientific data to assist in prescribing an Army worldwide TOS.

Identify system characteristics for development of the best possible functional system design and qualitative materiel requirements for the Armywide TOS.

Gather data on maintenance and training requirements.

Provide USAREUR/7th Army an interim operational TOS during and following development.

A report on the USAREUR tactical operations system (TOS) addressing each of the above areas in detail will be furnished to this headquarters in January 1970. As of this date 18 functional areas have been identified through which ADP is expected to assist significantly in the conduct of field army tactical operations. Interim reports reflect enthusiastic endorsement of present system development. This contains five functional applications with six additional desired on a high-priority basis for support of division, corps, and field army levels. As a result of a recent functional system design evaluation test, the commander in chief, U.S. Army Europe recommended continuation of the TOS project as essential and its rapid development into an interim operations system. The earliest date by which this can be achieved would be 1972; however, it has been indicated that TOS in its present state of development provides significant improvements over the comparable manual functions.

Mr. MAHON. How were the fiscal year 1969 funds used and for what purpose will the fiscal year 1970 funds be utilized?

Colonel LAMB. The fiscal year 1969 funds were used to fund two ongoing contracts—Control Data Corp. for hardware rental and maintenance and Bunker-Ramo Corp. for development of computer programs—and to fund in-house costs which included systems development efforts and technical support of TOS-USAREUR to include testing. The fiscal year 1970 funds will be used to modify the system in Europe to optimize hardware and software configuration based on test results.

NIGHT VISION

Mr. MAHON. For advanced development work in the field of night vision you are requesting ——— million as compared with $14.4 million in fiscal year 1969. The fiscal year 1969 budget requested $13.9 million in this area. What was the reason for the increase in fiscal year 1969?

General BETTS. This increase was required to fund the procurement of spare parts and support equipment for four of the 11 items being developed for the Southeast Asia night operations programs.

Mr. MAHON. Generally speaking, the Army, Navy, and Air Force all have operational night vision systems now. In what way are you seeking to improve these systems? Are you essentially trying to make them smaller and lighter, or are you basically trying to obtain greater night vision capability with the new equipment?

General BETTS. We are in fact doing both. Second generation image intensification devices will be smaller and lighter, while our far infrared and pulse-gated systems will increase our present capability to see at night.

Mr. MAHON. What programs which were in the exploratory development effort in night vision have progressed sufficiently to be placed in the advanced development program in fiscal year 1970?

General BETTS. I would include the following components of night vision systems in the fiscal year 1970 advanced development program: new cryogenic coolers, special purpose second-generation image intensifiers, diode light sources, and pulse-gating circuitry.

ATTENTION TO REDUCING UNIT COSTS

Mr. MAHON. How much attention are you giving to possible cost reductions in night visition equipment? Some of the early equipment has very high-unit cost. Do you foresee some improvement in this area?

General BETTS. We are devoting a great deal of effort to reduce costs and are showing progress. First generation image intensifier tubes originally cost $2,000 a piece. This has dropped to just over $1,000 today. We have good estimates that our second generation tubes will cost $500 within several years.

Mr. MAHON. Submit for the committee a list of the major activities or pieces of equipment which you are trying to develop in this area, the estimated fiscal year 1970 funding of each and the estimated total development cost of each item.

(The information follows:)

Included are a helicopter mounted night surveillance system funded for ——— million in fiscal year 1970 and ——— million overall, a helicopter mounted 30-kilowatt searchlight funded for ——— million in fiscal year 1970 and ——— million overall, a stabilized night sight funded for ——— million in fiscal year

1970 and ——— million overall, a ——— driver's periscope funded for ——— million in fiscal year 1970 and ——— million overall, and a handheld thermal viewer funded for ——— million in fiscal year 1970 and ——— million overall.

Chemical-Biological Defense

Mr. Mahon. You are requesting $4.9 million for advanced development in the area of "Chemical-biological defense" as compared with $4.5 million in fiscal year 1969 and $2.2 million in fiscal year 1968. What part of this money will be spent in-house and what part under contract?

General Betts. The in-house effort is programed for $1.9 million and the contract effort for $3 million.

REASON FOR INCREASED FUNDING

Mr. Mahon. Why is this activity now being carried at the dollar level of $4.5 million after being at approximately $2 million level for several years?

General Betts. This is because in fiscal year 1968 and prior a number of items in the chemical and biological defense programs were carried in exploratory development for an extended period and then jumped to engineering development. To facilitate management, most of the items are now following the normal progression of exploratory to advanced to engineering development. We currently have the following items scheduled in advanced development for fiscal year 1970: The Chemiluminescent and Partichrom biological agent automatic detectors and alarms, the new protective mask, new decontamination materials and equipment, a combat vehicle chemical alarm and collective protection modules for vehicles, missile vans and protective shelters.

CHEMICAL AGENT CONTAMINATION SURVEY SYSTEM

Mr. Mahon. Describe the chemical agent contamination survey system which is to begin advanced development in fiscal year 1970?

General Betts. The sentence on page 300 of the Descriptive Summaries of the fiscal year 1970 R.D.T. & E. is in error. This contamination survey system is scheduled to begin advanced development in fiscal year ———. It will probably include ground vehicle and aerial chemical detection means with rapid reporting and plotting techniques to conduct large tactical area surveys.

PARTICHROME BIOLOGICAL ALARM

Mr. Mahon. What are the Army's plans to procure and deploy the "Partichrome" biological alarm?

General Betts. There are no firm plans to procure and deploy the Partichrome biological alarm for it will probably be a year or so before a decision will be made on whether to advance the Partichrome or its competitor, the Chemiluminescence biological alarm to engineering development. The Chemiluminescent device has just entered advanced development and shows significant promise. The scheduled type classification date for an automatic biological alarm is the fourth quarter of fiscal year ———.

CHEMILUMINESCENCE BIOLOGICAL ALARM

Mr. MAHON. What items from the exploratory development program entitled "Chemical-biological defense" have moved into advanced development in fiscal year 1970?

General BETTS. The Chemiluminescence biological alarm, an advanced respiration protection system (mask) and an advanced chemical agent decontamination system have progressed up from exploratory development.

Mr. MAHON. The "Descriptive summary" states that "the chemiluminescent biological detection effort will continue, to include prototype hardware development and testing." Is prototype hardware development and testing appropriately funded under advanced development?

General BETTS. Yes sir; this effort is appropriately funded under advanced development. The experimental breadboard model work was completed in exploratory development. We are currently in the process of evaluating competitive proposals for the contract for prototype hardware development and our testing capability has been established.

IDENTIFICATION, FRIEND OR FOE (IFF) DEVELOPMENTS

Mr. MAHON. You are requesting ——— in fiscal year 1970 for "Identification, friend or foe (IFF) developments." The justification book indicates this year's program will continue support of tests of the lightweight interrogator/transponder system. Is this a battlefield IFF?

BATTLEFIELD IFF

Colonel LAMB. That part of the program that provides military potential tests of a lightweight interrogator/transponder is for battlefield IFF. The synchronous identification antenna is applicable to both battlefield and other IFF systems.

USE OF MARINE CORPS BATTLEFIELD IFF

Mr. MAHON. In fiscal year 1970, the Marine Corps is requesting funds for the procurement of battlefield IFF equipment. Has the Army tested the Marine equipment and found it will not meet Army requirements?

Colonel LAMB. No the Army has not tested the Marine Corps battlefield IFF equipment. The Marine battlefield IFF equipment is designed to work with a Marine-only ground surveillance radar.

Mr. MAHON. Why will the Marine equipment not meet Army requirements? How are Army and Marine Corps battlefield IFF requirements different?

Colonel LAMB. The Marine Corps battlefield IFF equipment is designed to work with a Marine-only type of ground surveillance radar. In addition to being too heavy for Army battlefield IFF requirements, the Marine IFF equipment is not compatible with the new Army lightweight ground surveillance radars. However, the requirement for a means of battlefield identification, friend or foe is similar in both the Army and the Marines.

Mr. MAHON. Well, why is the Army and Marine Corps going their separate ways in developing a battlefield IFF?

Colonel LAMB. The Army and Marine Corps have not gone in separate ways in developing battlefield IFF (BIFF). The present Army effort is in exploratory development in new BIFF techniques and very lightweight, tri-service-compatible equipment. The Marine Corps has monitored these Army exploratory programs and the most recent equipments have been demonstrated to the Marines.

TOTAL ARMY BATTLEFIELD IFF FUNDING

Mr. MAHON. How much has the Army funded toward the development of a battlefield IFF through fiscal year 1969?

Colonel LAMB. $1 million.

Mr. MAHON. How much will be required to complete this development? Are any funds in the fiscal year 1970 budget for this purpose?

Colonel LAMB. The battlefield IFF efforts have been limited to exploratory development. Until techniques and/or equipments are selected for advanced or engineering development, no estimate can be given. The ——— in program element 6.27.02.A for fiscal year 1970 are exploratory development funds used primarily for battlefield IFF.

COMMUNICATIONS DEVELOPMENT

Mr. MAHON. The fiscal year 1970 program for "Communications development" is ——— million. You requested $5.5 million in fiscal year 1969, yet the justification book shows the fiscal year 1969 program to be only $3.1 million. What was the actual fiscal year 1969 program?

Colonel LAMB. The actual fiscal year 1969 program was $4.990 million.

Mr. MAHON. How and why was this program reduced?

Colonel LAMB. Congressional action reduced the $5.5 million requested to $5.07 million; $2,070 million was reprogramed out of this project as a result of the decision to postpone phase III of RADA. This was reported on fiscal year 1969–2 (Omnibus) (DOD fiscal year 1969–28) approved by OSD November 28, 1968. Army approved reprograming action after the submission of the fiscal year 1970 budget added $1.99 million to this program.

Mr. MAHON. Of the total requested for fiscal year 1970, $3.6 million is for strategic and tactical communications development. How will these funds be utilized and how does this work differ from that under "Military astronautics and related equipment"?

Colonel LAMB. In the strategic communication development area the funds will be used for advanced development of equipment peculiar to strategic communications. Example of efforts to be initiated include a 4,800 bit per second data modem, speech compression equipment, caller identification equipment, and space diversity techniques. In the tactical communications the funds will be used for advanced development in areas common to theater, Army area, corps, and divisional communications and includes transmission, switching and subscriber equipment. Under "Military astronautics and related equipment," the primary effort is in the development of ground terminals for the Defense Satellite Communications System. Presently this consists of development of two types of terminals—the heavy and the medium ter-

minals. Also under this program is the Army support for the Defense Communications System. This year work will start on furnishing some of the communications components of a lightweight transportable contingency station, and continued work on development of a pulse code modulation multiplex set.

Random Access Discrete Address (RADA) Communications System

Mr. Mahon. You are requesting ——— in fiscal year 1970 for the "Random access discrete address (RADA) communications system," and the fiscal year 1969 program is shown as $1.9 million, for a total of $2.1 million. OSD press release No. 282–69, dated April 16, 1969, indicates that Martin Marietta was awarded a cost-plus-fixed-fee letter contract amounting to $2.4 million. Total estimated cost of the contract is $5.4 million. Where will you get the funds to cover the letter contract and, later on, to cover the definitized contract? When will the contract be definitized?

Colonel Lamb. The funds to cover the letter contract were obtained by an Army reprograming action for $1.69 million and utilizing money already available to the project manager. The additional funds to cover the contract will be reported on a fiscal year 1970 reprograming action. This decision was made following the submission to Congress of the fiscal year 1970 budget. The contract will be definitized in September 1969.

Mr. Mahon. How much of the fiscal year 1969 and 1970 funds have or will be used for in-house effort on RADA?

Colonel Lamb. In-house funds expended in the RADA project were $218,000 in fiscal year 1969 and estimated to be $875,000 in fiscal year 1970. The fiscal year 1970 funds include effort on the military potential test.

RADA funding obtained through reprograming

Mr. Mahon. How can you award a letter contract in fiscal year 1969 amounting to $2.1 million when you have insufficient funds to cover the letter contract?

Colonel Lamb. Sufficient funds were available to cover the letter contract when it was signed as a result of Army reprograming action for $1.69 million and money already available to the project.

Mr. Mahon. Will you identify the fiscal year 1969 reprograming action, amounting to $1.7 million, the date it was approved by the Army, the date it was approved by OSD, and when it was approved by Congress?

Colonel Lamb. The reprograming action for this money was within the Army reprograming authority and as such did not require the approval of OSD or the Congress. It was approved by the Army on February 10, 1969.

Mr. Mahon. From what program was the $1.7 million obtained?

Colonel Lamb. The $1.7 million was obtained by reprograming small amounts from 13 projects in the 6.1 program.

Mr. Mahon. According to data provided the committee, a total of $21.6 million has been spent on RADA through fiscal year 1969. With

the proposed reprograming, this will increase to $23.3 million through fiscal year 1969. What has the Army obtained for this substantial sum?

Colonel LAMB. The Random Access Discrete Address system development is one of the first attempts of the Army to develop a fully automatic communications system for the tactical units. As a result of this latest contract, the Army will have sufficient advanced development models of this equipment to conduct a military potential test of the RADA concept. The Army will be able from this test to determine the extent of automation necessary and desirable in the forward units. In the technical field such questions as computer logic necessary for a fully automatic system, multipath propagation problems at higher frequencies, and mobile operations problems, will be answered. Technical data already derived from this project has been made available to other Army programs such as Mallard. In terms of equipments, 30 subscriber units and two retransmission units along with the necessary auxiliary equipments and spare parts will have been procured for the test.

TOTAL COST OF DEVELOPING RADA

Mr. MAHON. What is the estimated total cost of developing RADA? The committee has been advised it will total $48.1 million through fiscal year 1974. The fiscal year 1968 justification book, page 289, said $30.7 million; the fiscal year 1969 book, page 278, said $42.2 million; and the current book doesn't say.

Colonel LAMB. The estimated total development cost of RADA is ——— million.

Mr. MAHON. What are the reasons for the RADA cost increases?

Colonel LAMB. The ——— million increase in the estimated development cost of RADA is a refinement of previous estimates and represents a cost increase of only ——— of the estimated cost in fiscal year 1969 submission.

QUESTIONABLE FUTURE USEFULNESS OF RADA

Mr. MAHON. An official of D.D.R. & E. advised our investigative staff that there are considerable differences of opinion regarding the future usefulness of RADA, and that RADA may not be further funded, although no definite decisions have been made concerning further research effort. In view of this, why did the Army award a contract to Martin Marietta in April 1969 for RADA development?

Colonel LAMB. The Army believes that the future of RADA can be determined only after a complete military potential test has been conducted. In order to conduct a meaningful test the contract was awarded for the minimum number of equipment necessary to accomplish this objective.

Mr. MAHON. Tests were scheduled in April 1969 at two military bases for demonstrating laboratory models of RADA. Were these tests completed and evaluated before awarding the contract to Martin Marietta in April 1969?

Colonel LAMB. Demonstrations were conducted utilizing laboratory models of RADA prior to the contract being awarded. These demonstrations were however conducted at the Martin Marietta plant. The test demonstrated the feasibility of the RADA system.

RADA MAY NOT BE FULLY INTEGRATED INTO MALLARD

Mr. MAHON. According to our staff report, none of the three Project Mallard system contractors recommended that the RADA concept, in its entirety, be integrated into the Mallard system, and one contractor felt RADA would have limited application in Mallard and that RADA was not practical because of its complexity. Why then is RADA being continued if it cannot be fully integrated into Mallard?

Colonel LAMB. At the present time we are investigating the modifications necessary to RADA in order that it can be fully integrated into Mallard. At the time the contract was let for equipments to conduct the military potential test, the results of the Mallard system selection board were not known. No changes were made to the existing RADA equipments for this reason. The RADA system is being continued for possible use as an independent task force communications system not requiring the extensive trunking system proposed in Mallard. Consideration will also be given to the use of RADA as an addition to the present system. The Army communications system is being modernized with the fielding of AACOMS equipment through the 1974 time frame pending the implementation of Mallard. The addition of a limited RADA system capability in this time frame as an element of AACOMS would provide further improvement of the user's capability.

Mr. MAHON. According to current plans, when will RADA be deployed to the field? How about Mallard?

Colonel LAMB. The final configuration of RADA will not be known until after the military potential test. Only at that time can a deployment schedule for RADA be developed. Mallard is scheduled to begin production in ———. Final deployment plans are not complete at this time.

RADA PROCUREMENT COSTS UNKNOWN

Mr. MAHON. How many RADA systems will be required and what is the proposed cost of this procurement?

Colonel LAMB. The answer to that question cannot be determined until the results of the military potential test are known.

Mr. MAHON. If this is unknown at this time, how do you justify spending millions in developing RADA if it may be too expensive to buy?

Colonel LAMB. The exact configuration of the final RADA system is not known at this time. Only through a complete evaluation of the proposed system will we be able to determine if such a system is cost effective. The technical information which will be made available from the test will provide very valuable guidance for future developments of any automated system such as Mallard.

TACTICAL AUTOMATIC DIGITAL SWITCHING SYSTEM (TADSS)

Mr. MAHON. What is the justification for the development, lease, and procurement of a tactical automatic digital switching system (TADSS) for the 7th Army, particularly since Autodin is being deployed throughout Europe? In other words, why must the 7th Army have a tactical switch in addition to what is available and will be available through the DCS and Project Mallard?

Colonel LAMB. The tactical automatic digital switching system (TADSS) is intended to replace and upgrade present non-DCS manual relays (7th Army transceiver network) at three locations in Germany. In addition, during field operations it will provide automatic switching for the 7th Army teletype network. TADSS will provide mobile and air transportable communication service for 7th Army, whereas the three Autodin switches in Europe are sophisticated fixed installations of the DCS which have replaced DCS manual facilities. One of these Autodin switches currently provides communications in USAREUR down to the corps and division headquarters in garrison. However, in tactical operations when these headquarters move, they will no longer be able to communicate directly through the Autodin switch. The TADSS will provide a continual automatic switching capability for the corps and divisions by automatically interfacing with the Autodin switch no matter where the switch or the supported units are located. If Autodin were destroyed, TADSS could restore communications from the combat zone into any intact DCS Autodin center. This TADSS service will be secure, accurate, and speedier than that which is currently available in the non-DCS tactical system. It will have the capabilities of automatic storing, switching and forwarding traffic from numerous division and corps units without requiring changes to existing terminals or new equipments. It meets the requirement of DOD directive 4630.5, "Compatibility and Commonality of Equipment for Tactical Command and Control, and Communications," in that it provides a means to interface with Autodin terminals of all services as well as to handle field teletypewriters and digital data transmission devices. Also TADSS can provide experience factors for input into Project Mallard whose equipment will eventually displace the TADSS in the ——— time frame.

TOTAL TADSS FUNDING

Mr. MAHON. What is the total cost of TADSS, including Government-furnished equipment, for each fiscal year, including proposed fiscal year 1970 costs? Also, how is this system being financed?

(The information follows:)

For 2 TADSS of a possible 5:

Fiscal year 1968	$1,237,700
Fiscal year 1969	747,000
Fiscal year 1970	*1,676,200

*Of this amount $175,000 is for internal management and $1,501,200 is for the lease in 2 months of fiscal year 1970 and 10 months in fiscal year 1971.

If decision is made by the 7th Army to obtain and lease three additional TADSS, the total cost in fiscal year 1970 will be increased to $2,236,000 to include additional consultant services, internal management, and Government-furnished equipment. The procurement and lease of the system (TADSS) is being funded through USAREUR O. & M.A.-2020 funds. The Government does have an option in its contract to buy the TADSS.

Mr. MAHON. What are the proposed costs for fiscal year 1971 and beyond?

Colonel LAMB. Fiscal year 1971 and subsequent years for two TADSS: $1,501,200/fiscal year for the lease of two TADSS for 2 months of fiscal year 1971 and 10 months of fiscal year 1972. For five TADSS: fiscal year 1971 and subsequent years: $3,753,080/fiscal year.

Mr. MAHON. Do the costs for each fiscal year include annual lease costs, which amount to $750,616 per switch?

Colonel LAMB. The costs for fiscal year 1968 and fiscal year 1969 do not include any cost for leasing. For fiscal year 1970, following the acceptance of the delivery of the first two switches—scheduled for April 1970—and subsequent years, the annual leased cost will amount to $750,616 per switch.

TADSS TO BE REPLACED BY PROJECT MALLARD

Mr. MAHON. Our staff investigators were advised that, since 1955, the military services have spent approximately $55 million in research and development funds toward the development of an automatic switch for tactical communications without producing a satisfactory switch. Will TADSS fall into this category?

(The information follows:)

The Department of the Army has spent about $27 million since 1955 in R. & D. funds on an analog telephone switch and $6 million in PEMA funds for the Seventh Army Tactical Switching Systems,[1] TADSS is not an R. & R. effort but it is the initial effort to provide the Field Army with a store and forward digital message switch capability which will be less sophisticated than that of AUTODIN. This is proposed to be accomplished by leasing off-the-shelf commercial equipment which has been successfully used by U.S. industry in similar concept to that of TADSS. The principal difference will be in the van mounting of the off-the-shelf commercial equipment for tactical operations.

Mr. MAHON. Will the TADSS become an integral part of Project Mallard, or will the TADSS interface with Project Mallard in some manner? If the latter, what will be required to make TADSS interface with Mallard?

Colonel LAMB. TADSS will not become an integral part of Project Mallard, but will be replaced by Project Mallard equipment.

SOVIETS COMMUNICATIONS EQUIPMENT

Mr. MAHON. Do we have any information the Soviets use the digital form of communications for tactical purposes in their army structure?

Colonel LAMB. We have no information that the Soviets use the digital form of communications for tactical purposes in their army structure.

GROUND SURVEILLANCE AND TARGET ACQUISITION

Mr. MAHON. You are requesting —— million in fiscal year 1970 for Ground Surveillance and Target Acquisition. You requested $3.5 million in fiscal year 1969, but this program element was increased by reprograming during fiscal year 1969. What was the actual program for the last fiscal year?

Colonel LAMB. The actual program for the last fiscal year was $10.953 million. I will have to provide the allocation of the funds with the appropriate actions for the record.

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[1] Consisting of four 300-termination and two 600-termination automatic switches with ancillary equipments (telephones, converters, etc.) required for systems operation.

(The information follows:)

	Millions
Presidential budget	$3.5
Congressional action	−0.5
Reprograming action fiscal year 1969–2 (omnidirectional countermortar radar AN/TPQ–28)	+2.5
Subthreshold reprograming action (integrated observation device, Ensure)	+1.103
Emergency funds action fiscal year 1969–12	+3.6
(Ground surveillance radar	0.5
Integrated observation device	1.4
Modifications to search radars)	1.7

Mr. MAHON. How did the funding for this program increase from $17.7 million through fiscal year 1968 to $25.4 million through fiscal year 1968?

Colonel LAMB. The increase was during 1968 by the reprograming of $3.1 million, supplemental funds of $2.4 million, and emergency funds of $2.2 million to this program for the development of the AN/TPW–28, Patrol Locator and Acoustic Ranging System.

AN/TPQ–28 COUNTERMORTAR RADAR

Mr. MAHON. What is the status of your tests of the AN/TPQ–28 omnidirectional countermortar radar?

Colonel LAMB. At the present time, technical measurements and signature data of tracked targets are being taken to determine the corrections necessary to improve the false-alarm rate and adverse-weather operation found during recent tests. The corrective measures will be tested and checked out before further development is initiated.

Mr. MAHON. In reprograming action fiscal years 1969–88 funds were requested to modify six AN/TPN–18 ground control approach radars and two AN/MPQ–35 Hawk acquisition radars for use as countermortar radars in Southeast Asia. What effect will these modifications, if successful, have on the need to buy the AN/TPQ–28 radars?

Colonel LAMB. The requirement for the AN/TPQ–28 has been recently reevaluated, and the modifications to these radars will not effect this requirement. The modified radars will provide a capability for detection and general location of enemy weapons to many airfields not programed to receive an AN/TPQ–28.

PROGRAM ACCOMPLISHMENTS AND OBJECTIVES

Mr. MAHON. What did you accomplish in fiscal year 1969 and what are your planned objectives for fiscal year 1970?

Colonel LAMB. The accomplishments in fiscal year 1969 include the development of a visual target acquisition system, the integrated observation device, for the Army and Marine Corps; the development of sound ranging systems to a testable configuration and initiation of military potential and engineering tests of the equipment; completion and preliminary testing of two fieldable AN/TPQ–28 systems; completion of engineering test of the patrol locator in Panama; and initiation of a military potential test of a moving-target location

system to replace the AN/TPS-25. The planned objectives for fiscal year 1970 include: Completion of engineering test and evaluation of the AN/TPQ-28; procurement of engineering test and service test models of moving target detection radar to replace the AN/TPS-25; completion of development and testing of the integrated observation device; and initiation of development of sensors for stay-behind forces.

AIRBORNE SURVEILLANCE AND TARGET ACQUISITION

Mr. MAHON. The request for "Airborne surveillance and target acquisition" in fiscal year 1970 is ——— million. You requested $2.9 million is fiscal year 1969, but the justification book shows it to be $3.4 million. What was the actual fiscal year 1969 program, and how and why was it increased?

Colonel LAMB. The current fiscal year 1969 program for this element is $6.4 million. Funding was increased by transfer from the budgeting reserve and through reprograming funds for FLIR systems as reported in Reprograming Action FY 69-9 (DOD No. 69-81) dated February 17, 1969.

Mr. MAHON. How did funding for this program decrease from $33 million through fiscal year 1968 to only $31.9 million through 1968, as indicated from a comparison of last year's justification book with this year's?

Colonel LAMB. The Army was assigned a recoupment objective of $48.3 million in fiscal year 1968. Action to recoup the $48.3 million was only partially successful. As a result it was necessary to accomplish program reductions of $28.1 million. The airborne surveillance and target acquisition element was one of those reduced.

FORWARD LOOKING INFRARED (FLIR)

Mr. MAHON. How much of the fiscal year 1970 request is for the forward looking infrared (FLIR)?

Colonel LAMB. ——— million.

Mr. MAHON. Why are you funding FLIR in this program element and also in program element "Aircraft weaponization" under "Aircraft and related equipment"?

Colonel LAMB. The FLIR under this program is advanced development of a night vision capability and fiscal year 1970 funds will be used for continuation of the program. The FLIR in "Aircraft weaponization" use the technology of this program but must incorporate the fire control in conjunction with target location.

PROGRAM ACCOMPLISHMENTS AND OBJECTIVES

Mr. MAHON. What did you accomplish during fiscal year 1969 and for what purpose will the fiscal year 1970 funds be used?

Colonel LAMB. The fiscal year 1969 work was continued development on airborne laser equipment for real time surveillance with equipment installation completed and ready for flight tests. Development was continued on the AN/UPD-3 high-resolution radar in conjunction with Air Force. Installed and flight tested two models of forward looking infrared system (FLIR). Four FLIR systems were procured for the

Southeast Asia evaluation. Development was continued on the laser target designator system with delivery of illuminators and seekers scheduled for August 1969. The fiscal year 1970 funds will be used to complete development of the FLIR and the airborne laser equipment, real time surveillance (ALERTS). Also, advance development will be continued on airborne foliage penetration radar and the laser target designation system (LTDS).

Electronic Warfare Development

Mr. Mahon. The fiscal year 1970 request for "Electronic warfare development" is ——— million as compared with the ——— million allocated in fiscal year 1969. Is this the same effort as was included in the fiscal year 1969 budget under the title "Intelligence and Electronic Warfare Development"?

Colonel Lamb. Yes, sir.

Mr. Mahon. The fiscal year 1969 budget request was ——— million for this activity; $8.7 million was actually allocated. What items were deleted or deferred from the 1969 program in this $3 million reduction?

(Information requested is classified and has been furnished separately to the committee.)

Mr. Mahon. What would be the effect of keeping the program at the fiscal year 1969 level?

Colonel Lamb. Funding fiscal year 1970 requirements at the same level as fiscal year 1969 will cause a widening of the technology gap between electromagnetic developments and electronic countermeasures. The fiscal year 1969 budget was insufficient to maintain the state of the art; consequently programs were either deferred or funded at a sustaining level. To limit the fiscal year 1970 funds to the fiscal year 1969 dollar amount will increase the technology gap. Exotic projects with unfound capabilities such as PDSI and DORBO will have to be deferred. Development of ECCM techniques and devices will be impeded.

Protection of Armored Vehicles for Guided Missiles

Mr. Mahon. Discuss your program for "Protection of Armored Vehicles for Guided Missiles" which is described on page 309 of the descriptive summary. What is the status of this effort; how much has been spent on it; what part of the fiscal year 1970 program is for this effort; and what is the estimated total cost and time of completion of hardware for this purpose?

(Information is classified and has been furnished separately to the committee.)

Other Classified Projects

Mr. Mahon. Discuss a program entitled "PDSI" for which you are requesting ——— million.

(Information is classified and has been furnished separately to the committee.)

Mr. Mahon. You are requesting ——— million for "Research and development support of electronic warfare quick reaction capability."

To what extent does this involve firm programs and to what extent does this provide a sum of money to fund presently unforeseen contingencies which may arise in this area?

(Information is classified and has been forwarded separately to the committee.)

COMMUNICATION COUNTER MEASURES

Mr. MAHON. What projects are included under "Advanced development communication countermeasures" for which you request ——— million as compared with ——— in the previous fiscal year?

The committee notes that in fiscal year 1969 you requested ——— million for this effort and it was reduced to the ———. If this effort could be deferred last year, why couldn't it be deferred again this year?

(Information requested is classified and has been furnished separately to the committee.)

GLOBAL MAPPING AND GEODESY

Mr. MAHON. You are requesting ——— for "Mapping and geodesy" advanced development as compared with the $5.634 million allocated in fiscal year 1969. What areas of the world of interest to the Army are at the present time unmapped or inadequately mapped?

Colonel TOBEY. The objectives of the R. & D. effort are to develop new and improved equipments and techniques for accomplishing mapping of any areas of the world. The requirements for the production of maps are determined by the DOD as required to support combat contingency plans. ———.

Mr. MAHON. The descriptive summary states that one of the objectives of the global mapping and geodesy program, which is the major program of the Army in this area, is to "provide improved geodetic data needed by long-range weapons systems." Since the Army does not have long-range weapons systems in its inventory why is this an Army effort? What are the major items which are under development in this area and which the Army hopes at some point in time to use operationally?

Colonel TOBEY. The Army has no long-range weapon systems in the sense of strategic missiles, aircraft or other delivery systems. The longest range weapon system in the Army inventory is the Pershing missile, which has an effective range of about ——— miles. However, DOD has given Army the responsibility for developing worldwide geodetic data required to support strategic (that is, long-range) weapons systems developed and being developed by Air Force and Navy. Major items under development by Army in support of these long-range weapons systems include:

A long-range position determining system (LRPDS) suitable for use by field units to establish geodetic control.

Improved definition of the size and shape of the earth; means for determining local gravity constants at various points on the earth; and geopotential data for areas of strategic interest. These data are all needed to reduce the errors inherent in strategic target coordinates so as to improve the effectiveness of long-range missiles.

Improved distance-measuring equipment for use in establishing precise base-lines in the field. These base-lines are required as the foundation for geodetic control networks.

Improved angle-measuring equipment to enable determination of azimuth to increased accuracies and under extreme conditions of temperature and poor weather.

Development of a man-portable ground station to allow use of doppler satellites in establishing geodetic control points.

TOTAL PROGRAM FUNDING IN LAST DECADE

Mr. MAHON. How much has the Army spent in advanced development for global mapping and geodesy in the past decade?

Colonel TOBEY. The Army has spent approximately $33 million for this project in the past decade.

USE OF SATELLITE MAPPING TECHNIQUES

Mr. MAHON. What utilization is made of satellite techniques in Army mapping and geodesy programs?

Colonel TOBEY. Satellite techniques are currently being used to establish a master worldwide geodetic control net around the equator of the earth. This control net will relate all mapping datums to a common grid. It is scheduled for completion in December 1969. Satellite systems currently being used to establish this net include the Army developed sequential collation of range (SECOR) system and the U.S. Coast and Geodetic Survey BC–4 system. These systems are to be replaced by the Navy developed geoceiver and doppler transponder that will be used to increase the number of network control points.

Army development in this area currently includes the use of satellites to determine position location with small, man transportable, ground stations in real time read-out for artillery survey and target acquisition requirements. The Army is investigating all known satellite techniques for this purpose. ———.

AIR FORCE CONTRIBUTION TO THIS PROGRAM

Mr. MAHON. What is the Air Force's contribution to the mapping and geodesy advanced development program?

Colonel TOBEY. Mapping and geodesy is a jointly coordinated research and development program in which the Air Force has primary responsibility for developing aerial data acquisition (data collection) equipments and techniques while the Army has primary responsibility for developing data reduction (converting collected data to useable topographic products) equipments and techniques as assigned by Department of Defense. For example, in the current development of a topographic all-weather mapping system (TAWMS) the Air Force is developing the radar for collecting topographic radar imagery and the Army is developing equipments for converting the imagery to useable topographic products.

A limited amount of advanced development in data reduction equipments is conducted by the Air Force. Its developments are oriented

toward solutions of problems primarily related to the production of air target materials but frequently have general application to mapping and charting. Research programs are closely coordinated between the Air Force and the Army to avoid duplication of effort.

THERAPEUTIC DEVELOPMENT

MALARIA PROPHYLAXIS

Mr. MAHON. It has been reported that the Army has been rather successful in developing drugs to cope with the malaria problem in Southeast Asia. Can you introduce statistics into the record at this point showing what the malaria rate and loss of man-days was in Southeast Asia in the early days of our role in the war as compared with the present time?

General BETTS. Yes, sir, I will.

(The information follows:)

The incident rate (new cases per thousand per year) reported for Army personnel in Vietnam for the calendar years 1965 through 1968 are listed below:

Year	Incident rate
1965	48.5
1966	39.0
1967	30.7
1968	24.8

The number of cases of malaria and deaths among Army personnel are listed below:

Year	Number of cases	Deaths
1965 (last 3 months)	1,972	16
1966	6,662	14
1967	9,124	11
1968	8,616	15

Man-days lost due to hospitalization have been reduced from an average of approximately 30 days in 1965, to 16 days in 1968. In addition to the time lost for hospitalization, an average of 7 days of nonhospital convalescence is required.

UNKNOWN NUMBER OF RESISTANT STRAINS

Mr. MAHON. The descriptive summary states that "because of the development of resistant malaria the world over, the goal of the Army malaria program becomes clear: new agents with different mechanisms of action must be developed so our troops may be sent into a malarious zone with encountering a situation similar to Vietnam." Does this mean that it is the objective of your program to develop specific medication for all resistant strains of malaria which can be found throughout the world? What is your estimate of how many strains of malaria exist?

General BETTS. The objective of the malaria program is to develop specific medication for all known resistant strains of malaria with consideration given to newly emerging strains. There are four basic types of malaria (falciparum, malariae, ovale, vivax). Of these, falciparum malaria is the greatest threat in that it develops resistance rapidly to wide varieties of medications. Considering these facts it is

not possible to estimate the number of "resistant strains." The number may, in fact, be limitless.

IMPACT OF REDUCED PROGRAM FUNDING

Mr. MAHON. According to the descriptive summary, we have spent about $32 million on this effort and you propose another $8.5 million in fiscal year 1970. The malaria situation in Vietnam has been generally brought under control. It would seem that the continuation of this program at an $8.5 million level might be an unnecessary continuation of development effort. Why can't this program now be reduced to something like a $2 million a year level?

General BETTS. The development of resistance to drugs by microorganisms has been repeatedly demonstrated. The decreased effectiveness of penicillin in recent years has been due to the development of resistance by microorganisms. The situation with malaria is the same. The development of resistance by malarial parasites has been repeatedly demonstrated in the laboratory and confirmed in clinical practice. The search for newer drugs must continue. In order to synthesize effective drugs, research into the biochemistry of the malarial parasite must be accomplished. Possible harmful effects to the patient from antimalarial drugs must be recognized and eliminated. A reduction to the $2 million level of funding would seriously reduce the drug screening program and sharply curtail the search for basic knowledge of the malarial parasite so vital to the selection and development of effective drugs. The military cannot guarantee that forces will not be deployed to malarious areas in the future, hence a severe reduction of the malaria program is not feasible.

MAJOR ARMY CONTRACTORS

Mr. MAHON. List for the record the major contractors and the sums allocated to them in this program in fiscal year 1969.

(The information follows:)

The following list contains the major contractors and amounts of each contract.

Contractor	*Fiscal year 1969*
Miami, University, of Coral Gables Fla	$645,000
Herner and Co., Bethesda, Md	518,000
Missouri, University of, Columbia, Mo	250,000
Chicago, University, of Chicago, Ill	216,000
Aerojet-General Corp., Sacramento, Calif	210,000
Bionetics Research Laboratories, Inc., Falls Church, Va	180,000
West Virginia University, Morgantown, W. Va	177,000
Maryland, University of, College Park, Md	170,000
Dow Chemical Co., Midland, Mich	158,000
Hazelton Laboratories, Inc., Falls Church, Reston, Va	145,000
New York University Medical Center, New York, N.Y	142,000
Midwest Research Institute, Kansas City, Mo	134,000
Stanford University, Palo Alto, Calif	125,000
Stanford Research Institute, Menlo Park, Calif	124,000
Pfizer and Co., Inc., New York, N.Y	120,000
Aldrich Chemical Co., Inc., Milwaukee, Wis	117,000
Computer Usage Development Corp., Washington, D.C	110,000
New England Nuclear Corp., Boston, Mass	104,000

PUBLIC HEALTH SERVICE DOING VERY LITTLE MALARIA RESEARCH

Mr. MAHON. To what extent is the Public Health Service involved in malaria research?

General BETTS. The Public Health Service at present is conducting very little research in malaria. The Army's malaria research program is the only program of its kind in the free world.

NAVY NOT INVOLVED IN MALARIA RESEARCH

Mr. MAHON. To what extent is the Navy involved in malaria research?

General BETTS. The Navy is not conducting malaria research at present. As I indicated, the Army's malaria research program is the only program of its kind in the free world.

UNMANNED AERIAL SURVEILLANCE SYSTEM

Mr. MAHON. Describe the unmanned aerial surveillance system program for which you are requesting ——— million in fiscal year 1970. How many vehicles are involved in this effort?

Colonel LAMB. The Unmanned Aerial Surveillance System (UASS) program will initiate UASS development to satisfy an Army advance development objective. This program will refine the systems requirements for a UASS to meet the Army mission objectives and initiate development of a system. The UASS will have a hover capability with an MTI radar and will be used at brigade or lower levels. It is unknown how many UASS vehicles will be required until system requirements are coupled with contractor proposals.

EXISTING DRONE SYSTEMS

Mr. MAHON. What Unmanned Aerial Surveillance Systems are currently available to the United States? How would the proposed new system compare wih the existing systems?

Colonel LAMB. There are several fixed wing drone systems available to the United States. Some are contractor proposals and some are limited-operational systems. The only currently operational drone system that has capabilities somewhat similar to the Unmanned Aerial Surveillance System (UASS) requirements is a Navy helicopter drone used for antisubmarine missions. In its present configuration, the limited endurance and the inadequate control system of this helicopter drone would restrict its use for UASS. None of the present drone systems have a MTI radar.

Mr. MAHON. What is the requirement for a hover-type airborne unmanned surveillance system to operate in the brigade area? Why can't present drones, helicopters, and fixed-wing observation aircraft accomplish this mission?

Colonel LAMB. The hover-type UASS will have an MTI radar for surveillance of movement of vehicles and personnel in the brigade tactical area of responsibility. The slow forward movement, or hover capability, allows MTI for detection of show-moving targets such as personnel. Also the hover mode allows a "pop-up" capability from

behind protective terrain in a heavy antiair environment. There are no drones with this capability at the present time and the system is required in a sophisticated antiair environment where the risk and cost of manned helicopters or airplanes are too great either physically or politically.

ESTIMATED DEVELOPMENT PROGRAM

Mr. MAHON. What is the estimated development cost of the proposed unmanned aerial surveillance system?

Colonel LAMB. ——— million.

Mr. MAHON. When do you anticipate completion of this development?

Colonel LAMB. ———.

TOTAL ARMY REQUIREMENTS UNKNOWN

Mr. MAHON. What is the Army's numerical requirement for such systems? If it is successfully developed, how many will you probably procure?

Colonel LAMB. The Army's numerical requirement for the UASS and the number to be procured cannot be determined until the capabilities of the selected systems are firm. The selected trade-offs in size, cost, complexity, and endurance of the UASS will be an early part of the program. For example, a UASS with long endurance and with a multisensor capability will require less vehicles to provide continuous coverage of the brigade tactical area of responsibility. However, the cost of the larger, long endurance, complex UASS will be considerably higher than a smaller version and loss of a larger vehicle may have a greater impact on the brigade mission.

PROGRAM ACCOMPLISHMENTS AND OBJECTIVE

Mr. MAHON. The allocation in this area in fiscal year 1968 was $375,000. No funds were required in fiscal year 1969. What was accomplished with the fiscal year 1968 funds and why were no funds requested in this area in fiscal year 1969?

Colonel LAMB. All developments of operational drone systems were halted in 1965 and the Drone data base program was initiated to fill the gaps in drone technology and maintain drone expertise. The fiscal year 1968 money was used for the Drone data base program. This effort included completion of the following studies: drone detectability study, flight dynamics of the Firebee drone, tethered platform with a TV unit, ground launched optical observation projectile, and low-cost accurate flight programer. Programs initiated were Universal radar tracker, advanced trilateration tracker techniques, study of meteorological conditions effect upon drones, and a drone survivability study. No funds were requested in fiscal year 1969 so that earlier projects could be brought to a close thereby making the expertise available for the fiscal year 1970 UASS program.

SUBSYSTEM RELIABILITY

Mr. MAHON. You are requesting ——— million for a program entitled "Subsystem Reliability." This is a ——— percent increase in

the $2.5 million allocated in fiscal year 1969. How many different items are included under this heading?

Colonel LAMB. There are six different items included under this heading. They are a vehicular VHF–FM 40-watt amplifier, an interphone system, a vehicular antenna matching unit, a squad radio, a lightweight man-pack radio and an auxiliary receiver for the AN/VRC–12.

AN/VRC–12 RADIO SET

Mr. MAHON. What have been the results of your efforts in this area with an AN/VRC–12 radio set program? Have you successfully developed an ultrareliable model of this radio set? Is it to be procured?

Colonel LAMB. Progress has not reached the stage where a meaningful evaluation can be made. This must await the delivery and extensive test of models. The contractor is currently putting together an electrical design model. This electrical prototype is expected to be available in October 1969. Its purpose is to verify that the design will perform the electronic functions of the AN/VRC–12. It will not be mechanically packaged as it is not a deliverable item under the contract. The ultrareliable models are scheduled to be completed, tested in plant and delivered to the Government in December 1970. No procurement of the ultrareliable AN/VRC–12 from the prime contract is intended. The objective of this initial effort is to investigate techniques of developing tactical radio equipment with substantially improved reliability. Only a sufficient number of models is being obtained to prove reliability.

FISCAL YEAR 1970 PROGRAM

Mr. MAHON. What new items of equipment will be included in the fiscal year 1970 program?

Colonel LAMB. In the fiscal year 1970 program the new items of equipment will be: a lightweight man-pack radio, a vehicular VHF–FM 40-watt amplifier, an interphone system, and a reliable vehicular antenna and coupler. We have deferred efforts on some other items until fiscal year 1971.

FISCAL YEAR 1969 PROGRAM

Mr. MAHON. The fiscal year 1969 budget request for subsystem reliability was $1.5 million. What is the actual sum allocated in this area in fiscal year 1969? What are the reasons for the increase?

Colonel LAMB. The $2.5 million is the actual sum allocated in fiscal year 1969. The increase was provided by the Department of Defense to allow orderly and timely progression into the fiscal year 1970 program of new work.

PROJECT BLUE ZEPHYR

Mr. MAHON. The fiscal year 1970 request includes ——— for Project Blue Zephyr. According to the justification book, page 322, a total of ——— has been funded for this purpose through fiscal year 1969. What is this project and what can you show in accomplishments thus far?

(Information is classified and has been furnished separately to the committee.)

Mr. MAHON. In view of the work being done in this area by the other military services, particularly the Air Force, why is Army participation in a program of this nature necessary?

Colonel LAMB. Army participation has been directed by DOD. In addition, the Army is interested since it does have responsibility for the ——— program to which Blue Zephyr provides data.

Mr. MAHON. Does this program contribute in any way to the——— program? If so, in what specific way?

(Information is classified and has been furnished separately to the committee.)

Mr. MAHON. The fiscal year 1969 justification book fails to show a writeup for this project. Were any funds requested in the President's budget for this project last year? If not, how and why was the $300,000 made available?

Colonel LAMB. No funds were requested in the fiscal year 1969 FYDP. DOD approval of the program was not received until after the submission of the fiscal year 1969 FYDP. The $300,000 was provided in the DOD apportionment.

PROJECT MALLARD

Mr. MAHON. You are requesting ——— million in fiscal year 1970 for Project Mallard, an increase of ——— million over fiscal year 1969. Will you describe Project Mallard, its purpose, and when it was initiated, and why?

Colonel LAMB. The Mallard project is an international cooperative effort (United States, United Kingdom, Canada, Australia) for the development and production of a major tactical trunking and distribution communications system for use in the field by all military services of the cooperating countries. The system will utilize digital-type automatic signaling which affords mobile access and full security. Project Mallard is divided into three phases: Mallard I has defined the operational technical characteristics and presented a communication plan and initial research and development plan. Mallard II is a detailed study and conceptual design of the communications system and the equipment required. The phase terminates with the selection of the system and the development of a plan for subsequent engineering development and production. Mallard III includes engineering development, production, and fielding of the equipment. Mallard was formally initiated on April 6, 1967, with the signing of the memorandum of understanding to insure a completely compatible tactical military communications among the participating nations.

Mr. MAHON. The fiscal year 1969 request of Congress for Mallard was $9.3 million, yet last year's program is shown as $8 million. Why and how was the fiscal year 1969 program decreased?

Colonel LAMB. The fiscal year 1969 program was reduced by OSD to $8 million. Certain technical support efforts were not performed as a result of the reduction.

ESTIMATED COST OF PROJECT MALLARD DEVELOPMENT

Mr. MAHON. What was the original estimated total cost of developing Mallard and what is the current estimate, including unilateral U.S. costs?

Colonel LAMB. The Mallard development concept paper of July 25, 1968, estimated the international cooperative cost of Mallard at ——— million. The U.S. cooperative cost was estimated to be ——— million, unilateral cost ——— million for a total estimated U.S. cost of ——— million. As a result of the detailed work done in phase I, the revised estimates are ——— million for the international cooperative cost. The U.S. cost is estimated to be ——— million cooperative and ——— million unilateral for a total of ——— million.

DEVELOPMENT OF U.S. MILITARYWIDE TACTICAL COMMUNICATIONS SYSTEM

Mr. MAHON. Why are we trying to develop an international tactical communications system for field armies when the three military services have never been able to get together on a U.S. militarywide tactical communications system using the same equipment, and often do not even build communications equipment which are compatible?

Colonel LAMB. As a result of the ABCA basic standardization agreement, service representatives of the four armies meet to discuss the results of standardization activities. Tactical equipment and logistics, TEAL, is the subject and title of these meetings. In April 1964, at the TEAL VIII meeting, fears were expressed that the incompatibilities that exist between current systems would be amplified in future years so that member nations could not communicate efficiently with one another on the battlefield; TEAL VIII, therefore, recommended that steps be taken to insure interoperability and that the chief communicators of the member nations meet to identify known problem areas and make recommendations for solving them. As a result of the TEAL IV meeting, it appeared that interoperability among countries was feasible and a working effort known as Project Mallard was begun. The Mallard project is a joint U.S. service project directed toward insuring compatibility and interoperability between the subsystems and equipments of the Field Army, and the tactical and strategic electronic or material systems of all the services.

PREVIOUS EXPERIENCES WITH INTERNATIONAL AGREEMENTS

Mr. MAHON. After our experiences over the years with joint developments under international agreements, why does the Army believe this one will be any more successful?

Colonel LAMB. The United States, by the memorandum of understanding, has a controlling leverage in the decisionmaking body which we have not had in other international programs; this has been a significant factor in the success to date of the Mallard program.

MEMORANDUM OF UNDERSTANDING

Mr. MAHON. Briefly describe the memorandum of understanding with participating nations, including the funding aspects.

(The information follows:)

The memorandum of understanding establishes the arrangements under which the ABCA governments will participate in the Mallard project. It establishes the objectives to be achieved through their common effort which are essentially: (*a*) The development and production of a common, secure, tactical, automatically switched digital trunk communications system with single channel access thereto.

(*b*) Field such a system between ———. (*c*) Eliminate duplicate development. (*d*) Assure the division of development work among participants in proportion to their financial contributions. (*e*) Ensure that each government will have the opportunity to compete on an equal basis for a value of production at least equal to that government portion of the total value of the production inventory requirements. (*f*) Utilize most effectively the military, industrial, scientific, and technical resources of the participating countries in the interest of mutual defense. The total cost for the development of Project Mallard is broken down among the governments: 62 percent United States, 30 percent United Kingdom, 5 percent Canada, and 3 percent Australia. Management of the program is exercised through a project management board whose members represent the ABCA nations. Voting powers are according to percent participation thus ensuring U.S. control. The MOU also establishes a joint engineering agency which is staffed in accordance with the degree of participation and headed by the United States.

Mr. MAHON. Under the management provisions of the memorandum of understanding, the vote of members of the program management board is weighted in proportion to the financial contribution of the member countries. On what issues or set of circumstances is the weighted vote provision exempted?

Colonel LAMB. The weighted vote provision is exempted and requirements for an unanimous vote on satisfaction of user requirements, system identification, program timing, division of work by countries, and engineering and service tests and required by the memorandum of understanding.

TRADE IMBALANCE PROBLEM

Mr. MAHON. If the United States plans to avoid, at all costs, serious trade imbalances among participating countries, it would appear that instead of free competition, allocation of production will be necessary with fewer production contracts awarded U.S. companies and an equivalent loss in monetary savings. Is this not so?

Colonel LAMB. No. The memorandum of understanding provides for unanimous agreement on the division of work. Should the results of the competition disclose a possible serious trade imbalance the participating nations are required to consult together to make sure adjustments as are mutually agreeable; or if this is not possible, any country could withdraw from the program.

Mr. MAHON. Has supplement II of the memorandum of understanding been negotiated?

Colonel LAMB. Supplement II of the memorandum of understanding has been negotiated and was signed on May 30, 1969.

Mr. MAHON. Have any of the problems previously discussed been resolved?

Colonel LAMB. All of the problems surfaced during the negotiations were resolved.

RIGHTS IN TECHNICAL DATA

Mr. MAHON. Concerning rights to technical data, an official of the Army Judge Advocate General's office advised our investigative staff that negotiations are continuing with regard to rights to background information which the United States does not feel were adequately covered by the basic MOU. Was this problem resolved under supplement II of the MOU?

Colonel LAMB. Yes, supplemental I to the basic memorandum of understanding added a paragraph relating to the interchange of background information which was found to be unworkable. Supplemental II deleted this addition and restored the original paragraph of the basic memorandum of understanding. The procedures required for implementation of this agreement are presently being developed by a Mallard legal group composed of representatives of each of the participating nations.

PROJECT MALLARD II

Mr. MAHON. When will phase 2 of Mallard II begin and end, and of what will it consist?

Colonel LAMB. Phase 2 of Mallard II began on June 1, 1969, and is scheduled to end June 30, 1971. Phase 2 will consist of functional modeling and simulations, and contract definition.

AUTOMATIC COMMUNICATIONS SWITCH

Mr. MAHON. Our investigative staff was advised that development of an automatic communications switch is one of the most important requirements in tactical communications today. Rather than develop a new switch, has the Army considered available general purpose computers developed under Government contracts, such as the Univac 642B or the 1219, which could be used as a central processor to provide both a circuit and digital message switching capability for traffic between stations?

Colonel LAMB. The Army has considered these developments and will apply the techniques and technology from these developments and any other source. The tactical automatic switch program, however, is directed toward the specific needs for a lightweight, rugged, automatic switch for field use. Any equipment not developed to these specifications cannot be used directly without at least some modification and repacking of components. The switch program is this type of effort.

MILITARY DEVELOPMENT OF AUTOMATIC SWITCHES

Mr. MAHON. Our investigative staff was advised that the 3 military services are independently developing or procuring automatic switches, and the Army has been designated as the focal point for these switch procurements. Will you provide for the record a description of each switch under development or procurement by the military services, including the Marine Corps, together with the estimated development costs, procurement costs, when these projects were initiated, and estimated completion date, where appropriate?

Colonel LAMB. To insure commonality and compatibility of tactical automatic switches within the Services and to preclude unilateral development and procurement the Secretary of Defense in December 1968 tasked the Army with initiation of a switching program which would be acceptable to all three Services. The Army is currently procuring six "off-the-shelf" narrowband 300 and 600 line analog switches to meet an urgent requirement. The Marine Corps is currently developing one wideband analog 600 line switch to meet an urgent requirement. The Air Force is procuring one improved version of the narrow-

band analog switch for their 407L communication system with an option for 24 more for use in category II tests of the 407L system. To date, the Army, over the last 12 years, has invested approximately $27 million in developing tactical automatic switching. The current Marine Corps contract is for approximately $2 million, and the Air Force investment to date is approximately $23 million. The current plan being submitted to OSD for approval is to test the Army and Marine Corps models against their respective specifications and procure the one which proves most cost effective for all services. Test models should be available in the fourth quarter of fiscal year 1970. Estimated procurement costs for a system "slice," which includes the switch and all items needed to make the system function, ranges from $550,000 to $750,000 for 300 line and 600 line switches respectively. The total interim requirements of the three Services is for 138 switches estimated to cost $62 million.

Mr. MAHON. Are these switches designed to ultimately phase into or to be utilized with Mallard?

Colonel LAMB. No. These switches are scheduled to meet the immediate needs of the Army (and the other Services) prior to phase-in of the Mallard system. In the early stages of the phase-in of Mallard, these switches will still be in service and will be used with Mallard; but, due to technical incompatibility, they will not be phased into Mallard.

SECURITY PROBLEMS

Mr. MAHON. What communications security problems will be involved if it is decided to include NATO and SEATO countries in project Mallard?

Colonel LAMB. This problem is still being addressed by the Department of Defense in conjunction with the National Security Agency.

INSURMOUNTABLE INTERFACE PROBLEMS

Mr. MAHON. How can Mallard be designed to interoperate with some 39 military and civilian tactical and strategic communications systems in the United States, plus those of the United Kingdom, Canada, and Australia, as well as interface with the many tactical communications systems of the three military departments?

Colonel LAMB. The problem of interface is receiving a hard look in the Mallard development. Such interfaces will be addressed on a case by case basis and solutions will range from fully automatic to manual systems.

TACSATCOM SEPARATE FROM PROJECT MALLARD

Mr. MAHON. What relationship will Mallard have to the Tacsatcom program; will Mallard interface with Tacsatcom or will Tacsatcom become a part of Mallard?

Colonel LAMB. The Mallard program desires to utilize satellite circuits within the system and has made its requirements known to the Tacsatcom program. Mallard will interface with Tacsatcom, but Tacsatcom will not become a part of the Mallard program.

Mr. MAHON. Navy officials advised our investigative staff that the Navy fears that Mallard might influence the Tacsatcom program to

satisfy the needs of Mallard and ignore Navy requirements. Are these Navy fears well-founded or do they have some validity?

Colonel LAMB. Both Mallard and Tacsatcom are joint programs and as such no service requirements will be ignored. Through the joint compatibilty program steps are being taken to assure compatibility of all new communication equipments.

Mr. MAHON. Will you explain how the Random Access Discrete Address (RADA) system will become a part of Mallard? In other words, will RADA become a part of Mallard in toto or only pieces or portions thereof?

Colonel LAMB. The final decision on the integration of the Random Access Discrete Address (RADA) system into the Mallard has not been made. The RADA program is about 5 years ahead of Mallard at this time. The decision as to the interrelationship will be made following the military potential test of RADA and the completion of phase 2 of Mallard.

ESTIMATED COST OF DEVELOPING MALLARD

Mr. MAHON. Our investigative staff was informed that the estimated R.D.T. & E. costs of Mallard, fiscal year 1967 thru fiscal year 1974, will be approximately ——— million, including unilateral U.S. costs of about ——— million. What is the latest estimated total cost of developing Mallard, which began in fiscal year 1966, as well as the U.S. share including unilateral costs?

Colonel LAMB. The present estimated cooperative cost of developing Mallard is ——— million of which ——— million is the U.S. share. The unilateral U.S. cost is estimated to be ——— million for a total U.S. cost of ——— million.

COST TO DEPLOY MALLARD

Mr. MAHON. What is the estimated total U.S. cost for development and deployment of Mallard? The committee has heard estimates as high as ———. Our investigative staff was informed that the first reliable estimate of procurement funding would be made in July 1969.

Colonel LAMB. No estimates have been made of the deployment cost of Mallard at this time. The first estimates of production cost will be made in fiscal year 1971 and be refined as a result of contract definition in fiscal year 1972. The U.S. cost for development of Mallard is estimated to be ——— million.

ESTIMATED COSTS FOR OTHER TACTICAL COMMUNICATIONS

Mr. MAHON. While R.D.T. & E. efforts on Mallard are progressing through fiscal year 1974, what is the total amount programed for other tactical communications research through fiscal year 1974?

(The information furnished is classified.)

Mr. MAHON. What is the estimated procurement funding for tactical communications through fiscal year 1974?

Colonel LAMB. The estimated procurement funding for tactical communications is ——— million through fiscal year 1974.

PARTICIPATION BY OTHER SERVICES IN MALLARD

Mr. MAHON. If project Mallard has been designated as a joint U.S. military program, how and to what extent is the Navy, Air Force, and Marine Corps participating?

Colonel LAMB. The Navy, Air Force and Marine Corps are considered participating services in Mallard. There are 13 Air Force, three Navy and two Marine Corps personnel presently assigned to and filling key positions within the project. The senior service officer assigned for each service reports directly to the project manager and speaks for his parent service subject to the limitations prescribed by that service.

Mr. MAHON. Our investigative staff received indications there is a fear that Mallard may drain off some research and development money from the other military services with a resultant degradation of their capability to develop tactical communications on their own. Does Mallard, therefore, have the full enthusiastic support of the Navy, Air Force, and Marine Corps in all aspects?

Colonel LAMB. Although under the joint project manager charter the Army is designated as the executive service for the Mallard project, the Navy, Air Force and Marine Corps are identified as participating services. As such each of the Services has formally agreed to cooperate in the conduct and management of the project. Within the area of the Mallard program all of the Services' requirements are fully considered.

IMPACT OF MALLARD ON NUMBER OF MILITARY PERSONNEL

Mr. MAHON. If Mallard is successful, what effect will it have on the number of tactical communications personnel presently required for field Army communications?

Colonel LAMB. It is estimated that a reduction of between 3,000 to 6,000 communication personnel will be achieved in the field Army.

EVER-INCREASING NEED FOR COMMUNICATIONS

Mr. MAHON. Our investigative staff was advised that the Soviets follow the doctrine that "only those in need communicate" and as a result the Soviets employ only about one-half the communications equipment the U.S. Army uses in a given unit. One U.S. military officer commented that today in Vietnam there is a tendency to provide communications to too many people in the field. Have we had a tendency in recent years to go "overboard" in the area of military communications? Are we reaching the point where no decisions will be made on the battlefield, where, according to an old saw, wars are won?

(The information follows:)

The need for more communications continually expands with the ever increasing range of weapons and area of the battlefield. Requirements are continually reviewed to insure that only those personnel needing to communicate are provided with this capability. We cannot assure maximum utilization of all of our resources on the battlefield unless we have a reliable communications netweek.

STRIKE COMMAND WANTS LIGHTER COMMUNICATIONS EQUIPMENT

Mr. MAHON. An official of strike command has been quoted as saying that command wants lighter communcations equipment, pointing out that it would take 75 C–130 aircraft to carry the electronics gear Strike Command would require for a major overseas commitment. Would you say that Mallard would compound this problem or help it?

Colonel LAMB. The Mallard equipment will help. Present studies indicate a substantial reduction in size and weight will be accomplished with the Mallard equipment.

Mr. MAHON. When our investigative staff visited Strike Command, communications officials of that command were unaware of the existence of Project Mallard and, in fact, had only recently submitted their own communications requirements to the Joint Chiefs of Staff. Why is it that a major undertaking such as Mallard had not received widespread dissemination within the Defense establishment?

(The information follows:)

The results of the international system selection board of Project Mallard defines the proposed system in sufficient detail for long range planning purposes. This information has become available after the Strike Command submission and is receiving widespread dissemination within the defense establishment.

Mr. MAHON. In view of the Mallard effort, what was the decision on the recently submitted Strike Command communications requirements?

(The information follows:)

The Strike Command communications requirements have been returned to Strike Command by the Joint Chiefs of Staff for a review to determine if present service developments cannot fulfill their requirements.

MALLARD FUNDING THROUGH FISCAL YEAR 1969

Mr. MAHON. How much has been made available for Project Mallard through fiscal year 1969?

Colonel LAMB. $19.3 million has been made available to Project Mallard through fiscal year 1969.

MISSILE ELECTRONIC WARFARE

Mr. MAHON. The fiscal year 1970 request for missile electronic warfare is ——— million, the same as the fiscal year 1969 level of funding. You requested ——— million in fiscal year 1969. What was the reason for decreasing the program and to what effort was the ——— reprogramed?

Colonel LAMB. The program was decreased as the result of higher priority program funding within the fiscal year 1969 budget approved by congress. A reduction of ——— million in missile EW was reported in the omnibus reprograming actions fiscal year 1969–2 (DOD fiscal year 1969–28). Reprograming totaling $74 million was reported in the above action. In the President's budget $100,000 was added back into the program as part of the statistical distribution of facilities and installation support costs. The projects for which the ——— was intended were deferred for fiscal year 1970 funding.

Mr. MAHON. Were you able to complete all your objectives in fiscal year 1969? If not, on what tasks was the ——— million used and what was not completed?

Colonel LAMB. I will have to supply that for the record.

(Information is classified and has been forwarded separately to the committee.)

Mr. MAHON. What are your objectives for fiscal year 1970?

(Information is classified and has been furnished separately to the committee.)

WORK ON NIKE-HERCULES AND HAWK MISSILE SYSTEMS

Mr. MAHON. Will any of the fiscal year 1970 funds be used for work on the vulnerability of the Hawk and improved Nike-Hercules? If so, why are you spending funds on these weapons if the Nike-Hercules will be replaced in the next couple of years and the Hawk is to be replaced by the improved Hawk?

(The information follows:)

Yes a limited amount of in-house studies will be conducted. It is true that we plan to replace the Hawk and Nike-Hercules missiles but these will be in the inventory for several years to come. As long as a missile system is in the operational inventory its vulnerability to new ECM techniques must be known so that ECCM techniques can be developed. Secondly, the known ECM vulnerabilities can be eliminated from the improved systems. We presently have $595,000 programed for this in-house work.

USE OF DEVELOPMENTS BY OTHER SERVICES

Mr. MAHON. Have you been able to use any ECW developments by the Navy and Air Force which may contribute to this program element? If so, give some examples.

(The information follows:)

Very limited use. In the test of the Nike-Hercules system Air Force state-of-the-art jammers were employed. Every effort is made to use developments of the other services.

STRATEGIC COMMUNICATIONS

Mr. MAHON. The fiscal year 1970 request for strategic communications is ———. You requested $1.1 million for fiscal year 1969, yet the justification book, page 328, shows the fiscal year 1969 at only $700,000. How and why was the fiscal year 1969 program reduced?

Colonel LAMB. This was reprogramed into higher priority projects as a part of an overall reprograming action of $74 million reported to Congress on fiscal year 1969–2 omnibus, DOD number fiscal year 1969–28.

Mr. MAHON. What was accomplished during fiscal year 1969?

Colonel LAMB. A contract was awarded for the development of a service test model of a fully automatic high speed page reader. The reader can read the body of the message, addressees, information in the heading, translate the information into teletype format, and automatically transmit the message to a computerized message switching central. Limitation of funds has precluded additional contractual efforts.

Mr. MAHON. How do you propose to use the fiscal year 1970 funds?

Colonel LAMB. We plan to continue development supervision and service testing of the high speed page reader contract initiated in fiscal year 1969. Contract for an advanced development model of a *new* ultra-high-speed page printer. Due to funding limitations, efforts for an ultra-high-speed typing reperforator and an ultra-high-speed tape reader will be limited to in-house work.

HIGH SPEED MESSAGE ENTRY EQUIPMENT

Mr. MAHON. How much have you spent on the high speed message entry equipment which was installed in the Army Pentagon facility?

Colonel LAMB. A total of $453,499 has been spent of which $40,000 was for maintenance of the equipment.

Mr. MAHON. This equipment, according to information provided the committee, had many deficiencies and was never fully operable. According to the fiscal year 1968 justification book, page 311, it was to be adopted as standard equipment in fiscal year 1969. What happened to this development?

(The information follows:)

The system has been considered a success meeting or exceeding most of the original objectives. It was used in our operational configuration for 18 months in the Pentagon facility. However, this system is not militarized and development is continuing in this area.

ULTRA-HIGH-SPEED PRINTER TAPE READER TAPE REPERFORATOR

Mr. MAHON. According to the fiscal year 1968 justification book, page 311, the ultra-high-speed page printer, the ultra-high-speed tape reader and the ultra-high-speed tape reperforator were to be adopted as standard after successful completion of tests. How much was spent on these equipments and what happened to the development?

(The information follows:)

No development work has been done on the ultra-high-speed tape reperforator at this time. The ultra-high-speed page printer was tested. The equipment met most of the test objectives but did not print sufficiently well to justify procurement of service test models. The matter is presently under study. Cost of this equipment was $165,300. The ultra-high-speed tape reader is undergoing test at this time. The cost of this equipment was $97,000.

"KATHRYN" SYSTEM DISCONTINUED

Mr. MAHON. What is "Kathryn", on which engineering and service tests were to be completed in fiscal year 1969 after correction of deficiencies, according to the fiscal year 1969 justification book, page 300?

(The information follows:)

Kathryn was a variable rate digital data and teletypewriter transmission system incorporating special antijaming and graceful degradation capabilities for use with HF radio.

Mr. MAHON. How much has been spent on "Kathryn" and what happened to the project?

(The information follows:)

$3.2 million has been spent on Kathryn. This project is being dropped. With increased availability of satellite systems the use of HF radio communications is being greatly reduced in the worldwide system negating the requirement for this capability.

HIGH SPEED PAGE READER

Mr. MAHON. During fiscal year 1969 you awarded a contract for a fully automatic high speed page reader. How many are you buying and where are they being tested?

(The information follows:)

The contract calls for only one automatic high speed page reader. It will be tested at the Pentagon facility.

EQUIPMENTS PROCURED AND TESTED UNDER THIS PROGRAM

Mr. MAHON. Will you provide for the record a list of equipments procured and tested under this program element since fiscal year 1963, the cost for each through fiscal year 1969, and the status of each development, including successes and failures?

(The information follows:)

A complete list of equipments is not available at this time since the records prior to fiscal year 1966 have been retired. A total of $7.3 million has been approved for obligation under this program since fiscal year 1963. A partial list of equipment includes: (1) Kathryn—a variable rate digital data teletypewriter transmission system with special antijamming and graceful degradation capabilities. The total cost of this procurement was $3.2 million. This project is being terminated. (2) The ultra-high-speed page printer. The cost to date of this procurement was $165,300. Test results on development models of this equipment are being evaluated. (3) The ultra-high-speed tape reader. The cost of this procurement was $97,000. This equipment is presently undergoing test. (4) A page reader. The cost of this procurement was $453,499. A follow-on improved version of this item is being procured for testing.

Mr. MAHON. What role does DCA play in the Army's development of these equipments?

(The information follows:)

The developments in this program are not in the DCA area of responsibility. However full coordination is maintained with DCA to insure technical interface compatibility with their system.

TACTICAL COMMUNICATIONS

Mr. MAHON. The fiscal year 1970 request for tactical communications is ——— million. You requested $12.5 million for this purpose in fiscal year 1969, but the actual program was only $10.7 million. How and why was the fiscal year 1969 program reduced?

Colonel LAMB. $1 million scheduled for the Army area communications system development could not be used to go to contract and money was reprogramed to meet a SEA requirement for the development of a low frequency beacon for navigation of Army aircraft. Approximately $300,000 was reprogramed to meet the needs for funds on the advanced LAW and advanced rotary power equipment. The remaining reprogramed funds were used for such higher priority com-

munications-electronics areas as automatic data processing equipment, the tactical operation center and special warfare. This action could be taken by delaying action planned in the tactical communication area and rescheduling them at a later date.

ARMY AREA COMMUNICATIONS SYSTEM

Mr. MAHON. Will you describe the Army area communications system?

(The information follows:)

The system can best be described in terms of its purpose, characteristics, and concept of employment:

Purpose.—The Army area communications system provides the Army in the field with an organic capability for multichannel communications. AACOMS employs a variety of communications assemblages consisting of radio relay and multiplexing equipment and ancillary items mounted in shelter or trailer facilities to meet tactical field army requirements. These assemblages provide secure or nonsecure multichannel communications for command and control circuits. AACOMS assemblages are primarily utilized from brigade to Army rear, but by using system in varying combinations and quantities, AACOMS will meet common user, sole user, or special purpose needs for all types of field organizations through theater level.

General characteristics.—AACOMS is an integrated system of multichannel Field Army communications equipment providing secure or nonsecure, high quality circuits capable of telephone transmission via radio and cable. Many different types of communications components are engineered into vehicle or shelter facilities to develop the basic functional operational element (TOE end item) identified as a communications assemblage. Assemblages, communications security devices, trailer-mounted power generator sets, vehicles, and special tools and test equipment comprise a multichannel system. AACOMS assemblages, which are being developed to meet specific requirements (e.g., security and increased channel capacity) expressed by Combat Developments Command for the fiscal year 1970 Field Army, are grouped into the following systems:

(a) Low channel (6/12) capacity PCM.
(b) Medium channel (12/24) capacity PCM.
(c) High channel (48/96) capacity PCM.
(d) Tropospheric scatter.

Concept of employment.—AACOMS project managed systems will be employed throughout the theater of operations from brigade through theater army to furnish tactical multichannel communications links. Principal organizational levels at which AACOMS systems will be operational are division, corps, Army Command and Army area.

TACTICAL AUTOMATIC TELEPHONE CENTRAL OFFICE

Mr. MAHON. Please explain the tactical automatic telephone central office for which a contract will be awarded during fiscal year 1970?

(The information follows:)

This is just the official name of the Army triservice switch discussed in detail during our discussion of Project Mallard (p. 693).

SOUTHEAST ASIA AUTOMATIC TELEPHONE SYSTEM

Mr. MAHON. How will this differ from the Southeast Asia automatic telephone system, which will consist of some 70 automatic telephone exchanges and nine tandem switches, being installed throughout Vietnam? This was described to the committee as a tactical direct dialing telephone system.

(The information follows:)

These switches are the type we could have used in Southeast Asia if we had them. The switches being developed under this program are rugged tactical exchanges developed for field use. The Southeast Asia automatic telephone system is a tactical direct distance telephone dialing system using existing commercial equipment installed in air-conditioned buildings to meet an immediate need in a tactical situation where fixed facilities could be used. We cannot expect to be able to do this in future tactical situations, and we would be much better off in Southeast Asia today if we had the transportable tactical switch when we needed it.

TACTICAL AUTOMATIC SWITCHING SYSTEM

Mr. MAHON. For the last 3 fiscal years the Army has been funding in the PEMA account for tactical automatic switching system. The Army is requesting $10 million in fiscal year 1970 for 13 such systems. What relationship does this system have to the tactical automatic central office?

(The information follows:)

These are the same overall projects. The PEMA account is for procurement of equipment that does not require development. The R.D.T. & E. task is for the testing and development of the related elements of the system which still requires some R.D.T. & E. to complete development.

AIRBORNE COMMAND POST

Mr. MAHON. You are developing the AN/ASC–16, an airborne communications facility for "an airborne command post." Will you describe this airborne command post, its purpose, how much has been spent on this effort thru fiscal year 1969, what type of aircraft is involved, the estimated development costs, the number of airborne command posts required for the Army, and the estimated total procurement cost of the airborne command post, including aircraft and equipment?

(The information follows:)

The AN/ASC–16 is actually an airborne communications facility which will provide the ability for a standard Army aircraft (HU–1 or LOH) to be used as "an airborne command post." The facility will be a palletized assemblage of the latest standard airborne communications used in the Army division and packaged for ready installation in an Army aircraft. Installation of the assemblage in an aircraft will enable the battalion, brigade or division task force commander to communicate with his forces on the ground or higher headquarters while he is airborne. When not required the assemblage will be removed from the aircraft.

The Army has obligated $1.386 million for development of the facility through fiscal year 1969. The total estimated development cost is $2.2 million. A firm basis of issue for the facility has not yet been established, but a total procurement of 230 is being considered. Based on this quantity each facility should cost about $40,000. Since the facility is a palletized assemblage to be used with existing aircraft to increase the ability of the aircraft to be used on a command post, no additional aircraft cost is involved.

CORPS-ARMY AREA COMMUNICATIONS

Mr. MAHON. Will you describe the Corps-Army area communications on which you propose to find ——— million in fiscal year 1970 and on which you have spent $38.2 million through fiscal year 1969?

(The information follows:)

This is the same as the Army area communications described earlier. The word corps is included to show that the Corps command Communications System will use the same equipment on the Army area system.

Mr. MAHON. The fiscal year 1970 PEMA budget, page 19 of the P–1, contains a total request of $62.3 million for corps-Army area radio relay systems and a radio troposcatter system for command control. A total of $173.1 million has been funded for this same purpose during fiscal years 1968 and 1969. For what purposes were and are these PEMA funds being used, and why are we spending PEMA funds for corps-Army area communications still under development, according to your justification book, page 331?

(The information follows:)

These funds are being used to provide equipment for the Army area communications system (corps-Army area long distance common user and command links) equipment to the active Army. The Army area communications system is composed of a large number of equipments for a number of needs (radio relay, technical control, testing, switching, et. cetera). Some of the equipment has completed development and can be used. Other equipment such as the switch and some test and technical control equipment is still under development. We can procure that equipment which has completed development but we must still develop and test other components of the system.

Mr. MAHON. Why are we continuing a high level of effort on these tactical communications systems and at the same time going all out on Project Mallard?

(The information follows:)

You have to look at the time relations between the tactical communications systems and Project Mallard. The tactical system program is pre-Mallard. This equipment is for use in the present and short-range future needs of the Army. The Mallard program will produce the next generation of equipment.

TACTICAL AUTOMATIC TELEPHONE CENTRAL OFFICE

Mr. MAHON. Will any of the equipment we have discussed, such as tactical automatic telephone central office for which a contract will be awarded in fiscal year 1970, be used in Project Mallard?

(The information follows:)

Yes; as far as some of the components are concerned. We do not, however, at this time, think we can use the tactical automatic telephone central office for Project Mallard.

Mr. MAHON. How long will it take to develop the tactical automatic telephone central office and what is the estimated total development cost?

(The information follows:)

As indicated in reply to the earlier question on tactical automatic central office, the final development of the central office is almost complete. All that is required is testing and R. & D. of some equipment used with the system. Development should be completed in fiscal year 1972. Over the past 12 years the Army has invested about $27 million in tactical automatic switching. The $432,000 scheduled for fiscal year 1970 should complete the development effort.

Mr. MAHON. How many such central offices will be required for all the military services and what is the estimated total procurement costs therefor?

(The information follows:)

The answer on procurement cost is very tentative and subject to change based on final equipment specification. However, at this time we plan to procure a total of 132 central offices for all services. There will be 81 300-line exchanges and 51 600-line exchanges. The estimated total procurement cost of central offices for the services is $62 million.

Tactical Automatic Data Processing Systems Equipment

DIVISION TACTICAL OPERATIONS SYSTEM (DIVTOS)

Mr. Mahon. You have no request for funds in fiscal year 1970 for tactical automatic data processing systems (ADPS) equipment and your project listing has no funding for fiscal year 1969.

The committee has two fiscal year 1969 reprogramings pending, fiscal years 1969–89 amounting to $3.5 million and fiscal years 1969–88 amounting to $6.3 million for tactical ADPS equipment. According to these reprogramings, the $9.8 million will be used for a division tactical operations system (Divtos). The fiscal year 1969 and 1970 justification books fail to mention tactical ADPS equipment or Divtos. Will you explain Divtos, how it operates, and the requirement for this equipment?

(The information follows:)

Divtos will consist of computers and appropriate displays at the division and brigade levels, input/output devices down to battalions, and handheld input devices for use by companies, patrols, sensor monitoring stations, radar sites, and other surveillance and target acquisition sites. The total system will be mobile and use standard communications equipment and channels. Divtos will apply ADP to division tactical operations. This will significantly increase the battalion, brigade, and division commander's capability to command and control his tactical units and fire support elements. Through rapid transmission of accurate information and improved processing procedures, more responsive support will be immediately available to front line combat units. While the combat commander will still be required to make all critical decisions to include allocation for forces, approval of fire requests, and assessment of combat effectiveness, ADP will replace highly repetitive, complicated and time consuming manual tasks necessary for effective conduct of combat operations. The urgent requirement for Divtos emanated from Southeast Asia because of the inability of the present system to expeditiously process large volumes of information obtained through patrols, the expanded use of sensors, and other surveillance and target acquisition means. The development of Divtos will assist significantly in the rapid and accurate portrayal of the true tactical situation for higher echelons.

Mr. Mahon. Under advanced development, automatic data system for the Army in the field, program element 6.37.03A, you have been funding a tactical operations system "to automate selected operations, intelligence, and fire support coordination functions within the Army in the field." A test bed of computer hardware was located at USAREUR headquarters, tested, demonstrated, and the effort will be continued in fiscal year 1970 toward the possibility of an operational system for USAREUR. How much has been spent on this effort and how does TOS differ from Divtos beyond the fact it will be for use in divisions?

(The information follows:)

A total of $15.6 million has been spent on the USAREUR tactical operations system (TOS) through fiscal year 1969 with $0.95 million RDTE programed for fiscal year 1970. While TOS, Europe utilized bulky, off-the-shelf, transportable,

commercial equipment. Divtos will possess equipment that has been developed into a mobile, militarized system capable of sustained operation under those rigorous environmental conditions associated with varied combat operations. The purpose of tactical operations, Europe is to develop and test a provisional system to obtain military and scientific data for prescribing a subsequent Armywide TOS. Applications developed were aimed primarily at support of commanders at the Field Army, corps, and division levels.

Mr. MAHON. What was the urgency of submitting two fiscal year 1969 reprograming documents totaling $9.8 million for Divtos when no funds were requested in fiscal year 1969 or 1970 for this purpose?

(The information follows:)

This requirement resulted from a recognition and realization in Southeast Asia that significantly improved methods were needed to capitalize on information currently available to support operations at the division level. Methods include improved procedures for the transmission, processing, and integration of information to bring effective countermeasures against the enemy and to support friendly units. As a result of the above considerations, development for Divtos was initiated on a high priority basis.

DIVTOS RELATIONSHIP TO TACFIRE

Mr. MAHON. What is the relationship of Divtos to Tacfire?

(The information follows:)

Divtos and Tacfire are complementary. Divtos addresses operations, intelligence, and fire support coordination, while Tacfire encompasses fire support planning and execution. It is proposed that Divtos utilize militarized equipment currently being developed for Tacfire. Through use of Tacfire equipment, Divtos can be fielded earlier, at less cost, and will be compatible with other systems currently under development.

Mr. MAHON. When did you place the option in the Tacfire contract for Divtos equipment, and why was this done when you had no funds programed for Divtos in either fiscal year 1969 or 1970?

(The information follows:)

The 1967 Tacfire contract includes options for the purchase of quantities of hardware in addition to specific quantities to be developed and produced for Tacfire. The purpose of this option was to achieve equipment commonality between systems upon validation of the Tos concept and when confidence was achieved in its feasibility for ADP application.

Mr. MAHON. A Tacfire prototype is to be delivered in about mid-1970 and it will undergo engineering and service testing for about a year after that. Would it not be prudent to await the results of the Tacfire tests before committing funds for Divtos equipment? What would you do if Tacfire tests developed deficiencies in the computer equipment?

(The information follows:)

No apparent technical problems exist in the development of the Tacfire equipment which would preclude its availability for Divtos. In view of this, the fielding of the Divtos prototype system in Southeast Asia to support a critical combat requirement is considered to offer a high probability of success. However, if the Tacfire computer develops deficiencies, the contractor would be legally bound to correct them under the terms of the present contract. Divtos would be delayed accordingly and the Government would experience no monetary loss.

Mr. MAHON. The committee has been advised that you want to test DIVTOS in a division to determine at what level it can be best used. Does this mean it can be utilized possibly at higher command levels? If so, what impact will it have on the USAREUR effort?

(The information follows:)

The development of DIVTOS is in consonance with the USAREUR effort. Both contribute to the overall hardware and software development of an armywide tactical operations system. It is visualized that equipment used in DIVTOS may be used at field Army and corp levels as well as division in the armywide TOS. As a result, the commercial equipment in the USAREUR effort will be replaced when the armywide system is fielded.

Mr. MAHON. For what purposes was the $7 million used in fiscal year 1968 for tactical ADPS equipment?

(The information follows:)

This $7 million was programed and applied to the Tacfire program in fiscal year 1968. (In fiscal year 1968, Tacfire was listed under tactical ADPS equipment.)

DIVTOS FUNDING

Mr. MAHON. How will the $9.8 million in reprogramed fiscal year 1969 funds be utilized in connection with DIVTOS?

(The information follows:)

The $9.8 million will be utilized as follows:

	Millions
Systems engineering (this includes preparation of a functional system design requirement, interface with surveillance target acquisition and night operations, and adaptation of system specifications to Tacfire hardware)	$1.0
Purchase of hardware	5.8
Software and system maintenance	2.0
Hardware system integration and contractual requirements	1.0
Total	9.8

Mr. MAHON. Will you require funds for Divtos in fiscal year 1970? If so, how much?

(The information follows:)

Funds required for fiscal year 1970 presently total ——— million. This amount will be used for purchase of spare parts, software development, testing, and contractual and in-house requirements.

Mr. MAHON. What is the estimated total cost of developing DIVTOS?

(The information follows:)

The total estimated developmental cost of DIVTOS is ——— million.

Mr. MAHON. If DIVTOS development were successful, how many would be required Army-wide and what is the estimated total procurement costs for DIVTOS?

(The information follows:)

Since Divtos is considered a prototype, its total costs are visualized as ——— million R.D.T. & E. However, if proven successful and cost effective, and a decision is made to equip the active Army, 26 systems would be required at an estimated cost of ——— million.

Mr. MAHON. Are there any funds in the fiscal year 1970 PEMA budget, or in previous fiscal years, for DIVTOS? If so, how much and for what purpose?

(The information follows:)

No PEMA funds have ever been requested for DIVTOS. This includes fiscal year 1970.

Mr. MAHON. Are there any other funds in the R.D.T. & E. or O. & M. budget for fiscal year 1970 for DIVTOS? If so, describe. How about previous years?

(The information follows:)

There are no other funds in the R.D.T. & E. or O. & M. budget for fiscal year 1970 or prior, ——— million R.D.T. & E. funds are presently programed for fiscal year 1971 to complete the ——— million R.D.T. & E. program.

Aerial Combat Surveillance Systems

Mr. Mahon. For what purpose will the ——— being requested in fiscal year 1970 for aerial combat surveillance systems be utilized?

Colonel Lamb. The ——— will be used to complete development of a new distance measuring subsystem for the AN/UVS–1 visual airborne target location system; to correct deficiencies revealed during special evaluation tests and operational evaluation of the AN/UVS–1; and continue monitor-participation in the triservice joint inflight data transmission system program.

Mr. Mahon. In what type aircraft and for what missions will the equipments being developed be used?

Colonel Lamb. The equipment will be used in a UH–1 helicopter to accurately locate targets for artillery and/or air strikes.

Mr. Mahon. You requested $1.6 million for this purpose in fiscal year 1969, yet the actual program is shown as $2.6 million. How and why was this program increased during fiscal year 1969?

Colonel Lamb. $1.0 million was provided from the OSD emergency funds to add an infrared remote gun flash detector to the AN/USV–1 and to support the Southeast Asia test.

Mr. Mahon. Does the airborne target location system relate in any way to the sensor package developed for the YO–3A aircraft?

Colonel Lamb. No. Size and weight preclude consideration for use in the YO–3A airplane.

Mr. Mahon. Will any of the equipment being developed under this program element be used in the ——— aircraft we previously discussed?

Colonel Lamb. No.

Ground Based Surveillance System

Mr. Mahon. You are requesting ——— in fiscal year 1970 for ground based surveillance systems, an increase of ——— over the fiscal year 1969 program according to the justification book.

You requested $3.8 million for this purpose in fiscal year 1969, but the approved program was only $2.8 million. How and why was this program increased, and to what total amount?

Colonel Lamb. The program was increased during fiscal year 1969 by emergency funds of $4.45 million to purchase an engineering service test model of the automatic atmospheric sounding set AN/TMQ–19 and for the development of modified models of the Camp Sentinel foliage penetration radar for Southeast Asia. The procurement of these models was not programed in the fiscal year 1969 R.D.T. & E. program and emergency funds were used to satisfy the requirement.

Mr. Mahon. Will you explain why the Army is developing field meteorological data sounding system AN/UMQ–7, and the meteorological balloon systems?

Colonel Lamb. Meteorology data (wind direction and speed, air temperature and density) up to high altitudes is mandatory for the Army to insure accurate first round artillery fire for effect for both

conventional and special warheads and for the prediction of nuclear effects. The present meterology data gathering system has been in the Army for over 20 years, which is costing more to maintain than to replace and the system lacks the tracking accuracy necessary to meet present day requirements.

Mr. MAHON. How much have you funded through fiscal year 1969 for meteorological equipment and systems?

(The information follows:)

The funds through fiscal year 1969 are as follows:
Fiscal year 1969, $3,400,000; fiscal year 1968, $920,000; fiscal year 1967, $748,000; fiscal year 1966, $852,000.

COORDINATION WITH OTHER SERVICES

Mr. MAHON. In what way have you utilized Navy and Air Force developments in this area? Give some specifics.

Colonel LAMB. During the period 1959 through 1965 the Army Integrated Meteorological Systems Committee held meetings twice a year to coordinate requirements and developments in the meterological area. Presently, the Army, Navy, and Air Force have an agreement whereby meterological requirements are reviewed before development is initiated and meteorological equipments are coordinated prior to issue.

AN/TPQ–28 COUNTERMORTAR RADAR

Mr. MAHON. What have you done and what are you doing in the area of countermortar radar developments?

Colonel LAMB. The development of a countermortar radar is presently concentrated in the AN/TPQ–28 omnidirectional countermortar radar for Southeast Asia. The same technology and operational concept of the AN/TPQ–28 will be used to develop a countermortar system to meet worldwide requirements when the AN/TPQ–28 development is completed.

Mr. MAHON. How much has been funded through fiscal year 1969, in all R.D.T. & E. program elements, for countermortar radar development efforts?

(The information follows:)

The R.D.T. & E. funds through fiscal year 1969 for countermortar radar developments are as follows:
Fiscal year, 1969, $3,300,000; fiscal year 1968, $11,040,000; fiscal year 1967, $6,060,000; fiscal year 1966, $1,350,000.

Mr. MAHON. Reprograming action fiscal year 1969–88 provided $1.7 million to modify 2 AN/MPQ–35 and 6 AN/TPN–18 radars as countermortar and artillery radars. What effect will this have on your fiscal year 1970 program?

Colonel LAMB. The modification of the AN/TPN–18 and AN/MPQ–35 to provide them with the additional capability as counter weapons radars will not effect the fiscal year 1970 program. This modification will provide detection and general location data of enemy weapons to those air bases not programed to receive more accurate location means. The requirement for accurate mortar and artillery weapons location for Southeast Asia and worldwide operations is still valid and the fiscal year 1970 program is directed to meet this requirement.

COUNTERBATTERY RADAR DEVELOPMENT

Mr. MAHON. Will you describe the counter battery radar development for which you are requesting ——— million in fiscal year 1970?

Colonel LAMB. The counterbattery radar development for fiscal year 1970 will be a continuation of an exploratory development of a phased array antenna. The antenna and its monopulse assembly will be combined with an off-the-shelf transmitter and receiver and new processing equipment to make a test bed counterbattery radar. The test bed system will be used to evaluate the capabilities and limitations of the antenna and its components.

ARMY AND AIR FORCE DEVELOPMENTS IN MAN-PORTABLE RADARS

Mr. MAHON. General Betts, your statement mentions the development of a man-portable radar designed by the limited war laboratory. In early May 1969, the Air Force Aeronautical Systems Division awarded a contract to RCA for 20 hand-held tactical radar sets reportedly able to monitor remote areas and identify moving targets such as walking and running men, jeeps, trucks, and tanks. Are you familiar with these radars? Does the Army have similar equipmnet?

(The information follows:)

The Air Force purchased hand-held tactical radar set is the RCA model 2019, now designated AN/PPS–11. The system is a lightweight moving target detecting radar to direct small arms fire in all weather and visibility conditions. The maximum range capability of the system is 500 meters. The Army does not have similar equipment.

Mr. MAHON. If the Army has similar equipment, why would the Air Force contract for such equipment? Is it because they are better than the Army equipment?

(The information follows:)

The Army does not have similar equipment.

Mr. MAHON. Will you check with the Air Force and have them provide for the record at this point the Air Force requirement for such equipment?

(The information follows:)

The Air Force Limited War Air Base Defense Program Office stated that the requirement for such equipment is contained in the PACAF required operation capabilities No. 13–68, subject: "Intrusion Detection Equipment". The PACAF document is classified and has been furnished separately to the committee.

NUCLEAR SURVEILLANCE SURVEY

Mr. MAHON. The request in fiscal year 1970 for nuclear surveillance survey is ———. Will you describe this program?

Colonel TOBEY. Nuclear surveillance survey provides the Army with specialized tactical military equipment for the detection and measurement of nuclear radiation from fallout over large areas and on personnel, equipment, food, and water. It also includes engineering development of a tactical dosimeter in a cooperative effort with the Air Force and standardizing the ——— DT–311, in conjunction with the Navy. A new capability in a tactical device, AN/TSS–6, to measure the yield of a nuclear burst is being realized.

Mr. MAHON. What did you accomplish in fiscal year 1969 in develop-

ing specific equipments and what do you hope to accomplish in fiscal year 1970?

Colonel TOBEY. A contract for 30 models of the tactical survey meter and vehicular radiac set was let and some prototypes were furnished for the main battle tank program. Four models of the aerial radiac system were procured for installation in helicopters and work was initiated to integrate the system into the Mohawk aircraft. Tests were performed on the radiac calibrator, ——— aerial radiac and nuclear yield measurement set. Funding for 1970 will allow only a limited program. A contract will be let for ——— models of the IM–185 tactical dosimeter, the radiac calibrator will become standard, and final engineering and service testing will be accomplished for the aerial radiac, the nuclear yield measurement set, and the tactical survey meter/vehicular radiac set.

IDENTIFICATION, FRIEND OR FOE (IFF) EQUIPMENT

AIR TRAFFIC CONTROL RADAR BEACON SYSTEM

Mr. MAHON. You are requesting ——— in fiscal year 1970 for identification, friend or foe—IFF—equipment. According to the project listing these funds will be used for air traffic control radar beacon system, IFF Mark XII system. Does the Navy and Air Force use similar equipment?

Colonel LAMB. The IFF Mark XII is a joint Army, Navy, and Air Force system. The radar beacon system is a ground interrogator for use with air defense radars and is part of the overall IFF system. The Air Force and Navy do not have similar Mark XII compatable interrogators.

Mr. MAHON. How were the fiscal year 1969 funds used, and how will the fiscal year 1970 funds be utilized?

Colonel LAMB. The fiscal year 1969 funds were used to complete service tests on interrogators AN/TPX–46 and AN/TPX–50; transponder AN/TPX–72; and MARK XII cryptographic equipment. The fiscal year 1970 funds will be used for continued engineering developments of the AN/TPX–46 ground interrogator for use in new acquisition radar developments. Battlefield IFF engineering development will be initiated contingent on progress in the advance developments.

SUPPORTING DEVELOPMENTS FOR COMMUNICATIONS

Mr. MAHON. You are requesting ——— million in fiscal year 1970 for supporting developments for communications, an increase of ——— million over the fiscal year 1969 program. What is the reason for the increase funding?

Colonel LAMB. The initiation of the project for a short-range mission radio for Special Forces is a new project in this program area; it is estimated that this effort will require the increased funding.

AN/PRC–70 RADIO SET

Mr. MAHON. Will you describe the AN/PRC–70 radio, when you initiated development of this radio, and how much has been spent on this effort through fiscal year 1969?

Colonel LAMB. The AN/PRC–70 is to be a back-pack radio providing extended frequency range, multimode communications for Special Forces and conventional long-range patrols. Through fiscal year 1969 we have spent or committed $6.2 million on this effort. This effort was first initiated in fiscal year 1966.

Mr. MAHON. What is the estimated total cost of developing the AN/PRC–70 radio?

Colonel LAMB. $7.4 million.

Mr. MAHON. Have there been any slippages or cost increases in the development of this radio?

Colonel LAMB. No, sir.

Mr. MAHON. When will a technical data package be delivered for this radio, and when do you hope to eventually compete it?

(The information follows:)

Part of the technical data package is scheduled to be delivered with the service test models in fiscal year 1972. The remainder will be delivered as part of the first production contract in fiscal year 1975. The development of the radio is currently expected to be completed in fiscal year 1973.

PROGRAM ACCOMPLISHMENTS AND OBJECTIVES

Mr. MAHON. Will you describe your fiscal year 1969 accomplishments under this program element, and how the ——— million in fiscal year 1970 will be utilized?

(The information follows:)

Development of the AN/MSQ–85 auto visual unit and the AN/UIH–6 public address set required for psychological operations in SEA was completed. Action was taken to award a contract for engineering and service test models of the AN/PRC–70. Effort was continued on a number of small projects for jungle warfare and electronic test equipment.

The planned use of the ——— million is:

——— short-range mission radio for special forces.
——— techniques to improve jungle communications.
——— AN/PRC–70.
——— electronic test equipment.
——— installation kits for C–E equipment.
——— improvements in antenna mast.

ELECTRONIC WARFARE

Mr. MAHON. You are requesting a ——— percent increase in funds for engineering development in the area of electronic warfare. The fiscal year 1970 request is for ——— million as compared with $7.6 million in fiscal year 1969 and $2.7 million in fiscal year 1968. What is the reason for the very large increase in this area?

(Information is classified and has been furnished separately to the committee.)

Mr. MAHON. What new items of equipment in the area of electronic warfare will be initiated in engineering development in fiscal year 1970?

(Information is classified and has been furnished separately to the committee.)

Mr. MAHON. Describe the new items, the requirement for the items, the proposed capabilities of the items and the anticipated development cost of each item.

(Information is classified and has been furnished separately to the committee.)

Mr. MAHON. How firm are your estimates in this area? Is the ——— million based on detailed plans for specific programs?

Colonel LAMB. Of the ——— requested, $13.3 million is for engineering development of communications countermeasures equipment of which ——— is for the CEFIRM Leader program. Our programs are based on the enemy threat as provided by the intelligence community. In that respect there is a degree of uncertainty. The actual programs in question are based on very detailed plans since the equipment has progressed through the R. & D. chain from exploratory development, advanced development, and finally engineering development.

COMBAT FEEDING, CLOTHING, AND EQUIPMENT

Mr. MAHON. You are requesting $3.8 million for "Combat feeding, clothing, and equipment" as compared with $2.9 million in fiscal year 1969. How many individual items are included in this program element?

(The information follows:)

The program element "Combat feeding, clothing, and equipment" is comprised of the following four projects:

Environmental control equipment, such as heaters, air conditioners, and their components and accessories.

Tents and organizational field equipment, such as tents, food service equipment, bath, laundry, and other support equipment.

Individual combat protective clothing and equipment, such as combat uniforms, footgear, headgear, loadbearing equipment, and body armor.

Combat feeding systems, such as combat rations for individuals as well as for unit or small detachment feeding.

COLD WATER DETERGENT DEVELOPMENT

Mr. MAHON. How much money do you plan to spend on cold water detergent development in fiscal year 1970? What is the reason for the Army's effort in this area?

(The information follows:)

The Army needs to increase the productivity of field laundry assemblies and accelerate laundry service to field elements. An effective cold water detergent has potential in accomplishing these goals by reducing fuel requirements for heating water, ultimately leading to more efficient service by elimination of the water heating components of the field laundry. However, no R.D. & E. money will be spent on "cold water detergent" in fiscal year 1970 or future years. Search for a suitable cold water detergent is now being pursued by investigation and evaluation of commercially available products.

Mr. MAHON. What items under this heading have you completed advanced development on and plan to initiate engineering development on in fiscal year 1970?

(The information follows:)

Engineering development will be initiated on the following items in fiscal year 1970:

Lightweight, cold weather boot.
Chemical-biological protective clothing for explosive ordnance demolition personnel.
Antilaser goggles.

Cold weather mask.
Wet weather handwear.
Lightweight, wet weather parka and trousers.
Lightweight, cold weather, POL protective handgear.
Chemical-biological protective handwear.
Heated, holding and evacuation casualty bag.
Map cover.

DEVELOPMENT OF A NEW CANTEEN CUP

Mr. MAHON. One of the items mentioned in the descriptive summary is a 2-quart collapsible canteen cup. How much money had been spent by the Army in development of this canteen cup? Where was this development effort performed, by what in-house, or what contractor organization?

(The information follows:)

The Army has spent $58,550 to date in development of this canteen cup. The in-house effort in this development is being performed at the U.S. Army Natick Laboratories, Natick, Mass. Two contractor organizations, Mitron R&D Corp., Waltham, Mass., and Roland Telner Co., Inc., Everett, Mass., have performed work on this item.

NIGHT VISION

Mr. MAHON. Submit a list of the individual items included in the ——— million requested in fiscal year 1970 for "Viewing and Illumination."

(The information follows:)

A 1-kilowatt xenon searchlight, a far infrared target indicator, a handheld searchlight, second generation starlight scope and crew served weapons sight, night vision goggles, second generation night observation device, night vision binoculars, night sight for TOW missile, and a helicopter mounted low-light level television system.

TRAINING DEVICES

Mr. MAHON. You are requesting $2.7 million for fiscal year 1970 for "Training Devices" as compared with $3.9 million in fiscal year 1969 and $2.7 million in fiscal year 1968. What individual items are included in the $2.7 million? How much of the $2.7 million is for completion of the simulated helicopter flight training system?

(The information follows:)

This program element consists of three projects: Army support to the naval training device center (NTDC), the synthetic flight training system (SFTS), and nonsystems training devices. The first one is the Army contribution to the support of the in-house professional capability at NTDC. This support arrangement stems from an Army/Navy agreement dating back to 1950, and for fiscal year 1970 amounts to $550,000. The second project I mentioned is the development of the SFTS and it is programed for $1,810,000 in fiscal year 1970. There are two items in this project. One is the development of the basic system, consisting of four UH–1 helicopter cockpit modules, the instructor station, and the computer support; the other item is the development of a CH–47 helicopter cockpit module for integration into the basic system. The third project is for the development of training devices that have general application; that is, the application is not limited to a particular system. We have three items in this project. An area radiac survey trainer is being developed that will permit us to train personnel in detection and mapping of radioactive areas without being subjected to the hazard of radiation contamination. A second item is the development of a target for tank gunnery training. What we want to do here is to improve our training of tank gunners by use of a target that will indicate right away when a hit has been scored. If the gunner does not get an indication of a hit, he knows he must fire again immediately and must modify his aim. This is certainly the

kind of feedback he gets in a real combat situation. This target will be capable of operating in a stationary form or as a moving target. The third item is the development of an armed aircraft qualification range system that will permit recording hits on ground targets at a central location remote from the firing area. This range system will be used to train aircraft crews in gunnery and to maintain proficiency after initial training. The nonsystems training device project is programed for $340,000 in fiscal year 1970.

DEVELOPMENT OF A MOVING TARGET FOR SMALL ARMS RANGES

Mr. MAHON. What is the Army's requirement for the development of a moving target for small arms ranges? Aren't such moving targets available now? What is the estimated development cost of such a moving target?

(The information follows:)

We are in the process of evaluating the need for a moving target for use on small arms ranges. The Army's combat development command has prepared a draft requirement document that proposes the development of a radio controlled moving target system for small arms training. This requirement document is being coordinated with field agencies in the Army to insure that it is a valid requirement and, if valid, to insure that the proposed target system is practical. The people working on this want a self-powered portable device that can be used on existing ranges and in tactical training areas for the rifle squad and platoon. At some of our training installations, field expedients have been developed for this purpose. While having some merit, these expedients have not satisfied the requirement as combat development command sees it. What this means is that the individual soldier and the rifle squad as a team do not get adequate training in firing at moving targets. When the coordination and evaluation is completed in the field, the requirement will be submitted to Department of the Army Headquarters for review and approval. One of the things to be checked thoroughly during this whole process is to determine if there are any commercial target systems available that meet the Army's requirement. To the best of our knowledge now, there are none. I would estimate that the development costs of such a target system would be about $350,000. Since we are developing a tank gunnery target system that has some of the same characteristics, the cost could well be less.

MAPPING-GEODESY

Mr. MAHON. You are requesting a very large increase in engineering development in the area of mapping and geodesy. The fiscal year 1970 request is for $4 million as compared with $866,000 in fiscal year 1969 and $705,000 in fiscal year 1968. What are the basic reasons for an increase of this magnitude?

Colonel TOBEY. The basic reasons for the increase of funds in engineering development for mapping and geodesy is to provide funds for previously unfunded approved developments. The major developments for which these funds are required are the long-range position determining system and the topographic all-weather mapping system (TAWMS).

LONG-RANGE POSITION DETERMINING SYSTEM

Mr. MAHON. Describe the long-range position determining system which is to be initiated in fiscal year 1970. Compare the capabilities of the proposed system with the capabilities of present equipment and give the estimated total development cost of the system and the Army's requirement for such systems.

(The information follows:)

The long-range position determining system (LRPDS) is an electronic ranging system used to provide position location for artillery survey and target acquisition. It consists of three major components: (1) the master station, (2) the airborne unit, and (3) the manpack unit used on the base stations and the points to be located. It will locate 24 manpack units within a corps area of operation (200 kilometer or 120 miles in range) in a half hour at an accuracy of 20 to 70 meters (65.6 to 229.6 feet), depending on the distance from the base stations.

The present positioning equipment consists of conventional surveying tools and methods, such as transits (theodolites), tapes and calibrated rods used by a large number of trained surveyors during daylight hours in moderate weather. These surveys are performed in occupied friendly territory. To position targets at longer ranges, reconnaissance photography combined with existing map information must be used. The advantage of LRPDS is that positions can be located with sufficient accuracy in less time and with fewer personnel than current methods allow.

Development cost on the present system is estimated at ——— million for the complete system.

The Army requires a rapid and accurate positioning system that will provide artillery survey and position determination in three dimensions on a real time basis commensurate with the highly mobile divisions that move every few hours. The LRPDS can provide this capability and also allow the artillery to convert from present adjusted fire methods to predicted fire.

AIRBORNE CONTROL SURVEY SYSTEM

Mr. MAHON. Describe the airborne control survey system which you plan to initiate engineering development of in fiscal year 1970. How will this system be used? What equipment is being used for this function at the present time? What are the increased capabilities of the proposed new system? What is the estimated total development cost of the new system and what is the Army's numerical requirement for such systems if it is successfully developed?

(The information follows:)

The airborne control survey system (ABC) is a short-range position determining system that employs microwaves to establish highly accurate ranges to fixed or moving vehicles along radio range of sight. The system consists of two responders and a helicopter-borne interrogator that automatically measures the slope distance between two responders and visually displays these ranges in 5 metric digits. The position of the helicopter can then be computed and various techniques can be employed to determine ground position.

The fiscal year 1970 effort is a followup evaluation of the Vietnam test effort of a commercial airborne control survey system. The equipment was procured for Vietnam on an emergency basis and performed well when operable, however, because of maintenance problems the system was withdrawn.

Because of the problems with the system in RVN the fiscal year 1970 effort will compare the airborne control system capability with other positioning systems such as the long-range position determining systems (LRPDS) and the visual airborne target locating system (VATLS). The possibility of positioning the helicopter to ABC system accuracy, using LRPDS or VATLS base stations, will be explored. This will combine two capabilities in the same system and avoid development, procurement, and logistical costs of fielding another system.

The system, if developed, will be employed to establish artillery and engineer survey control quickly and accurately. Current methods employ the use of surveyors and conventional survey equipment and techniques that require considerable manpower and are slow and cumbersome. The new system will provide the same data with a reduced manpower effort, a faster reaction time, and less manpacked equipment. The estimated total cost of the development is ——— million. The deployment of the system is programed for ——— which would require approximately ——— systems.

General Combat Support

Mr. Mahon. You are requesting ——— million for "General Combat Support" as compared with $21.2 million in fiscal year 1969, and $20.4 million in fiscal 1968. The fiscal year 1969 budget requested $25.9 million for this effort. What items requested in fiscal year 1969 were deleted in this reduction? Which of the deleted items are in the fiscal year 1970 request?

(The information follows:)

Three actions changed the funding level of this element. First certain projects concerning electrical power sources and ——— million were taken from "General Combat Support" to another program element. A second action transferred ——— million to the "Combat Support" program element in exploratory development. Lastly there was an increase of ——— million resulting from a pro rata distribution of facilities and installation support funds to all program elements. None of the above actions materially affected the work effort on any of the developmental items inthe General Combat Support program element.

Vietnam Laboratory Assistance Program

Mr. Mahon. Describe item D470, "Vietnam Laboratory Assistance Program," for which you are requesting $1 million. This appears to be a new item not funded in fiscal years 1968 and 1969.

Colonel Lamb. Vietnam Laboratory Assistance Program, Army was started in second quarter fiscal year 1969. The purpose of this program is to provide the Army materiel command representatives in Vietnam a means of tasking their parent laboratories directly to undertake quick engineering solutions to problems encountered in the field. The restrictions are that the tasks must be coordinated with USARV, cost less than $50,000, and be provided to RVN in 3 to 9 months.

System Integration Border Security

Mr. Mahon. You are requesting ——— for "System Integration Border Security." Describe this program and discuss its relationship to the effort under "Defense Communications Planning Group."

(The information follows:)

The program was initiated in 1968. The requirement was derived from a Combat Developments Command study on border security anti-infiltration operations which was precipitated by continuing enemy infiltration along border areas in Southeast Asia and Korea. The objective of the program is to conduct studies, investigations and testing to ———. An essential part of the program is coordinating and encompassing related activities of DOD, the Army and the other services. Therefore the program ——— portion of the border security program.

Mr. Mahon. List the individual items included under "System Integration Border Security." How much of the ——— would go to the Honeywell contract?

(The information furnished is classified.)

Mr. Mahon. When will Honeywell's detailed systems analysis be completed?

(The information follows:)

The initial phase of the Honeywell contract will be completed this quarter and they will begin writing their final report in early October. This report will cover

the work accomplished with fiscal year 1968 funds but does not include a contract modification using fiscal year 1969 funds which is being processed to extend the study to worldwide scenarios and to refine and exercise the simulation model.

FORKLIFT TRUCK DEVELOPMENT

Mr. MAHON. What is your requirement for a 15,000 pound rough terrain forklift? What will the development of such a forklift cost?

General BETTS. The 15,000 pound rough terrain forklift truck will be used in a theater of operations to handle large, irregular (outsized) loads and container consolidated thru—shipped unit supplies, such as CONEX and TRI-CON containers, weighing up to 15,000 pounds. The R.D.T. & E. cost to develop this item is estimated to be $1,500,000.

PREFABRICATED AIRFIELD SURFACE

Mr. MAHON. You are requesting ——— for continued effort in "Prefabricated Airfield Surface." Both the Marine Corps and the Air Force have also expended effort in this area. What unique requirements does the Army have in this area which are not shared by the Air Force and the Marine Corps?

General BETTS. The requirements for all three services are the same. Army Engineers must be capable of constructing airfields which will accommodate Air Force and Navy aircraft. There is therefore a close coordination of our development efforts. This coordination includes reviewing each others requirements documents and joint meetings on development reviews.

FIELD PRINTING AND DISTRIBUTION EQUIPMENT FOR SPECIAL WARFARE

Mr. MAHON. What is included in the $225,000 program for development of equipment for "Field Printing and Distribution Equipment for Special Warfare"?

(The information follows:)

The "Field Printing and Distribution Equipment for Special Warfare" program provides the Army with essential items of field printing equipment and supplies in support of special warfare (psychological) operations. The $225,000 programed for fiscal year 1970 provides for development of a three language ideographic composing machine (Chinese/North Korean/Japanese) to provide rapid photocomposition of ideographic text material for use in propaganda leaflets and other publications; and, for development of type fonts and typemasters for rapid and efficient composition of precoded foreign language material by nonlinguistic operators on standard Varityper composing equipment.

PORTABLE POWER PLANTS

Mr. MAHON. You are requesting a large increase in the development of portable power plants. You are requesting $5.1 million in fiscal 1970 as compared with $1.9 million in fiscal year 1969. What new programs will be initiated in engineering development in this area in fiscal year 1969?

(The information follows:)

New items include a 150 to 200-kilowatt turbine engine-generator set, a 1.5-kilowatt Rankine cycle power plant, 15-, 30-, and 60-kilowatt generators as a part of the DOD standard family of generators, and a 10-kilowatt turbo alternator.

Mr. MAHON. Provide a complete listing of the individual items included in the $5.1 million program.

(The information follows:)

The following items are included: a family of diesel powered generator sets in the range of 15 to 200 kilowatts, turbine generators sets, 300-watt fuel cell and Rankine cycle silent power sets.

Mr. MAHON. What are the deficiencies in current engine generators which you are trying to overcome through this program?

(The information follows:)

We are working to provide electrical power sources with longer life, higher reliability, lighter weight and quieter operation.

EARTH-MOVING EQUIPMENT

Mr. MAHON. You are requesting ——— for development of "Earth Moving Equipment." What items of equipment are included here, at what development cost in fiscal year 1970 and at what total development cost for each item of equipment?

(The information follows:)

During this year the Army has recognized a requirement for a family of helicopter transportable construction equipment. As a consequence we now propose to fund this project at ——— for fiscal year 1970. This family of engineer construction equipment which goes by the acronym "FAMECE" would consist of a common power module and a variety of work modules such as a dozer, grader, front-end loader, and compactor. As each of the modules is helicopter transportable it gives the Army mobility not available with off-the-shelf items. This is programed at ——— for fiscal year 1970 with a total development cost of ——— for the entire family. In addition there ——— for a liquid distributor for our new dust palliatives. The total cost for this item is ——— There is ——— to complete the ——— development of the universal engineer tractor, designed for combat engineer troops. The remaining funds are for component development.

CARGO-HANDLING AND TERMINAL EQUIPMENT

Mr. MAHON. What cargo handling and terminal equipments are included in Project D598 for which you are requesting $450,000?

(The information follows:)

The $450,000 for Project D598 is programed to support developmental effort in the following areas relating to cargo handling and terminal equipment: Steel TRI-CON containers; ammunition TRI-CON containers; aluminium TRI-CON containers; fiberglass reinforced plywood TRI-CON containers; special lightweight pallets; family of shipboard cargo handling equipment; 8-by 8-by 20 feet refrigerated containers.

AUTOMATIC TEST EQUIPMENT—INTERNAL COMBUSTION (ATE–IC) ENGINE

Mr. MAHON. Describe the ATE–IC engine program for which you are requesting ——— million.

(The information follows:)

ATE–IC are the initials for Automatic test equipment—internal combustion engine." The purpose of the program is to develop test equipment using state-of-the-art techniques which permit reduction in time and manpower requirements, while at the same time increasing the quality of the work performed. The principal goal of the present development is to provide a set of this equipment for use at organizational level by fiscal year 1971, with direct and general support

sets to be developed later. Successful developments in this field can quickly pay for themselves in terms of increased availability of equipment and reduced manpower requirements for maintenance.

PROJECT MUST

Mr. MAHON. You are requesting $950,000 for Project MUST which involves development of a medical unit self-contained transportable. The descriptive summary states that MUST hospitals are in operational use in Vietnam and have been widely acclaimed. If they are so successful, why must we continue spending development funds on them?

(The information follows:)

The MUST hospitals currently in Vietnam represent only a portion of the development effort. Other subsystems of the MUST hospital not in Vietnam and currently in development are the food service subsystem and the water and waste management subsystem. The dolly for transporting some of the sections of the MUST is also still undergoing development. The $950,000 is requested for the continuation of the development of these subsystems.

Mr. MAHON. How much has been spent on this program to date?

(The information follows:)

From fiscal year 1963 through fiscal year 1969, $16.6 million has been spent on this program.

CHEMICAL-BIOLOGICAL DEFENSE

Mr. MAHON. You are requesting $4 million in fiscal year 1970 for engineering development in the area of chemical-biological defense as compared with $5.5 million in fiscal 1969. You requested $6.2 million in fiscal year 1969 in this area. What items were deleted or stretched out in the reduction from $6.2 million to $3.5 million in fiscal year 1969? Which of items deleted in fiscal year 1969 are included in the fiscal year 1970 program?

(The information follows:)

The Portichrome biological alarm was deleted due to technical difficulties and pending a Combat Developments Command study to critically define the overall biological warning requirements. It remains in advanced development for fiscal year 1970. The collective protection materiel for the command post vehicles program was stretched out in 1969. It should be completed this year.

Mr. MAHON. What items of chemical-biological defense equipment were adopted as standard in fiscal year 1968? What items were adopted as standard in fiscal year 1969?

(The information follows:)

In fiscal year 1968 we standardized the M-72 chemical agent identification and training set. The XM-28E4 lightweight mask for riot control agents and the XM-3 concealed personnel detector, aircraft (People sniffer) was standardized for limited production. In 1969, the M-8 portable chemical agent automatic alarm, which is our first automatic alarm, and the M-52 chemical operations and training system were adopted as standard.

Mr. MAHON. Describe the collective protection equipment for a series of vehicles, vans, and shelters which you propose to enter into engineering development in fiscal year 1970.

(The information follows:)

We will start engineering development on a modular type collective protection system for the improved Hawk missile system shelter. It is comprised of an air filtering and purification unit, air ducts, airlock entryway and the necessary con-

trols for maintaining the required positive pressure in the working area. We will complete engineering devlopment on similar collectve protection systems for the M-577 command post vehicle and the M-292 expandable van truck.

TESTING

Mr. MAHON. You are requesting ——— million for testing as compared with $43.9 million in fiscal year 1969 and $42.2 million in fiscal year 1968. Last year, the budget request for testing was for $51.5 million. The program was reduced to $43.9 million. Also last year, it was indicated that the fiscal year 1968 program would be $47.4 million and it now turns out the actual 1968 program was $42.2 million. Is the fiscal year 1970 estimate probably overstated in the area of $5 million also?

(The information follows:)

The difference between the budget requests for fiscal year 1968 and fiscal year 1969 and the reported figures for those years result principally from a removal of two program elements, congressional cuts and Army reprograming actions which were reported to Congress. The removal of the Deseret testing and Dugway Proving Ground testing elements accounted for a decrement of $18,485 million in fiscal year 1968 and $16,530 million in fiscal year 1969. Reprograming actions brought them back to the reported figures. The fiscal year 1970 request does not have those elements in it and represents minimum funding for the testing element. It is not overstated by $5 million.

A detailed explanation of the changes in the budget is shown below:

RECAPITULATIONS

(All funds in millions)

	Fiscal year 1968	Fiscal year 1969
Budget request	$53.4	$51.5
Congressional cut	—.2	—3.7
Army reprograming	—1.3	+3.8
Distribution of facilities and installations cost	+8.8	
Pay adjustment		+8.8
Transfer of Deseret and Dugway Proving Ground	—18.5	—16.5
Reported figure	42.2	43.9

Mr. MAHON. What would be the effect of holding this effort to the fiscal year 1969 dollar level?

(The information follows:)

The request for ——— million for testing is considered to be a minimum request. Many desirable projects such as improvements in instrumentation and methodolgy with possible attendant future conservation of resources have had to be deferred. Present manpower constraints coupled with increased wartime production acceptance testing has created a sizable backlog in R. & D. testing. Holding this effort to the fiscal year 1969 dollar level would result in further cutbacks in testing personnel, possible closing of one or more test agencies, increased backlog in R. & D. testing, and further deferrals of needed improvements in test instrumentation and methodolgy.

ARMY TEST AND EVALUATION COMMAND

Mr. MAHON. Much of this money is for the U.S. Army Test and Evaluation Command? Discuss the role of the Test and Evaluation Command in the Army R.D.T. & E. structure.

(The information follows:)

The primary role of the U.S. Army Test and Evaluation Command (USATECOM) in the Army R.D.T. & E. structure is to conduct testing necessary

to determine whether materiel being developed or procured to meet Army requirements is suitable for issue to troops. In accomplishing this role, USATECOM operates four proving grounds, six test boards, three environmental test centers, a national missile range and a general equipment test activity to conduct engineering tests, service tests, check tests and initial production tests. USATECOM is responsible for establishing test objectives, preparing and approving the various test plans, conducting the tests, evaluating test results and preparing and distributing test reports. In order to insure that user requirements are fully considered, the U.S. Army Combat Developments Command—as the designated user representative—must formally approve the service test plan prepared by USATECOM.

A concurrent and secondary USATECOM role is to perform cost reimbursable supporting test services to other commands, services, and Government agencies. There are times when supporting test services account for over half the test workload. For this function, the requesting agency rather than USATECOM is responsible for establishing the test objectives, preparation, and approval of the plan of test, and the evaluation and distribution of the report of test.

Mr. MAHON. What weight is given recommendations by TECOM in making decisions as to whether or not weapons under development are ready for procurement? In hearings this year, we have discussed specific programs such as the Sheridan in which it appears that the efforts of TECOM went for naught since the command was overruled at higher levels in making the determinations on procurements. To what extent, as a percentage, are the recommendations of TECOM in this area overruled?

(The information follows:)

USATECOM test reports and recommendations pertaining to suitability of materiel for issue to troops are important factors in the decision process. Some of the other important considerations affecting materiel decisions include the enemy threat, the urgency of the requirement for the equipment, and the technical assessment of whether materiel deficiencies noted can be corrected in production. Detailed examination of USATECAM's records reveals that since 1967 their recommendations have been overruled seven times in 217 production decisions for a percentage of 3.2.

PROJECT MEXPO

Mr. MAHON. Describe Project MEXPO for which you are requesting $2.7 million.

General BETTS. Project MEXPO is a highly classified sensitive project that is scheduled to end in fiscal year 1970. Access to the program is limited. I will be pleased to provide a special briefing in an appropriately safe-guarded facility, on request.

(Discussion off the record.)

MUNITIONS EFFECT TEST

Mr. MAHON. What is the reason for the proposed ——— million increase in "Munitions effect test"? You had ——— million in fiscal year 1969 and now proposing ——— million in fiscal year 1970.

General BETTS. The indicated increase does not actually exist. This project received $3.65 million in OSD fiscal year 1969 emergency funds making a total of $4.78 million for fiscal year 1969. Thus, the ——— million figure for fiscal year 1970 reflects a decrease and is the bare minimum needed for activity. The $3.65 million was reported to Congress in reprograming action fiscal year 69–12 (DOD No. fiscal year 69–88) dated March 28, 1969.

DESERET TEST CENTER

Mr. MAHON. You are requesting $18.4 million for the Deseret Test Center as compared with $20 million in fiscal year 1969. This is a new program element. Explain the funding in 1969 as compared with 1970. Where was this effort located in the project listing for fiscal year 1969?

General BETTS. Project Deseret was combined with Dugway Proving Ground on July 1, 1968, and placed under a new program element. The descriptive summary for fiscal year 1969 still showed the old organization, presenting Project Deseret on page 346 and CB field testing, Dugway Proving Ground on page 348. In fiscal year 1969 Congress approved $7.880 million for Project Deseret and $12.180 million for Dugway Proving Ground for a combined total of $20.060 million. The missions and functions and funding of the two organizations were combined into the new organization, called Deseret Test Center. The combined organization was expected to make better use of existing facilities for chemical and biological field testing. The fiscal year 1969 funds were to support 10 joint operational field tests supporting the unified and specified commands and the services together with developmental, engineering, and service tests for the Army. The fiscal year 1970 funds for Deseret Test Center were requested to support 10 joint operational field tests and the Army's developmental, engineering, and service test program.

Mr. MAHON. Is anything involved in this program element other than the testing of chemical and biological items?

General BETTS. Everything in the program element supports testing of chemical and biological items.

Mr. MAHON. Describe the 11 joint operational tests which are planned for fiscal year 1970.

(The information follows:)

There are actually only 10 joint operational tests in the program. The Navy withdrew one test designed to support operational hardware that, due to technical difficulties, will not be available for test during fiscal year 1970. The fiscal year 1970 joint operational test program has not yet been approved by the Secretary of Defense. Information received from the Office of the Secretary of Defense indicated that the decision on the fiscal year 1970 test program will be deferred until the President's review of chemical and biological policy is completed.

(Additional classified information was provided to the committee.)

Mr. MAHON. Describe the major tests conducted in fiscal year 1969 and the results of these tests.

(The information provided is classified.)

Mr. MAHON. At what locations were chemical and biological tests made in fiscal year 1969 and what locations are proposed for tests in fiscal year 1970?

General BETTS. In fiscal year 1969 chemical agent tests were conducted at Dugway Proving Ground, Utah, Edgewood Arsenal, Md. ———. Biological simulant trials were conducted at sea in the Pacific. ———.

In fiscal year 1970 chemical agent trials will be conducted at Dugway Proving Ground, Utah, and Edgewood Arsenal, Md.

PROJECT MANDRAKE ROOT

Mr. MAHON. Describe the objectives, procedures, and costs involved in the Mandrake Root study referred to in the descriptive summary.

General BETTS. In accordance with the instructions contained in the Secretary of Defense Decision/Guidance A–4–040, "Toxic Chemical Munitions," dated September 11, 1964, the Army directed the U.S. Army Combat Developments Command to conduct a comprehensive study of tactical chemical and biological operations. The study was to develop the rationale and concepts of employment of chemical and biological systems and to determine qualitative and quantitative requirements for chemical and biological materiel supported by cost effectiveness data. Because the study did not provide an adequate basis for approving qualitative and quantitative materiel requirements or the realinement of the R.D.T. & E. program, an addendum study to Project Mandrake Root (ASPMR) was conducted by the Combat Developments Command and contract organizations. This project was the most comprehensive study ever made to assess the potential value of chemical and biological weapons in support of land combat and to establish definitive requirements for weapons and protective equipment.

By Chief of Staff Memorandum 67–380, dated September 26, 1967, the Army Chief of Staff approved the addendum study, Project Mandrake Root (ASPMR). This memorandum delineated the responsibilities of the Army staff agencies for follow-on actions developed as a result of the approval of the ASPMR. Among these responsibilities I was to "make alterations to the R. & D. program consistent with the approved Mandrake Root and addendum study findings based upon relative requirements and priorities." An extensive R. & D. program reorientation was initiated in 1968 and should be completed this year.

———.

NUMBER OF PERSONNEL AT DESERET TEST CENTER

Mr. MAHON. How many Army military, civilian, and contractor personnel are assigned to Deseret Test Center activity?

General BETTS. There are 70 officers, 5 warrant officers, 198 enlisted men and 1,084 civilians presently assigned to Deseret Test Center. Since Deseret Test Center is a joint organization personnel from all four military services are assigned there.

Mr. MAHON. Gentlemen, I have listened to your responses to my questions and to those which have been asked by Mr. Minshall, by Mr. Rhodes, and by Mr. Davis. We want to make sure we develop a reasonably adequate record for the guidance of the committee when the time comes to make a determination of our recommendation for Army R. & D.

In closing, I want to thank you for your patience over these long days of inquiry and I want to assure you that, while our questions at times have seemed a little sharp, our only interest is in promoting the interests of the United States. We want a strong Army and a strong military posture in this country because we think it is to our best interests and in the cause of peace.

Thank you very much, and we look forward to future hearings.

Mr. POOR. We are most appreciative for your help and support.

Mr. MAHON. You have been very cooperative and very responsive and very attention to our inquiries.

Mr. POOR. Thank you, sir.

STATEMENTS OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING AND THE DIRECTOR OF ADVANCED RESEARCH PROJECTS AGENCY

Mr. MAHON. Since we have not this year scheduled the appearance of Dr. Foster and Dr. Rechtin, we shall insert at this point in the record their statements in explanation of activities in the Office of the Director, Defense Research and Engineering, and the Advanced Research Project Agency.

(The statements follow:)

STATEMENT OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING, DR. JOHN S. FOSTER, Jr., ON THE FISCAL YEAR 1970 DEFENSE RESEARCH, DEVELOPMENT, TEST AND EVALUATION PROGRAM

1. INTRODUCTION AND GENERAL HIGHLIGHTS

1.1 Introduction

Mr. Chairman and members of the Committee, I welcome this opportunity to report to you on the research, development, test and evaluation programs of the Department of Defense.

Secretary Laird has already presented the FY 70 RDT&E program and budget in the context of overall Defense Department plans. My purpose today is to explain in more detail the proposed RDT&E program. With your permission, I intend to present the introduction and general highlights of my testimony, and then answer any questions you may have.

As you are aware, On 10 June the Deputy Secretary of Defense announced the termination of the Manned Orbiting Laboratory (MOL) Program. The primary factors in the decision to cancel the MOL project included: (1) the continuing urgency of reducing Federal defense spending and (2) advances in automated techniques for unmanned satellite systems. The fiscal implications of that decision are not reflected in this statement.

In Total Obligational Authority for FY 70 RDT&E, we are requesting $8.227 billion, compared with $7.647 billion in FY 69. This represents an increase of $580 million or about 7.5 percent. I will explain in detail the basis for this increase.

Let me say first that managing this large program is my major responsibility, and I take this responsibility very seriously. I have reviewed carefully all of the recent and continuing discussions of defense R&D management, especially the criticisms of techniques for controlling the costs and schedules in the acquisition of major systems. Secretary Laird, Deputy Secretary Packard and I are giving priority attention to assessing our experience in contracting practices and to making all needed changes. We have recently started a number of activities--involving senior officials in DoD and independent consultants--designed to provide a careful and definitive analysis of the impact of the management methods introduced in the early 1960's. So far, our initial results show that defense R&D management has, in fact, improved substantially during the last few years. But key problems remain, and the new Administration is dedicated to solving them. In Section 6 of the detailed statement, I have included a discussion of the major issues involved. I welcome the opportunity to review them with you.

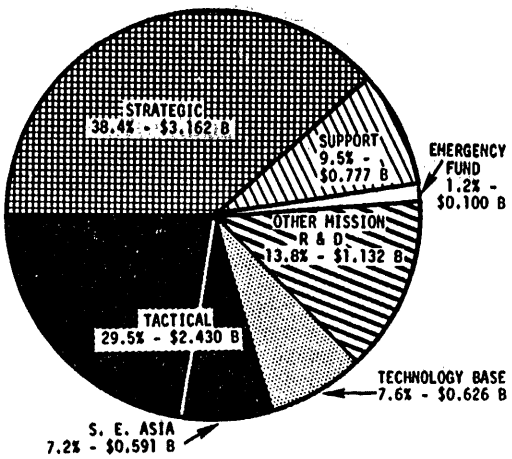
To give you first an overview of the program and budget, I have three charts providing estimates of the allocation of our requested FY 70 funding. The first shows the estimated distribution of funds by broad mission objective. The second shows the distribution in terms of the phase of R&D activity. The third shows the distribution of funds to various R&D organizations. In addition, there is a table showing the trend in this breakdown over the past two years.

I have simplified the distribution of funds within missions to show only broad categories. About 38% of the RDT&E funds support our strategic forces. About 30% support our tactical forces. These two mission categories represent most of the programs in our categories of advanced development, engineering development, and operational systems development, as well as some of the directly related supporting technological efforts. The category listed as "Other Mission R&D" includes work to improve our capabilities in fields such as airlift and sealift and command, control, and communications; such activities generally support both the tactical and strategic areas.

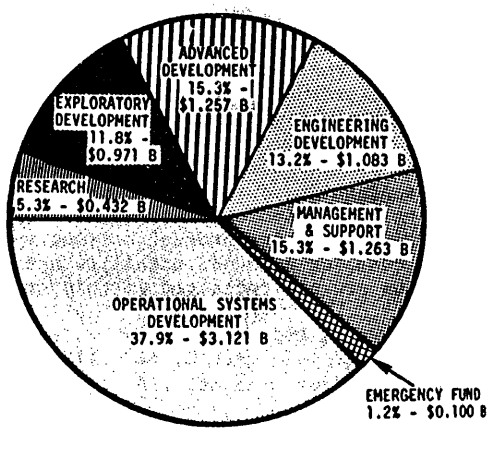
When we look at the requested FY 70 funding with respect to the phase of R&D activity, we find that almost two-thirds of the funds will support

ESTIMATED DISTRIBUTION OF FY 1970 DOD RDT&E

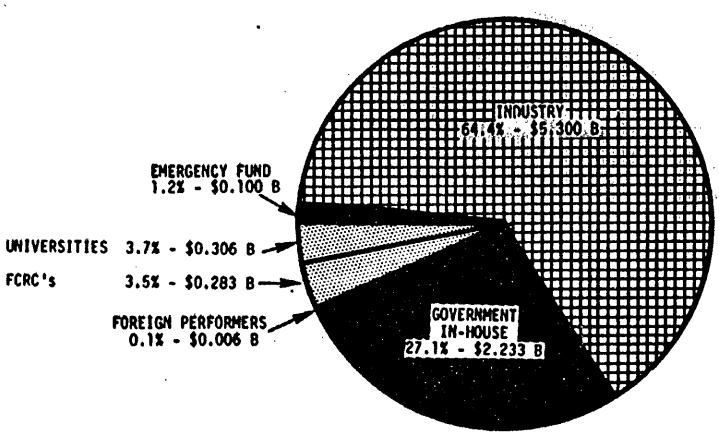
($8.227 Billion)



Mission Distribution



Development Distribution



Performer Distribution

ESTIMATED DISTRIBUTION OF DOD RDT&E
(TOA - DOLLARS IN MILLIONS)

	FY 1968		FY 1969		FY 1970	
	$-68	%-68	$-69	%-69	$-70	%-70
MISSION DISTRIBUTION						
Strategic	2,843.3	38.9%	2,937.6	38.5%	3,162.4	38.4%
Tactical	2,023.0	27.7%	2,215.7	29.1%	2,429.9	29.5%
Southeast Asia	(855.9)	(11.7%)	(818.3)	(10.7%)	(591.0)	(7.2%)
Other Mission R&D	1,205.8	16.6%	1,096.9	14.4%	1,132.0	13.8%
Technology Base	520.9	7.1%	579.2	7.6%	626.3	7.6%
Support	709.8	9.7%	768.8	9.8%	776.8	9.5%
Emergency Fund	-	-	49.0	0.6%	100.0	1.2%
TOTAL	7,302.8	100.0%	7,647.2	100.0%	8,227.4	100.0%
DEVELOPMENT DISTRIBUTION						
Research	368.6	5.0%	406.1	5.3%	432.3	5.3%
Exploratory Development	908.8	12.5%	875.4	11.5%	970.5	11.8%
Advanced Development	730.9	10.0%	974.9	12.8%	1,257.1	15.3%
Engineering Developement	810.5	11.1%	728.5	9.5%	1,083.4	13.2%
Management & Support	1,126.1	15.4%	1,209.4	15.8%	1,262.7	15.3%
Emergency Fund	-	-	49.0	0.6%	100.0	1.2%
Operational Systems Development	3,357.9	46.0%	3,403.9	44.5%	3,121.4	37.9%
TOTAL	7,302.8	100.0%	7,647.2	100.0%	8,227.4	100.0%
PERFORMER DISTRIBUTION						
Industry	4,772.2	65.3%	4,936.7	64.5%	5,342.7	64.9%
Government In-House	2,030.6	27.8%	2,127.4	27.9%	2,232.7	27.1%
Federal Contract Research Centers	252.3	3.5%	270.5	3.6%	283.4	3.5%
Universities	234.6	3.2%	254.4	3.3%	262.9	3.2%
Foreign Performers	13.1	0.2%	9.2	0.1%	5.7	0.1%
Emergency Fund	-	-	49.0	0.6%	100.0	1.2%
TOTAL	7,302.8	100.0%	7,647.2	100.0%	8,227.4	100.0%

development work directly related to advanced hardware and systems close to production. About 17% support what we call the research and technology base -- that is, research and exploratory development.

The last chart indicates that about one quarter of the RDT&E funding is used for defense in-house activities by both DoD and other government agencies. You should recognize that this category includes our ranges and test facilities as well as laboratories. For prior years we have actual expenditure figures which show that approximately 18.2% of the total RDT&E is spent on in-house work and equipment. The rest of the "government in-house" category is used on contracts supporting in-house work and on contract management. Almost 65% of the RDT&E funding is expected to go to industrial contractors. Roughly 3.7% of the FY 70 funds will support research and development at academic institutions.

From the tables following the charts, you will note that the major changes from the FY 1969 budget to that proposed for FY 1970 are the increases in the advanced and engineering development categories. The increases are due primarily to rather large increases in a small number of significant programs as indicated below.

($ in Millions)	FY 69	FY 70	Increase
Advanced Development (Total)	(974.9)	(1257.1)	(+282.2)
Heavy Lift Helicopter	1.0	15.0	
SAM-D	59.9	75.0	
Undersea Long Range Msl Sys	-	20.0	
AMSA	25.0	100.2	
Supersonic Cruise Armed Decoy	4.0	17.1	
CONUS Air Defense	-	18.5	
Adv Ballistic Reentry Sys	105.0	121.4	
Def Subsys Devel & Demo Program	1.0	12.9	
Adv ICBM Technology	10.0	20.0	
Total Above Programs	205.9	400.1	+194.2
Engineering Development (Total)	(728.5)	(1083.4)	(+354.9)
S-3 (VSX) Aircraft	62.7	165.4	
AX Aircraft	-	12.0	
F-14 B/C Aircraft	30.0	50.0	
F-15 Aircraft	45.4	175.1	
Adv Surface Msl System	23.7	67.9	
Sub Sonar Development	9.1	22.4	
Hard Rock Silo	25.0	50.0	
Utility Tact. Trans. Acft Sys	2.1	12.5	
Total Above Programs	200.0	555.3	+355.3

Now I will outline highlights of how the overall R&D picture has changed since we last met: first, an assessment of shifts in the threats we face and other factors influencing our programs; next, some of the recent results from R&D; then some of the plans for significant activities in FY 70; and, finally, a few comments on the budget request.

1.2 Overall Assessment of Threats and Programs

I will begin with a broad assessment of the threat and the aims of some of our major R&D programs designed to meet the threat.

1.2.1 General Characteristics of Soviet and Chinese Technical Threats:

The first broad charcteristic of the threat environment, although familiar, is no less influential than in the past. It is the remarkable secrecy maintained by the Soviet Union over its R&D efforts. This secrecy, shrouding most details of Soviet (and Chinese) defense activity, often leads to uncertainty about some areas of the longer term threat. The general U.S. strategy to cope with this dimension of the situation, as you recognize, is to carry out an aggressive R&D program adequate to meet emerging advanced threats, and to minimize the possibility of technical surprise. This approach is particularly needed in the R&D programs to support our strategic forces because the risks are greater, the threat changes more rapidly, and the impact of advanced technology is larger. Without question, our past R&D programs have been successful. Our margin of technical superiority, which we believe is still clear, must be preserved.

The second broad threats are the size, continuity, and most important, the rate of growth of Soviet R&D. Technology is the pacing factor -- the "leading edge" -- in maintaining an adequate, modern military force. We are concerned, therefore, about the sustained rapid growth of Soviet R&D. The best estimates indicate an increase of about 10% per year in Soviet expenditures for military, space, and atomic energy R&D during the last few years. We compare this with a U.S. increase of roughly 4% per year in military R&D during the past six years and with only 1% per year in our combined military, space, and atomic energy R&D during the last few years (owing largely to the recent reductions in NASA funding). I must caution that data on Soviet R&D funding are not precise, but we are reasonably confident that their total expenditures are known within 10 to 20%.

The U.S. has had a large, vigorous technical base since World War II, much larger than the Soviet Union's until quite recently. Thus, our cumulative investment in R&D has been substantially greater — and this is quite important. Nevertheless, because the formerly high growth rate in U.S. R&D has flattened out, the overall effort of the Soviet Union is now roughly the same size, about $14 billion per year. Let me try to characterize quite briefly a few details of their activity.

Soviet technology is generally characterized by a continuing heavy investment -- in the expansion of their physical plant and the enlargement of their trained manpower pool -- and by continuing emphasis on the satisfaction of military requirements.

The Soviet Union has allocated vast resources to the training of professional manpower; this trend is expected to persist through 1980. The enrollment in Soviet higher educational institutes is increasing steadily and is expected to rise from 3.8 million students in 1965 to 8 million students by 1980. Although enrollment in institutes of higher education in the United States will remain greater than that in the Soviet Union through 1980, the USSR continues to graduate more scientists and engineers.

Because of congressional interest in these data during my earlier presentations, I have included below a table which shows trends in the annual college graduates of the Soviet Union and the United States.

Soviet and U.S. Graduates
(Thousands)

	1950	1955	1960	1965	1968
Soviet					
Engineers	38.5	67.4	102.1	175.5	238.0
Natural Scientists	28.0	23.2	33.3	33.3	33.5
All Others	166.8	179.0	192.0	222.2	252.2
TOTAL SOVIET	233.3	269.6	327.4	431.0	523.7
United States					
Engineers	51.0	25.8	30.8	35.9	41.0
Natural Scientists	22.6	22.7	42.9	68.0	73.1
All Others	204.5	255.0	305.5	436.0	556.5
TOTAL U.S.	278.1	303.5	379.2	539.9	670.6

One trend indicated in the table is a greater than 600% increase in the output of Soviet engineers from 1950 to 1968, while the U.S. output actually dropped slightly. The Soviets seem to have graduated about six times as many engineers as the United States in 1968. Another trend seems to be the relative constancy of Soviet graduates in natural science while the U.S. more than tripled its output since 1950. While we lagged behind the Soviets in graduating natural scientists in 1950, we now educate more than twice as many as they do, and our output is still rising.

The improving quality of Soviet technical manpower is reflected in the increasing number of scientists and engineers with advanced degrees. Equally important, the number of major laboratories within the Soviet scientific establishment has grown rapidly.

Of the researchers in the Soviet Union, 75% are working in applied research at institutions in the industrial ministries. About 15% are engaged in basic/theoretical research, mainly at facilities of the academies of sciences. These proportions are roughly comparable to those in the U.S. The number of applied researchers has nearly quadrupled in the Soviet Union since 1956. Since 1955, there has been a fivefold increase in the number of Soviet investigators engaged in engineering research. Overall, the pool of professional manpower available to the Soviet defense industries is already large and is growing rapidly. No shortage of professional manpower for the performance of weapon system R&D is anticipated.

Soviet advanced research in fields applicable to military developments is now probably about equal to that of the West. Nevertheless, Soviet military hardware frequently has not reflected the most advanced state-of-the-art in the USSR. In part, this can be attributed to their consciously conservative design philosophy, which emphasizes proven technology and favors robust, relatively simple equipment. In part, however, this Soviet choice may have been forced by deficiencies in manufacturing and fabrication techniques and by the inflexibility of a cumbersome management system.

Considering the size and quality of the Soviet R&D effort, we must expect that the USSR will move ahead of the U.S. in fields of military importance to the USSR which are not emphasized by the U.S. There are, however, no areas at present in which we know Soviet technology to be significantly ahead of ours. (A few specific areas of Soviet work are discussed in Section 5 of my supplementary statement.) On the whole, I conclude that, although the Soviet Union has a vigorous and growing technical effort, we can preserve our margin of technical superiority if we provide the needed funds to meet our opportunities.

Finally, I want to discuss briefly what we know about the general character of Chinese military R&D programs.

Within overall Chinese strategy, advanced weapons seem to be viewed as the instrument to enhance their prestige and strengthen their claims to leadership in Asia and status as a world power. The Chinese may believe that their ability to strike the U.S. and targets in Asia with nuclear weapons would limit the U.S. military influence and action in Asia and thus would keep any direct confrontation at the level of conventional arms, where the Chinese would expect many advantages. The Chinese thus are expected to continue trying to protect their advanced weapons programs from the disruptive effects of political turmoil.

Overall, their nuclear accomplishments have been impressive and their investment in missile programs substantial. However, the apparent deferral of their expected MRBM deployment, the delay of more than a year in their first ICBM test, and the relatively long period between the failure of their thermonuclear test in December 1967 and the successful test in December 1968 -- all these suggest the existance of problems or limitations, whether technical or the results of the Cultural Revolution.

Perhaps somewhat obscured by the controversy over the effects of the Cultural Revolution has been the continuing lack of a broadly based scientific-industrial establishment in China. Although the Chinese have put together research and development teams, the progression of systems to production will require upgrading their capacities both to manage complex processes and to produce in quantity the components of advanced weapons. Their limitations of trained manpower and sophisticated industrial plants will hold production quantities far below those known in the U.S. and the USSR for some time.

What counts in the final analysis is the nature of Soviet and Chinese developments and the size of their deployed forces. I shall therefore outline some specific, major shifts in the threat during the past year.

1.2.2 Strategic Programs: Let us first review the threat faced by our strategic forces and the R&D programs designed to meet the threat.

The Soviet Union has continued the rapid expansion of its offensive missile force during the past two years, growing from 250 operational launchers in 1966 to almost 1,000 by the end of 1968. Over 200 of these operational launchers, and new launchers under construction, are for the SS-9.

During the latter half of 1968, the Soviets carried out the first tests of a new SS-9 reentry system consisting of three warheads, each of which is capable of a yield of about 5 megatons. Another delivery mode for the SS-9 is the Fractional Orbit Bombardment System (FOBS) which also has been tested by the Soviets. The continuing deployment of the large, liquid-fueled SS-9, together with development of new and more sophisticated reentry and targeting systems, are consistent with the development of a first-strike capability. The SS-9 is of special concern to us because it is the Soviet's most accurate missile, carries the greatest payload, could be MIRVed, and is still being deployed. For these reasons, we must prepare for the possibility that it might be deployed to attack Minuteman, the land-based component of our deterrent missile force. In addition, the FOBS, as I said last year, seems to be useful mainly for a surprise attack against our B-52's.

The Soviets have also started deployment of Polaris-type submarines, seven or eight of which have been built. This is a significant step forward from the 3-launcher SSBN previously deployed. During the last few years they have tested this new Polaris-type submarine, which carries 16 missiles believed to have a range of 1500 nautical miles. This weapon, operated in a depressed-trajectory mode from about 400 miles offshore, could reach our coastal strategic bomber bases which means that even an "ideal" warning system would not give us adequate time to "flush" our alert bomber force.

The Soviets have also pressed forward with defensive systems. They have continued deployment of their radar network, which is an ICBM warning system. They have deployed a limited ABM system around Moscow, although the pace of deployment has been reduced; and they have radar coverage of our Minuteman attack routes to Moscow and the surrounding area. They are installing the Tallinn system, and now have complexes with some missile launchers either under construction or operational. This is generally agreed to be an advanced antiaircraft missile system, but we cannot eliminate completely the possibility that it has some limited capability against some classes of ballistic missiles. They also have continued to build the Bravo class attack submarine.

Finally, as I mentioned earlier, China's recent thermonuclear test shows its long-term commitment to a nuclear force. The Chinese still have not fired an ICBM, but their work on launch facilities continues. They are not expected to have an operational capability until 1972 at the earliest.

I want to pause here for a moment and review our basic approach to sorting out various elements of the threat and deciding which R&D efforts to emphasize.

Intelligence permits us to know somewhat more about the near-term threat and, thus, our possible near-term needs. However, where intelligence is not so clear and a particular move by a potential enemy might be to his advantage, we must "hedge" against this uncertainty so that we are prepared -- even for technically difficult and relatively improbable events. These relatively improbable events represent what we call "greater than expected threats." Often in our development program we "hedge" in several directions corresponding to several conceivable directions of the changing threat. But the cost of each program increases rapidly as we develop and more exhaustively test a new system. Thus, we invest more heavily in those few approaches that we think are both needed and feasible.

The central guideline throughout the whole R&D planning for strategic weapons is essentially this: Considering the total range of uncertainties, we make decisions on programs to provide all reasonable hedges against possible new needs or changes in threat. We continuously make a series of projections, starting with intelligence, to compare our own estimated lead time with the "worst case" (from our point of view) for the deployment lead time of a potential enemy. We carry out R&D to provide all reasonable options. Deployment is a clearly separate decision. We deploy either when there is a clear, actual or imminent threat, or when we cannot ensure against our uncertainty with only an R&D program.

Applying this approach to the evidence on Soviet progress on what seem to be counterforce weapons and defensive systems, we take the conservative view for our R&D planning that they may be building a first-strike capability. We must, then, orient our strategic programs to ensure the survival of our credible deterrent.

From the range of possible U.S. actions to counter the threats I mentioned a few moments ago, a central one is the President's decision to deploy on a controlled phased schedule, the SAFEGUARD system -- a modification of SENTINEL. SAFEGUARD is, as you know, oriented toward protection of our deterrent forces, beginning with a limited defense of Minuteman. If the threat in the future justified further deployment, SAFEGUARD could be fully deployed to defend most of our bomber bases against a possible SLBM attack. With its full 360-degree radar coverage and the improved Spartan, which we have been developing for the past year, SAFEGUARD should be effective in countering a SLBM attack during the few minutes required for most of our bombers to escape.

Another future option in the SAFEGUARD concept would be to extend the Minuteman defense from two to four defense batteries and add more Sprint interceptors. This deployment would be expected to permit the survival of a significant number of Minuteman even in the event of a heavy Soviet first strike.

Expansion of SAFEGUARD to defend against the SLBM threat would automatically provide a thin area defense of most of the country against a Red Chinese attack in the 1970's. If the Chinese threat were considered alone, a less costly version of SAFEGUARD with only north-looking radar faces could be deployed.

Our efforts to protect our strategic deterrent are not confined to ABM. As an additional hedge against the possibility that the Soviets expand their ICBM force sufficiently to pose a serious threat to Minuteman, we are developing and will test the "hard-rock" silo concept. This system is being designed to withstand an overpressure greater than that of current systems; such a silo would require the Soviets to achieve a delivery accuracy greater than the current capability in the SS-9 to produce the same target effects.

As the Soviet threats to the Minuteman force become clearer, we will be able to balance our emphasis as required between hardening with the hard-rock silo and active defense with SAFEGUARD.

We have taken additional measures to protect our bomber force by starting to keep bombers on alert at additional bases and by planning for dispersal of the bombers during periods of tension. Beginning shortly, this year, airplanes will be kept on alert at these bases in addition to the main operating bases of SAC. With this new basing concept, since fewer airplanes will be on alert at each base, the time required to get the entire alert force airborne will be reduced. In addition, during any period of world tension, we will disperse bombers and tankers to additional bases, where the airplanes will be maintained on alert during the crisis. This also will reduce the time to achieve airborne operation, and it will make targeting difficult for the enemy by increasing the number of aiming points.

To ensure adequate warning for our bomber force against the possibly increased threat of Soviet sea-launched missiles, effort will continue which will provide early warning by satellites. If the Soviets used depressed trajectory SLBM's against our bomber bases, their missiles' flight time would be even shorter, so short that most of our bombers could be destroyed on the ground, even with the best possible warning. To counter this threat, the SAFEGUARD system will have seaward-looking radar faces and suitably deployed missile batteries to intercept the first missiles of any attack.

SAFEGUARD, like any other defensive system, is not perfect and can be overwhelmed if the Soviets choose to bring sufficient numbers of attackers against it. However, we could add to our stock of defensive interceptors and radars to match the threat, if we choose, and at a lower incremental cost than the cost to the offense to counter them.

We are developing Minuteman III and Poseidon equipped with MIRV payloads as a way to ensure our ability to penetrate Soviet defenses. Both of these systems are now in the flight test phase. The purpose of the flight test is to validate the adequacy of their engineering design. The tests are programmed at about three a month. It is important to maintain this schedule so as to provide an early hedge against the possibility that the Tallinn system has been or will be converted to have some ABM capability. We plan to deploy Minuteman III. It will be equipped with penetration aids as well as multiple warheads. We also plan to deploy Poseidon, which will carry a large number of multiple warheads. Both of these systems are designed to penetrate the defenses by exhausting their stockage of interceptors.

To meet an advanced Soviet air defense system, we are developing the SRAM and plan to develop the SCAD air-to-ground missile which will assist our bombers in penetrating improved defenses. SRAM is tailored to penetrate heavy terminal defenses, while SCAD is designed to help the bomber penetrate area defenses over an extended region.

In addition to these programs, we plan to investigate new, larger land- and sea-based missiles and to proceed on the first phases of development of a new bomber, AMSA (the replacement for our B-52), and a new SSBN submarine (designated ULMS).

The prospect of talks on strategic arms limitations with the Soviet Union merits special note. Any agreements reached probably should be reinforced with an intelligence and weapons R&D program, along with other precautions, to protect our security against the appearance of new threats. Indeed, we cannot depend on the strategic arms talks to remove all uncertainties about future Soviet capability and intent. While this will probably require a broad R&D effort such as we now have, we recognize that a reorientation of the relative priorities within our program may become necessary, based on the specific terms of any treaty. A Defense Science Board task force is now reviewing the range of possible strategic R&D requirements in the light of the range of possible arms limitations.

Our entire R&D program devoted to strategic forces is discussed in Section 2 of my supplementary statement.

1.2.3 Tactical Programs: I turn now to the R&D programs related to our tactical forces. This area has experienced perhaps the most dramatic changes in threat and included some of the most important new R&D efforts during the last year.

The most significant change in the tactical threat environment has occurred at sea. In recent years, the Soviet Navy has emerged from its traditional role as a coastal defense force and has developed a capability for operation on the high seas well beyond the periphery of the USSR. While the Soviet Navy has no attack carriers or battleships, the Soviets are building submarines and surface ships well equipped for sustained long-range operation. New major surface combatants with surface-to-surface missiles are still being produced by the USSR, but the emphasis in current surface ship construction and conversion programs is on air defense and ASW, as well as improved seaworthiness, propulsion and range capabilities. Currently, 39 major Soviet surface combatants are missile equipped. In addition, 60 cruise missile submarines are operational. One hundred and forty-nine guided-missile patrol boats which carry shorter range cruise missiles (22 nm) are also operational. In addition, some 285 land-based medium jet bombers are equipped with antishipping cruise missiles.

Taken together, these developments increase the threat to our Navy and merchant shipping, and demand improved counterair, counterfleet and ASW capabilities. Recognizing this threat, we must reappraise our convoy concepts, our methods of conducting near-shore operations and the antiair defensive capabilities in our ships.

To meet the threat of a substantial enemy surface navy, we must revitalize the naval attack role of our submarines, our ships and our aircraft. We are developing improved torpedoes, stand-off surface-to-surface weapons, and specialized air-to-surface ordnance.

The Soviet antisubmarine warfare (ASW) and submarine capabilities have increased through their introduction of new airborne and surface ship ASW systems and by the appearance of new types of submarines. Among these, a new class of SSBN has been identified as well as new classes of faster, quieter Soviet attack submarines, at least two of which are nuclear powered. These developments have

reduced the margin of effectiveness of our ASW capability, and require the development of improved ASW systems within the next several years, when the new threat will become quantitatively significant. To begin to meet this situation, we are increasing our ASW R&D programs on new submarines, starting work on a new ASW aircraft -- the S-3 (VSX) -- and expanding our surveillance systems. Overall, our ASW development activity will increase by more than 40% in FY 70 (largely because of the S-3 funding) compared with FY 69.

Land combat may well have been revolutionized for the years ahead, not so much by a change in threat, but by the emergence of a new family of sensors for remote detection and for rapid delivery of firepower. Building on our experience in Vietnam, the "instrumented battlefield" has become possible. This concept includes an array of sensors to locate the enemy, integrated with an automated command and control system for rapidly commiting artillery, helicopter and air strikes, along with highly mobile infantry. Critical elements of these remarkable infiltration sensor systems were employed successfully and partially evaluated during the siege of Khe Sanh and in the defense of Saigon. Command and control elements for artillery coordination (TACFIRE) and for air-strike direction (Airborne Command Post and AWACS) are being developed for adaptation to the "instrumented battlefield." Night sensors for ground and air units -- together with all-weather weapon director systems -- will further expand the concept to exploit darkness and adverse weather.

Although our control of the air space has not been seriously challenged since World War II, the Soviets and nations supported by the Soviet Union can field a large force of high-performance short-range aircraft for air-to-air combat. The potential threat posed by MIG-17's, -19's and -21's has had to be considered in our tactical deployments throughout the world, and has imposed demands on a significant portion of our force in Vietnam.

An even greater tactical air threat has been emerging in the form of the Soviets' new high-performance FLAGON and FOXBAT aircraft. We recognized this threat and have been developing the technology needed to produce aircraft with the necessary range-payload capabilities and with the aerodynamic characteristics and weapons needed for successful close-in air combat against the advanced Soviet fighters. We are now starting major developments of a new generation of Navy and Air Force air-superiority systems, the F-14 and the F-15. We are developing the advanced avionics, the efficient high thrust-to-weight engines, and the advanced missiles and guns needed for air combat. The F-14 in 1973 and the F-15 in 1975 will provide a genuinely needed increase in our air combat capability.

There are, of course, many additional R&D projects related to tactical forces -- new and more accurate laser-guided bombs, improved air-to-surface and air-to-air missiles, the promising EA-6B electronic warfare aircraft, and others. This is discussed further in Section 4 of my suplementary statement.

1.2.4 Programs to Support Our Effort in Vietnam: I want to move now to a brief assessment of the overall situation in Vietnam from an R&D perspective. Section 3 of my statement provides a comprehensive review of the R&D efforts started and accelerated to support our forces in Vietnam.

There is no question about the clear payoffs from this part of our program. Recent results of R&D have improved our forces' effectiveness in the field -- and there are many examples of these payoffs. Just as important, we have learned lessons in Vietnam combat that will lead to significant improvements in our general military capabilities for many years. Nevertheless, we have also learned that advanced technology is probably not the decisive factor in this kind of war. I will discuss now a few of the highlights of our accomplishments and our problems.

As I mentioned earlier, there has been an extraordinary impact on many aspects of the war through the introduction of new sensors. Nowhere is this impact more pronounced and more central than in tactical intelligence collection and in the rapid, reliable reconnaissance for immediate strikes. For combat in Vietnam, the demands on tactical intelligence are staggering. Depending upon the situation, we must detect -- essentially in real time -- trucks, tracks, people, guns, occupants of tunnels, obscure trails, and so on. But we have peeled away some of the natural cover exploited by the guerrilla -- with new radars, night vision devices, and infiltration sensors, and with air-coordinated strikes made possible through improved integration of real-time tactical intelligence. This equipment has proved its worth in battle, and has made a crucial military difference to our forces.

Turning to other parts of the war, the confinement of air attacks to south of the nineteenth parallel and the bombing halt after November 1968 have resulted in reduced aircraft combat losses, though our total strike sortie rates have remained roughly constant. Aircraft losses have been reduced, of course, because all interdiction strikes were flown over South Vietnam where the threat consists primarily of small arms fire and visually directed AAA, and where currently there is no SAM threat. Our major unsolved problems in these areas include: improving our pilot rescue capability; exploiting fully our new generations of much more accurate bombs and antiradiation missiles; and applying even more widely our improved techniques and equipment for base and city defenses.

The pacification program moves slowly, and its toughest hurdles still lie ahead. There has been a recent VC trend toward returning to guerrilla tactics in rural and resettlement areas as evidenced by increased incidents of terror, sabotage, and harrassment. To some extent, this can be regarded as an indicator of success in the main-force phase of the war. We have a number of projects designed to improve hamlet security and infiltration detection systems and to achieve even more rapid communication of infiltration patterns.

Perhaps more important, however (and I discuss this in detail in Section 3), will be our ability to evaluate new ways to assist the Government of the Republic of South Vietnam until the completion of successful negotiations. We are setting up training teams to transfer to the Vietnamese some of our technological resources. In addition, we must consider carefully the influence of cultural and social variables underlying long-range pacification activities, taking account of the military, economic, social, and political forces in the conflict. Though Defense R&D is but one component of the national effort, we are trying to reformulate the R&D required to improve the effectiveness of the DoD's assigned role in pacification.

Part of the overall threat in Vietnam concerns a "disclosure" problem. In Vietnam -- though the war has been terribly cruel and grueling -- we have had opportunities to observe Soviet equipment in action, and to test our capabilities against it; and in this process, we disclose our own strengths and deficiencies. "Disclosure" is obviously a two-edged phenomenon. The war has revealed our weaknesses in many areas -- starkly, for example, in our inability to find and hit small, concealed, fixed or mobile targets. Another area in which we are learning important combat lessons is electronic warfare, especially against the Soviet-supplied air defense weapons. It is essential that, despite the awful price of the war, we learn from this disclosure of Soviet strengths and this identification of key U.S. gaps. The hard-earned lessons will pay off in improving our entire tactical forces long after the Vietnam conflict has ended.

1.2.5 Research and Technology Base: My last point of emphasis in this overall assessment is our defense research and technology base, the activities funded from the Research and Exploratory Development categories. Last year I discussed with you my growing concern about the level of effort in these programs. My concern was not that we had lost or were about to lose our technical superiority -- because, let me emphasize, we have not reached, and are not on, any "technological plateau."

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Rather, I became concerned about the effects of a steadily declining level of effort which we had allowed to develop as an "experiment" to determine the critical minimum effort required. A pattern of indicators began to emerge which proved rather clearly that, in the future, our program would not fulfill our needs unless it received substantially greater funding. As I mentioned earlier, the Soviet Union is expanding its R&D effort at a much greater rate than the growth rate of comparable U.S. activities. There is no surer bet today in national security affairs than that 10 years from now our relative defense position will be only as strong as our research and technology base during the next few years. Thus, last year you approved a 9% increase in Research, and you made no reductions in Exploratory Development. We appreciated this support.

This year we are requesting essentially a cost-of-living increase for Research (from $406 million to $432 million) and a slightly larger increase for Exploratory Development (from $923 million to $970 million). I urge you to consider carefully the discussion of these areas in Section 5 of my statement. You also will see (in Section 6) that we have taken decisive and constructive actions on the related management issues you raised last year, such as on social science research and on the studies and analysis efforts.

Before I leave this discussion of our research and technology base, there is a final topic I should mention. I recognize the increasing anxiety regarding disorders on the campuses of some universities and, in particular, whether these disorders seriously affect the progress of Defense-supported research at academic institutions. When we discussed this matter last year, you may recall I argued strongly to continue our policy of leaving the responsibility and initiative for solving the problems with the university. I believe our universities generally are remarkably resilient institutions which will adapt their structures and policies to responsible suggestions for reform. This year I continue to be concerned as disruptions of educational and research activity have recurred. I regard some of the current turmoil as irresponsible action, for violence has absolutely no place in the process of constructive change. But I still have confidence in the ability of the academic community, in the aggregate, to cope ultimately with the situation. Many universities seem to be finding at least partial solutions.

We still see no evidence of major adverse impacts on Defense Department-sponsored research and development at our universities. As you know, however, several institutions that are heavily engaged in Defense R&D have experienced turbulent demonstrations. These institutions have started university-wide reviews of their relationships with the Department. I support the concept of these reviews, and I have met with some of the faculty members and students who are involved.

At Stanford, for example, a firm decision has been made to separate the Stanford Research Institute from the University itself. Separation alone will have no serious impact on Defense research at either activity. Indeed, we have specific assurances from both organizations that it will not. However, Stanford University is also examining a policy apparently designed to eliminate most classified work. The elimination of classified projects, particularly at the Stanford Electronics Laboratory, would represent an important change -- and, from our point of view, an unfortunate change -- in Stanford's policies. Nevertheless, we have alternative sources of competence, and we can arrange orderly transitions if necessary.

At MIT, a special University Panel completed on 31 May its review of the activities of the Lincoln and Instrumentation Laboratories. The Panel recommended, among other actions, that MIT and the Labs "explore new projects" in non-Defense areas -- which we had already officially encouraged -- and that the laboratories should continue their Defense R&D, including classified work. Thus, while we expect to make gradual changes, in cooperation with MIT, in the composition of their effort, there does not appear to be any immediate substantial impact on the critical R&D that MIT carries out for us.

In both the Stanford and MIT cases, as well as in similar campus reviews, I believe the "issue" of classified research has been put into better perspective in at least three ways. First, it is more widely recognized now that only a very small fraction -- about 4% -- of the DoD-sponsored work at universities is classified. Second, the amount and the impact on university life of even such a small effort can be reduced through a more discriminating administration of security regulations, without changing the nature of the work itself. Third and most important, the remaining classified DoD projects -- and, without question, essentially all unclassified Defense R&D -- are so critical to the country and so challenging technically that faculty members seek to be involved as researchers and consultants.

In general, I am hopeful -- in fact, confident -- that our academic institutions will continue a vigorous participation in our R&D. Why do I hold this view? Because, although there have been cases of individuals taking strong public positions against policies of the Department of Defense, and indeed against policies of the entire Executive Branch, these cases usually reflect legitimate differences of opinion. They constitute the debating process upon which the security and health of the country -- in particular, the research community -- depend. As the debate proceeds, most institutions recognize the need to respect the research choices made by individual faculty members as well as the strong need for academic R&D in the interest of national security.

I hope you will not be misled by those who suggest that DoD's academic research represents a sort of "sandbox for scholars," irrelevant to Defense missions, unproductive technically and, worst of all, inimical to the best interests of universities. The facts are quite different, and the historical record shows how authentically important academic research has been in serving national security.

How have universities assisted in preserving the national security? It is not just the significant research results that have been produced, nor just the advanced training of thousands of students in technical areas central to defense, nor even the availability of scarce specialists who consult with you and us on the nation's most critical defense problems. It is more fundamental. It is the great national advantage we possess because we are able to bring together essentially independent and well-informed people -- from government, industry, and universities -- over long periods of time for voluntary work on our tough problems. This is the core of our capacity for technical superiority. And this becomes a main reason for my reluctance to take, or to endorse the Federal government's taking, any major steps that might be an overreaction to the current problems facing university administrators. Nevertheless, as President Nixon pointed out recently, the law must be enforced while universities develop solutions to their local problems.

Thus, I conclude: First, we must discuss differences of opinion with those in the academic community who are prepared to have responsible discussion and to consider in a flexible way rational changes in their relationships with the Defense Department; and second, we must not run the risk of eroding nationally important research by precipitate punitive action against features of university life that are essential to our future.

1.3 Some Recent Results of Research and Development

One of the best questions for the R&D manager is "What have you done for us lately?" I have already touched on some results, and my full statement presents a rather comprehensive review of FY 68 and early FY 69. But now I will highlight some clearly defined, significant results to give you a sense of other parts of our program.

* August 16, 1968 was a doubly significant day in the development of strategic missiles. The first flight tests of both the POSEIDON and MINUTEMAN III were held on that day, and both tests were successful. Our initial overall evaluation is that both MINUTEMAN III and POSEIDON show great promise and we expect to meet our development goals.

* The first submarine equipped with the modified POLARIS A3T missile was deployed on schedule. Part of the Atlantic Fleet will have been modified by the end of this calendar year.

* During the past year, three of the four major components of the SAFEGUARD ABM system have been tested full scale: the Missile Site Radar (MSR), with its data processor, and both of the missiles, SPARTAN and SPRINT. Since January 1968, the SPARTAN has had 8 complete successes, and 2 partial successes and 2 failures in 12 flight tests, and the SPRINT has had 18 complete and 7 partial successes and 9 failures in 34 tests. As I described earlier, the SAFEGUARD system, if deployed fully, would protect our retaliatory forces, provide the continental U.S. with a thin area defense against the potential Chinese ICBM threat, and protect the country against the accidental launch of a missile from any source.

* Further, we have reorganized our ABM activities to support the initial deployment of SAFEGUARD and to continue an aggressive R&D program to enable us to upgrade the system if and when required. We have created within the Department of the Army the Advanced Ballistic Missile Defense Agency (ABMDA) -- by transferring to the Army $45 million (FY 69 funds) and 14 personnel from ARPA's Project Defender Office, as well as 20 personnel from the NIKE-X Advanced Development Group at Redstone Arsenal. The ABMDA has also hired a number of specialized staff from industrial and academic research groups to start their new programs.

* We continued the accelerated deployment of additional over-the-horizon forward-scatter radars to provide improved warning of any mass missile launch. As I have indicated, this new system will help to provide warning -- along with SAFEGUARD -- for the SAC bombers against any threat from FOBS. We achieved an interim capability early in 1968.

* Our military medical research has continued to make impressive gains in solving problems experienced in Vietnam. One example arises from the ground operations in the Delta in which soldiers are in the water most of the time during patrols. After four continuous days in water, almost all members of each unit have painfully irritating fungus infections of the skin on their feet and legs, which usually require 2 weeks of treatment and drying to heal. On the average, some of the combat elements of one division has been out of combat all of the time during the past year because of this single environmental condition. Preliminary reports of an Army medical research team effort currently in progress in Vietnam shows that an antifungal prophylactic drug (Griseofulvin) taken daily by mouth is cutting the fungus infection rate more than 90 percent, in the units under study.

Let me review some other results from our R&D related to Vietnam:

* The sensor system -- in which sensor data were used for remote direction of air and artillery strikes against enemy troop and vehicle infiltration -- has led to the entirely new concept of the "instrumented battlefield" which I mentioned earlier. Initial results of in-country tests of these real-time sensors have been extremely encouraging.

* A prototype AC-130 Gunship, a specially equipped C-130 transport modified to carry new sensors and air-to-ground weapons, introduced in Southeast Asia for an operational evaluation, produced an impressive record. During the period February-November 1968, this one aircraft destroyed or damaged 378 boats and trucks, and caused 97 secondary explosions during nighttime missions. During

one mission it was credited with 225 enemy personnel killed in action during the support of a Special Forces camp that was under attack. During the first part of 1969, production Gunships were deployed and results have been similar.

* The employment of laser-guided weapons last summer resulted in better CEP's, compared with past accuracies. With increased accuracy, we could reduce ordnance expenditure, thus potentially saving substantial funds in ordnance procurement and in aircraft operations and maintenance.

* The introduction of improved reconnaissance photo equipment contributed significantly to breaking the siege at Khe Sanh. This high-resolution panoramic camera was able to locate camouflaged targets, which were subsequently destroyed through air strikes.

* As you recall, the F-111A was deployed to Southeast Asia in March 1968 for a trial 6 month period. There have been problems, of course, in fielding the F-111. But you should recognize that the aircraft has performed well. Although the evaluation in Southeast Asia was limited by the accidents and by the bombing halt, the operational test data show that the F-111A has better penetration capability and night/all-weather bombing accuracy than other systems in the Air Force inventory. The F-111A has a greater combat radius compared with the F-105 and F-4. This longer combat range permitted all strikes to be flown without air refueling. Its Terrain Following Radar (TFR) enabled low-altitude penetration and attack, protecting the aircraft from enemy defensive reaction until after bomb release. Its avionics systems made it possible to find and attack targets largely immune to attack during darkness and adverse weather. The F-111 attained a better combat CEP compared with the F-105 and F-4 on similar interdiction missions at night and in adverse weather. Perhaps most important, the F-111A actually has proved to be quite reliable. During most of its deployment in Southeast Asia it had an excellent reliability rate of about 90%, and its 35 maintenance man-hours per flight hour was about the same as the man-hour cost of the F-4 which has been operational for some years.

In closing my account of the highlights of some recent R&D results, I will mention one that is not in the category of major hardware.

* As you may know, Air Force and Navy jet aircraft use a liquid-oxygen (LOX) system to supply oxygen to the pilot and crew. This LOX system requires substantial ground-based support equipment and personnel. In addition, it requires special safety equipment to cope with fire hazards. But a few years ago, the Air Force Flight Dynamics Laboratory demonstrated a new principle for a self-contained oxygen concentrator that now promises to save at least $20 million in operations and maintenance costs annually.

1.4 Some Major Plans for FY 70

As you recognize, the Defense research and development program includes each year a number of programs that do not seem to change very much. We must continue, year in and year out, our research in ballistic missile defense, antisubmarine warfare, highly discriminating sensors for many applications, and other fields upon which our technical superiority rests. Yet every year there are critical "new starts" or accelerations in R&D that will influence our defense capability for many years. In FY 68 and 69, we validated the basis for several such important programs to be started or expanded in FY 70. Some of these I have already mentioned. I will highlight all of the major ones now, beginning with a few that are especially important.

* As I mentioned earlier, approval has been given to start in FY 1970 the development of an Advanced Manned Strategic Aircraft (AMSA). We intend to shorten the time that would be required for deployment by carefully and competitively evolving the design and resolving the technical difficulties before a firm development or production commitment is made. In doing this, we will formulate a procurement approach that reduces overruns and will update our plans to reflect recent decisions to simplify the avionics. By these actions we will be in a good

position to implement engineering development of a supersonic bomber and to award contracts for a development program next year. We intend to review the technical progress and changes in threat at specific milestones throughout the development program. As we have not approved a production program, no IOC date has been established.

* I mentioned briefly to you last year our plan to start concept formulation studies and some critical technology development for a new submarine to carry long-range missiles. We have started these and will expand our efforts in FY 70. The concept, called ULMS (Underseas Long-Range Missile System), would be designed to maintain our superior position relative to submarine-launched strategic missiles if new, more effective Soviet ASW capabilities and larger, faster, quieter Soviet submarines begin to appear. It might also be an economic replacement for our present fleet and reduce manpower requirements to support a given missile force. Either modified Poseidon or a new missile system could be carried.

* The experiments during the past 2 years in airborne radars looking hundreds of miles overland enable a development program that will revamp our current strategic air defenses, which are now vulnerable to low-altitude attack. As we explained last year, the planned new system will have a much increased capability against all altitude attacks, and will offer annual maintenance savings of as much as $600 million compared with the current defenses. This system is expected to include some Airborne Warning and Control System (AWACS), aircraft, a land-based over-the-horizon radar system for much improved early warning, and a much upgraded version of the F-106 with a new missile and fire-control system for defense against low-, medium-, or high-altitude bombers. We have reviewed the arguments for choosing of the F-106 over other interceptors, including the F-12, for defense against the current and anticipated Soviet bomber threat. Again we have concluded that the plan is sound. It will give us the least expensive, yet fully effective defense against low- and high-altitude bombers. We retain the option to augment air defense with an advanced interceptor if the future threat requires that action. I urge you to approve the elements of this plan.

As you know, on June 10, 1969 Secretary Laird announced that, with the concurrence of the President, he had decided to cancel the Air Force MOL Program. The primary factors in the decision to cancel the MOL project included: (1) the continuing urgency of reducing Federal defense spending and (2) advances in automated techniques for unmanned satellite systems. Not all of the $525 million previously requested for MOL in the Fiscal Year 1970 Budget will be saved as a result of this cancellation. Sizeable close-out costs will be involved. Savings in FY 1970 of several hundred million will accrue. In addition, more than a billion dollars will be saved in Fiscal Years 1971 through 1974. This termination is in no sense an unfavorable reflection on the Air Force or the MOL contractors. The goals of the MOL program were practical and achievable. Under other circumstances, its continuation would have been fully justified.

* Following many years of research, in 1968 a new laser technique was demonstrated. In FY 70 ARPA and the Military Departments will conduct a joint program to exploit the new technique.

* I have described in the past the improved combat capability provided by new night-vision systems. The R&D program in this field has been so successful that we are curtailing production of first-generation devices in anticipation of the second-generation devices in FY 71. The new systems -- up to 50% cheaper, 75% smaller, and 80% lighter -- will find application throughout our military forces. Low Light Level Television and Forward Looking Infrared systems, for example, are now being introduced into our combat aircraft fleet. Night sights are also being developed for our TOW and Dragon antitank missiles. Night driving systems are under development for the MBT-70 and other ground vehicles. Many of the new night vision systems will be operationally evaluated during FY 70.

* A new design of nuclear attack submarine (SSN-688 class) has been included in the FY 70 shipbuilding program. This program intends to provide the best new class of submarines attainable, using the technology available with high confidence in time. The SSN-688 class will incorporate advanced sonars, new fire-control equipment, the Mk-48 torpedoes, higher power propulsion systems to increase speed, and the latest techniques to ensure maximum quieting.

* Research is under way that should lead to improved tactical nuclear capabilities in atomic demolition munitions, air-to-surface and surface-to-surface missiles, and artillery projectiles. We intend to emphasize the final development stages of the LANCE surface-to-surface missile, which should be much more effective than the HONEST JOHN, LITTLE JOHN, and SERGEANT that it will replace. In addition, we will review the technology required for the CONDOR air-to-ground missile. We also are reexamining the command, control and communications systems that could be used with tactical nuclear weapons.

* Recognizing the technical problems encountered with the M-16 rifle and ammunition, we have reviewed all of the research, development and test programs related to small arms, and have made a number of improvements in the management structure of these activities. We have established a new, strong, central management with the Army Small Arms Systems Agency. This group will take an integrated approach to all future development of small arms and ammunition, from basic research through production. Beyond this, we intend to encourage industry to conceive fresh solutions for our current and future small-arms development problems. Our intent is to place the U.S. in the forefront of small-arms R&D within 5 years.

I will close this capsule review of FY 70 plans with a list giving an overview of our R&D programs.

The following list shows projects planned to receive substantially greater funding in FY 70 than they received in FY 69:

- SAM-D: surface-to-air missile for defense of theater forces ($75 million)
- Heavy-Lift Helicopter: a 20-30 ton aerial crane helicopter ($15 million)
- Mallard: tactical communications system for U.S., U.K., Australia, Canada ($21 million)
- ULMS: definition of a new missile-launching submarine ($20 million)
- Ocean Engineering System Development: deep submergence vehicles ($30M)
- AMSA: initial competitive design studies and subsystems needed for advanced bomber ($100 million)
- SCAD: air-launched vehicle for stand-off missile/decoy to improve penetration characteristics of bomber force ($17 million)
- CONUS Air Defense Interceptor: definition of aircraft (preferably F-106X) for new air defense ($18.5 million)
- S-3: Navy ASW aircraft ($165 million)
- AX: AF close support aircraft studies ($12 million)
- F-14A: Navy Fleet Air Defense aircraft ($175 million)
- F-14B/C: Navy replacement for F-4 aircraft ($50 million)
- F-15: AF fighter ($175 million)

- ASMS: Navy surface-to-air and surface-to-surface missile for escorts ($68 million)

- Submarine Sonar: improve sonar capability of Polaris/Poseidon/SSN fleet ($22 million)

- Hard-Rock Silo: design for tenfold increase in hardening for missile silos ($50 million)

1.5 General Comments on the Budget Request

Earlier I presented three charts showing the expected distribution of our requested FY 70 budget, and I have just given you two additional lists of our major programs. In summary, the FY 70 RDT&E request, compared with FY 69, is as follows:

		$ Millions RDT&E (TOA)	
		FY 69	FY 70
6.1	Research	406	432
6.2	Exploratory Development	875	971
6.3	Advanced Development	975	1,257
6.4	Engineering Development	729	1,083
6.5	Management and Support	1,209	1,263
	Operational Systems Development	3,404	3,121
	Emergency Fund	49	100
	Total (TOA)	7,647	8,227

I cannot emphasize too strongly that this budget has been reviewed with extreme care many times, from many points of view. In fact, the entire budget has been reviewed in detail, as you realize, by both the former and present Administrations. Though the total request and the increase over last year's budget are substantial, I believe our program is closely reasoned. The requested funds are necessary, in our judgment, to meet our national security needs. They are indispensable for retaining our technical superiority.

Before concluding this general introduction, I must try to give you an understanding of how I view this overall program and budget.

I suspect you sometimes tire of hearing year after year what seems to be the same general justification of research and development expenditures. For it is easy to become rather blase about the extraordinary achievements of technology. Men going to the moon, intercontinental ballistic missiles, supersonic aircraft, the speed and capacity of modern computers -- these achievements have become expected rather than startling, familiar rather than remote. Then, too, the rhetoric about the process of, and the goals for, research and development has not changed very much since World War II. So I thought it might be helpful for me to try to bring into focus just how unpredictable and exciting the R&D business is. The best way I know to do this is with an illustration.

One of the most effective illustrations arises out of the history of the development of computer technology. Some of you may recall discussions of the first experimental computers built during the late '40's and early '50's. They were built with vacuum tubes, their storage devices had very limited capacity, and their reliability was marginal. Although they were delicate laboratory devices, their capability was impressive, and their potential for both military and civilian applications was enormous. And yet even the most optimistic managers and scientists at that time grossly underestimated the future growth of the computer industry.

This growth has been due in part to the opening up of new applications made possible by new capabilities undreamed of earlier -- such as computer-controlled telephone switching systems -- and in part to enormous improvements in technology resulting from widespread R&D programs. The developments of ceramic magnetic materials, the magnetic core memory, the transistor, and more recently integrated circuits and thin films, have led in less than 20 years to improvements in speed, storage capacity, and reliability -- nearly a thousandfold improvement in all of the computer's prime characteristics. Even more striking improvements have been made in size, weight, and cost. Costs for comparable capability have come down in the last 10 years to one one-hundredth of previous costs. Incidentally, the Soviet Union is still substantially behind us in computer technology.

As one example, the first of the large-scale computer-based military systems was SAGE, which was operational in 1958. Ten years later we have small airborne and tactical field computers that have much greater capability than the original SAGE processors, operate under extremes of environmental conditions with relatively negligible maintenance, and cost only a fraction of early models' price.

Despite the widespread civilian use of digital computers, the R&D leadership has come usually from the DoD and the AEC. Our needs for capacity, reliability, and mobility not only led to many of the initial developments but forced and are still forcing most of the major advances. Throughout this experience we have known that digital computer R&D had application to existing needs. Yet in every case, there have been even greater applications to unforeseen needs.

My general point is that we try to avoid making unqualified specific promises about R&D simply because such predictions or promises are so rarely imaginative enough to anticipate what a vigorous R&D program actually will produce. In short, I have no doubt that the funds requested for FY 70 will create possibilities for radically improved military systems. Research and development may have become more familiar, but it has not become less dynamic and productive.

Mr. Chairman, this concludes my introduction. I will be happy either to continue with parts of my detailed statement or answer any questions you may have.

2. STRATEGIC FORCES

2.1 Introduction

To be a sufficient deterrent, our strategic forces must be capable of inflicting unacceptable damage, with very high confidence and under dependable control, in retaliation to a first strike against us. From the R&D perspective, this is accomplished by maintaining a technical or qualitative lead over the Soviets, and by choosing systems that are as insensitive as possible to the details of the Soviet systems designed to degrade or negate our capability.

2.2 Strategic Retaliatory Forces

2.2.1 Soviet Threat to Our Retaliatory Forces: The Soviets are continuing to develop and improve a broad spectrum of both offensive and defensive strategic weapon systems. Facilities for R&D, test, and production of strategic systems continue to expand. I will review their most significant achievements during the past year and point out the ways in which these achievements could affect our retaliatory forces. Although the National Intelligence Estimates are the basis of this discussion, I will consider possibilities which are not part of the current estimates. Since our task is to ensure that we have sufficient strategic capability under any reasonable circumstances, I feel this approach is required.

SS-9: Of the most significance were Soviet tests of the SS-9, a large payload ICBM, which dispersed three large reentry vehicles. These tests indicate a footprint size adequate for targeting Minuteman silos.

We are not certain what accuracy the Soviet Union has achieved with the SS-9.

There are now more than 200 SS-9 locations. If these missiles had a MIRV capability and each had a CEP of 0.5 nm, then they would pose a significant threat to the Minuteman system.

FOBS: The precise capability of the Fractional Orbit Bombardment System (FOBS) version of the SS-9 is still not clear. On the other hand, it could be oriented toward destroying fixed U.S. command and control with a few launches, or penetrating the SAFEGUARD system, or evading our bomber warning systems, if we took no counteractions. Since we do not yet know how this system will evolve, we must carefully consider all reasonable possibilities.

SS-11: There have been no surprises in the SS-11 deployment, which has continued but at a somewhat slower pace. The CEP of this system is estimated to be rather large. However, since the possibility of improved accuracy exists, the large force also poses a threat to Minuteman.

SS-13: Deployment of this new small, solid ICBM began in 1967 and continues at a slow rate. Only if this system were deployed in large numbers and were given high accuracy would it pose a threat to our retaliatory forces. A mobile version may be deployed.

New SLBM: This SLBM is for the new 16-tube Soviet Yankee-class ballistic missile submarine, of which 8 or more have been launched. The estimated number of these submarines being constructed (4-8 per year) will make it possible for the Soviet Union to mount a continuous missile submarine patrol off of our coasts. Such patrols with the range of its missile (estimated at 1500 n.m.) present a threat to the survivability of the SAC bomber force. If this missile could be flown in a depressed trajectory mode, the time of flight would be so short that even with our current warning most of the bomber force could not be warned and launched in time. It is unlikely that this missile has sufficient accuracy to pose a threat to Minuteman.

Bombers: No significant changes in the capabilities of the Soviet bomber force have been noted.

SAM Systems: One surface-to-air missile system is believed to be capable, with proper siting, of intercepting aircraft at low altitudes. There is insufficient technical evidence to make a final, definitive judgment on the capabilities of the Tallinn system. Although most evidence indicates a design goal of a high- and medium-altitude aircraft threat, a low altitude aircraft defense capability and some limited BMD capability cannot yet be ruled out.

Interceptor and Fighter Aircraft: It is believed that some interceptors now have an all-weather capability. The newer Soviet Long-Range Interceptor, Foxbat, is likely to be the first interceptor with advanced capabilities. A retrofit of advanced systems into the Fiddler, is a possibility.

Ballistic Missile Defense: We have indications that the Soviets are preparing to test a new BMD system or to improve the present Moscow system.

A limited BMD capability for the Tallinn Air Defense System still cannot be ruled out definitely, although we consider it unlikely. In any case, the system could be modified to provide some BMD capability.

As I mentioned, it is possible that development is under way on a second-generation BMD system. If so, and if the deployment schedule on the Moscow system were repeated, deployment could begin in one to two years with IOC occurring in about four to five years.

Soviet ASW: As part of the increasing growth of Soviet naval power and their effort to improve ASW capabilities, the new attack submarines (C, V and B classes plus the new types not yet determined to be class construction and the ASW-equipped Moskva helicopter carrier must be noted with some concern. The Soviet Union is also known to be experimenting with surveillance systems, and is keeping an almost constant watch off Polaris forward bases with intelligence collection ships. While their large ASW improvement program must be continuously reevaluated, it does not now appear to be an immediate threat to the Polaris/Poseidon system.

Civil Defense: During the last year, the Soviets continued to build a professional military cadre of civil defense specialists. Training of the civilian population is publicized annually. A network of civil defense control centers and communications exists. Their program objectives have emphasized (a) evacuation of nonessential personnel in a time of tension before an expected attack; and (b) the provision of shelters for key personnel with secure communications to provide postattack recovery control.

This completes the review, from the R&D perspective, of Soviet threats to our strategic forces.

2.2.2 U.S. Bomber Force: At the end of FY 69, our current bomber force will consist of 255 B-52 G&H, 195 B-52 C-F, and 78 B-58's. The FB-111 becomes operational in August 1970.

The first problem of concern regarding bombers is that of prelaunch survivability in the event of ICBM, SLBM or FOBS attack. To counter this, bombers should be easily dispersable, so as not to be tied to a relatively few readily targetable airfields. To effectively use a dispersal capability, improved tactical warning capability is needed. As I stated last year, we are developing OTH radar and satellites to improve our warning capability. Warning may not be enough, however, in the event of an attack by depressed-trajectory SLBM's. Thus we are considering adding radar faces to the SAFEGUARD ABM system (which I will discuss later) to provide an all-azimuth defense for the bombers. I will discuss these in more detail later when I discuss defensive systems in general.

Regarding dispersal, the principal development requirement is a short take-off and landing ability. Preliminary designs for AMSA incorporate this feature.

As you know, the AMSA development program is still pending. It is currently anticipated that the AMSA program will be started in late FY 70. The planned program includes a number of milestones at which performance can be assessed and configuration changes inserted. We plan to use these reviews to take advantage of all technological advances up to that point, and to reconsider our approach in the light of updated information on the likely threat. The basic reason for starting the AMSA program is to maintain a flexible overall strategic force, taking account of the possible vulnerability of part of our missile force, and thus complicating the Soviet defense plans by our progress toward a new bomber with improved penetration capability; $100.2M is requested for AMSA in FY 70.

Looking at another aspect of the bomber problem, there is substantial uncertainty as to what tactics, weapon techniques and weapon loadings are required to assure bomber penetration through Soviet area and local defenses. Accordingly, we have several specific bomber penetration efforts under way at present. The first is SRAM. This bomber-carried missile, designed to penetrate terminal defenses by exhaustion and/or suppression, is in flight test. SRAM will be carried by both B-52's and FB-111's. AMSA will also have the capability of carrying SRAM.

To assist in penetrating the USSR's advanced area defenses, we started in FY 69 the concept formulation on a long-range decoy, with the capability also of carrying a nuclear warhead. Known as SCAD (Subsonic Cruise Armed Decoy), it is expected to have a long range at low altitude and to be equipped with electronic bomber simulation aids. By providing a large number of bomberlike targets, it will tend to dilute the defenses and exhaust interceptors. Since it carries a warhead, it cannot be ignored by the interceptors. We expect to start advanced development in FY 70 with funding of $17.1M.

As another counter to the Foxbat threat, we will continue to investigate the BDM (Bomber Defense Missile) in FY 70. It would be desirable for such a weapon to have dual capability -- bomber defense and terminal defense penetration -- and our investigations are directed along this line. The propulsion requirements for this mission will be pushing current technology to its limits.

Since AMSA is a new design, we also can tailor its physical characteristics to assist in penetration. For example, one design visualizes supersonic capability, low radar cross-section, reduced IR signature, and sustained high subsonic speed at low level, each of which may contribute to penetration ability. Admittedly, it is difficult now to assess quantitatively the extent to which each of these contribute to the mission. We will investigate this problem thoroughly before a final configuration freeze on ASMA, to ensure we have made the best trade-offs on survivability and penetration.

The FB-111A airplane is now halfway into its R&D flight test phase with flight tests by Air Force personnel just starting. These airplanes are equipped with the MK-IIB avionics. System integration tests with SRAM have started, and flight tests are scheduled. The FB-111A program is progressing satisfactorily. FY 70 RDT&E funding is planned at $84.9M.

2.2.3 U.S. Land Based Missile Force: The present landbased force consists of 54 Titan II and 1000 Minuteman I and II. By the end of CY 1975, the Minuteman Force will have roughly equal numbers of Minuteman II and III.

As I indicated earlier in discussing the threat, the emplaced Minuteman is potentially threatened by the MIRV possibility of the SS-9, or a more accurate SS-11. In addition to the SAFEGUARD system, we are looking in several directions to find the best countermove(s). First, and probably most obvious, is the development of Hard Rock Silos (HRS). I have discussed this program with you before. The goal is an increased "in-silo" hardness. Our present program is aimed at technology demonstration and site surveys. No production decision has yet been made. We request a budget of $50.0M in FY 70.

But hardening alone is not the complete answer, because an enemy can always counter it by improving accuracy. Therefore, we are examining other alternatives.

Mobile ICBM's or deceptively based ICBM's are possibilities for improving our force survivability. Substantial mobility would be expensive; and there may be practical limits to deployment area, thereby limiting force size. Depending upon the specific concept, even mobile systems might be subject to identification and targeting by satellites. Deception provides false aim points for the attacker, thus increasing his force requirements. We expect to place greater emphasis in FY 70 on studying alternate basing modes, using the funding provided in our Advanced ICBM Technology effort.

We do not plan to start operational systems development of a new, larger, land-based ICBM. It would be subject to the same problems mentioned before and would not be significantly better than Minuteman III deployed in Hard Rock Silos. We believe that a substantially better concept is needed to justify such large expenditures.

As my comments on the threat indicated, there have been no major changes in the Soviet ABM capability. There is, however, no justification for complacency on our part. I will review briefly our current and planned programs for missile defense penetration.

Area penetration aids have been under operational development for the Minuteman II since late 1965. The Mk-1 chaff system has achieved its IOC. It is judged to have adequate capability against early warning radars, but the newer, more sophisticated radars may be capable of detecting the booster in the chaff cloud and thus inferring the location of the reentry vehicle. To correct this deficiency, a follow-on variation, the Mk-1A, is being deployed. These penetration aids should present an area defense system with separate potential targets from each booster. The warhead is "hidden" from the defense radars in one of the chaff clouds.

Area penetration aids and terminal decoys are now being developed for the Minuteman III which will provide an improved penetration capability against terminal defenses, depending upon the credibility of the decoys.

Our present program is judged to provide adequate capability for penetration of presently anticipated Soviet defenses. In fact, since there is still no firm evidence of a terminal defense threat, we can say that there is even some long-term insurance in the Minuteman III pen aids program.

In the event the enemy deploys terminal defense with the ability to discriminate decoys, we need to take further steps. The answer here could be in the provision of more RV's per missile -- either smaller RV's on present missiles, or more of the present RV's on a larger booster. In the FY 70 ABRES program, we will investigate the seriousness of this problem. We are critically examining these possibilities.

For a damage-limiting mission, both Minuteman II and III are adequate with respect to warhead yield and guidance accuracy. Although the Titan II, with a single large warhead, has good hard-target kill capability, its survivability is questionable owing to the small force (54), its attractiveness as a target.

2.2.4 U.S. Sea-Based Missile Force: Our current force consists of 656 Polaris missiles deployed on 41 boats. Our planned force is 496 Poseidon on 31 boats and 160 Polaris A-3 on 10 boats. The Poseidon payload is a MIRV configuration, with many reentry vehicles per missile.

As I did with land-based missiles, I will consider first prelaunch survivability and then penetration problems.

Prelaunch survivability pertains to the survivability of the launch platform -- the submarine. This we believe to be good; we do not believe there is any Soviet ASW activity which significantly affects the FBM system at this time, although they may be striving for this goal.

I must emphasize strongly, however, that we are not complacent. The Soviets are building their second-generation nuclear submarines. The next generation might be quiet, effective attack submarines with an ASW capability against our FBM. There are also indications that a greatly enhanced ASW surveillance capability might be developed. We must assume they will eventually have such a system and plan our R&D options and hedges accordingly.

As a general insurance measure, we are starting in FY 70 a new SSBN survivability effort designed to examine the specific problems of maintaining the FBM current high survivability well into the future, and to work out a range of solutions for any possible threat that might arise. It will include development work on analytical techniques, tactics, sonar, quieting, ensonification, decoys, and other areas. As a first step in this direction I asked the Vulnerability Task Force of the Defense Science Board -- the same task force which has made a major contribution to reducing the nuclear vulnerability of our missiles -- to take a hard look at the over-all question of FBM submarine survivability, including communication links.

Another hedge against improved Soviet ASW capability is ULMS (Underwater Long Range Missile System). I mentioned this to you briefly last year. The system involves a new generation of quieter, optimized FBM submarine with possibly a longer range missile. The longer range missile could be a completely new one or it could be a modification of Poseidon at minimum cost and schedule. Because of this modified-Poseidon option, we are concentrating FY 70 efforts on the submarine, the long-lead-time item in the system concept. The greater sea operating room enabled by the longer range missile, coupled with the improved characteristics of the new submarine design, will compound the Soviet ASW problem by an order of magnitude. But most significantly, the FY 70 effort will provide the option of expanding our offensive submarine forces if this should appear desirable in view of the various Soviet offensive threats. It is our intent to also incorporate techniques to reduce operating costs and to minimize the extent of work performed (and the time required for it) at the periodic submarine upkeep periods. We are doing concept formulation on ULMS in FY 69-70, and expect to start actual design in FY 70. Planned FY 70 funding is $20M.

I am considering the desirability of building a dedicated R&D submarine for the ULMS prototype, which could be retained for use in on-going R&D programs after the ULMS development was complete. The cost will be high, but I believe this capability will be needed continuously to assess the ASW situation and to devise and test appropriate counters.

Turning to the penetration problem, we have completed the Navy's Antelope development program, which covered development of boost-phase hardening fixes and a penetration aid system for the Polaris A-3 missile.

I spoke to you last year about the new Poseidon. As you know, Poseidon will carry a number of small RV's. Its large capacity for RV's is, in itself, a very effective penetration technique, since the MIRV capability will provide adequate spacing between RV's in such a way that each RV must be attacked by an enemy interceptor as a separate target. This should be adequate for both area and terminal defense over a broad range of Soviet ABM deployment.

Accordingly, we have not placed additional emphasis to date on penetration aids for Poseidon. An all-RV attack, with no pen aids, is the least risky approach against a sophisticated area and terminal defense system capable of discriminating against decoys. However, we are proposing to study in FY 70 what might be feasible or desirable in the area of Poseidon pen aids, so that, if some technique were particularly attractive, we might use some FY 70 funds for the development of Poseidon pen aids.

Overall, the assured destruction mission capabilities of our sea-based missiles are sufficient until the Soviets deploy fourth-generation submarines that would have significantly improved ASW capabilities, or deploy a much larger number of their third generation, or learn to determine a submarine's location through detection of its characteristics. At that time, we intend to be ready with counters -- improved FBM and/or ULMS, and improved communications.

2.2.5 Operational Testing: I would like to review the operational testing of the Polaris and Minuteman.

Polaris A-2 and A-3 operational tests are now conducted in both the Pacific and Atlantic Oceans. The test impact points are instrumented to allow measurement of accuracy near Midway and Ascension Islands. Thus far, the A-2 configuration has been successfully launched over 70 times with an in-flight success ratio of well over 90%. The A-3 configuration has had over 40 successful launches with a success ratio of about 80%. Follow-on operational testing of the A-3 is continuing.

The Minuteman I and II operational tests have used the Western Test Range for firings. The Minuteman I (A) has been phased out. The I (B) series have been successfully launched over 100 times with an in-flight success ratio of just under 80%. The Minuteman II system is presently undergoing an OT firing program. Because of its fixed land-based -- hence, restricted -- launch location, the Minuteman operational testing requirements pose the following special problems:

First, we require an adequate range facility at which we can test the multiple target capability of the MIRV and the full-range and -weight Minuteman III system.

Second, the performance of Minuteman on various azimuths (i.e., polar vs. equatorial trajectories) must be appraised.

Another problem we face is the need to conduct Minuteman launches under conditions which more realistically duplicate their operational employment. We have had several failures in launches from operational sites using short-burn missiles. We should also conduct full-range launches from operational silos to obtain a realistic assessment of the readiness, accuracy and performance of the Minuteman force. The associated problems of range safety and public acceptance are obvious. We are now developing a program and obtaining coordination for an operational base, full range, Minuteman launch program to start as early as December 1970.

Finally, the cost of these operational tests is high in terms of dollars and numbers of tests. We recognize the need to achieve the required verification of system performance with a minimum of tests. A special study on test and evaluation techniques, requirements, and program optimization was completed in 1968, and we are now studying possible modifications of our operational test plans.

2.3 Strategic Defensive Forces

The strategic retaliatory R&D program I have just described can be characterized as producing high confidence (or assured) systems, while the strategic defensive systems can be characterized as producing flexible or responsive systems. In general, it is not as important that defensive systems warrant high confidence that they will stop every threat as it is that they remain sufficiently flexible to respond rapidly to countermeasures and effectively lower the attacker's confidence.

Again, I will first discuss the threats facing our defensive forces and then the development program responsive to those threats.

2.3.1 Soviet Strategic Threat to U.S. Defenses

ICBM's: The major Soviet threat to U.S. national survival today, and for the foreseeable future, is their large ICBM force, which includes a large number of hardened missile silos and some soft missile launchers. There is

no evidence yet that these soft missile sites are being deactivated. The Soviet ICBM force has continued its high rate of growth and has surpassed the U.S. land-based ICBM force in number of launchers. As I noted earlier, the deployment of the SS-9 has continued.

SLBM's: The Soviet Union has continued conversion of its missile submarines, and production of the Yankee-class ballistic missile submarine, both of which I mentioned earlier. The number of operational SLBM launch tubes is expected to increase greatly, by mid-1975, depending on the production rate of the Yankee-class submarines. These missiles, combined with the Soviet ICBM force, form the backbone of the Soviet strategic offensive and retaliatory force.

Bombers: As in previous years, there has been essentially no change in the size or composition of the Soviet heavy bomber force, but the long-range training flights indicate a strong role for the bomber component.

While the new SST recently flown in Russia is very unlikely to be converted to a supersonic bomber, the technology would be applicable to such development. There is no evidence of any follow-on heavy bomber development.

2.3.2 Chinese (CPR) Threat

ICBM: The CPR ICBM program has undoubtedly been changed and probably delayed about a year. However, we can expect the first test this year, with a nominal operational date possibly as early as 1972. We still have no information on the specific delivery system being developed. The delay might be attributed to technical redirection, to technical problems, or perhaps to the effects of the "Cultural Revolution."

Bombers: Since the CPR bomber force consists of a few TU-4's (a copy of the B-29), several Badger medium bombers and some IL-28 light bombers, there is little in the way of a strategic bomber threat to the continental U.S.

2.3.3 U.S. Ballistic Missile Defense: As you realize, one of the most pressing challenges assumed by the new Administration was a reappraisal of the decision on deploying the Sentinel anti-ballistic missile defense system approved by the last Administration. After intensive review, the President decided that, first, the Sentinel program would be substantially modified so that its defensive intent would be unmistakable; second, the safety of the country demanded a different, carefully phased deployment schedule related clearly to the changing threat situation; and third, the new program would be reviewed annually from the standpoints of technical development, changes in the threat, and diplomatic considerations.

The modified program, called SAFEGUARD, is aimed at three main objectives: active local protection of our land-based retaliatory forces against a missile attack by the USSR; thin defense of the country against a Chinese ICBM attack; and protection against an accidental or small attack from any source. In addition, the components will be deployed to provide early warning and area defense of our bomber bases and command and control system.

The new deployment will use the same components as the one previously approved: the Perimeter Acquisition Radar (PAR), the Missile Site Radar (MSR), and the SPRINT and SPARTAN interceptors. Of course, they will be deployed differently.

Since the components are the same, the previously planned R&D program is largely unaffected. This program will be carried out essentially in two parts. First is the difficult but relatively straightforward effort to complete the development and test of those components selected for the SAFEGUARD ABM system deployment. Second is a substantial effort known as the Advanced BMD (formerly Nike X Advanced Development) Program designed (a) to develop system concepts and components which could be introduced, if necessary, into the SAFEGUARD system -- to extend its effective life against increasing Soviet and CPR threats to our deterrent force;

and (b) to continue to explore new possibilities which may permit defending our urban/industrial complexes against massive and sophisticated threats.

Many issues have arisen with respect to the ABM system. The public expressed concern about dangers caused by deployment. Typical questions, especially about the previous Sentinel deployment plan, were these. Is the Spartan warhead safe while stored in its silo? Will the presence of a Sentinel battery attract attackers? Will the Spartan interceptor trigger the attacking warhead which, in turn, would cause fatalities and damage on the ground?

The new SAFEGUARD objectives do not, of course, include battery installations near cities, with the exception of Washington, D.C., so some of the past questions are no longer entirely relevant. However, safety has always been and continues to be of critical importance. We have recognized this problem for about twenty years, and have done a great deal of analysis and testing of safety devices. This broad base of experience has led to excellent designs; our nuclear devices are equipped with special safety devices for both shipment and storage. In our 20 years of experience with handling nuclear warheads, within and outside of the United States, there has never been a nuclear yield resulting from an accident. We believe the likelihood of an accidental nuclear explosion is essentially nil.

Detonation of an enemy warhead by our interceptor is a frequently raised concern. Spartan missiles are designed for an intercept outside the earth's atmosphere, i.e., where a sympathetic detonation would not cause damage on the ground. More important, the system is designed so that our interceptor would destroy the incoming warhead before it had time to operate and explode.

These questions of safety, however, are less fundamental than two others which have been raised. Will the system work? And will it "grow" in an uncontrollable way?

We expect the system will work against the rapidly growing threat of Soviet SLBM's for specific cases such as defense of the bomber force during those few crucial moments when they are flushing from their bases. The deployment now takes this threat into account, and we intend to review the threat annually. Deployment against Soviet SLBM's required adding additional faces to the MSR's so that these radars look in all directions, rather than exclusively to the north as in the old deployment concept. Also, the long-range PAR radar chain must be extended around the perimeter of the U.S. -- by adding seaward-looking faces to the Boston-area and Seattle-area PAR's, and by adding two PAR's, one in the Southeast and one in the Southwest to complete perimeter coverage. In this way, the system can protect us against SLBM's launched from the east, west and south. It will also be effective in a regional coverage against FOBS which can arrive from the south.

With respect to the Chinese threat, you should recognize that SAFEGUARD incorporates our third generation of ABM technology. Thus, I have no doubt it will be effective in countering the modest first-generation Chinese ICBM threat through the '70's. We expect the Chinese to develop ultimately more sophisticated ICBM technology, probably including penetration aids. However, we know from our experience that the development of sophisticated penetration devices is technically difficult, time consuming, and expensive.

Finally, let there be no question on this point: Although we cannot now design an ABM system that would protect our cities from unacceptable losses during a massive Soviet ICBM attack, we do know how to protect our Minuteman deterrent capability from a massive Soviet first strike. The protection of Minuteman is fundamentally much easier because we need only protect a fraction of the force to preserve an adequate deterrent. Loss of part of the Minuteman force can be tolerated, whereas loss of the same fraction of the population of our large cities is clearly unacceptable. Safeguard will fulfill its design goals, and since protection of our offensive forces in no way weakens the Soviet deterrent, Safeguard will not, in my judgement, destablize the strategic situation.

I am very much aware of the fears that Safeguard will grow in some uncontrolled fashion with an enormous increase in cost. We have -- within the DoD and within the country's normal governmental process -- mechanisms to prevent this. In short, the process is this: Each revision of the present plan must be approved annually by the Secretary of Defense and by the President, and is then submitted to the Congress for discussion before funds are appropriated. I believe this has been and will continue to be a deliberate process in which all of the pros and cons on all critical issues are debated.

The Safeguard R&D program, based upon the previous Sentinel R&D, is still essentially on schedule, although the schedules of work at the first sites have now slipped about 18 months. Three of the four major hardware components have been tested full scale -- the Missile Site Radar (MSR), and both of the missiles, Spartan and Sprint. In the year ahead, integrated MSR/Spartan tests will be conducted at Kwajalein against live ICBM's fired from Vandenberg. Similar MSR/Sprint firings are scheduled for FY 71. The FY 70 R&D request for Safeguard is $401M.

The FOBS presents two potential threats. First, it could reduce the warning time available to our bomber forces and, second, it could reduce the area coverage of the Spartan interceptors. We are accelerating the development and deployment of our forward-scatter Over-the-Horizon (OTH) warning system. This system is being installed now. An interim capability to keep Soviet missiles and FOBS under operational surveillance was attained last spring.

To extend the useful life and dependability of the OTH system, we are improving its resistance to jamming, and deploying another warning system, which works on an entirely different principle. This system will provide warning against ICBM, FOBS and SLBM.

The Nike X Advanced Development Program, for which we request $141M in FY 70, is concentrated on countering the most probable defense penetration schemes. A major threat possibility is chaff designed to conceal the attacking RV. Because of the great length of chaff clouds, the terminal defender can either use a great number of interceptors and attack the entire chaff train or wait until the RV is separated from the light chaff by the atmospheric drag starting at about 50 nautical miles' altitude. Because the time to impact after chaff-RV separation is very small, either (a) a very high acceleration interceptor (Sprint-like) must be used, or (b) a slower, longer range interceptor (Spartan-like) must be launched before the RV is separated from the chaff. Both of these concepts are being investigated. The former, designated the Remote Sprint, requires minor guidance system changes. The latter, called improved Spartan, requires propulsion system and guidance improvements. These improvements in Sprint and Spartan also improve their capability against FOBS.

Still another way to combat concealment of RV's in chaff is to improve the radar resolution -- the ability of the radar to resolve or separate two targets which are very close together. The better the radar resolution, the more chaff required to hide the RV. Also, the better the radar resolution, the higher the altitude at which the radar can see an RV emerge from a chaff cloud when the chaff strikes the upper atmosphere. The MSR has growth potential for much improved resolution. In the process, the volume of space in an MSR resolution "cell" can probably be reduced to a fraction of its present size. Improving the MSR will be an important part of any SAFEGUARD upgrading.

A still more advanced concept in radar is to further improve range resolution until the radar can detect the difference in length between a full-sized reentry vehicle and an object such as a small, heavy, deeply penetrating decoy. An experimental radar having this capability has been installed at Kwajalein to make measurements against U.S. reentry vehicle and chaff systems to demonstrate the concept.

2.3.4 U.S. Air Defense: Our current air defense system permits an intercept only a few hundred miles from the North American Defense perimeter. More important, we have essentially no capability against low-altitude attackers.

Finally, the ground control structure is vulnerable to destruction by ballistic missiles or submarine-launched cruise missiles.

Because of these deficiencies, we plan to develop and install an improved area air defense, based on over-the-horizon warning radar, for peacetime surveillance of targets at all altitudes and at considerable ranges offshore, and an Airborne Warning and Control System (AWACS). The AWACS will permit us to conduct intercept of aircraft targets at all altitudes and at large distances from the defense perimeter. During the past year, preliminary tests successfully demonstrated the feasibility of AWACS. After careful review of these results, we have entered contract definition this year and flight test of the first AWACS R&D model is planned. FY 70 funding is $60.0M. Tradeoff studies of potential CONUS OTH radars will lead to an early decision to enter contract definition for that system.

To exploit this new AWACS capability in its role in continental air defenses, we must also upgrade our manned interceptors. Continued studies have shown that an improved F-106 force, with an advanced look-down fire control system, is far less costly per aircraft than any other candidate interceptor system (hence, available in larger numbers) and is superior in effectiveness against the near-term threat.

We continue to review terminal bomber defenses, including an assessment of the relative utility of Hercules/Hawk and SAM-D in both strategic and tactical roles. Studies have been completed which define the improvements that could be made to Nike-Hercules to extend its lifetime. For the longer term, we continue to pursue the Advanced Development effort on SAM-D. In addition, studies are under way to determine how SAFEGUARD and SAM-D might assist or complement each other in the air defense and antimissile roles and to define R&D objectives for supporting technological programs.

2.3.5 Civil Defense Research: In the Civil Defense research program we are continuing to develop an understanding of what would be required for the U.S. to survive a nuclear attack and achieve rapid economic and military recovery. Means to improve the fallout shelters in existing buildings and to incorporate shelters into new construction throughout the country are being sought. Alternative future passive defense programs, such as limited evacuation and blast shelters, are being analyzed. Planned funding for FY 70 is $5.0M.

2.4 Strategic Command and Control

Effective strategic command and control is very much dependent on our strategic surveillance and warning capability and on the communications systems through which we gather information, transmit decisions and orders, and control actions resulting from those decisions and orders. Our ability to communicate reliably and securely on a global basis is particularly important for effective strategic command and control, and as a result we have, over the years, developed and installed a number of communications systems. Let me emphasize that these systems are in reality subsystems of a single system in which each command center and each communications link has been planned as part of the overall capability to supply information to the President and to provide him the means to control strategic forces. Our planning is based on the unique needs of the strategic forces and the need for diversity in both communications means and routes, to ensure the greater survivability of communications.

Despite improvements which have been made, our communications capability suffers from its vulnerability to physical and electronic attack, as well as from the time, difficulty and cost of installing large global capacities. In addition, the more survivable airborne systems are currently limited to 10-12 hours of unrefueled flight and are restricted in the functions they can perform by the size of the staffs and amount of equipment which can be carried. To achieve higher confidence in control of our forces for several days or longer, additional endurance of our command centers and communications would be needed. This problem and the possible need for more sophisticated control such as retargeting and reprograming will receive increasedg attention during the next year.

Our preparations to improve strategic command and control include five main efforts: (a) improvement of our satellite surveillance and warning capability; (b) improvement of the JCS Minimum Essential Emergency Communications Network (MEECN); (c) improvement of our airborne command post capability; (d) improvement of Polaris FBM submarine communications; and (e) improvement of the Defense Satellite Communications System (DSCS).

A satellite early warning system has been approved to develop warning from space against ICBM, FOBS, and SLBM launches. The spacecraft would provide a fairly accurate indication of an attack.

The function of the Minimum Essential Emergency Communications Network (MEECN) is to provide a survivable communications network for passing execution orders to nuclear forces assigned to the Single Integrated Operational Plan (SIOP). The MEECN consists of elements of survivable communications systems that are interneted to enhance survivability through redundancy and mobility. The most important elements currently included in the MEECN are: (a) the Navy's VLF/LF FBM Communications System; (b) the Air Force's VLF/LF Special Purpose Communications System; and (c) the Air Force's Emergency Rocket Communications System (ERCS). Currently we are preparing recommendations regarding the MEECN program, and I expect that shortly we will have decisions on technical, system engineering, and procurement issues.

We are continuing to investigate possibilities for a new system of airborne command posts to replace all or part of the EC-135 aircraft fleet which we now operate for survivable command of our nuclear forces. Present aircraft are limited in endurance to 10 to 12 hours, unrefueled, and they carry insufficient staff and communications and processing aids. The aircraft choices under consideration include refurbishing the EC-135's, aircraft such as the DC-8/707, and very large aircraft such as the C-5A/747. The command and control system alternatives range from modification of the present communications equipment to more elaborate combinations of satellite communications, switching and data processing to support the activities of a large (e.g., 40-man) battle staff. The funds requested for FY 70 will be used for additional design studies of the alternatives and analysis of the effectiveness which the airborne systems could contribute to the performance of our strategic forces. Assuming the successful completion of the design and analysis efforts in FY 70, contract definition for a new system could be initiated in FY 71. Estimated costs to develop and acquire a new system range from $300M to $700M, depending on aircraft and command and control system choices. Total R&D for the command post could be on the order of $100M if the most complex option were chosen.

Peacetime Polaris command and control is exercised through worldwide fixed transmitters operating on very low, low and high frequencies (VLF/LF/HF). Additionally, TACAMO relay aircraft are used in both the Atlantic and Pacific. Although we have highly redundant communications -- to try to ensure survivability -- each part of the system has deficiencies.

The currently operating Defense Satellite Communications System (DSCS) was established by converting our research and development system to operational use. This system has amply demonstrated the utility of military satellite communications. It provided improvements in our strategic command and control capability, but it has several problems: We need, for example, greater resistance to physical and electronic attack; greater capacity; small, less costly, very reliable terminals; and improved synchronous satellites. As a result of analyses made in preparing the Development Concept Paper for this program, we will develop and procure modern satellites equipped with both earth coverage and narrow-beam antennas; modify existing earth terminals to work with the new satellites; and develop and procure new earth terminals and improved modulation equipment. Additionally, we will continue development of new shipboard and aircraft terminals. We expect to launch the first of the new satellites early in 1971, by which time we will have modified all the existing terminals to the proper configuration; the new terminals will become available later in 1971 and in 1972. We have planned FY 1970 RDT&E funding of $35M to support this program.

2.5 Nuclear Effects and Nuclear Test Detection

These two programs continue to be extremely important to assuring the survivability and effectiveness of our strategic and general purpose forces. Nuclear effects programs evaluate, with a high degree of confidence, the vulnerability/survivability of military systems. Major efforts are applied to the development of nuclear effects simulators for laboratory and field use. Where simulation techniques are not yet developed, and for confirmation of laboratory experiments, underground nuclear tests provide the necessary data.

In nuclear test detection, our purpose is to learn about the nuclear weapons programs and progress of potential adversaries. This provides the background for estimates of the nuclear threats which our systems would be expected to encounter and survive.

2.5.1 Nuclear Weapons Effects: Investigations of nuclear effects include three complementary efforts: research, tests, and the maintenance of "readiness-to-test" (should we decide to resume atmospheric testing). A major portion of this program is a responsibility of the Defense Atomic Support Agency.

Effects Research: Major objectives are to understand nuclear detonation phenomena, to develop techniques and simulators for laboratory and field use, and to develop improved computer techniques for better prediction of effects. Simulation is a more methodical and controllable technique than the much more expensive underground nuclear testing.

We now have simulators available or in development for several specific effects. Shock tubes covering a wide range of sizes and pressures are in widespread use for simulation of direct air blast. The High Explosive Simulation Test (HEST), initially developed to expose missile silos to air-induced over-pressure, has been modified to include the effects of direct ground shock and is currently being expanded to provide great overpressures for testing superhard silos.

Our missile systems, both offensive and defensive, depend extensively on electronics for guidance, control, and fuzing and firing functions. These electronics are inherently susceptible to the effects of nuclear radiation and must be shielded or hardened. We now have available several simulators to produce Transient Radiation Effects on Electronics (TREE). However, these existing machines are adequate only for testing small components at relatively low doses. During FY 1969, we expect to complete final design and start construction on a large TREE facility which will be capable of producing a high gamma-ray dose and will have a large usable test volume. Even with this machine, we will still need confirmatory underground tests.

Another type of simulator which we hope to complete in late 1969 is the Advanced Research Electromagnetic Simulator (ARES). ARES will permit testing an entire missile at the predicted threat level at the frequencies from an exoatmospheric detonation that would be encountered by a missile in flight.

This nuclear effects research program, which I have briefly highlighted, is a major fraction of the DoD contribution to Safeguard II, "Maintenance of Modern Nuclear Laboratory Facilities and Programs."

Underground Testing: Underground testing is still the only available method for determination of many facets of systems vulnerability to nuclear effects. Our major effects test efforts continue to be associated with the vulnerability of systems.

In CY 1968 we successfully executed five DoD effects tests, one joint AEC-DoD test to determine the feasibility of producing hypervelocity pellets and a seismic decoupling test related to possible treaty-evasion tactics. Four of the effects

tests were designed to establish X-ray vulnerability of systems. During the next 18 months, we now expect to complete more X-ray effects tests.

As you know, the DASA underground effects testing constitutes the DoD portion of Safeguard I, for which FY 70 RDT&E funds are requested.

Atmospheric Readiness-to-Test: This is the program which provides for maintenance of a capability to resume atmospheric testing. There are several types of tests which cannot be accomplished underground. In their absence, we must rely on calculations and simulation to provide an effects analysis.

The readiness program includes maintenance of the scientific and operational facilities at Johnston Atoll, maintains Joint Task Force Eight, and includes the overseas readiness exercises. We will also develop improved, hardened instrumentation for the types of tests I have noted above. The AEC and DoD have recently completed a detailed study aimed at reorienting the readiness program to make it responsive to the high-priority problems as we now see them. These are primarily related to the ABM system. In this context, we are also compiling technical plans for possible use of the facilities at Kwajalein and for a Floating Test Site. The latter would permit tests at operational latitudes. For the DASA portion of Safeguard III, we are requesting funds in FY 1970.

2.5.2 Test Detection: Nuclear test detection serves two purposes: (1) to monitor the terms of Safeguard IV of the Limited Test Ban Treaty, and (2) to learn about the nuclear weapons progress of foreign nations. To meet these objectives, we support two programs: the Advanced Research Projects Agency's VELA, and the Atomic Energy Detection System (AEDS).

VELA: This ARPA program provides research in advanced sensors and techniques for detection and evaluation of nuclear tests in all environments -- underground, underwater, in the atmosphere and in space. The FY 1969-1970 program has several major objectives: (1) completion and launch of the fifth pair of satellites to supplement the AEDS capability, (2) completion of the Norway Seismic Array (NORSAR), (3) construction of the first of two increments of the Alaska Long Period Array (ALPA), (4) research on evasion techniques including theoretical and experimental investigations of seismic coupling and decoupling, and (5) research on developing means of acquiring and interpreting diagnostics data on foreign nuclear devices.

The VELA satellite program has provided a continuous nuclear test detection capability in space and the upper atmosphere since 1963. Launch IV in 1967 extended that capability deeper into the atmosphere with earth-oriented optics. VELA V, launched in May 1969, augments that capability by providing improved optics and more reliable earth orientation. With the launch of the last VELA satellites, all further work will consist of the analysis of data from the VELA satellites in orbit.

The NORSAR seismic array, when completed, will utilize a combination of long- and short-period arrays. Used in conjunction with the Montana LASA short-period arrays and the ALPA long-period arrays, the combination will provide a minimal set of stations for evaluating seismic discriminants at different locations. Data from all three systems will be viewed simultaneously at the Seismic Array Analysis Center (SAAC) in Washington, D.C.

FY 1970 RDT&E funds are requested for support of Safeguard IV.

Atomic Energy Detection System: The AEDS R&D effort provides for incorporation of advanced sensors and techniques into the operating detection system. Data from the first increment of the ALPA will be made available to the ARPA SAAC. Other efforts involve new techniques for obtaining EMP signals from nuclear detonations, improvement of data processing and debris sample processing.

In addition to the AEDS investment program, funds are also requested for O&M and Military Personnel.

3. R&D SUPPORT OF THE WAR IN SOUTHEAST ASIA

3.1 Introduction

Much of our research and development for the past few years has been tightly linked to combat experience in Vietnam -- responding to urgent needs and anticipating, wherever possible, problems in the immediate future. Our R&D programs focus on the full range of needed capabilities, from non-lethal urban combat to greater bombing accuracy, from special sensors to adaptations of existing aircraft. Priority consideration has been, and will be, given to those Vietnam-oriented R&D objectives which can be achieved relatively quickly and which will assist in our efforts to Vietnamize the conflict. Last year, for example, we introduced over 130 new items of equipment in Southeast Asia for test and evaluation; nearly as many were introduced into the operational inventory during the same period.

Our investment -- of both talent and funds -- in advanced technology and special weapon systems to meet needs in Vietnam continues to be substantial. We recognize the war involves a complex interaction of historical, political, economic, and social as well as military factors. Frankly, because of this complexity, we find it difficult to assess or predict whether our unmistakable technical achievements will prove eventually to be a decisive factor in bringing the war to a close. In any event, I am convinced our R&D investment for Vietnam is sound, and I can give you two general reasons to support this view.

The first reason concerns the combat in Vietnam itself. By means of a variety of sensors, modified aircraft, innovative command and control systems, extremely accurate weapons, and efficient munitions, we have been able to hold the flow of supplies from the North to the South to a lower level than the enemy desires. As a result of our technical advances we have been able to conduct operations at night as well as during the day. Recently, we have been able to detect and destroy targets even when hidden beneath the jungle canopy. We now use a number of different types of new sensors to provide good surveillance of targets. The "instrumented battlefield" may turn out to be one of the most important developments of the war, particularly once the Military Departments complete the job of thinking through the most effective ways to adapt their doctrine and tactics with the new sensors.

Overall, as I mentioned in my introduction, there is no question that our forces in Vietnam are more effective as a result of the contributions of R&D and that the most important increases in our effectiveness have come from improved and automated all-source intelligence data collection and tactical utilization. While we must make further improvements in our "political" intelligence system to support the police functions in Vietnam, our military units now exploit routinely the much more effective night vision devices, radars, and other sensors. These new techniques have produced the data necessary to apply firepower more quickly, more accurately, and more selectively. Frequently, artillery can be placed on targets within two minutes of acquiring the target through sensor activations.

My second general reason for believing that our Vietnam-related R&D investment is sound, concerns the future. We are using most of our modern tactical equipment in the conduct of the war. On the other hand, the enemy has been using Soviet Union export models, some new and many relatively old. In planning our tactical capability for future critical situations, we consider the fact that the Soviet Union has exported similar arsenals to their other allies. Furthermore, within the USSR itself, many of these operational systems represent a considerable part of the current Soviet capability. As a result of our intensive Vietnam-oriented R&D program, we have seen the deficiencies in our weapons and have started a large number of prototype developments which will become important candidates for future operational systems in our general-purpose and strategic forces. In short, the expenditures on R&D to support the war represent an investment in improving our entire military capability.

Before discussing some of the specific R&D programs related to the war in Vietnam, I will review briefly the financing of this effort.

In FY 68, our total RDT&E needs for Southeast Asia (SEA) amounted to $856 million -- $290 million more than could be identified when the initial FY 68 budget was prepared. FY 69 was similar; we added more than $300 million to the $522 million identified for SEA at the time the budget was submitted last year. In FY 1970, the special R&D account for Vietnam work -- called PROVOST -- initially is about $600M. I estimate that by the end of next year, new requirements will force our SEA RDT&E funding needs again to reach approximately $800M.

PROVOST is a large fraction of our FY 70 program, mainly because of the overall austerity of the proposed RDT&E budget. Last year's reduction of the Emergency Fund to $50 million, representing less than one-tenth of one percent of the total R&D effort, severely limited our flexibility to react to unforeseeable urgent SEA needs. I urge you to support this year's request for a $100 million Emergency Fund.

The following presents a summary of our PROVOST funding since FY 1964.

PROVOST FUNDING ($ Millions)

	FY64	FY65	FY66	FY67	FY68	FY69	FY70
TOTAL PROVOST	100	200	370	680	856	826	800 (Est)

I will now discuss a few of our accomplishments, some of our problems, and some of the promising plans for the future. I will discuss these subjects in the context of the four major areas of operations in Vietnam:

* Counterinfiltration

* Neutralization of VC/NVA Main Force Threat

* Interdiction Operations in North Vietnam

* Pacification

3.2 Counterinfiltration

The VC/NVA regulars and guerrillas are equipped primarily from Soviet, Chinese, and other communist bloc sources. Hence, their ability to escalate either main-force or guerrilla operations is largely dependent on the capability to infiltrate men and materiel into SVN from the North through the DMZ, Laos, Cambodia, or from the sea.

We recognize that we cannot make all possible infiltration routes completely impassable, even using prohibitive amounts of our resources. However, careful analysis of the terrain and the enemy's transportation methods, combined with efficient reconnaissance and judicious use of resources, can force the enemy to pay a very high price in men, materiel, and time and in scheduling uncertainty for any large operation.

The development of target detection and acquisition systems for use in land warfare will rank as one of this war's major technological contributions to the strength of our forces. When coupled with command and control systems and a far-reaching operational concept, we may well be on the verge of providing complete, real-time battlefield surveillance around the clock. The overall program leading to this fledgling capability has been a joint service effort managed by a special office created for the task. They have done a superb job. However, much remains to be done, and we are pressing ahead with further developments in this key area.

Departing now from the discussion of our anti-infiltration system, let me talk about some other accomplishments and plans for bolstering our security and discouraging enemy intrusion.

During the past year, the Army demonstrated the value of quiet aircraft in the reconnaissance role. We are developing successor aircraft which incorporate better night vision devices, greater flight performance, and improved payload capability.

In another PROVOST development, four MOHAWK Army reconnaissance aircraft carrying significantly improved side-looking radar and other sensors were tested in SVN in 1968. Preliminary results of these tests indicated that more targets could be discerned with the new sensors.

Mortar and rocket attacks against our bases and outposts, which account for a number of our combat fatalities and some 1968 Air Force aircraft combat losses, have highlighted our continued vulnerability to stand-off weapons. We are taking a number of approaches to try to solve this problem. The Air Force, for example, is now testing new equipment and techniques, the best of which will be selected for integration into a base defense system for Southeast Asia deployment this year. Candidate subsystems include improved optical systems, personnel detection radar, low-light-level TV and covert light sources.

Meanwhile, development of the Army's ambitious TPQ-28 360-degree countermortar system is progressing rapidly. Our increased emphasis on countermortar/rocket capability has also suggested that several existing air defense/air control radars may be modified to adapt them to the local artillery, mortar, and rocket threat as an interim measure. Sensor systems recently developed have demonstrated some effectiveness during Vietnam tests in a mortar-locating role. These systems now require a manual plot of data; they are undergoing additional development to enable the sensor data to be processed through a small computer, thus automating a solution to the mortar-locating problem. Their mobility may make them an attractive option for remote outposts and outlying base defenses.

Last year we achieved a substantial increase in our night attack effectiveness against trucks, boats, and camp sites through introduction of the Air Force AC-130 and AC-119 side-firing GUNSHIP aircraft. The GUNSHIP's initial effectiveness (targets destroyed or damaged per sortie) was greater than the overall effectiveness of all aircraft experienced during the first 5 months of 1969.

River craft, barracks ships, cargo vessels, and port facilities have been especially susceptible to underwater demolition attack. In 1968, over 70 of our boats were destroyed or damaged by swimmer-sapper operations. Next year we will have available new patrol craft to replace the modified commercial boats which we were forced to press into service. These will incorporate planning hulls, quiet propulsion, improved surveillance equipment, better armor, and improved communications equipment. We are also investigating and experimenting with electronic and acoustic methods of detecting and warning of underwater incursions.

Let me summarize our assessment of the infiltration problem. Intelligence estimates vary on the amounts of supplies required to maintain current enemy main force and guerrilla threat levels in SVN. Roughly 300 tons per day appears to be the general range of total VC/NVA daily needs, and about one-third is infiltrated. Even when our anti-infiltration efforts appeared to be most effective (September 1968), we estimate the NVA still infiltrated almost 40 tons per day, and in February of this year, that number was back up to 90 tons per day. You can see, then, that to cut off all of the flow is basically an unsolvable problem. We may never be able to restrict the flow below the enemy's minimal needs to maintain his current level of violence. But I believe we can make it difficult for the NVA to sustain combat activity by large units.

3.3 Neutralization of the VC/NVA Main-Force Threat

It is the extensive natural cover of vegetation in Vietnam, along with the mountains, sanctuaries, and darkness, that have allowed the guerrilla to elude detection and neutralization, permitted the VC/NVA main-force

units to avoid contact until a time of their choosing, and, at their option, to break contact and fade quickly into the vegetation and darkness. In the past, the enemy has trained, recruited, foraged for food, collected taxes, hidden his weapons and ammunition, and moved to his attack positions largely undetected. But our R&D efforts have begun to strip away more of the cloak of natural cover.

We have developed many types of night vision devices for use by foot soldiers, forward air controllers, and riverine boat crews. We have provided more effective night illumination with flares and with searchlights for helicopter and fixed-wing aircraft. We are now combining the sensors and illuminators to provide covert illumination of benefit only to properly equipped friendly forces. We have made great improvements in our passive infrared detectors, and they are still highly competitive with other night vision devices.

Let me give you a few examples of current projects:

*SMASH, the Army's SEA Multisensor Armed Surveillance Helicopter, started with FY 68 Supplemental funds, will provide the AH-1G (HUEY) COBRA the means to detect, engage, and maintain contact with the enemy at night and in foul weather -- through the integration of now demonstrated sensor systems with its current fire-control system and 20mm guns.

*With FY 68 Emergency Funds, we seized on recent advances in radar technology to develop several relatively mobile foliage-penetration radars. We are also testing "heli-borne" configurations and plan to proceed with wide-area surveillance versions to compensate for unfavorable topography.

*Special techniques and munitions for clearing jungle growth and sweeping enemy mines and booby traps at potential helicopter landing sites are under development by all three Services. We have just completed an in-theater evaluation of COMBAT TRAP, a system for creating new landing zones using 10,000-pound bombs dropped by the CH-54 heavy-lift helicopter or the C-130 cargo aircraft. Tests of this systems were highly successful. Thus, we have started operational use of these off-the-shelf munitions.

*To discourage the enemy from reentering areas previously cleared by our ground mobile units, we are developing a family of leave-behind devices and mines.

*Our fuzed-munition dud rate in Vietnam has been totally unacceptable. We have been able to acquire meaningful data on several categories of munitions, but it is not possible to establish an accurate dud rate for all munitions expended in Southeast Asia. We do know that even a 1% dud rate will leave thousands of pounds of unexploded munitions potentially available for use against us. For instance, we currently expend 75,000 tons of artillery shells alone per month. Rugged, miniaturized electronic components will now permit development of contact, delay, and variable-time fuzes with at least 99% reliability, and we have several programs to meet this objective. Even if we cannot eliminate duds, we must try to minimize them.

COMUSMACV has stated a priority request for equipment to successfully detect, locate, neutralize or destroy enemy mines and booby traps without damage to friendly equipment or personnel. Let me explain the basis of this need. In 1965, about 90% of these devices were then locally manufactured by the enemy from captured or dud U.S. munitions. Some of the friendly casualties in 1966 were caused by these weapons. In 1967, they caused considerable losses. Through May 1968, enemy mines and booby traps caused the loss of a number of Armored Personnel Carriers (APC), and tank losses have been caused by mines. In 1968, U.S. Army elements unintentionally actuated many of the enemy mines and booby traps encountered.

Improved models of both tank and APC-mounted mine-clearing rollers and an APC-mounted command wire cutter are currently being evaluated. After

individual components are evaluated in SVN, they will be made operationally available, if successful. Concealed cargo and munitions detectors are being developed, and testing is to begin in FY 70. These devices may aid in determining the location of mines and munitions workshops.

In this war, where so much depends on mobility and firepower, our foot soldier still stands out as the most effective combat "system." Much has been done to increase his effectiveness, to enhance his survivability, endurance, and comfort, his firepower, and the reliability of his weapons and equipment -- generally, his combat capability. But he needs lighter weight body armor and headgear (models of body armor that weigh approximately 50% less have now entered large-scale production). We have recently commenced to provide light-weight mosquito-resistant clothing to help guard him against malaria, improved combat boots to reduce the incidence of foot damage and fungus disease, light-weight and more efficient intrenching tools, and other improved individual equipment. We are also working on the small infantry unit as a system -- logistics, armament, sensors, communications, and mobility -- as part of an ARPA/Army/Marine program to explore the feasibility and effectiveness of a Small Independent Action Force in limited or counterinsurgent warfare.

3.4 Air Interdiction Operations

Since the 1 November 1968 total bombing halt over NVN, our principal air interdiction objective has been to disrupt the flow of men and material from the North into SVN. Emphasis is being placed on storage areas and targets of opportunity.

We are confident that the overall effectiveness of the interdiction campaign will multiply as target identification and strike force operations are consolidated under a single command and control responsibility, as new munitions with improved interdiction capabilities are procured and employed, and, finally, as an increased sortie allocation permits 24-hour pursuit of the enemy's infiltration logistics.

We are still trying to evaluate and apply the lessons learned from 2 years of experience flying in the hostile environment over North Vietnam. I will give a few examples of the progress being made.

Combat operational tests of a family of guided bombs late in FY 68 have provided encouragement that major advances in operational bombing accuracy are technically within our grasp. The CEP's demonstrated recently with guided bombs herald a new era in target damage or destruction probability, compared with the CEP's achievable with conventional bombing. Fewer sorties, expenditure of less munitions, and fewer aircraft losses should result.

Our new antiradiation missile, STANDARD ARM, was effective against enemy acquisition and fire-control radars, but we need to continue to improve its targeting versatility.

Many unrecovered airmen could have been saved except for our inability to locate them precisely, to penetrate hostile search areas, and then to arrive at the prospective rescue site in time to prevent capture. This is a tough problem. Four years of performance data on rescue of aircrewmen downed by enemy action in SEA show no real trends in any geographical area. The apparent rise in rescue rate in NVN during 1968 was due to the bombing restrictions that confined combat missions to the southern panhandle.

In FY 69, we achieved for the first time a limited night rescue capability with the HH-53 Air Force rescue helicopter by the addition of night observation devices and covert illumination systems. In FY 70, we will add doppler navigation equipment and terrain-following radar to make it an all-weather system.

During air operations over NVN in 1967 we commanded a 5:1 aircraft kill ratio in air-to-air engagements. In FY 68, improved enemy equipment and an

extended GCI net permitted the NVN to cut our advantage by destroying 26 U.S. aircraft, while losing 31 of their own. FY 70 plans include engineering development of gun systems optimized for air-to-air combat and a family of improved 20mm rounds characterized by increased mass, size and impact energy.

From 1965 through 1968 we have lost 117 aircraft to surface-to-air missiles. Losses peaked in 1967 at 60 and dropped in 1968 to 12. Actually, the SAM effectiveness ratio -- SAM's fired to U.S. aircraft downed -- has gradually improved. We did degrade the SAM threat through effective employment of electronic countermeasures equipment, EW aircraft, and tactics.

3.5 Pacification

Regardless of military achievements, the final measure of success in Vietnam is the level of pacification and the overall strength of the country itself. We must identify the potential insurgent and lessen his discontent, guarantee protection, to the populace and demonstrate to them the need for cooperation with, and participation in, the national and local government. We must convince the active insurgent of the penalties of his violence.

The pacification effort is moving much more slowly than the military effort -- more slowly than desired, of course. Though I will not discuss operations here, I must point out that we appear finally to be reaching the point where the NVN main forces are being defeated, and where territorial security is being established over an increasing area. Many local VC bases, inviolate for years, have been rooted out. The work of finding and eliminating the enemy infrastructure is beginning to get under way. The Government of South Vietnam can now begin to establish its political system and economic infrastructure firmly in the villages. And they appear to be making some progress.

Now that positive results in the military part of the war are firmly in hand, the long task of pacification is beginning to gain some momentum. But the lesson of the Tet attacks is that we cannot expect the enemy to allow this to happen as long as he has any military strength left -- which he clearly does.

In 1968, abductions, assassinations, and terrorism directed against the general populace in SVN increased from the 1967 level by over 100%, from 9,800 to 21,000. Similar incidents of terrorism directed against government officials and employees increased by about 50%, from 1,200 to 1,800. Obviously, the particular circumstances surrounding these acts are highly significant and must be analyzed to understand these data. Nevertheless, the overall trends are striking. In a year when the VC/NVA accelerated the campaign of violence so markedly throughout SVN, their emphasis on the civilian population may indicate their awareness of the potential for growing cooperation with the central government, both in the countryside and in urban areas.

A fundamental question can be posed about our R&D support to pacification in Vietnam. First, let me say again that pacification -- not in the sense of imposing "quietness", but in the sense of developing effective government and democratic processes throughout the country -- is the fundamental U.S. goal in assisting the Government of South Vietnam. Thus, the question is: Since the R&D program is designed to support U.S. goals, what is the role -- past, present and future -- of R&D in this central pacification effort? This is a straightforward, penetrating question. The answer turns on three considerations.

First, our R&D usually is focused on the physical and engineering sciences, and on the hardware output of work in these fields. Using this framework, our R&D has been productive. As I have already indicated, it has contributed significantly to the effectiveness of our military forces in Vietnam. And since our forces have played a dominant role in achieving what peace and stability there is in Vietnam today, advanced technology has served the pacification program well.

Second, as we have come to recognize the broader problems in helping to build a free and independent South Vietnam, we have begun to examine the

challenging jobs for our specialists in the social and behavioral sciences. Unfortunately, precision in even defining the correct directions for this R&D activity is not always possible today. But the toughest problems in the future may well be those in the social sciences underlying pacification. So I see a modest growth, and I attach increased significance to our R&D in this area.

Finally, when we consider the situation in Vietnam during the next few years, we are faced with tough questions that demand answers taking account of variables in all areas -- military, technical, political, economic, and social. For example, what has been the impact of our new sensor technology on all of the U.S. goals in Vietnam? How and when should we transfer some of this technology to the Vietnamese to help with problems such as border and hamlet security, communications within the country, and sustained counter-terrorist campaigns? How do we strengthen the crucial capability of the police forces throughout the countryside? What resources would an international supervisory body need to effectively enforce agreements that may be reached in Paris? Though these questions surely are not exclusively "technical", they demonstrate the complexity and integrated character of the required "pacification" R&D. I am convinced that, as we pursue this work, we will develop an understanding that will help to deter the development of future Vietnams.

Let's look now at a few of our past and current R&D programs related to pacification.

I will first describe the R&D directly supporting pacification, most of which is undertaken by ARPA. An example of useful payoff of long-term R&D arises from the work on VC motivation and morale, begun several years ago. Through extensive interviews with VC prisoners and defectors, studies have provided a wealth of information on VC methods and organization and even their reactions to more recent RVN pacification efforts. In recent months this work was consolidated into a brief manual in English and Vietnamese, for use by the operating community, that describes the VC infrastructure and shows how component members can be recognized in the villages and hamlets by their behavior, contacts, and movement patterns. This small volume has been distributed by the thousands in Vietnam. The work will be continued, by others in the R&D community, to establish a routine means for observing changes in the infrastructure and incorporating them into updated operating instructions. At that point, the concepts will be incorporated into standard operating procedures.

All the pacification-related R&D data coming out of Vietnam has been integrated and the information is being analyzed for the lessons learned and their implications relative to future tactics and strategy. This effort will provide an overview of the pacification effort as a complex operating system with an input to, and support of, on-going tactical military efforts, and ultimately related to the strategic and tactical approaches to the problems of post-hostilities security.

To perform short-term research, a pacification research task force was established in Vietnam to work directly with the Deputy to COMUSMACV for CORDS, Ambassador Colby. This task force is responsive to "spot" research questions, and is generally assigned one- to two-man research tasks lasting 2 to 6 months. Reports are developed on subjects such as the circumstances and suitability of the Regional Forces and Popular Forces for certain police-oriented work in the villages; why certain hamlets and villages regress after Rural Development cadres leave, while others (apparently similar and having had equal attention) do not, but continue on the Government side; and why some RD cadres fail to perform while others succeed, when both have apparently similar backgrounds and the same training. This task-force approach meets the short-term research needs in the field on a quick-reaction basis.

One minor but encouraging indicator is the establishment of a graduate school for business administration in Saigon. The school was established in February 1969 with an initial class enrollment of 150 students. Recognizing

the importance of broadening the in-depth understanding of difficult economic problems in Vietnam, the GVN has given draft deferments to about 30% of these graduate students. For the expense of sending one graduate student to the U.S. to study business administration, the school in Saigon can send 10 students completely through the 2-year curriculum.

Turning to other areas, the Defense Department, other agencies of the Government, and industry, are developing self-help housing techniques for the 1.2 million refugees now in temporary camps in Vietnam. We plan to make maximum use of local unskilled labor and natural resources and, initially, to provide self-help advisers to teach the techniques of construction. A variety of other items designed to encourage self-help are under development by our service in-house laboratories. They include such basics as lightweight quick-erect tents, remote area refrigerators, waste disposal units, hamlet rehabilitation tool kits, water analysis kits, and similar items.

One relatively minor achievement which has had a major impact on pacification in certain situations is the Department of Agriculture's heli-borne fire-bucket concept. It provides highly effective fire suppression among the crowded and flimsy dwellings typical of 60% of urban Vietnam.

The Tet offensive demonstrated our unpreparedness to cope with its accompanying forms of urban terrorism. Last summer, "urban warfare" was examined by a panel of the Defense Science Board, leading to specific recommendations for R&D on future weapons and tactics. New nonlethal weapons and techniques now under development will minimize the destructive impact on urban populations and property. We also have urged emphasizing the development of more effective nonlethal chemical munitions applicable to this environment.

Intelligence systems involving computer technology -- to process large data samples, monitor guerrilla activity, and interpret sensor activations -- have already been deployed. R&D prototypes of remote signaling devices have been developed to permit select occupants to alert nearby police or military units of the presence of hostile forces, or the danger of attack.

We are beginning to find increased enthusiasm among the Vietnamese for application of many of our recent military developments to provide a deterrent to insurgency within the hamlets and villages and along the roads and canals which provide their economic lifeline. Remote sensors, motion-detection radar, and night vision devices have applications along such vital highways as Route 4 from Saigon to the Delta. Xenon searchlights are already in use in this role, and U.S. forces have come to learn the value of such items in minimizing the number of troops required for sentry and patrol duty.

We will, of course, continue to pursue a range of pacification studies in cooperation with South Vietnamese authorities. We will support joint R&D programs with other agencies of the U.S. Government which contribute to the nation-building process and establish guarantees of Vietnamese security.

3.6 Summary

Over 4 years ago, we entered this strange war with no battle lines established, no visual way of telling friend from foe, no unified central government through which to coordinate our support, no South Vietnamese national objectives -- save the national desire to choose their own way of life. We found the enemy -- both the insurgent and the infiltrator -- highly skilled in using the natural cover of the jungle and darkness to mask his assembly, his advances, and his retreats. We had to cope with a language comprised of literally hundreds of dialects, a social structure tied to scores of individual cultures and influenced by dozens of religious sects. Since joining battle, we have been impeded by enemy sanctuaries and opposed by weapons ranging from poisoned arrows and punji sticks to sophisticated SAM systems. Frankly, many of these fundamental problems of combat are not yet solved.

Nevertheless, we have demonstrated that those R&D items started or expedited for this conflict, when introduced to the theater in operational quantities, have assisted in turning the military advantage to favor the Free World Forces. A great many more developments are now undergoing test. Many will soon reach Vietnam to contribute more to our operational effectiveness.

We have been able to adapt to the changes in emphasis brought about by the military and political developments of the past year. With the assistance of the in-theater scientific advisers to COMUSMACV, we have established close and permanent rapport with the operational organizations in the field. I am convinced that our R&D efforts over the past few years will have a significant impact on our ability to assist the Vietnamese, to maintain the superiority of our postwar tactical warfare inventory.

In summary, these are the general areas where we intend to concentrate our R&D in support of SEA:

Counterinfiltration

1. Extend the systems approach in the application of sensor/computer/weapon technology to border and perimeter defenses.
2. Expedite advanced countermortar/artillery radar, moving-target radar, and night vision devices to provide increased surveillance capability for bases and outposts.

Neutralization of the VC/NVA Main-Force Threat

1. Improve real-time airborne reconnaissance/strike systems to pinpoint the enemy at night and during foul weather and bring maximum effective firepower to bear.
2. Develop a full range of ordnance that will permit the matching of reliable munition/fuzing for selected targets.
3. Continue work on lightweight night observation devices, target illuminators, and lightweight communications equipment to improve the effectiveness of ground mobile and riverine units.
4. Reduce the threat of enemy mines and booby traps by improving mine detection and sweeping equipment and techniques.

Air Interdiction Operations

1. Improve air-delivered ordnance accuracy by exploiting the rapidly unfolding electro-optical guidance technology.
2. Expand night and all-weather rescue capability.
3. Develop electronic countermeasures and electronic warfare capabilities to match the changing threat.

Pacification

1. Adapt the whole field of advanced sensor technology, from remote acoustic devices to moving target radar, to the special needs of police, village and hamlet defense and intrusion alarm.
2. Assist the GVN in research and surveys to determine the motivation and basic needs of the populace, assist in the establishment of leadership and communications within the villages, and (in cooperation with other U.S. departments and agencies) provide self-help techniques and equipment aimed at life-support functions.
3. Train and equip local police and Popular Forces with the latest equipment and techniques suitable to their capabilities to maintain law and order for economic growth in the villages and along routes of travel.

4. TACTICAL FORCES

4.1 INTRODUCTION

During 1968 tactical warfare research and development achieved much. A number of systems emerged from R&D and were evaluated in combat. Critical milestones were reached in on-going developments. And major new programs were started as our analysis of the changing threat revealed the need for, and the capability to develop, new systems.

I mentioned a few highlights about the tactical threat and about our tactical warfare R&D in my introduction. Now, I will elaborate on those and other programs, discussing our activities in terms of air, land and sea warfare and airlift.

4.2 AIR WARFARE

4.2.1 Command, Control and Electronic Warfare: Land and fleet air defense, the control of our interceptors, and the conduct of air strikes in an environment of sophisticated enemy air defenses -- all these require air surveillance tied into good communications, command and control. We also need electronic warfare devices to reduce our aircraft attrition. Because of their different needs, the Navy and the Air Force perform these functions somewhat differently.

The Navy uses the carrier-based E-2A airborne early warning radar aircraft which, through its computer and data link, transmits the air picture to the Naval Tactical Data System (NTDS) aboard the ships of the fleet. It can, at the same time, exercise control over our strike and interceptor aircraft. Specially equipped ships such as the PIRAZ also play an important role in the command and control of air warfare. To protect our aircraft we carry on-board jammers, and we also use specially configured electronic warfare aircraft such as the EA-6A to perform standoff jamming and other functions.

With respect to the E-2A, as of 1 September 1969 the Navy needed more systems than they now have on order so as to deploy the required number of E-2A's per large CVA type aircraft carrier now in commission. This situation will continue to deteriorate as E-2A's are lost due to normal attrition and as large deck carriers are placed in commission to replace older, smaller carriers. In determining what to do about this situation, it was noted that the E-2A had a low reliability due to the fact that its design dates back to the late 1950's and uses the electronic components available at that time. By adhering closely to the original E-2A avionics design, placing emphasis on increasing reliability and using recently developed highly reliable components, it is estimated that we can improve the reliability of the E-2A. By so doing, we will increase the availability of the new system to the point where it is cost effective to develop and produce a new avionics system for the E-2A airframe as compared with attempting to buy new editions of the old design. This new system, the E-2A airframe with new avionics, is called the E-2C. In addition to the increase in reliability, we are also improving performance by modifying the radar to make it more effective and provide a display that will enable a well qualified operator to detect fighter type aircraft flying at low altitudes. We believe that the selection of this radar is appropriate for the E-2C since it provides a capability commensurate with the mission of the Navy carrier task force and has already been developed and flight tested to the point where its development and production schedule can support the early delivery of systems to meet the urgent quantitative requirements of the Navy. In addition, we are adding a new passive detection system. This will greatly improve the versatility of the E-2C.

In order to meet its needs for airborne tactical command, control and communications, the Air Force has modified and is using several different types of aircraft, each of which does a part of the job. For example, the EC-121 airborne radar surveillance and intercept control system originally developed as an airborne seaward extension of the SAGE system is being used in SEA to perform some surveillance and aircraft control functions. The C-130 transports

have been modified to perform as an airborne communications and command center. KC-135 tankers have been modified for radio relay. These modifications are, at best, a piecemeal approach to the problem of providing the needed tactical airborne surveillance, command, control and communication capability. The Air Force's analysis of its needs for a tactical system, designed to improve effectiveness and reduce the different types of aircraft, indicates that there is approximately an 80% commonalty between an AWACS for air defense and an AWACS for tactical employment. The 20% difference between the two is primarily in computer programming rather than in hardware. Based on this analysis, we believe that an AWACS system developed for air defense can be configured to perform the tactical mission or vice versa. Therefore, the AWACS program that we are planning to pursue will involve the early flight test of the radar and other equipments that will be equally applicable to either tactical or air defense applications.

We are using ECM extensively to degrade the enemy's surveillance, command, control and communications capabilities. To increase the survivability of our strike aircraft, we use on-board ECM, stand-off jammers and suppressive weapons in combination.

ECM in Vietnam has proved to be effective in enhancing aircraft survivability. However, because our ECM techniques are being revealed to the enemy, we must develop new systems that will not be affected by the enemy's ECCM.

We previously examined the relative merits of an aircraft uniquely configured for stand-off and escort jamming to augment the on-board jammers on strike aircraft in dense electromagnetic environments, such as in certain areas of North Vietnam. It was concluded that a specialized aircraft, the EA-6B, would more than offset its cost by reducing attack aircraft losses, and would provide a hedge against possible improvements in the enemy's defenses. EA-6B flight tests started in May 1968. Preproduction system performance demonstrations were recently completed. Production is scheduled to begin in FY 70.

Antiradiation missiles threaten the enemy's antiair system. They thus impose a transmission discipline on the enemy which, in conjunction with ECM, limits his tracking opportunities, further degrading his defensive capability. In FY 70, we are continuing the development of follow-on versions to STANDARD ARM. Testing of the STANDARD ARM MOD 1 seeker and development of the MOD 2 seeker will be continued in FY 70. The MOD 2 seeker will be more sensitive and will cover a greater spectrum of radar frequencies.

4.2.2 Interdiction: Interdiction frequently requires attacks on heavily defended targets such as route packages 6A and 6B in NVN. This places a premium on weapon delivery accuracy, aircraft payload capability and penetration capability (ECM, low-altitude penetration, ability to take advantage of adverse weather conditions, evasion and defensive capabilities). These characteristics are embodied in the F-111A, which was deployed to SEA in March 1968 for a six-month evaluation. Test results were limited by the loss of three of the eight aircraft (six plus two replacements) and by the subsequent imposition of the bombing halt. Causes of the losses are still under investigation. One of the SEA losses and a CONUS loss were traced to workmanship and quality-control defects. However, the SEA tests did show genuinely significant improvements in penetration capability and especially in night and all-weather bombing accuracy. The F-111 attained a smaller combat CEP than the F-105 and the F-4 on similar night or adverse-weather interdiction missions. We are developing the Mark II advanced avionics package for the F-111D to provide even greater precision in navigation and bombing accuracy (improved velocity sensing, ballistics computation, and radar resolution). I am requesting funds for the F-111 in FY 70, to support continued avionics development and the uprated TF-30 engine development.

The Navy A-7A proved its versatility, flexibility, and increased ordnance capability in combat in SEA. Employed in interdiction, armed reconnaissance, close support and rescap missions, it met or exceeded our goals. Although the more sophisticated A-7A requires roughly 20% more maintenance per flight hour than the

earlier but still useful A-4, the A-7A has greater range and payload capability than the A-4. The A-7A procurement cost is higher than that of the A-4, but less than that of the A-6. The A-7 thus bridges the gap between the A-4 and the A-6, and is comparable to the A-6 under visual operating conditions. The A-7D/E joint Navy/Air Force development, incorporating significantly improved avionics and the higher thrust TF-41 engine, continues on schedule. I am requesting funds for the Navy and the Air Force in FY 70 to support the later phases of test and evaluation.

We can trade off warhead size in free-fall ordnance against the reduced miss distances of guided air-to-ground missiles. The nature of the target affects the choice, as does the intensity of the defenses at the target, since a guided weapon allows stand-off attack.

We have attained excellent results with the TV guided bomb, WALLEYE, in SEA, destroying many of the targets attacked. This success prompted development of a larger variant utilizing many of the same components. Building on the WALLEYE technology, the Navy is developing the TV-guided CONDOR missile, which will deliver an HE warhead with accuracy. CONDOR system flight tests will be performed during FY 70. I am requesting funds in FY 70 for the continuation of CONDOR development.

The Air Force will proceed with the air-launched rocket-boosted MAVERICK missile into its second year of Engineering Development. This missile will provide the capability to attack small, hard tactical targets such as tanks and field fortifications. Because of its accurate guidance and the high lethality of its conical shaped-charge warhead (which will penetrate steel or concrete), it has been possible to keep MAVERICK sufficiently small to allow a relatively large number to be carried on a single aircraft. We request funding in FY 70 to continue this development.

4.2.3 Close Air Support: Historically (World War II, Korea, Vietnam), close air support is a most demanding mission in terms of aerodynamic efficiency and weaponry performance. Delivery of ordnance in close proximity to friendly forces demands superior individual aircraft and weaponry performance. It demands accurate, timely, on-call firepower under all conditions in which our ground forces must fight. Experience in close air support against guerrillas in South Vietnam has added a new dimension to the requirements for close air support. We have found that, in an environment with essentially no threat of enemy air opposition and with enemy ground defenses limited usually to small arms and machine guns, excellent results can be achieved with cargo aircraft modified as gunships, trainer aircraft modified to deliver air-to-ground ordnance, armed helicopter gunships and armed visual observation aircraft (Marine version of the OV-10).

Last year I told you that the Air Force was conducting concept formulation (CF) of a new close support aircraft, the AX. After a careful review of the Air Force studies, we have directed continuation of CF to include consideration of a broader range of characteristics: nighttime and adverse weather (as well as day) operations; a revised spectrum of range-payload, takeoff-landing distance, and delivery combinations; and operations in an enemy defense environment ranging from that typical of South Vietnamese experience to the much higher threat defenses anticipated in the future.

4.2.4 Air Superiority Mission: The Soviets have traditionally stressed the development of counterair fighters. These aircraft are extremely difficult to surpass if in our aircraft we try to fulfill the additional requirements of long range and multimission capability, as has been our doctrine in recent years. We have had to find ways to define air superiority systems that are consistent with our mission requirements yet able to successfully engage the new generation of Soviet fighters.

After several years of detailed study and development efforts, we have evolved two complementary solutions to the air superiority need. For the Air Force, we are proceeding with the development of the F-15, a single-place twin-engine turbofan-powered aircraft with an advanced avionics system and advanced air-to-air missiles

and guns which will make it superior in air combat to any present or postulated Soviet fighter in close-in, visual and stand-off encounters at moderate range. In the F-15 CF studies, emphasis was placed on optimizing the combination of takeoff weight, avionics and weapons for both stand-off and close-in engagements, energy maneuverability for close-in engagements and radius for the air superiority mission. The relative merits of single and twin-engine configurations were studied in depth, as was the relationship between system flexibility and specialized counter-air capability for one- and two-man crew configurations. The decision to build a single-place aircraft for close-in combat optimization at the cost of reduced maximum range stand-off potential and the absence of all-weather bombing capability was the final decision to be made before we proceeded with contract definition(CD).

The Navy's interest initially centered on VFAX, the F-4 replacement to be used in combination with the the F-111B. However, Navy dissatisfaction with the F-111B program and subsequent reductions in funding precipitated a combined review of the fleet air defense (FAD) and other fighter role (OFR) needs by the Navy Fighter Study Group. The review confirmed the need for a long-range stand-off missile for fleet defense, which could be satisfied by the AWG-9/PHOENIX system from the F-111B. The F-111B's TF-30 engines were also found to be satisfactory for the VFX-1 or F-14A. The principal problem to be resolved in CF was the determination of means by which the requisite performance characteristics for the FAD and OFR missions could be obtained with the same basic airframe design. A decision was reached to enter CD on designs for a common airframe that would be overloaded (slightly restricted maneuverability) in the FAD role, with PHOENIX missiles and external fuel, and would be at the design load with SPARROW missiles and no external fuel. Later on, the F-14 airframe may be fitted with advanced engines, derived from a joint development with the Air Force, to produce the F-14B and, still later, with an advanced avionics suit to produce the F-14C.

The Navy F-14 will be a new dual-place, twin-engine fighter with all-weather multishot long-range air combat stand-off capability in the F-14A version, and all-weather air-to-air stand-off capability in the F-14C (VFX-2 and F-4 replacement). The F-14C would also have all-weather air-to-ground capability.

We are requesting funds for the Navy and Air Force to support the F-14A and F-15A developments. In addition, we are requesting funds for the Navy to support the advanced propulsion development necessary to start its F-14B version. The AWG-9/PHOENIX development has been proceeding satisfactorily, and funds are requested in FY 70 to continue this basic program. Required funding to adapt the cockpit configuration of AWG-9 avionics (from F-111B side-by-side seating to F-14A tandem seating) is included in the F-14A program estimate.

Both the F-14 and the F-15 will need improved air-to-air missiles and high-rate-of-fire guns. Present missiles are being improved to provide minimum range and maneuvering target capability. Two advanced development programs on short-range missiles were supported in FY 69, one in the Air Force and one in the Navy. Funding is requested in FY 70 for the Air Force and the Navy for subsystem development.

New and modified weapons should be tested against targets (drones) that are representative of the current and projected threats. In general, we continue to have serious shortcomings in our current targets. Among the areas requiring emphasis are low-altitude targets, multiple targets, maneuvering targets, certain high-altitude, high-speed targets, and targets for antiradiation missiles. We started in FY 1967 to correct the deficiencies, but it is anticipated that several additional years will be required to bring our target capabilities to an acceptable level. I am requesting funds for this purpose.

4.3 LAND WARFARE

Our current land warfare R&D is influenced by three main considerations arising largely from experience in Vietnam. First, the conflict represents a situation in which no main battle lines are drawn; we can be attacked from any

direction; and there are no large concentrations against which our superior firepower can be brought to bear. We must therefore develop techniques to find the enemy, deliver weapons with accuracy, and defend ourselves from ambush and surprise attacks.

The second factor influencing our land warfare program is the helicopter. Until recently, we adapted our tactics and equipment to the available helicopters. We are now developing specialized helicopters and are configuring equipment like howitzers for helicopter transportability.

Thirdly, we have to develop much improved equipment to upgrade our capability as we replace aging equipment of all types.

4.3.1 Offensive Combat Operations: The essential elements of offensive combat operations are to find, to fix, and to destroy the enemy.

Battlefield Surveillance and Target Location: Our first problem is to locate the enemy. I already mentioned several target-location programs when I described our SEA-oriented R&D. In addition to these, we are in advanced development on radar, infrared and electromagnetic sensors to extend the reconnaissance capabilities of our ground forces. The Khe Sanh experience demonstrated that combining remote sensors with other surveillance devices is one of the most promising areas in which technical developments can give us superiority in land combat. I request support in FY 70 for remote sensors and related receiving and processing equipment for the Army.

More conventionally, ground forces often employ reconnaissance scout vehicles to find the enemy. The current M-114 weighs 10 tons, has low crosscountry speed and limited mobility. It is also noisy, thus alerting the enemy. We plan to replace the M-114 with the Armored Reconnaissance Scout Vehicle (ARSV) which should have good cross-country mobility, while retaining high road speeds. Contract definition on ARSV will be continued in FY 70.

Fixing the Enemy: Once the enemy is located, mobility and firepower are employed to maneuver our forces into a tactically advantageous position. The enemy is pinned down by artillery to deny him a capability for surveillance. Under continuing artillery cover, we then attack.

The Army plans to develop two 155mm howitzers. A lightweight (helo-transportable) towed 155mm howitzer will be a general support weapon for the infantry division and corps artillery battalions. An armored 155mm self-propelled (SP) howitzer (XM-179) will be used in direct support of armored and infantry units. They will be able to fire conventional ammunition to 20,000 and 24,000 meters, respectively. The towed howitzer achieves an excellent range, and the SP howitzer even greater range when firing rocket-assisted ammunition. We will start contract definition on these systems in FY 70.

To improve field artillery target analysis, reduce response time and allow better use of ammunition and weapons, we are developing the Tactical Fire Direction System (TACFIRE), a computer complex with automatic data processing, storage, and display devices. Engineering development, which started in FY 68, will continue in FY 70. RDT&E funding in FY 70 is required to complete the development.

To provide an even longer range weapon with either a nuclear or conventional bomblet warhead, we plan to use the LANCE system. During the past year the LANCE program was reoriented to provide only an extended-range version, instead of a two-phase program including an initial 75-kilometer version. The operation date has slipped, owing to technical and funding problems and the elimination of the 75-kilometer version. Toward completing the program, funds are requested for FY 70.

Infantry normally accompanies tanks in combat operations. In order to give our infantry a rate of advance commensurate with that of tanks, we use armored vehicles. Since the present M-113 inventory is being depleted rapidly, we plan to

develop the Mechanized Infantry Combat Vehicle (MICV-70). This vehicle will be lightly armored, will provide protected cross-country mobility compatible with that of the MBT-70, and will be able to fight on the move. One of the candidates for its primary weapon will be the Vehicle Rapid Fire Weapon System (VRFWS), which is an automatic gun/ammunition combination with appropriate fire control. The VRFWS is also a candidate for the secondary armament on the MBT-70. The R&D program on MICV-70 includes concept formulation and initiation of contract definition in FY 70. Funds have been requested for VRFWS.

Our heavy armor capability for the mid-1970's is now planned to be provided by the Main Battle Tank, the MBT-70, developed through a joint program of the U.S. and the Federal Republic of Germany (FRG). We reappraised this program last year when the funding ceiling was about to be exceeded. Some of the problems were corrected, but new ones have developed. We are again assessing the situation at this time. Basically, we had three problems. The U.S. air-cooled engine did not perform satisfactorily; the German automatic loader had only begun to be tested but appeared to be unreliable; and the tank's unit cost was much higher than our M60A1E2 Tank using the M-60 chassis. We are trying to resolve these problems by using the water-cooled engine developed by the FRG; expediting testing of the automatic loader; and starting a design review with emphasis on reducing cost.

We are continuing the development of the Main Battle Tank, the MBT-70, on a joint program basis with the Federal Republic of Germany (FRG). The MBT-70 has encountered a number of engineering problems in the past year, involving weight reduction and component reliability. Most important to program status has been a reassessment of the program objectives with respect to performance and cost trade-offs. In view of the above, the development and testing schedule has been re-oriented to allow for completion of (a) the Producibility/Cost reduction study from which the most cost-effective configuration will be selected and (b) completion of the comparative field trials to clearly delineate the relative combat effectiveness of MBT-70 as compared with inventory tanks. A joint US/FRG review of the program is in process.

Development is continuing on three antitank guided missiles: SHILLELAGH, TOW and DRAGON. SHILLELAGH, the first to become operational (in 1967) is fired from a tank-mounted 152mm gun which also fires conventional rounds. We are requesting funds in FY 70 for work that includes product improvement.

TOW is a crew-served, wire-guided missile for use at the infantry battalion level. To complete engineering tests, service tests (other than arctic and tropic), and continue development of a night sight, FY 70 support is requested.

DRAGON is a man-portable wire-guided missile whose development will be continued in FY 70.

As you know, helicopter operations are an increasingly important part of our mobility. Air-mobile operations have proved effective in SEA. The new AH-1G COBRA gunships and OH-6 light observation helicopters have performed well. We are now doing concept formulation for the successors to the UH-1D HUEY and CH-47 CHINOOK to attain the specified squad transport capability under adverse operating conditions. These future helicopters are the UTTAS (utility tactical transport) and LTTAS (light tactical transport) aircraft systems. Concept formulation for the UTTAS is well under way but it is not clear when contract definition will be approved and started.

The AH-56 CHEYENNE development program has made considerable progress during the past year. Although many important features of the system have been successfully demonstrated, the development has encountered difficulties which prevented the CHEYENNE from being produced according to the schedule and performance specifications required by the production contract. For this reason, the production contract was terminated by finding the contractor in default. Development progress has resulted in a considerable expansion of the flight envelope and the accumulation of over 430 flight test hours. Using the computerized fire control system,

each of the five weapons subsystems has been successfully fired in flight. Specification accuracies of the navigation system have been accomplished on several flights of over 100 nautical miles. The CHEYENNE basic development contract is fully funded to its ceiling price and Lockheed is proceeding according to their contract obligation. Lockheed has proposed an adjusted program scope which they believe is more consistent with the present program status. This proposal is currently under review and some negotiated adjustment to the development program will probably be desirable. We are hopeful that a satisfactory program to continue this development can be negotiated. We do not have a basis at this time to change our initial estimate of our funding needs for FY 70. Cancellation of CHEYENNE production has necessitated procurement of additional COBRA's to meet our current needs. This will result in a substantial inventory of COBRA's for some years. There are several significant improvements which can now be made to the COBRA to improve its effectiveness and it appears prudent to do this now in view of the slippage in the CHEYENNE development. Further, the problems with CHEYENNE have identified a fundamental deficiency in our understanding of helicopter rotor dynamics. A research program in this area is planned which will parallel the CHEYENNE development. We are requesting funds for these efforts.

SEA experience has proved that the flying crane, the CH-54A, is practically indispensable. By its ability to retrieve downed aircraft alone, it has paid for itself many times over. But we need a heavy-lift helicopter (HLH) with about three times the payload capacity of the current CH-54A to transport all but a portion of Army/Marine ground forces' equipment and retrieve all our tactical aircraft without requiring their stripping or partial disassembly. Other uses for the HLH would be over-the-beach off-loading of ship cargo and transfer of cargo from, for example, a C-5A, at a strategic airlift destination. Thus, the HLH would be of use to all Services in addition to having possible civil uses. Concept formulation is under way by the Army with consideration of all Services' needs. I am requesting monies in FY 70 for contract definition and critical supporting technology. The Marines have a more immediate need to retrieve their CH-53 helicopters, and the present Army CH-54 crane does not have sufficient capacity for this. We are requesting funds in the Navy budget to fund initial development of a 15- to 18-ton lift helicopter compatible with both shipboard use and C-5A carriage. If feasible, this size of helicopter may meet Navy, Marine, and Air Force requirements.

Weapon subsystems are being developed for all Army helicopters to cover three broad target categories: soft point, area, and hard point targets. Present capability against soft point targets is represented by the 2.75-inch rocket. In the future this role will be filled by the 20mm automatic weapon on the AH-1G COBRA. Present capabilities against area targets are provided by the M-60 7.62mm high-rate-of-fire minigun and the 2.75-inch rocket. Against hard point targets we use the French SS-11 wire-guided missile on the UH-1 helicopters. In FY 70, improvements to the 30mm ammunition and a replacement system for the 2.75-inch rocket will be continued. Also, completion of a multiweapon fire-control system and major progress in sight-line stabilization with automatic ranging for a majority of the armament subsystems is expected. Funding is requested for this work in FY 70.

Final Destruction of the Enemy: To accomplish the final destruction of the enemy on an infantry level, the rifle, machine gun, and grenade come into play. We have succeeded in increasing the reliability of the M-16 (which had, as you know, a tendency to jam and corrode), and further improvements are being investigated. The development of the SPIW (Special Purpose Individual Weapon) is continuing to correct deficiencies uncovered in earlier tests. In FY 70, major emphasis in small arms will be on caseless ammunition weapons, SPIW, and new weapons concepts.

Some of our most important, though relatively inexpensive, activities are in the development of personal equipment for the combat soldier. I am requesting funds in FY 70 for development of improved clothing, selected personal equipments, lightweight armor, and food items for the soldier.

4.3.2 Defensive Systems: We must protect our airbases and other installations in the field Army against air attack. In SEA we depend primarily on our

manned interceptor force for antiair protection because the air threat against our installations is not serious.

Development activities in tactical air defenses concern families of weapon systems: Medium-range surface-to-air missiles are intended to provide air defense against all but low-altitude aircraft, and high-intensity defense of point targets at all altitudes. We are developing the Improved HAWK system to operate against a variety of countermeasures and to reduce operating costs by approximately 10% per year. For the longer term, as a defense against sophisticated countermeasures, tactical ballistic missiles and high-performance aircraft, we are continuing SAM-D development. We expect to start SAM-D Engineering Development in FY 1970, and have requested $75M for R&D.

Research and development for CHAPARRAL and VULCAN are essentially completed. The remaining R&D funds in the FY 1970 request will be used to complete system evaluation under extreme conditions for worldwide deployment and to cure any deficiencies disclosed by these tests.

The Advanced Forward Area Air Defense System includes further development of CHAPARRAL and REDEYE capabilities, to adapt the short-range low-altitude air defense systems for the threat of the later 1970's. In particular, a forwardhemisphere kill capability for CHAPARRAL and REDEYE, together with necessary modifications to the Forward Area Alerting Radar (FAAR) will be provided.

The need for a 360-degree countermortar capability is evident from our Vietnam experience. The primary effort is the development of the AN/TPQ-28 Countermortar Radar which will be able to detect mortar shells and precisely locate the launchers of simultaneously observed mortar rounds. Recent tests of a preliminary model indicate the need for additional R&D; and a decision to start production will be made as soon as the requisite performance capabilities are demonstrated. A shorter term project is the modification of the AN/UPS-1 Search Radar. Tests have been completed by the Marine Corps and the results have been favorable.

4.3.3 Combat Support and Service Support Activities: Combat support, though not glamorous, requires an evolutionary R&D effort. For example, in logistic support the XM-705 (1½-ton) truck is needed by tactical units behind brigade rear boundaries as a replacement for the M-37 (3/4-ton) and M-715 (1¼-ton) trucks. Special-purpose configurations of the XM-705, ambulances and communication vans, are also planned. The R&D program is scheduled through FY 1970.

Communications obviously is an important combat support activity. We are upgrading the security of all tactical circuits for both voice and digital information. Various means of elevating antennas above the foliage (such as balloons and portable towers) are being developed to extend combat and communications range. Improved location and authentication devices are being developed for aviator survival communications.

Project MALLARD is being continued to provide fast, flexible and secure, tactical communication for the Armies, Air Forces and, where appropriate the Navies of the participants (U.S., Britain, Canada and Australia) in the post-1975 period. It will replace tactical trunking and distribution facilities and provide single-channel access into the network for individual users. Advanced development modeling and testing will start in FY 70.

The three Military Departments -- jointly participating in the Tactical Satellite Communications (TACSATCOM) Program -- are conducting experiments on the feasibility of using space repeaters for medium- and long-range tactical communications. These experiments use space repeaters with the surface terminals installed in tactical vehicles, operational aircraft, and Navy combat surface ships and submarines. A limited initial operating capability -- using the experimental TACSATCOM equipment -- to respond to certain emergency situations could be available by mid-1970. For this development funding is requested in FY 1970.

Combat service support activities provide the POL distribution and dispensing equipments, power generating and distribution equipment, the specialized earth-moving equipment, prefabricated airfield surfaces, cargo handling and terminal equipment. Another group of projects includes field medical equipment and hospital systems (MUST) that, coupled with helicopter evacuation, have given our combat soldiers a greatly increased probability of survival. For these combat support R&D activities, I am requesting funds in FY 1970.

4.4 SEA WARFARE

The emergence of a strong Soviet surface Navy, an increasingly formidable Soviet submarine threat, and the proliferation of enemy antishipping missiles of all types are beginning to produce a radically altered naval environment, requiring that we reassess our present concepts and provide an effective defense. The anti-ship missile threat requires reappraisal of the convoy concept and of near-shore (amphibious or other) operations. We must ensure that the defenses of our major combatant ships are adequate and also consider the development of offensive naval systems.

Since we are heavily dependent on passive sonars to detect the noise of enemy submarines, and since these noise levels have been decreasing, changes must be made in our ASW systems. Some of the required changes are clear; others await the results of reassessments now in progress. Overall, ASW problems are among the toughest we face.

4.4.1 Antisubmarine Warfare: To appreciate the impact of the increasing submarine and cruise missile threats, I will review our ASW policies of the past and the R&D directions we have taken.

Until the advent of the Soviet nuclear submarine about a decade ago, our counter to the large force of Soviet diesel submarines consisted of our submarines and patrol aircraft (VP), which employed passive acoustic systems as the primary method of detection; the VP also used radar and visual search.

Perimeter defense was provided by surface escorts employing active sonar against the Soviet submarine force with its short-range antishipping torpedoes. Our counter strategies were also augmented by carrier ASW task forces with the speed, mobility and flexibility to provide a concentration of force in high-threat areas.

In R&D we are now confronted with the next events in a changing threat picture -- a quieter nuclear submarine with better antishipping torpedoes and a more sophisticated anti-ship missile system. Fortunately, we can make significant improvements in equipment, based on the technology we have been supporting in past years. We have a task of several years before us and a similar period in which the new threat will become quantitatively significant. We are now assessing the merits of alternatives to ensure that a new course is charted which maintains a balance between systems that cope with the still important threat and those that are designed to cope with the new one. While we will place emphasis on systems that use existing kinds of ASW vehicles, we intend to search for entirely new concepts for solving the overall ASW problems.

Airborne ASW: Our development programs are significantly enhancing the aircraft's effectiveness against current submarines. We developed DIFAR to improve passive search and localization capability; A-NEW to permit the effective handling of data by a small flight crew; short-range active sonobuoys and improved MAD to aid in final localization and classification before weapon drop; a new radar to detect periscopes, snorkels and surface targets; and the MK-46 homing torpedo. These developments culminate in the P-3C, now in production, and in the S-3, for which a development contract was recently issued.

While these systems are optimized to counter the present threat, their capability to cope with a quieter threat is considerable.

Submarine Systems: We are structuring a new submarine program to maintain our qualitative superiority over the enemy. R&D programs emphasize reducing submarine-radiated noise and sonar self-noise levels, improving sonar detection and classification performance, continuing development of submarine-launched torpedoes with antisubmarine and antishipping capabilities, and improving secure underwater communications and acoustic countermeasures. In addition, we have started concept formulation for a long range tactical type of weapon with antisubmarine and antishipping capabilities.

The submarine-launched ASW torpedo program, MK-48, was expanded in FY 1967 to include development of an antiship capability. Through competition, with differing technical approaches, we are enhancing the likelihood of obtaining good ASW/SLAST MK-48 torpedoes.

To improve submarines in the critical area of radiated noise, we have programs to develop quieter machinery and propulsors and reduced hydrodynamic flow noise. We are requesting monies for exploratory and operational systems development in FY 70.

A major new effort is the design of the SSN-688 class submarine. This submarine will feature improved combat systems and will provide an increase in speed over our present STURGEON-class SSN's. Many of the combat system developments associated with the SSN-668 schedule can be retrofitted into our present submarines. These include improved sonar, acoustic countermeasures systems, fire-control systems, and command, control and communications capabilities.

We are also developing sonar improvements for submarines now in the fleet. These programs represent the best short-term improvements realizable with existing technology.

Longer term efforts entail concept formulation studies for new sonars for submarines and surface ships, exploiting common technology and subsystems to the maximum practical extent.

Naval Nuclear Propulsion: Specific development objectives in the nuclear propulsion area are: higher power levels, at the same time reducing volume, weight and operating noise; longer life and lower cost; improved reliability and maintainability. Analysis of new reactor types will be continued, as will evaluation of presently operating ships to determine the optimum powerplant characteristics for each type of vessel. A vigorous effort to reduce operating noise without sacrificing speed is required. I am requesting RDT&E funds for FY 1970.

Surface Ship ASW Systems: Shipboard sonars still provide less than the desired detection and classification performance; weapons do not exceed the ranges of the enemy's weapons and do not permit sufficiently rapid attack at long range. To increase the probability of detecting enemy submarines before they can attack, we are completing the development of long-range active and passive sonars, both hull-mounted and towed, and an acoustic intercept receiver. We have established a torpedo detection and countermeasures program to provide our ships with self-defense capability. We are programming funds to develop a command and control system for intraship and intership use to improve coordinated ASW operation.

We are supporting programs to evolve new escort-type ships. The DX and DXGN programs which are in contract definition, and the DXG program, which is in concept formulation, have been established to develop new type of ASW gun and missile escort ships to replace obsolescent escorts presently scheduled for deactivation in the early 1970's. We request funds for DXG contract definition in FY 1970.

To improve the survivability of surface ships, I am funding programs that will be described under antiship missile defense. As part of this effort and to increase the flexibility of surface ships, we are doing concept formulation under a program that will utilize existing helicopters.

4.4.2 Antiship Missile Defense Program: In the past year we made good progress in formulating a comprehensive cruise missile defense program. The task before us is formidable and will require many years to complete. The theme of the near-term program is the self-defense of individual ships, custom tailored to each ship class and introduced into the fleet as the availability of funds and equipment permit and as required by military priorities.

The self-defense capability of an individual ship depends on its ability to detect, deceive, and destroy the antiship missile and its launch platform. The missile can be detected by radar, by passive EW, or by IR devices. Its homing system can be jammed and deceived by shipboard EW and IR equipment, or decoyed by chaff and IR decoys which provide targets other than the ship on which the missile can home. Finally, the missile can be destroyed by shooting it down with SAM's or guns.

The Point Defense Missile System, 3-T improvements, shipboard electronic warfare systems (SHORTSTOP), and intelligence data collection equipments are all part of the missile defense program. New items in the FY 70 budget for ship defense are the SAMID (Ship Antimissile Integrated Defense) and the HARPOON (ship and air launched antiship missile) programs. SAMID, for which funds are requested in FY 70, includes radar, EW and command and control back-fits into ships deployed in SEA. Studies are now being completed aimed at the development of a new antiship capability for the Navy (HARPOON). We are requesting support for HARPOON in FY 70.

Two SHORTSTOP prototypes will be evaluated in FY 1970. Development of SHORTSTOP JR., a "small-ship variant" for escort ships will continue into FY 70; funding is programmed in FY 1970 for SHORTSTOP JR. Additional money is requested for system improvements applicable to SHORTSTOP SR.

Development of the Shipboard Infrared Countermeasures (IRCM) system will also be continued into FY 1970. This program, which was initiated in FY 1969, is included in the FY 1970 request.

The Advanced Surface Missile System (ASMS) will be a new, fast-reaction missile system that will be incorporated into the DXG when it becomes available. The DXG program is based on the use of the TARTAR-D. However, if the ASMS or its versatile phased-array radar is available in time for initial DXG installation, it would be used to provide improved capability without incurring retrofit cost. FY 1970 is the first year of engineering development of the ASMS systems.

Subsystems and components from ASMS will be used to provide continued improvement for the "3-T" systems against enemy countermeasures and low-flying missiles. Utilization of ASMS elements in the "3-T" systems permits the continuing improvement of these systems at a decreasing R&D expenditure rate.

With the Basic Point Defense System (utilizing the SPARROW missile) in operation in the fleet, the development efforts now center on a more advanced system with a rapid reaction capability. The program consists of two major parts: NATO SEA SPARROW and a new acquisition system with a radar which, in simplified form, can also be used with Basic Point Defense. The program also provides for initial studies leading to replacement of the SPARROW missile with a lighter, less expensive, dual-mode weapon.

4.4.3 Logistics: We are developing two related systems that will enhance the effectiveness and reduce the vulnerability of the combatant fleet. The first will increase the rate of rearming carrier-based aircraft by developing a system for handling and storing weapons in assembled form. This system is scheduled for completion in FY 1970. The second will result in a standard, reliable system for the underway replenishment of combatant ships that will cut replenishment time in half. These programs are included in the FY 1970 request.

4.4.4 Riverine Warfare: We are working to develop better hull designs, propulsion systems, and armament suits for boats, defenses against underwater swimmers, swimmer support systems, and the adaptation of land warfare equipment in the riverine environment.

4.4.5 Other Sea Warfare Programs: Marine Engineering and Technology covers the development of shipboard propulsion systems and machinery, hull design and structure, the development of advanced surface craft, ship concept formulation and computerized ship design, submarine safety, damage control and fire prevention, and the Deep Submergence Program.

A new policy subjects new ship designs to the concept formulation (CF) and contract definition (CD) procedures. At this time, the LFS, MCS, DX, DXG, DXGN, and SSN types of ships are following this procedure. In FY 1970, funding is requested for CF and for CD.

The Deep Submergence Program is continuing in FY 1970 to develop vehicles and technology for personnel rescue from submarines, deep ocean search and salvage, ocean engineering, new diving techniques, and man-in-the-sea capability. The largest funding items included in FY 1970 are the Rescue Vehicle and the Search Vehicle.

4.4.6 Amphibious Warfare: In amphibious shipping, we are developing the LHA, a landing ship which is capable of (1) carrying a balanced load of troops, combat vehicles, and combat cargo needed in amphibious operations; and (2) landing these forces under assault conditions by helicopters or amphibian vehicles and landing craft. The LHA will replace, to varying degrees, the AKA, LPD, LPH, and LSD types of ships. The LHA development and production phase started May 1969; the first ship should be operational in March 1973. A planned production of nine ships is envisioned.

4.4.7 High-Speed Boats and Ships: Our current inventory of high-speed gunboats is primarily of the planing hull and displacement types, which have poor fighting capability in heavy weather. The hydrofoil research program demonstrated that hydrofoil ships up to 150 or 200 tons can now be built with confidence. An outstanding feature of hydrofoil ships is the minor falloff of performance (speed, endurance, and platform stability) in higher sea states.

The USS FLAGSTAFF (PGH-1), a 60-ton hydrofoil gun boat and the TUCUMCARI (PGH-2) have commenced operational evaluation. The USS PLAINVIEW (AGEH-1), a 320-ton hydrofoil ship, the world's largest, has commenced builders' trials. This hydrofoil is a test unit in a program to: (1) demonstrate the capability of hydrofoil craft to operate in high sea states at high speed (50 knots), (2) develop design criteria for future hydrofoil craft, and (3) determine the capability of hydrofoil craft to perform specific naval missions such as ASW, fast patrol, minesweeping, plane guard duty, and escort. In FY 1970, funds are requested for work on these hydrofoil ships.

4.5 AIRLIFT

The C-5A aircraft and its TF-39 engines have progressed into the testing phase without encountering major technical problems. The flight test aircraft have flown more than 250 flights, and over 825 hours, to date. Results indicate that it will meet all contractual performance requirements. The total RDT&E cost to the government for the C-5A, including the TF-39 engine, is estimated at $1,003M, or 8% higher than the original (1965) Air Force estimate of $930M for work of the same scope. The current total RDT&E cost estimate includes provision for the government's share of cost overruns up to ceiling on the RDT&E portions of the Lockheed and G.E. contracts, and price adjustments for abnormal escalation of the economy; this estimate does not include above-ceiling RDT&E costs which are contractor, rather than government, responsibility. We expect initial operational deliveries of the aircraft by late CY 69. Funding is requested in FY 70 to continue what is expected to be the next-to-last year of development funding support.

Although it is not primarily an R&D matter, I should mention that program reviews have revealed substantial increases in the estimated production costs that affect the present procurement as well as the price of subsequent C-5A purchases. The effect on procurement evolves from a price adjustment formula contained in the original contract (to which all competitors bid) which reduces unexpectedly large losses, or unexpectedly large profits, through the first production run to reasonable amounts. This is done by increasing or decreasing the target cost on follow-on production, and by correspondingly increasing or decreasing the ceiling price for the entire program then under contract.

The Air Force has exercised the option to procure 57 aircraft in the second production run, in accordance with the terms of the contract, but has limited expenditures and funding to long lead items as provided in the FY 69 procurement account. The FY 70 procurement request provides for the first 23 aircraft of the second production run.

The Air Force has for some time been proposing the development of a new intra-theater transport aircraft (LIT) to replace or augment the current tactical airlift aircraft (C-7, C-123, and C-130) in the mid-1970's. Last year, I expected concept formulation to be complete in FY 69 and requested funds to preserve the option to initiate CD. Completion of this concept formulation has slipped several months. The preliminary data now available fail to indicate an urgent need for LIT. However, upon completion of the present CF studies, we will review this matter with the Air Force. For FY 70, I am requesting funds to support continued studies and work on critical technology. If the CF studies demonstrate an urgent need for the system, we will initiate CD by reprograming. If we decide to defer CD for several years, any near-term deficiency in our tactical airlift forces could be filled by additional procurement of aircraft currently in production, such as the C-8 Buffalo and the C-130.

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5. RESEARCH AND TECHNOLOGY BASE

5.1 Introduction and General Assessment

The superiority of American military technology depends on many critical components -- talented people, a commitment by many to excellence, our industrial capacity to apply new technolgy. But the ultimate source of our technological strength today is the research and technology base so carefully built up over the past 5, 10 and 20 years. In the same way, our future strength can only be ensured by vigorous, balanced investments made now in exploring new ideas. This need is just that simple. Yet the work is often hard to explain and justify. I will try now to give you some sense of the significance of our research and technology base.

5.1.1 Broad Goals of Research (6.1) and Exploratory Development (6.2):

The goals of research and exploratory development must be formulated from two perspectives: long-term gain, consistent with the nature and direction of scientific technological progress, and shorter term matters of concern to our national security. Stated in the jargon of the investment business, we must maintain a basic portfolio of growth securities, devote a small fraction of our resources to high risk but promising speculative ventures, and maintain a capital reserve of technical competence adequate to cope with unexpected technological threats or opportunities as they arise. Neglecting any one of these could jeopardize national security. The greatest overall security obviously lies in an optimum balancing of available resources. It is difficult to know precisely when that balance is achieved.

For the long term, we seek to probe the frontiers of Defense-relevant science and engineering, to discover and understand new phenomena, to recognize and exploit those which have promise for improved military technology. Thus, we support research in the laboratories of the DoD, universities, industries, and the Federal Contract Research Centers. From these laboratories have come radar and rockets, transistors and television, combat radios and computers, sonar and satellites, and a host of indispensable military systems. Because a technical surprise today could unpredictably destabilize the international situation, our program must be broad and carefully diversified to allow us to move quickly in any required direction.

5.1.2 Nature of Soviet Technology: To suggest the character of the technical challenges we may face in the future, I believe it will be helpful to illustrate briefly some of the areas in which we believe the Soviet Union is particularly active. I do not introduce this perspective because of any anxiety that the Soviet Union is, technically, "ten feet tall." Nor do I believe we are on any "technological plateau," as some have argued; the facts show that we are not. But I do want you to understand that the Soviet Union is an advanced and vigorous technical nation, investing proportionately more of its scarce resources in research and development than we are, and presumably getting results from its investment. Except where I indicate otherwise in this discussion, few of the Soviet efforts represent substantially greater capability than we now possess, although in many areas we probably are about even.

The Soviet effort in magnetohydrodynamics is the largest in the world. Two prototype continuous open-cycle electrical generating power plants are now in operation in the USSR and the Soviets are developing a closed-cycle system. The latter could have strategic applications in submarine and in space propulsion.

Although the Soviets have not fully exploited their strong capability in semiconductor research in the past, the use of solid-state devices in the consumer, industrial and military fields is rapidly becoming a reality.

Microelectronics has not been widely applied in the USSR, although progress has been rapid since 1962. Miniaturization has not advanced much beyond the

employment of compact transistor circuits and is achieved principally by high-density packaging of discrete components on printed boards. Large-scale use of microelectronics appears to be several years away; its initial use will probably be in large digital computers in 1970-71.

Development of radar antennas has paralleled that of Western countries, current emphasis being placed on a wide variety of microwave antennas for general and special uses and on large, multibeam, electronically steerable phased arrays.

The Soviet Union has expended a massive effort to develop, produce and install active infrared sensory devices. By 1975 low-light-level image intensifiers should be available for widespread use in the Soviet Union.

Since 1962, the Soviet laser program has been expanding and is now second only to the U.S. in their overall R&D effort. The USSR may be ahead of the U.S. in the development of high-power solid-state lasers.

The Soviets will probably continue their underground nuclear tests, just as we will. These tests will allow them to develop improved fission and thermonuclear weapons tailored for special uses and to explore weapon systems vulnerability to nuclear radiation.

There have been and will continue to be strong Soviet efforts to improve the performance -- and increase the time between overhaul -- of their rotating (turbojet, turbofan) aircraft engines. This emphasis will result in new and improved engines such as the capability to qualify a Mach 3.0 cruise turbojet by 1969-70 and lift/cruise and direct-lift engines with very good thrust-to-weight ratios by 1970.

Soviet liquid-propellant rocket engines in some ways are distinctly different from those of the U.S., as reflected in larger expansion ratios, higher chamber pressures, different materials of construction and better control of combustion processes. The Soviets have the capability to build and utilize much larger liquid-rocket engines for space purposes than they have heretofore exhibited. For ballistic missiles, no completely new liquid-propellant engine designs are expected before 1972. However, as a result of concerted efforts beginning in 1958, the Soviets are capable of building solid-propellant motors having performance characteristics similar to those of the West.

Soviet capability in materials and manufacturing technology has developed surprisingly fast and is now generally equal -- in some instances, superior -- to that of the Western world. Difficulty in achieving the high standards of quality control necessary for the quantity production of highly precise and highly reliable components appears to limit Soviet production capability at present; however, it is expected that this problem will be solved in the next 2 or 3 years. Some of the areas in which the Soviets seem to be advanced are chromium-base alloys for long-time operation at 1900 degrees to 2200 degrees F., high-temperature adhesives, high-temperature polymeric coatings, use of glass-reinforced laminates, techniques and machinery for fabricating brittle materials and difficult shapes, and machinery for extruding and forging large metal parts.

Allow me to repeat that these Soviet technological programs have not eliminated our margin of technical superiority in most of our systems. Nevertheless, the range, pace, and apparent quality of their work in the fundamental sciences and applied technology are impressive.

5.1.3 Trends in our Research and Technology Base: The past fiscal trends in our research and technology base are shown in the following table:

(R&D in Millions)

	FY64	FY65	FY66	FY67	FY68	FY69
Research (6.1)	353	383	389	413	371	406
Exploratory Dev. (6.2)	1158	1128	1134	1042	948	878*
Total	1151	1511	1523	1455	1319	1284*

Note: *The reduction in FY 69 (compared with FY 68) includes a $45 million reduction in which these funds were transferred from ARPA's exploratory development effort on ballistic missile defense to the Army's advanced development effort on missile defense. The nature of the work supported has not changed in character. Thus, this was essentially an accounting change. FY 69 funding is, in effect, $923 million, and the total (6.1 plus 6.2) is, in effect, $1329 million.

Despite the increasing complexity of defense technology and the increasing costs of carrying on more demanding research and development, support for our overall research and technology base has continued to decline. We reversed the downward trend in the research category in FY 69, based in part on my special concerns about this activity last year. But the overall trend of our base is still downward -- because of both the increased cost of R&D and the continued erosion of exploratory development owing to urgent needs for funding other R&D activities. We continue to see the indicators of significant under-funding in this program: an increasing ratio of acceptable proposals to funded proposals; deferral of purchase of needed new research equipment in many academic and industrial research labs; layoffs of technicians and postdoctoral research fellows; and too few "new starts" because of the pressing need to continue existing projects.

As I mentioned in my introduction, continued failure to reverse the trend of this critical part of defense R&D could seriously jeopardize our future national security. Thus, I have requested increases for both areas in FY 70, including an especially substantial increase for exploratory development. I will discuss each area and give you my recommended funding.

5.2 Research (6.1)

5.2.1 Research Objectives and Policies: Within the broad goals of our research and technology base, the research component works at the frontiers of knowledge in the physical, engineering, environmental, biomedical, and behavioral sciences, emphasizing fundamental work relevant to long-range defense needs.

The DoD must manage a mission-oriented research base, as must (or should) all of the major agencies. Because the effectiveness of coupling basic science with defense technology is so vital and in many ways so subtle, the DoD must recognize and direct responses to scientific and technological opportunities or threats. We could not rely upon an accidental occurrence of this critical function.

5.2.2 Recent Research Accomplishments: New scientific findings continuously emerge from Defense-supported research. Significant contributions have been made by in-house laboratory, industrial laboratory, non-profit institutes, and university research performers. I will give you just a few examples.

Global thunderstorm activity detection: We are almost totally dependent on the electromagnetic spectrum for communication, detection of enemy activity by various types of sensors, missile guidance, and other military activities. Detailed knowledge of global thunderstorm activity would increase the reliability of our electromagnetic systems. We have found promising new sensors to obtain this global data through recording that spectral component of longest duration in lightning. The technique is being tested on U-2 aircraft and appears to be ideal for continuous surveillance by satellite. It is expected to be available for use within a year.

High-temperature lubricants: A new technique for the fluorination of organic compounds and graphite has been developed by passing a mixture of fluorine and an inert gas over the surface of the compound to be fluorinated. For example, graphite can be converted to perfluorographite, which has lubricating properties comparable to currently used lubricants at normal operating temperatures (400 degrees F) and much superior to them at temperatures in excess of 575 degrees F. They will be especially useful in the bearings and seals of advanced jet engines.

Ultrashort laser pulses: The range of Defense applications of laser technology has been enlarged by recent developments in the production of ultrashort laser pulses. Pulses of less than a millionth of a microsecond in duration have been generated. The much more precise timing and distance measurements, possible with these very short pulses, promise important improvements in optical radar, laser communication systems, rapid optical data processing, and ultrahigh-speed photography.

These examples typify the thrust of scientific and technological achievements to Defense goals.

Before leaving this discussion of specific, rather basic research efforts, I want to illustrate the way in which this work leads to applications. A good illustration comes from the materials sciences, in particular, composite materials. The promise inherent in filamentary materials was originally predicted from independent theoretical studies and independent university research on metallic whiskers. The fundamental objective of this work was to study why theoretical strengths could not be achieved in actual materials. While this work was interesting from a scientific point of view, it could contribute little to the materials used in military applications unless someone identified the connections between the basic scientific findings and the DoD needs. The research managers in DoD, having just such a motivation -- i.e., that scientific findings can and must be put to practical use -- recognized that these discoveries could help solve some military problems.

It was the requirement for stronger, lighter materials that caused the Military Services, as far back as the late 1940's, to make fine filaments, to study their properties, and to conduct research to improve them. Basic and applied research in the Air Force alone (which had the greatest need and interest) reached almost $3.5M in FY 66. This pursuit of a promising scientific finding led to an on-going advanced development program which will put composite materials into many Air Force and other military applications with substantial savings in weight, or increase in engine thrust, payload, range or maneuverability.

Occasionally I am asked whether some of our more basic research could be carried out as effectively under other than DoD sponsorship. It is the kind of evolution that I just illustrated that convinces me the Defense Department must sustain clear and close links to the scientific community.

But then I am asked whether we tend to duplicate the work sponsored by other agencies. I am quite confident that there is essentially no duplication, except where there are distinctly different scientific approaches to solving the same basic problem. Last year, for example, we examined the work being conducted under ten contracts sponsored by the National Science Foundation in the materials sciences. The total value of these contracts was about $500,000. It was determined that very little, if any, of the contracted work was directly germane to DoD mission objectives but that about 10% (or $50,000) could be considered relevant.

Let me give you another example of the coordination process we use to avoid duplication. The DoD and NASA have conducted annually a detailed review of all research and exploratory development projects in the biological, medical and life sciences at the individual work-unit level since FY 1965. Methods were developed to compile all related research work by subject matter, which is then analyzed by DoD/NASA technical teams. Research efforts that might overlap are identified and subjected to a detailed review, and a joint decision is made on terminating a contract, if appropriate. Out of about 4,000 tasks reviewed recently, there were no more than six cases of even partial overlapping. This procedure has been very effective in (1) assuring that no unwarranted duplication exists; (2) ensuring that each agency has full knowledge of the scope and content of each others' research programs; and (3) aiding the day-to-day coordination between agencies by the biomedical research program managers.

5.2.3 Project THEMIS: During FY 67 and 68, we selected and funded 92 programs at universities which had previously received relatively little Defense R&D funds. For FY 69, $28.5 million was appropriated to fund 25 additional new starts, plus renewals for the programs already under way. We have maintained close surveillance of the progress and contributions issuing from each of the centers and are highly encouraged. Last fall we evaluated the progress of the 49 projects funded in the first year of the program. Most of the projects were making satisfactory progress, and some are already producing first-class results. But we found that a few were not showing sufficient progress, and they were put in a "probationary" category. By next July we also will have completed a thorough evaluation of the 42 programs started in the second year of the program. For FY 70, which is the last year of new starts in the THEMIS experimental program, we are requesting $33.0 million to fund 25 new programs and to renew all of the effective programs.

5.2.4 Foreign Research: During the past year, I have taken further specific actions on DoD-sponsored research at foreign institutions. These actions include tighter and more explicit policy criteria for support of foreign research; reduction in overseas military and civilian research personnel; instructions for colocation of the European research offices; and revised funding guidance to reduce DoD research funds assigned to foreign institutions and investigators.

We plan to reduce the number of DoD research personnel in the European Offices to 53 by 30 June 1970, as compared to 144 for Fiscal Year 1965.

The Army Research Office, Europe (Frankfurt), and the European Office of Aerospace Research (Brussels) are being colocated with the Office of Naval Research in London.

Revised funding guidance has been given to the Army, Navy and Air Force for Fiscal Years 1969 and 1970 to further decrease research and exploratory development funding assigned to foreign performers. The guidance now places a three-Service limit of $5.3 million and $3.7 million, respectively, on research and exploratory development carried out by foreign performers in FY 1969 and FY 1970, compared with the estimated total amount of $7.2 million for FY 68.

I must emphasize, however, that DoD has continuing, clear needs for certain selected foreign research and development projects. In some areas of communications, meteorology and medical research, for example, it is simply not possible to meet key DoD goals without supporting some research abroad. Often there are requirements for unique environmental or geographic characteristics which are essential for the investigation. In general, because the scientific community is essentially international, we must not cut off our valuable liaison with productive investigators and research groups throughout the world. In short, the U.S. has no monopoly on good ideas or on talented researchers. Therefore, it is not desirable to eliminate completely our sponsorship of foreign projects.

5.2.5 Recommended Budget for Research: Following an in-depth review of the various levels and directions of research programs, I am recommending a total of $432 million for FY 70. This increase provides for 25 new THEMIS programs, and for a 4% cost of living increase for the rest of the research activity. As I said earlier, this investment is for the future -- this is the investment that will determine, in larger measure, whether we maintain our technical superiority.

5.3 Exploratory Development (6.2)

I will turn now to Exploratory Development, the second segment of our research and technology base.

The purpose of exploratory development is to demonstrate the feasibility and applicability of research discoveries to DoD needs. It is also the mechanism we use to ensure that each technological opportunity has a matching military utility, and that feasibility determinations are made in full realization of the anticipated use of the device or component. Thus, before we embark on expensive advanced or engineering developments of any weapon system, we use exploratory development to give us a high degree of confidence in the technical feasibility of the system.

Past studies have shown that new systems that are markedly improved over their predecessors frequently are made possible by the aggregation of many component improvements. This aggregation and eventual proof of feasibility may take as long as ten years to become operational in a finished system. Thus, we must attempt to predict our military needs in advance, well ahead of firm official requirements. These predicted needs can change in many directions, including changing enemy technical threats. To guard against serious technological surprise, we have a broad exploratory development program to provide a choice when our needs become clearer and our optimum response more firmly defined. This is one of two main reasons why we have thousands of exploratory development projects.

The other main reason for a broad program is that the development of a system to meet one operational goal often leads to an array of many difficult technological problems and projects. Let me illustrate this.

The Vietnamese War has clearly demonstrated the high cost of flying aircraft directly over well-defended targets. For such purposes it is becoming increasingly necessary to deliver tactical ordnance from a stand-off position, i.e., outside the range of the defensive systems. Stand-off ranges of 20 to 30 miles would be adequate today, but longer ranges will be required in a few years. A closer look at this requirement reveals two most demanding subrequirements. First, since this type of missile is not intended to deliver large quantities of high-explosive ordnance, it must hit the target within a few feet. Second, since the weapon's effect is relatively small, the cost of the system must be low.

Achieving this one new, comparatively straightforward operational capability -- stand-off, low-altitude delivery of high-explosive ordnance -- has required major improvements in guidance and propulsion. Of these, let me illustrate how the propulsion problem alone fanned out into a range of tasks for new technology.

There are at least three distinctly different types of propulsion systems that had to be explored to achieve the earliest possible capability and eventually, the highest possible performance. They are first, a pulse-type solid rocket, which appeared to be the most readily achievable; second, a ramjet with integrated booster; and third, a high-density solid-fuel ramjet with integrated booster, which appeared to offer the higher performance, the range ultimately desired.

Each of these types, however, involved a whole series of technological problems. For example, to achieve a stop/restart capability in solids, several methods had to be investigated: water quench, variable-area nozzles, secondary gas generators, and inhibiting partitions. Exploratory tests of all of these methods were run, and, for this application, inhibiting partitions appeared to be the simplest and most readily achievable. But, to keep the area of the inhibited faces small, the burning rate of the propellant had to be increased, which involved the development of new burning rate catalysts and higher chamber pressures. The new catalysts required the development of new liner materials; and the higher chamber pressures raised the erosion of nozzle throats and imposed increased pressure loads. These effects led to the required development of new nozzle materials and new methods of bonding the propellant to the case. In a similar manner, the solid-fuel ramjet posed a whole series of new technological problems. A new grain formulation which would yield a fuel-rich, highly combustible exhaust had to be discovered and developed. Its combustion efficiency had to be measured under simulated ramjet combustor conditions, and an aft inlet had to be worked out for use on a missile maneuvering at high angle of attack.

The point which I wish to make here is that, to achieve this single new capability, it has been necessary to pursue three options, each requiring solutions to a series of technological problems. This is typical of how our exploratory development program evolves. In this case, all of our efforts have paid off, and the solutions obtained in the process have created a background of knowledge applicable not only to air-launched propulsion but to surface-launched tactical and strategic systems as well. I am confident that, had we tried to achieve this operational capability without the necessary technological base, the consequences would have been a far greater development expense and the serious compromise of system performance.

5.3.1 Recent Contributions of Exploratory Development:
The exploratory developments of the past few years have made many significant contributions to our military capabilities. The three initial conditions that must exist before we embark on any exploratory development project are: first, some understanding of the physical phenomena involved; second, one or more clear concepts about how these physical phenomena can be harnessed to perform some function; and third, really most important, that we see a general need for this function, whether new or improved. I would like to illustrate these points.

During the early operational phases of the POLARIS submarines, the Navy recognized the operational advantages of achieving greater depth and speed. Thus, in 1960, the Navy began efforts to develop a higher strength steel for submarine hulls, stronger than the steel then available for POLARIS submarines. During the period from 1960 through 1968, the Navy spent about $6 million on exploratory development of high-strength steel.

When the Soviet submarine threat became clear in 1967-1968 and the decision was made to proceed with development of advanced nuclear attack submarines, the technology of the desired steel was sufficiently understood to embark on an advanced development (6.3) program. This program is timed so that the high-strength steel can be qualified and certified for use on this new class of submarines.

This capsule history brings out an important point. When the development of the new steel was started in 1960, no firm "requirement" existed, but a clear, though generalized need was anticipated. Had we waited for a firm and detailed requirement, the material would not have reached a sufficiently advanced stage of development in time to be used for the advanced nuclear attack submarine.

To complete the history to date by quantifying the effectiveness of the new steel: For ships having substantially the same length, displacement and speed, the maximum operating depth can be greatly increased by using the stronger steel. More advanced steels and titanium alloys, which are now in exploratory development, would enable operation at even greater depths.

Let me say a few words about titanium. The titanium industry is a direct consequence of DoD sponsorship of exploratory development. Starting about 1948, the Army, Navy and Air Force established a substantial coordinated R&D application effort on this metal. The impetus for this work was recognizing the potential of titanium alloys, which have high corrosion resistance, to become the strongest metallic structural materials known in proportion to their weight.

In 1968 the U.S. produced 33 million pounds of titanium. Titanium alloys are used in both military and civilian aircraft as structural members and in the compressor stages of the engine. Without titanium, the SST would not be capable of meeting its operational goals. The metal is also to be used in submersibles because of its lightness, strength and corrosion resistance. Its corrosion resistance has put it into such civilian applications as food and chemical processing. Uses in the near future will include desalination plants and steam power-generating equipment as well as equipment for the transportation industry. By 1978 it is estimated that 100 million pounds of titanium will be used. Our new aircraft will be able to reach their required performance in part because years ago we stimulated the developments which made titanium alloys available today. The DoD has profited, but so have many American industries and our whole national economy.

To return to the main theme, let me give another current example of melding technological opportunity with military need. Our night combat efficiency in SEA has been spectacularly improved with the introduction of night vision devices. Continuing support for the night-vision exploratory development programs is responsible for this achievement. Direct payoffs from the program, as many of you realize, are the Starlight Scope for individual weapons, a night vision goggle for use by individual soldiers, and night vision devices for crew-served weapons and aircraft such as thermal night sights for our antitank missile systems and the night fire-control system of the new Cheyenne helicopter.

Another illustration arises from the military space program. The cost of placing a pound of payload in orbit has decreased as larger, more effective space launch vehicles are used and as the reliability of all vehicles increases. However, new and even more effective launch vehicles appear possible which might halve the cost of delivering a pound of payload to low orbit (from $800 to $900 per pound to about half this cost). Since the DoD will spend from $250 to $300 million per year on vehicles and launch services, a new concept, drawing on our exploratory development technology, could lead to substantial future reductions in the cost of launching military payloads. One of these concepts involves technological advances such as: (1) scalable, stable low-cost injectors; (2) simple, expendable ablative nozzles; (3) readily weldable low-cost tankage materials (HY-130/140) that will not fail catastrophically; and (4) simpler pressurization schemes. The replacement of the expensive, regeneratively cooled

nozzle and sensitive engines, as well as the complex tankage assemblies, with these technological advances may save up to $100 million per year after development costs are amortized, based upon the present rate of TITAN III utilization.

One example comes from the rather less glamorous needs of military construction. Military situations exist where it is important, sometimes critical, to have the capability to repair immediately an airfield runway damaged by bombs or mortar shells. Under our exploratory development program, a stabilized, rapidly curable cement has been developed that can be processed in ordinary cement-mixing equipment. It hardens in 20 minutes and possesses the strength of 28-day-old concrete.

Finally, our military medical research continues to produce remarkable innovations. Drugs used during the Korean War were considered to be the answer to the malaria problem, with the result that worldwide research was almost eliminated. However, as with many other diseases, the infecting microorganisms developed resistance to standard drugs. In 1968 there were 12,000 cases among combat troops in Vietnam, representing 240,000 man-days lost, a cost of $36 million, and obviously reduced combat effectiveness of units losing the men. To combat this drug-resistant disease, four significant gains have been achieved: (1) a new prophylaxis was developed which reduced the attack rate by 50%; (2) the death rate has been reduced by a factor of 5; (3) a new combination of drugs is being administered that reduces the average hospital stay from 30 to 16 days; and (4) a very recent field trial in Vietnam showed that 21 of 25 cases were cured with one dose of the new drug combination, potentially reducing the average hospital stay to 4 days.

There are other examples of products from exploratory development that have proved highly effective. I have mentioned some of these in previous sections of this presentation: the antifungal treatment to prevent infection from water immersion, laser-guided weapons, some of the sensors for the instrumented battlefield, an oxygen concentrator to replace LOX for pilots, second-generation night vision devices, foliage-penetration radars, flechette-type weapons, and miniaturized high-reliability fuzes. There are many others such as ceramic personnel armor, transparent armor, "soft-recoil" artillery weapons with greatly reduced weight, a crashworthy fuel system for UH-1 helicopters, a plasma-deposited tungsten-composite rocket nozzle which will operate uncooled at flame temperatures of 6500 degrees F., an air-cushion landing system for aircraft, improved binary chemical munitions which do away with storage and shipment hazards, and free-swimming divers attaining 1000-foot depths.

Further enumeration of such examples, valuable and exciting as they are, would become tedious. A catalog of these accomplishments is important, in a sense, because we see clearly what we get from our investment. But what is more important is that, year after year in the past, our research and technology base consistently has given us new opportunities and new options. We must support our technological effort so that, in the future, we will have comparable technical opportunities and choices. For it is in exploratory development than the U.S. technical advantage, the U.S. margin of technical superiority, is strengthened.

5.3.2 Recent Trends: The demands placed on our exploratory development program have increased considerably over the years. Many additional projects are necessary to support the varied technological problems inherent in new, sophisticated weapon systems. Yet, as we face the decreasing level of funding, some necessary programs are being pushed aside or reduced in favor of higher priority efforts. In FY 1964, the exploratory development program was funded at almost $1.2 billion. In FY 1969 it had declined by over 25% to $878 million. If, in addition, we take into account the increase in the cost of performing this work, then our actual FY 69 effort is only slightly over half of the effort active 5 years ago.

If this trend continues, we will be forced to reduce our level of effort in projects having even higher relative priority in our program. Our ability to meet known threats will be compromised, and we will lose urgently needed options for potentially needed future developments.

I cannot reemphasize too strongly that we must increase our forward momentum in replenishing the reservoir of science and engineering upon which national security depends. This conviction has been validated so often that it has become our guiding principle in the support of our technology base. As I highlighted in my introduction, the decade of the 70's will reveal the results of the impressively growing Soviet and Chinese technical programs. We surely do not want to be technologically stagnant so that a slight technological advantage or surprise could have historic implications.

I am aware that some have argued that a large DoD program in exploratory development may be justifiable but so poorly coordinated with other large Federal R&D programs that funds are wasted. In particular, for example, some people have asked whether the coordination with NASA is effective. As I mentioned in discussing the research (6.1) budget, we try hard to discuss our entire program with NASA in several ways through several mechanisms throughout the year. Last summer, for instance, the Secretary of Defense and the Administrator of NASA directed a special series of joint "economy studies." These detailed studies cover a number of common DoD/NASA activities in the space and aeronautics areas directed toward identifying actions which can lead to savings.

In the networks area a joint study identified certain consolidations in tracking stations, possible relocation of proposed new facilities, ways to reduce the need for certain radar equipment, and some streamlining of management of Apollo ships and aircraft as possible ways to achieve more efficient operation. The use of data relay satellites was recommended as a way to overcome certain network deficiencies and possibly achieve future cost savings. In the area of recovery of returned astronauts and spacecraft performed by DOD for NASA's Apollo missions, the joint study concluded the present service is now being conducted efficiently. However, as increased confidence is gained in the spacecraft, commmand and tracking systems, and in the recovery operation further reductions in ships and aircraft should be possible. Ships and aircraft required for recovery were reduced by more than 50% during the course of Gemini. Reductions in ships and aircraft for future manned missions by factors of 2 to 3 times below that presently needed for Apollo should be possible. In the area of launch vehicles a joint study group examined the future mission requirements of both DOD and NASA and considered many alternative ways of meeting these requirements efficiently and economically. As a result the TITAN IIID-Centaur was recommended as the most promising vehicle for future NASA unmanned missions. It was also concluded that both agencies should give consideration to the use of retired ballistic missiles, Atlas and Minuteman, as low cost stages in space launch vehicles. A joint study group also examined the support operations at the DOD Eastern Test Range and the NASA Kennedy Space Center. This study is not yet complete, but the joint study group has made good progress thus far in identifying activities wherein savings might be achieved. While these are the more promising studies and results, a number of other areas were examined in detail. After reviewing all of the reports submitted by the various study groups, Dr. Newell and I have concluded that, while few near-time savings were identified, and this was expected, the studies were beneficial in showing the way to substantial long-term savings and in promoting better understanding between DOD and NASA in areas where we have common activity.

5.3.3 Budget Recommendations: We have reviewed every proposed technology program, have related them to priority Defense needs, and have totaled the funds necessary to accomplish the overall program. On this basis, I am recommending that $970.5 million be allocated to exploratory development, compared with $878 million in FY 69 (see earlier note in Section 5.1.3 concerning the FY 69 funding level). This will reverse the recent trend, accelerate promising current programs,

and permit the start of necessary new programs. I urge you to support this increase.

5.4 The Advanced Research Projects Agency (ARPA)

I have already referred in other parts of my statement to recent research and exploratory development in which ARPA has made a major contribution, notably in strategic technology, nuclear monitoring, overseas defense research, and advanced sensors.

Now we should discuss briefly the role of ARPA in our overall RDT&E establishment and mention some other ARPA accomplishments. These accomplishments include technical advances as well as several areas of management changes in the transfer of programs to the Services.

ARPA, as you know, was established in early 1958 in response to a need for centralized management of selected, high-priority projects. In the past ten years, ARPA has proved to be extremely effective in handling projects in which feasibility demonstration is essential to DoD but for which there is no clear Service mission; projects that are multi-Service in nature; and projects that require an especially quick reaction. Because ARPA's primary mission is ensuring the DoD against technological surprise, it must search out new fields and ideas, accelerate R&D where surprise could be critical, and bring developments to a stage at which sound decisions can be made on their further exploitation.

It is ARPA's objective to carry programs to a certain stage in research or exploratory development and then transfer them to an appropriate Service. This past year, the radar and interceptor technology programs of ARPA's ballistic missile defense project (DEFENDER) were transferred to the Army's Advanced Ballistic Missile Defense Agency (ABMDA) in consonance with the latter's NIKE-X R&D and range sensor development responsibilities. To ensure the successful transfer of the programs and facilities, approximately $45 million in FY 1969 funds and appropriate staff were also transferred. After a review of the strategic R&D field, a Strategic Technology Office was thereupon created within ARPA to pursue a broad program of research and development designed to identify, explore, and demonstrate advanced concepts and technology that could have major technical impact on the offense/defense balance -- hence, on the U.S. strategic capability. One of the major areas assigned to the Strategic Technology Office is laser technology. Selected areas that were inappropriate for transfer to ABMDA were assigned to the Strategic Technology Office to provide the technical core for its new activities. The transfer is judged successful by all concerned.

A new area to be investigated by the Strategic Technology Office in FY 1970 is research and development in large sea-surface platforms. The objective of this program would be to demonstrate the feasibility of large, ultrastable floating platforms adaptable to a wide variety of functions at sea, including forward basing (in addition to, or instead of, foreign-based installations), surveillance, logistics, ballistic missile defense, and tactical command and control.

During FY 1969, ARPA established another new program -- advanced engineering. Its major objective is to explore new areas of advanced engineering for selected tactical warfare problems. These problems include the development of quiet aircraft and helicopters and developing new concepts in small arms. Included in this program's research plans for FY 1970 are the investigation of a low-cost, lightweight flying machine (perhaps less than 150 pounds in weight and $5,000 in cost) which could be used for individual troop mobility, and a surface-effect vehicle that would have considerably greater range, endurance and speed than the present generation.

Another of ARPA's projects was reoriented in FY 1969. The effort, formerly called Nuclear Test Detection (VELA), now includes programs concerned with nuclear proliferation, prediction of the location of clandestine nuclear tests, countermeasures to capabilities and techniques previously developed by the VELA program, and diagnostics data on nuclear explosives. These new programs have been entitled "PRIME ARGUS." A substantial phasing down in the older, on-going VELA program concerned primarily with nuclear test detection will take place during FY 1970.

In FY 1970, a Military Geophysics Program will be started under the newly formed Nuclear Monitoring Research Office -- which also manages VELA and PRIME ARGUS -- to demonstrate the feasibility of countering threats to the national defense posture posed by the modification of the natural environment. The program will try to determine the extent to which underground nuclear explosions can stimulate earthquakes, the extent to which man's non-nuclear, defense-related activities can stimulate earthquakes, and, finally, the feasibility of techniques that might permit control of earthquakes. Because of the great national interest in this field, we will arrange for intra-agency consultation on all major elements of this program.

ARPA has three projects that are funded in the research (6.1) category: Information Processing Techniques, Behavioral Sciences and Materials Sciences. In each of these projects, a major portion of the effort is conducted for ARPA by universities. We have attempted to provide these institutions with a funding mode that will permit them to make the required commitments for staff, facilities, students and university funds.

In the past year, ARPA's Information Processing Techniques project has completed research on a computer software system for data management; ADEPT (the operating system) and TDMS (a set of user-oriented data management programs) will permit far more rapid and effective computer operations than were possible in the past. Already in trial use in the National Military Command Center and the Air Force Command Post, ADEPT makes it possible for many users to have simultaneous access to the computer and incorporates such advances in file organization that requests for computer services that formerly took hours to fill may now be answered in minutes.

In the behavioral sciences area, we are terminating the former program in "Change in the Developing Nations" which involved university work in foreign countries in order to support another area in behavioral science of greater need and probable payoff to the Department of Defense. It appears possible to use recently developed computer sciences to assist the behavioral sciences in developing tools to solve DoD problems in interaction effects in man-machine and group situations, to improve national security forecasting and planning, and to improve the realism of military-political gaming techniques. These problems are quite similar in being rich in data but poor in analytical understanding. Computers make it possible to organize and process the data for the researcher until working theories and tools emerge. Preliminary efforts have shown considerable promise in producing useful results for DoD and we are therefore expanding this effort to replace the less promising overseas work.

Recent fundamental research on penetration mechanics supported by ARPA's Materials Sciences project has pointed the way to new approaches that may lead to the capability of providing adequate protection for the infantry soldier with a considerable reduced weight penalty. These research findings are being made available to the Army for exploitation. Recent work in explosive forming technology has resulted in substantial advances in the fabrication of large shapes. For example, single-piece domes are currently being produced by this technique for the SPRINT missile.

In Fiscal Year 1970, the Materials Sciences project will start an intensive investigation of properties of rare earths and other exotic materials, with the expectation that certain of these materials will lead to great improvements in

magnetic and semiconducting devices. Effort is continuing to increase the relevance of the fundamental research in the Interdisciplinary Laboratory (IDL) Program to DoD needs. A large number of IDL researchers began regular visits to DoD laboratories during the past year to assist in the solution of DoD materials problems.

ARPA has six projects funded in the exploratory development (6.2) category: Strategic Technology, Nuclear Monitoring Research, Overseas Defense Research, Advanced Sensors, Advanced Engineering, and Technical Studies. I have already mentioned some of these areas, but I will now give you a few more examples of current activity.

In 1968, ARPA continued to make quick-response R&D contributions for Vietnam through its Overseas Defense Research and Advanced Sensors projects. I have already mentioned a number of these efforts in Section 3, but I want to highlight two especially important efforts.

In 1968, ARPA continued its progress in counterinfiltration and intrusion detection technology. At the request of the U.S. Commander in Korea, ARPA undertook a system design study of the infiltration problem facing the Republic of Korea.

In Thailand, ARPA is working as a member of the Country Team carrying on systematic R&D on how to deter insurgency. Every project is approved in advance by the Thai Government and by the U.S. Ambassador. With their approval, we work closely with the Thai Government. For the past two years, ARPA has conducted a system design and test program. The resulting pilot system designs have been carried through the final phases, and the Thai Government is taking over further responsibility. ARPA has also provided technical assistance to the Thai Government to develop a boat hull for patrol vessels suitable for the shallow, rocky Thai waterways. The Thai Government is now proceeding with the development of the hull entirely on its own.

ARPA's Technical Studies project provides specialized scientific, technical, and engineering support to the rest of ARPA and to my office. The effort is generally in the form of short-term investigations of major problems, often of a quick-response nature, covering the state of the art of a given technology or reviewing alternate solutions to technological problems facing the DoD.

Our FY 1970 budget request for ARPA totals $238.1 million. This includes $48.6 million for Research (6.1) and $189.5 million for Exploratory Development (6.2) divided among the projects as follows:

6.1 Research	(Dollars in Millions)
Materials Sciences	$17.3
Behavioral Sciences	5.4
Information Processing	25.9
	$48.6

6.2 Exploratory Development	(Dollars in Millions)
Strategic Technology	$ 71.7
Nuclear Monitoring	38.5
Overseas Research	29.4
Advanced Sensors	29.5
Advanced Engineering	13.1
Technical Studies	7.3
	$189.5

TOTAL	$238.1

6. TOPICS OF RECENT SPECIAL INTEREST

In this section I will discuss seven topics that have been of recent special interest to the Congress. For each I will give a short assessment of the situation. The topics are:

- Development Concept Papers
- R&D Management Policies
- Foreign-Area-Related Social Science Research
- Studies and Analyses
- Security Policy on Technical Information
- In-House Laboratories
- Federal Contract Research Centers

6.1 Development Concept Papers

I will discuss the overall policy framework for R&D management in a moment. But first I want to give you a progress report on a new "discipline" for R&D management on major programs. I am quite satisfied with the initial impact of this new discipline which is imposed through Development Concept Papers (DCP).

A DCP is a summary top-management document for the Secretary of Defense which presents the rationale for starting, continuing, or stopping a development program at each critical decision point. It assesses the known risks involved in each decision, along with the full military and economic consequences of the program, and lays out explicit decision-review "thresholds" for key factors such as technical performance, cost and schedule. In short, a DCP tries to minimize biased "advocacy" points of view and to state clearly all of the known uncertainties involved in major decisions on R&D.

We have had more than a year's experience with this approach. Since late fall 1967, we have prepared 81 draft DCP's. The Secretary has personally signed 25 involving more than $12 billion in funding over several years. The others were either approved by my office or returned for further work now in progress. In a few cases we are in the second cycle of revising and updating a DCP for the Secretary's review.

While we have found it difficult to prepare a single, succinct, analytic document for the Secretary which contains all of the issues -- and all the pros and cons on each issue -- the new process is genuinely effective. The work of preparing a DCP is remarkably valuable in itself, because it forces a dialogue -- usually rather objective -- among all the key people interested in decisions on major R&D programs. To ensure that the system continues to improve within certain ground rules, we are now drafting a DoD directive on the process.

6.2 R&D Management Policies

For many years and especially during the last few months, there has been much discussion on the management of defense research and development. Some of this discussion and the resulting publicity have been quite critical, pointing to specific cases (past and current) in which our goals apparently were not achieved or in which our management allegedly was not adequate. I want to discuss these issues and problems with you briefly, broadly and candidly, and I will be happy to try to answer any specific questions you may have.

Let me begin by restating the major criticisms. Some have said DoD has no effective ways to control the costs of major development efforts -- and the C-5A transport aircraft development and procurement has been singled out to "prove" this charge. Some have said we start programs long before the required technology is available -- and the SRAM bomber missile development has been used to support this charge. Some have said we agree to unreasonably optimistic schedules for development efforts -- and the delays encountered in completing development of the Mk-48 torpedoes have been cited as demonstrating this failure. Some have said we do not carry out a sufficient number of competitive prototyping efforts, and for this reason we fail to achieve reliable results in advancing the state of the art -- and a series of electronics programs during the 1960's has been "analyzed" to "prove" this charge. Finally, some have said we tend to reward the least efficient contractors with follow-on contracts and to grant unreasonably high profits to most contractors.

If none of these charges were in any respect valid, we would simply be the targets of irresponsible criticism. If this were the case, we would not be concerned, although we would have to improve our communications. But the facts show that each criticism contains some element of truth, unfortunately along with a much larger element of misinformation and distortion. Further, the facts show that the DoD has been concerned and active in solving the management problems revealed in the past. Overall, defense R&D continues to be complex, costly and (most important) central to our national security. Thus R&D management has been a prime concern of past Secretaries of Defense. While I am primarily and continuously responsible for R&D management, it also holds the first-priority attention of Secretary Laird and Deputy Secretary Packard.

Let me now outline what I regard as the basic issues underlying defense R&D management, and trace briefly the history of changing management approaches.

There are many approaches to acquiring weapons. We can concurrently develop the system in the laboratory and prepare to produce it. We can develop prototypes first so that we can "fly before buying." Or, we can buy items that have been developed at the supplier's risk and are on the shelf.

Over the past 20 years, we have seen different strategies for using these options. These strategies have been shaped as much by the national objectives and priorities then current as by technical possibilities and management policies. Throughout the 1950's, the Soviets were presenting many challenges and rapid improvements in their strategic nuclear forces and in the conventional arms with which they threatened NATO. The Iron Curtain amplified our uncertainties concerning their objectives and their progress. The rapid and continuing progress in electronics, aircraft, missiles, and weapons provided almost unlimited choices and unlimited potential threats. Given these great uncertainties in threat and technology, we had to take risks and pursue multiple and parallel approaches. We could not risk the delays inherent in the idealized sequence of developing and then testing laboratory models, then developing and testing prototypes, and then building production versions. National objectives dictated concurrent establishment of production facilities, in anticipation of the successful development efforts. Letter contracts were awarded before specifications were fully completed. Competition for programs often could be judged only by evaluating broad technical approaches and organizational competence. Compensation was based on costs.

The management consequences of these approaches were generally well understood from the beginning. However, by the 1960's, the results and short-comings were beginning to emerge.

For example, a Harvard study, in 1962, carefully examined the development of a number of major systems: five air defense missile systems, one candidate ABM system, three supersonic aircraft, and three ballistic missile systems. The study concluded:

* All but one of these systems became operational and satisfied the goals that had evolved during the development of the programs.

* The systems required development times on the average at least a third greater than the initial schedule -- in several cases, twice as long.

* The systems required increased development funding averaging three times more than the initial estimates -- in one case, seven times greater.

By the 1960's government and industry had learned a great deal about the development of major systems. Moreover, the successes of the programs of the 1950's gave us a position of clear strategic superiority that permitted a change in the urgency and character of national objectives. We were therefore in a position to stress a much more deliberate approach to each phase of exploration and acquisition.

Our purpose was to reduce the costs to the government of major systems acquisition. As you know, the only way to reduce cost without reducing profit is to reduce the risks and cost of manufacture. Therefore, we introduced the philosophy and procedures of concept formulation and contract definition. With this philosophy, new emphasis was placed on thorough reviews of need, feasibility, performance, schedules and costs. Before a major development could be started, the DoD insisted on a demonstration that technology was available and on an explicit analysis of precisely what was expected from the investment. When it was decided to acquire a new system, an attempt was made to achieve fixed-price competitive contracts wherever possible.

Concept formulation defines the mission and performance goals of the new system after a thorough evaluation of the costs of alternative means of satisfying the military requirements. It examines many technical alternatives to select the best technical approach. It seeks to ensure that the effort has reached a point where the needed technology is available and proved, so that no further substantial experimental effort will be required. Concept formulation analyzes the estimated cost, effectiveness and schedule for development of the proposed system to ensure that it compares favorably with all other similar and competing systems.

After all advanced development work is completed, we start contract definition. It is a competitive process designed to verify the completion of concept formulation and to establish realistic, firm management plans. Contract definition culminates in a signed contract based on the expectation that the system will be produced and go into the operational inventory.

Several major weapon system developments have now been carried through using the program management philosophy and procedures formulated in the early 1960's. Some of these systems will shortly be entering the inventory. It is therefore timely to call for a deliberate examination of the results of that philosophy and to extract the lessons in our recent experience. Any management approach tends to be evaluated more by its failures than by its successes. Each of us has impressions of the impact of concept formulation and contract definition. I would like to outline our tentative views on the experience of the 1960's.

Our reviews are not yet complete. Cost overruns, schedule slippages, and drifting concepts are still with us. However, it is clear that the systematic application of concept formulation and contract definition has resulted in a significant reduction in cost overruns and schedule slippages.

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Typical increases in actual system costs have been on the order of less than twice our initial estimates rather than three to seven times greater, as documented in past studies. Often these overruns have seemed larger to you and to the public because the costs publicized originally were the minimum target and did not include recognized incentives and contingencies. In short, we believe cost controls have, in fact, improved. Most increases in cost recently have been the result of an explicit decision to develop a better product using newly proved technology.

Representative delays in introducing operational systems into the inventory over the dates scheduled at the time of contract definition appear to be reduced from the delays common during the 1950's. Systems concepts and specifications also seem to be drifting much less from contract definition to deployment than was true for the major systems developed in the 1950's.

This system works best where only straightforward engineering efforts are needed after the decision to enter production. When we simultaneously set a schedule for production while complex and risky development remains to be accomplished, we usually find that we are forced into a concurrency of production and development that compounds our problems. Unfortunately, in too many cases, the desire for a fixed-price contract before the risks have been reduced has placed a dangerous premium on optimism. On occasion, it has strained the technical integrity of both government and industry.

We have learned that paper design studies, and even extensive analysis and simulation, are essential. However, studies alone cannot always produce an adequate basis for selecting an effective design and laying out achievable schedules, performance and cost. In some cases it is essential that we reduce critical subassemblies or components to hardware, often on a competitive basis, in order to gain adequate assurance of feasibility and design stability. Where the system integration is itself a major source of risk, complete prototypes may be mandatory. Where development costs are small in comparison with acquisition and operating costs, the added costs of competition in hardware may well pay off in total economy. In general, where the total R&D cost represents only a few percent of the total systems cost, competitive prototyping is wise; and we will continue to follow this practice, perhaps in more situations.

In general, the key to sound defense R&D management is deceptively simple: Our objectives on each program and the way we choose to manage it must be clearly and explicitly stated and then fully debated, especially on the largest programs. We must assess deliberately the threat we face, the national goals, the urgency of solution, the status of the concept and technology, the capabilities of industry, the options available, the costs, and the competing national priorities.

It is a major objective of the new Administration to review our experience and policies on R&D management, and to make sure we benefit from the wisdom we can collectively bring to bear on this subject. We must bring the perspectives of industry, government and science into new reviews of the experience in the 1960's. We have therefore started major reviews by all appropriate senior military and civilian officials of the DoD and by major independent advisory groups.

In particular, we have started work by independent analysts and managers from the Defense Industry Advisory Council and the Defense Science Board which advise the Office of the Secretary of Defense. And we have begun detailed supporting assessments which should be completed by this summer. We expect to make any changes in our management practices shown to be needed.

I hope it is now clear that we are aware of the trends and the deficiencies in defense R&D management. Frankly, I believe we have made substantial improvements. We can and will improve it further. I welcome your suggestions on areas which, in your judgment, require special emphasis.

6.3 Foreign-Area-Related Social Science Research

Last year, I was asked a number of questions about our social science research and study projects related both to foreign areas and to policy issues that include political and economic as well as military considerations. Many of the questions were clearly rooted in some misunderstanding -- either of the title of the project or of the reasons for Defense sponsorship. I want to give you a brief status report on certain management actions we have taken to sharpen and streamline the character of our work in this area.

Let me begin by restating the premises of our overall policy on this research field. The DoD strongly supports foreign-area social science research efforts as a key national need. But national security affairs today are too complex and too critical for any single agency to assume the burden of providing all of the studies necessary to clarify our thinking and consider alternatives to current policy. We do not intend to expand our activity. We have encouraged other parts of the Executive Branch to increase their activity. And we may decrease our support of work on problems of multiagency interest as other agencies do more. We will continue to try to create such an improved national posture, and have taken three significant management actions recently that I wish to emphasize.

First, as a step toward encouraging greater efforts elsewhere, we are considering -- with the support of the Bureau of the Budget and the Office of Science and Technology -- ways to transfer a few projects of multiagency interest, together with currently available funds, to other groups such as the Department of State or the National Security Council staff. This is the kind of action recommended, incidentally, in a recent report by the National Academy of Sciences on Behavioral Sciences and the Federal Government. If this experiment is successful, we hope the new sponsoring agency then would request and receive funds to continue its research program.

Second, in the past year, the Defense Science Board recommended to me and to the Secretary of Defense a government-wide planning committee for foreign-area social science research, under other than DoD leadership. We hope other departments will join with us to adopt this suggestion, and we are currently discussing it on an interagency basis.

Third, we also recognize other countries' sensitivity to DoD-sponsored social science research conducted overseas and have acted to reduce potential friction points. Our revised policy criteria limit our support for field research overseas to cases where: (1) there are substantial U.S. military forces in the country at the time of the study; or (2) work is requested by U.S. military officials in the country and by the host government; or (3) the study deals only with U.S. personnel serving overseas and not with foreign nationals. Research projects that do not meet any of these criteria must be reviewed and approved individually by the Secretary of Defense. These restrictions are in addition to the foreign sensitivity precautions for field research: As you probably recall, projects must be cleared by the U.S. Ambassador to the country involved, by the Assistant Secretary of Defense (International Security Affairs), and by the Foreign Affairs Research Council connected to the State Department's Bureau of Intelligence and Research.

Before concluding this section, let me give you one striking example, a historical one, of the importance of foreign-area-related studies. With the 1948 coup in Czechoslovakia and the Berlin blockade, it became clear that U.S. national security required dependable knowledge about the current and future intentions and capabilities of the Soviet Union. Accordingly, the Air Force, which was already responsible for strategic intelligence and air targeting for the USSR, was given responsibility for an interdisciplinary effort to provide that knowledge. From 1950 to 1955, work was supported at

the Russian Research Center, Harvard University, under the direction of the noted anthropologist Clyde Kluckhohn. The work resulted in: (1) identification of the basic indicators by which to evaluate the strength and future course of action of a major adversary; (2) subsequently validated forecasts of post-Stalin developments; (3) immediate responses to Air Force, Defense and State needs for assistance in assessing policy options during the early years of the cold war; (4) aid in psychological warfare plans to deal with the North Korean and Chinese forces engaged in Korea; (5) a model analytic strategy to study a closed, hostile society; and (6) perhaps most important in a sense, the generation of specialized American analysts of the Soviet Union. Incidentally, one specific suggestion for psychological warfare in Korea greatly reduced the effectiveness of hostile fighter pilots and sharply increased the number of MIGS the U.S. knocked out, while reducing our losses.

In the long term, there must be more R&D devoted to the remarkably complex policy problems and the underlying social and behavioral sciences inherent in decisions on national security. These problems cannot be sorted out neatly into exclusively military, exclusively political, and exclusively economic issues. Because the issues are interrelated, so must be our research. Personally, I urge you to concentrate not on our occasional failures in research -- for this is simply the nature of R&D -- but on the more fundamental question: How can the country move more efficiently to meet its overall needs in this area?

Finally, I will review the requested budgets for all social and behavioral science research to help put into perspective the relatively modest effort in foreign-area-related and policy studies. The following table indicates clearly the emphasis and trends in our overall behavioral and social science research program.

Behavioral and Social Science Research and Studies
($ in Millions)

	FY 68	Request FY 69	Final FY 69	Request FY 70
Human Performance Measuring individual physiological and psychological human capabilities related to military operations.	6.9	9.0	6.9	6.3
Manpower Selection and Training Methods to improve selection, classification, training, and use of military personnel.	14.0	18.7	21.5	25.3
Human Factors Engineering Human component in a man/machine system.	3.8	4.6	3.3	3.7
Foreign Military Security Environments Basic military, economic, and political factors bearing on possible U.S. military activity.	8.3	10.1	7.3	6.9
Policy Planning Studies Strategic planning in response to changing pattern of political and power alignments; threat analysis; contingency planning; force structure; and R&D requirements.	6.6	6.9	6.4	6.4
TOTAL	39.6	49.3	45.4	48.6

You can see that the dominant share of our program deals with the men in uniform, on whom our military effectiveness depends. The funds support work to ensure that "hardware" is built for efficient, reliable use; that men are selected, assigned and trained properly for increasingly complex jobs; that due account is taken of their basic physical and psychological capabilities. The proportion of effort devoted to these problems has increased steadily from 62% in FY 68 to 72% of the program in the plan for FY 70. Almost all of the increase requested for FY 70 is for such purposes. At the same time the funds allotted to foreign-area-related research and policy studies have declined. We received $14.9M for such work in FY 68 and request only $13.0M in FY 70. I will be delighted to provide you with more detailed information on our planned programs in any of these areas.

6.4 Studies and Analyses

Last year I discussed the overall framework of our study and analysis program in some detail, and gave illustrations of the range of study results. I recognized, however, that some of you still were concerned about this area, so I asked the Services and Defense Agencies to further strengthen and centralize our management of studies and analyses.

Recently, as a result of work last summer on study management, the Deputy Secretary approved a new DoD Directive which delineates the policy of DoD with respect to all studies performed under contract or grant. The directive established procedures for higher level review and approval of study efforts; a uniform programing and budgeting framework so that we can control more easily the size and balance of study funding; and a new DoD Studies and Analyses data bank so that we can more easily identify and use all past and current study results. All studies and analyses will be organized into six categories for convenience in programing, budgeting, and data collection: (1) manpower and personnel, (2) concepts and plans, (3) operations and force structure, (4) logistics, (5) science and technology, and (6) management (which is not an R&D-funded category). Each Service is establishing a single program element in the Management and Support Category of Program VI which will contain all RDT&E-funded studies and analyses. I believe this new management structure will help greatly to solve some of our past difficulties in controlling the quality and relevance of studies.

Funding Trend in Studies and Analyses
(Millions of Dollars, RDT&E)

		FY 67	FY 68	FY 69	FY 70
Army					
65101A	Studies and Analyses	12.4	11.5	9.6	10.0
Navy					
65104N	Studies and Analyses	9.3	10.0	9.2	9.8
65103M	Studies and Analyses, USMC	1.1	1.2	1.2	1.3
	Navy TOTAL	10.4	11.2	10.4	11.1
Air Force					
62103F	Cloud Gap	1.1	0.0	0.0	0.0
63101F	Studies and Analyses	6.7	4.0	4.5	4.5
62404F	Space Studies	0.6	1.0	1.0	1.8
	Air Force TOTAL	9.4	5.0	5.5	6.3
Defense Agencies					
65101D	Studies and Analyses (OSD)	10.6	9.0	9.9	10.5
62101D	Technical Studies (ARPA)	7.9	6.3	9.5	7.3
	Defense Agencies TOTAL	18.5	15.3	19.4	17.8
	GRAND TOTAL	50.7	43.0	44.9	45.2

Let me now reiterate briefly our overall policy-guiding studies and analyses. They are viewed as essential tools of management, an integral part of executive or command responsibility. They are used only where we expect a substantive contribution to solving essential problems and to clarifying critical issues on important military decisions, and only where the results of the study will receive careful consideration by the appropriate user.

You can see from the table that our FY 70 budget request has been carefully reviewed so that the total funding request is roughly equal to last year's program, which is tantamount to a 5% reduction because of the increased cost of this work. Some of these funds will go to the Federal Contract Rearch Centers for short-term projects, but note that I have separated these more general study activities from those assigned directly, on a long-term basis, to the FCRC's. (I will discuss the FCRC's and present the FY 70 request for FCRC's later in my statement.) I urge you to support this request because the proposed studies are significant and have been screened rigorously.

6.5 Security Policy on Technical Information

Questions have been raised during the past year about what some consider to be the large volume of valuable but unclassified U.S. military technology disclosed in open publications and thus made freely available to potential enemies. The Department of Defense fully appreciates this concern to make sure that information requiring protection in the interests of national defense and foreign policy is adequately safeguarded.

Thousands of DoD scientific and technical personnel must determine each day what specific information needs protection and what does not. The basic dilemma in these decisions is, on one hand, to encourage the maximum interchange of technical information within the scientific and technical community of the Free World for our own benefit and yet, on the other hand, to minimize any free technical assistance to countries whose interests may not coincide with ours.

I believe there is general agreement that the single best method of protecting important military technical information is the use of proper security classification. As a general requirement within the DoD, information -- and here I am quoting the formal definition -- "the unauthorized disclosure of which could be prejudicial to the defense interests of the Nation" must be classified. We have what I consider to be a solid policy to provide technical classification guidance to personnel at all levels within the Department to help them make the decisions on classification.

You must understand that the U.S. technical community depends heavily and thrives upon the process of open debate. Without debate in most critical areas of defense R&D, our current technical superiority would be jeopardized, just as surely as it would be if classified information were compromised.

Nevertheless, because of our continuing concern that DoD policies and practices do the best possible job of safeguarding technical information, we have been reevaluating all directives and procedures concerning this responsibility. The purposes of this reevaluation are to ensure, first, that the intent of Congress as expressed in relevant statutes is fulfilled; second, that procedures for identifying and safeguarding information that requires control are effective and as simple in application as possible; and, third, that the public and the scientific and technical community have free access to all information that does not qualify for protection under security directives or under other criteria established by law. This reevaluation is currently in progress. Secretary Laird and I will keep the Congress informed as conclusions and recommendations are formulated and approved.

6.6 In-House Laboratories

I will give you a brief progress report on our in-house laboratories. We have 80 such activities spending about $1.8 billion in RDT&E funds, split about equally between our in-house projects and the contracts managed by in-house technical staff.

Changing Role and Structure - In the past, we have had many individual laboratories but no effective system for integrating them within the DoD in terms of major problem areas. Our organization has been fragmented along relatively narrow technological areas and, as military needs arose, few organizations were capable of examining the total problem. Thus we have placed emphasis for several years on building larger aggregations with broader responsibilities, a broader view of problems, and with the range of specialized competence to solve each sub-problem.

As examples, within the past 2 years we have closed three smaller laboratories and have consolidated 16 others into six. The Army is now planning to consolidate 14 small activities concerned with R&D on nuclear effects into four larger groupings, as a first step toward a single "Nuclear Effects Research Center."

These new arrangements have permitted the laboratories to play a more important role in critical systems efforts such as threat analysis and development of requirements; planning for future weapons; the assessment of the vulnerability of proposed major systems; coupling across the entire research and development cycle; and quick-reaction support for operational forces.

There are many cases which illustrate the importance of having effective in-house labs. I will mention one recent example from each Military Department.

(1) The tragic loss of the nuclear-powered attack submarine SCORPION led to a massive search by more than 40 ships and 6,000 men. After the initial search effort, the primary follow-up work fell to the USNS MITZAR and scientists and engineers of Navy laboratories. For nearly 5 months this team conducted a painstaking and arduous search which was finally successful. The success of this extraordinary task gives hope of determining why the SCORPION was lost. Further, it is a major contribution to the Navy's programs in improved deep ocean search methods.

(2) An Air Force laboratory, during an exploratory development program, demonstrated an entirely new flight control system. The "fly-by-wire" flight control uses electrical wires between the pilot's control column and the control surface actuator, replacing the complicated mechanical linkage system now used in all aircraft. The system has been demonstrated in a B-47 flight test aircraft and shown to be technically feasible. This type of flight control system can reduce aircraft vulnerability as much as 50%, depending upon the type of aircraft and system configuration. It has been estimated that for the CH-46 and CH-47 helicopter a weight savings in the flight control system of 77% and 86%, respectively, would be realized by using fly-by-wire. Efforts are now being made to combine this development with another current development on integrated servo actuator packages for application to the F-15 aircraft. The new technique represents the first basic change to flight control systems since the days of early aircraft.

(3) Fires have been the biggest cause of death in helicopter crashes in Vietnam. Army labs have developed two approaches to reduce or eliminate this hazard. In the past year they have developed a successful crashworthy fuel system for the UH-1 aircraft and an emulsified fuel which shows considerable promise. The crashworthy system consists of an improved ballistic self-sealing material for the fuel tanks, along with breakaway fuel lines that seal when the aircraft crashes. This system is expected to reduce fire fatalities by approximately 70%. By preventing rupture of the fuel systems upon impact, crashes

that are survivable should not result in impact fires. These fuel systems will allow crewmen and passengers time to escape from the wreckage. First production UH-1 aircraft and retrofit kits will be produced and delivered in late FY 1970.

Environment for Quality and Productivity - One of our key objectives for the in-house laboratories is to provide a degree of administrative flexibility equivalent to that of progressive industrial R&D organizations. To try to reach this goal, I have had conscientious and sustained assistance from the Civil Service Commission. We have modified certain controls and regulations to meet the special needs of R&D organizations. Yet movement is slow in these areas, as you can appreciate, because improving the administrative environment of large units within even larger organizations requires patient, high-level attention.

We are providing the laboratory manager with the administrative tools to integrate his resources of people, program funds, facilities, and equipment. Frankly, today this obviously desirable integration is extremely cumbersome. So we have taken a number of important steps to improve the situation:

... We have taken actions designed to solve 90% of the key 42 management problems identified last year in areas such as recruitment, career development and training, personnel mobility, and compensation. However, the manpower controls required by last year's Revenue and Expenditure Control Act (PL-90-364) have inhibited our ability to deal with a number of these problems as rapidly as we intended.

... We are planning a two-year experiment to test the hypothesis that the utilization of fiscal controls without numerical manpower controls is a better way to manage the laboratories. This experiment is based upon our view that the traditional numerical ceilings on manpower, imposed in addition to fiscal controls, inhibit the labs' ability to integrate manpower, dollars, facilities and work load. The Bureau of the Budget supports this experiment.

... The broader application of recent authority to match the salary offers of competitors has permitted DoD laboratories to become more competitive in recruitment. We have improved our ability to attract first-class people into leadership positions, by more rapid promotion and by infusion of new personnel drawn from industry and universities.

... A number of our new weapon centers, which I discussed last year, are operational, and their initial effectiveness validates the concept. Next year we expect to establish at least two more such centers.

... Greater fiscal flexibility has been needed for some time in managing Exploratory Development (6.2) in the laboratories to meet new technical opportunities and to respond to urgent operational priorities. The Air Force now has achieved this with a single budget line item per laboratory. The Navy is restructuring its FY 70 program to permit greater "block funding" to its laboratories. And the Army is conducting a two-year experiment on single line item funding for three laboratories.

... Steps have been taken to facilitate the mobility of R&D personnel. The Navy has adopted a single job description for its principal laboratory technical directors, which will permit broader ranging assignments for incumbents. We hope this pattern will be adopted by the Army and Air Force.

... Finally, we have on many occasions encouraged our labs to contribute their specialized resources, on a selective basis recognizing DoD priorities, to solving the problems of other Federal agencies -- such as law enforcement with the Department of Justice, housing with the Department of Housing and Urban Development, and air traffic control with the Federal Aviation Agency.

My overall assessment is that we have made some clear progress along well-conceived lines, yet much remains to be done.

6.7 Federal Contract Research Centers

Last year I discussed in detail the management actions we had been taking to improve our reviewing of the programs of the Federal Contract Research Centers (FCRC's), and to tighten and streamline our controls over their manpower and funding levels. As you may recall, I assessed our controls on FCRC size and growth and described a number of actions such as the new requirement for reports from each FCRC's Board of Trustees; the new program focal points within OSD to review overall FCRC performance; our recent studies of the salary levels for FCRC staff and executives; and, finally, our review of fees received by FCRC's. I believe this rather detailed presentation was responsive to your past concerns, and formed the basis for your approval of the financial flexibility that we requested.

This year I would like to present a few general points in our recent thinking about the FCRC's.

First, we are again emphasizing an extremely careful and comprehensive review of the programs assigned to each FCRC. My staff and I now regularly discuss the pertinent critical defense problems faced by the Defense Department with key executives of the FCRC's and with representatives of their military department sponsors. As a result of these discussions, I believe we can have even greater confidence that their programs have significant bearing and direct impact on solving our crucial problems. If you are interested in reviewing any one or all of the FCRCs' programs and accomplishments, I will be pleased to give you the annual compilation of their progress reports.

Second, we have reconsidered recently an issue which has been brought up from time to time for several years -- whether or not these primarily Defense-sponsored organizations should be permitted or even encouraged to apply selectively their specialized capabilities to major domestic problems such as transportation, urban redevelopment, housing, and medical services. We have concluded that when an FCRC has capabilities suitable to a non-Defense client, it should be permitted to undertake non-Defense work. In short, we believe the DoD has developed in the FCRC's a "national resource" which should be used as national priorities dictate, consistent with our needs in the national security area. Thus I have begun discussions with other parts of the Federal Government and with the FCRC's to introduce this concept of "selective diversification." I must add, however, that we do <u>not</u> intend to fund programs designed to solve domestic problems, nor do we intend to act as a permanent "middle man" in administering any such programs. Similarly, we do not intend to reduce or dilute our DoD funding to FCRC's for national security work, nor do we expect the FCRC's to reduce or delimit their contributions to defense needs.

Finally, I want to outline our current thinking on the broadest of policy issues related to the FCRC's -- the continuing need for their sponsorship and possible changes in their funding and functions.

In my testimony last year, I summarized our basic goals and needs for the capabilities represented by the FCRC's. Those goals and needs are still valid. We have received excellent services from these organizations, and we still do. Their services are, in fact, perhaps more critical today than ever before simply because, as defense problems grow more complex, we need as many experienced and objective analysts, designers, and managers as we can get. But certain changes have occurred during the past few years that will require continuing consideration of how we gain these services.

One important change, for example, is that civil service pay scales will reach approximate "comparability" with FCRC salary scales during FY 1970. This again raises the issue of whether we should study the possible advantages of transforming any of the current FCRC's into government institutes or laboratories. We understand that the possible advantages of government institutes are to be studied by the Bureau of the Budget on the recommendation of the General Accounting Office. We will of course cooperate in this study.

Another change is the increasing number of industrial and nonprofit groups which have capabilities similar, but rarely equivalent, to those of the FCRC's. This raises the possibility of introducing somewhat more competition into the procurement of some of the services traditionally provided only or largely by FCRC's. However, the funding limitations on the FCRC's largely insure that their sponsors do not ask them to undertake tasks which can be accomplished elsewhere.

Another significant factor which I have already mentioned is the increasing interest by several FCRC's in taking work from non-DoD agencies, both because this work is challenging, and because such work provides an opportunity for professional and corporate growth not possible with the funding available during the past five years. Such "diversification" holds the promise, as I mentioned earlier, of helping the country solve some of its urgent domestic problems. But the process of diversification could lead the management of some FCRC's to consider moving out of the sponsored status and becoming an independent profit or nonprofit group. The choice, thus, is not entirely ours.

These changes sharpen old issues and raise a few new ones. Yet above all else they reenforce our awareness of the marked differences among the individual FCRC's, all of which were created to solve some specific problem which could not be solved as well at the time in any other way. Some are affiliated with universities and are highly specialized in a few R&D areas. Others are strongly hardware oriented and exclusively coupled to major development programs in the Military Departments. A few are broad gauged and policy oriented, potentially capable of contributing to many national goals beyond DoD. Thus it is difficult to make valid generalizations about them as a class.

Because of these changes, and because of the diversity of the factors involved, we intend to stay very close to all of the management questions regarding the FCRC's during the next year. I will keep you informed as our work progresses.

STATEMENT BY DR. EBERHARDT RECHTIN
DIRECTOR, ADVANCED RESEARCH PROJECTS AGENCY

IN CONNECTION WITH THE ARPA RESEARCH, DEVELOPMENT, TEST AND EVALUATION PROGRAM FOR FY 1970

Introduction and General Highlights

1.1 Introduction

Mr. Chairman and Members of the Committee, I welcome this opportunity to report to you on the research and exploratory development programs of the Advanced Research Projects Agency. My testimony will be an extension of the ARPA part of the testimony by my superior, Dr. John S. Foster, Jr., Director of Defense Research & Engineering.

In total obligational authority for FY 70 we are requesting $238.1M compared with $233.5M in FY 69. Of the $233.5M in FY 69, ARPA transferred $45M in radar and interceptor programs in ballistic missile defense to the U.S. Army. This transfer is a part of the continuing process in ARPA of investigating new areas, demonstrating technical feasibility and transferring the results to appropriate agencies or Services for development to operational needs.

ARPA fulfills a unique role in the Department of Defense. ARPA, as you know, was established in early 1958 in response to a need for centralized management of selected, high priority projects. To insure DoD against technological surprise, ARPA must search out new fields and ideas, accelerate R&D where surprise could be critical, and bring developments to a stage at which sound decisions can be made on their further exploitation. ARPA has proved to be particularly effective in handling projects in which early feasibility demonstration is essential to DoD but for which there is not yet a clear Service mission, projects that are multi-service in nature or require a DoD-wide perspective, and projects that require an especially quick reaction. ARPA's programs total about 3% of the total RDT&E budget.

I have made a special point of reviewing the ARPA mission and program selection criteria with you because we have been particularly firm in using them in the management of ARPA during the past year. They form the rationale for the Defender (ballistic missile defense) transfer, the transfer now in process of the VELA satellite program to the Air Force, the termination of behavioral science research efforts overseas, the further structuring of the Agile (counterinsurgency) project along systems lines and in new areas of investigation, the reorientation of the material sciences and computer sciences into directions more clearly coupled to Defense needs, and the organized search for and investigation of new technological areas.

I would like to comment briefly on each of these management moves before describing the ARPA program in detail.

1.2 Management Highlights

This past year, the radar and interceptor technology programs of ARPA's Ballistic Missile Defense Project (Defender) were transferred to the Army's Advanced Ballistic Missile Defense Agency (ABMDA) in consonance with the latter's Nike X R&D and range sensor development responsibilities. To insure the successful transfer of the programs and facilities, approximately $45M in FY 1969 funds and appropriate staff were transferred.

After a review of the strategic R&D field, a Strategic Technology Office (STO) was organized within ARPA to identify and explore in depth advanced concepts and technologies that could have a major technical impact on the offense/defense balance and hence on the U.S. strategic capability. The assigned concepts include technologies distinctly different from those used in the SAFEGUARD system. The transfer is judged successful by all concerned.

The VELA satellite program to detect nuclear explosions in space has been underway in ARPA for some years. With the recent launch of the last VELA satellites, all further work will consist of the analysis of data from the VELA satellites in orbit. This analysis, a responsibility of the AEC, is likely to continue for some years. A transfer is, therefore, being effected to the Air Force where the results of the VELA program can be most efficiently combined.

Some years ago, a Behavioral Sciences Research Program was initiated which involved data gathering in foreign countries. The work was open, unclassified, and carried out by universities. Although useful work was carried out, this kind of research ran into difficult and sensitive problems. Consequently, ODDR&E, with the participation of ARPA, generated a set of guidelines for behavioral and social sciences work overseas designed to improve the situation markedly. On the basis of the guidelines -- with which I fully agreed -- ARPA terminated in the best interests of the Government virtually all overseas behavioral sciences research by university people.

Project AGILE was initiated in the early 1960's as a quick reaction R&D response to insurgencies. The present AGILE Project reflects the lessons learned since then. AGILE is now in a very limited number of countries and has a much more highly focused set of objectives. Insurgencies are now better understood. We can see the outlines of counterinsurgency systems which might help our Armed Services and those of our allies. We have learned methods of working with the governments of allied nations to help these nations help themselves.

The material sciences and computer sciences (Information Processing Techniques) efforts in ARPA were established to give a strong boost to two fields known to be important to Defense but lagging behind in being able to solve Defense applications problems. We are engaged in coupling them to Defense needs by establishing more personal contact between university and government laboratories, more joint funding of programs between ARPA and the Services, intensive summer studies by researchers of specified research problems, and management of funds to exploit new research ideas rapidly.

In considering technologies applicable to ARPA's mission, not underway in the Services, and likely to produce a major technological surprise, we have begun investigating the technologies of floating platforms, surface effect vehicles, earthquake control and climate modification. We have also oriented the Advanced Engineering Office into new approaches to the small arms problem, the Advanced Sensors Office into more concentration on laser photography, the Material Sciences Office into exploiting unique opportunities in rare earths and amorphous materials, the Behavioral and Computer Sciences into some highly promising joint efforts, and the AGILE project into a systems approach to counter-guerrilla patrols and border control problems.

The remainder of this testimony is organized by ARPA Office giving funding and a brief qualitative rationale for the major programs. Technical descriptions of the projects may be found in the January 1969 ARPA Budget Estimate General Justification, which was supplied earlier.

1.3 Funding Summary. Our FY 1970 budget request for ARPA totals $238.1M. This includes $48.6M for Research (6.1) and $189.5M for Exploratory Development (6.2) divided among the projects as follows:

6.1 Research	(Dollars in Millions)
Material Sciences	$17.3
Behavioral Sciences	5.4
Information Processing	25.9
	$48.6

6.2 Exploratory Development	(Dollars in Millions)
Strategic Technology	$71.7
Nuclear Monitoring	38.5
Overseas Research	29.4
Advanced Sensors	29.5
Advanced Engineering	13.1
Technical Studies	7.3
	$189.5

TOTAL	$238.1

2. STRATEGIC TECHNOLOGY

2.1 Funding

Fiscal 1969 $98M

Fiscal 1969 (Less ABMDA) $60M (includes $7M advanced to Lincoln Lab. on ABMDA's behalf)

Fiscal 1970 $71.7M

The FY 1970 estimate for Strategic Technology is the result of two major factors: the decrease due to the DEFENDER transfer and an addition due to increased emphasis on lasers and on a floating ocean platform.

2.2 Rationale for Major Programs

The recent major reorientation of the Strategic Technology Office makes this a particularly good time to describe both the technology and the rationale behind the major programs.

One of the major areas assigned to the Strategic Technology Office is laser technology.

The Strategic Technology Office will be continuing its research into the phenomena of atmospheric re-entry. This work from ARPA Defender has resolved many debates in the past over the relative ascendancy of offense and defense in the use and destruction of re-entry bodies. ARPA, acting as a neutral, also plays a strong role in the design of ballistic missile experiments and tests such that the greatest practical benefit accrues both to the military offensive systems and defensive systems.

The idea of mid-ocean platforms or islands has been around for decades. Several new developments have now made it worthwhile to take a more detailed look at the idea. Our preliminary studies have indicated that a wide range of sizes and types of platforms are technically feasible, and might be highly cost-effective for some missions. Platforms may have important and unique advantages for range testing operations.

The significant changes which have occured in recent years that have impelled us to take a fresh look at platforms are: first, the successful development of the FLIP or spar-buoy ship which showed that decoupling from wave motion is quite feasible; second, the rapid development of small off-shore drilling platforms; and third, the new technology in concrete construction which may prove well suited to mid-ocean platforms.

I can show you a film clip of a model platform which makes use of sparbuoys for support and stability. It is one of many designs which have been proposed and will require further engineering study before an optimum design can be determined.

3. NUCLEAR MONITORING RESEARCH OFFICE

3.1 Funding

Fiscal 1969 $37.4M

Fiscal 1970 $38.5M

The funding represents a decrease in the VELA Project (nuclear detection) and an increase in Project PRIME ARGUS (detection countermeasures, problems related to nuclear proliferation, and military geophysics).

$24.5M is for Project PRIME ARGUS, of which $7.0M is for the new military geophysics program. Excluding the military geophysics program, the PRIME ARGUS request this year is $17.5M as compared to an equivalent of $14.5M last year. Of the $3.0M increase in the basic PRIME ARGUS, $500K is to double the R&D on the nuclear proliferation problem; $1M is for PRIME ARGUS participation in the ILLIAC IV computer project; and the remainder is for an increase in diagnostics R&D.

3.2 Rationale for Major Programs

The Nuclear Monitoring Research Office, formerly called the Nuclear Test Detection Office, is mainly concerned with foreign nuclear development and activities. R&D in support of Safeguard (d) of the Limited Test Ban Treaty and assessment of technical problems concerning a comprehensive test ban treaty have been the chief concerns of this program. Emphasis of the program has, of course, changed over the years; for example, mere detection either of an atmospheric explosion or of a seismic event can be considered a solved problem. Positively identifying that a detected seismic event is an explosion remains an important problem.

Following Norwegian Government approval, construction of a large seismic array began in Southern Norway; also construction of a long-period seismic array began in Alaska. These two arrays are tools needed to provide seismic data for research on reducing the seismic identification threshold to and possibly below seismic magnitude 4.0. A new effort was started to improve our ability to locate the seismic explosions, with the objective of reducing location errors for seismic regions to five kilometers. The acoustic detection program will be completed. The ARPA portion of the VELA satellite program is being transferred to the Air Force. The VELA part of this office can, therefore, be expected to decrease steadily in the coming years.

The Limited Test Ban Treaty represented a major turning point in the development and testing of nuclear weapons. The technical problems associated with monitoring the compliance with the Treaty and of detecting large underground nuclear explosions are largely solved. It has been proposed in international disarmament discussions to go one step further and establish a ban on underground nuclear explosions as well. However, unlike atmospheric explosions whose debris makes them extremely difficult to hide, underground nuclear explosions can be at least partly hidden or disguised. The easiest underground explosions to disguise are the smaller, but important, ones which become more and more difficult to distinguish from earthquakes as the magnitude of the explosion decreases.

The detection problem is a complicated one. The magnitude or yield of the explosion cannot be determined directly. The explosion can only be detected through its energy transfer into the surrounding earth. This energy transfer can be reduced by making much larger cavities (which are very much more expensive and conspicuous) or by filling the cavities with some energy absorbing material.

The ARPA PRIME ARGUS Program is designed to work in this critical area of explosion magnitude, decoupling and evasion, detection countermeasures, and possible treaty safeguards.

During FY 1969, PRIME ARGUS work continued. The evasion program continued work on rock mechanics, computer calculations of decoupling of nuclear explosions, initiation of a series of gas explosions at Tatum Dome, Mississippi, and renewed research on yield-magnitude relations for fully tamped nuclear explosions. Of particular significance was developing the concept of enhanced cavity decoupling and starting the Diamond Dust physics experiments, using 10 to 20 ton nuclear explosions. Work this year also showed that permanently frozen, unconsolidated sediments probably coupled somewhat better than NTS dry alluvium but not as well as NTS tuff. As the result of an extensive study, several small projects were started to determine the feasibility of obtaining data on atmospheric explosions from several types of platforms.

In Fiscal 1970, the largest single project in PRIME ARGUS is the Diamond Dust decoupling experiment scheduled for May 1970.

In military geophysics, it has recently been demonstrated that under certain conditions significant earth motions can be produced by injecting fluids into the fault plane between major earth blocks. Depending upon the amount and timing of the fluid injection, the stresses that already exist across the fault region, and other geological conditions in the area, the resulting motion could vary in extent and abruptness. Under some conditions, the motion can be abrupt enough to be called an earthquake. In other conditions, the motion might be smooth enough that it relieves the local stresses and prevents a future earthquake. The technical problem is that, although we think we understand some of the elementary principles involved, we are a long way from being able to handle any practical situation in a controlled and predictable manner. To solve this problem will require controlled experiments and fairly extensive instrumentation. The program we have planned has been carefully compared with the National Earthquake Hazards Program and the goals of the two programs appear mutually compatible. We are interested in a cost effective way of reducing earthquake damage to the billions of dollars of defense installations in seismic areas.

4. OVERSEAS DEFENSE RESEARCH

4.1 Funding

FY 1969 $27.395M

FY 1970 $29.4M

The increase of about $2M is to support increases of effort in the border control and counter-guerrilla strike systems areas.

4.2 Rationale for Major Programs

Experience has demonstrated that much insurgency constituting a threat to international peace is supported from sources external to a country, with a flow of men and materiel across international borders. AGILE work in border control systems to date has improved our understanding of the problem to the point where some successful approaches to the border control problem have been developed. This work has been accompanied by development of improved intrusion detection sensors and sub-systems. In FY 1970, there will be further field tests and continuing development of intrusion detection items.

To minimize inherent problems in overseas work, AGILE uses a rather elaborate system of approvals. No work overseas is undertaken unless fully approved by ISA, State, the U. S. Ambassador, the host government, and the U. S. Overseas Command. No work in new countries (where there has been no AGILE work over the past several years) is started without specific request from the State Department (or, in the case of Korea, at the request of CINCPAC). AGILE has, in any case, restricted its considerations to a minimum number of countries in the known hot spots of the world. AGILE is an instrument of policy, not a maker of policy.

Occasionally, a laboratory engaged in one problem comes up with a solution to another problem. An example of this is the Lincoln Laboratory's Camp Sentinel Radar. It was known from counterinfiltration work and studies of insurgent tactics that a radar which could detect a crawling man, would be extraordinarily useful. A prototype radar to do this was developed at Lincoln based on a new technique they invented, and has been phenomenally successful in consistently detecting infiltrators in Vietnam. The Army, to whom the radar was transferred, is now extending the range and operational capability of the radar and is purchasing more.

A Handbook has been written on the VC Infrastructure which is helping the Vietnamese and American security forces find and neutralize that VC organization, particularly the part which supports terrorists and military operations. The Handbook was one result of years of research; in the process, thousands of interviews in depth were conducted with prisoners and Hoi Chanh. The techniques have now been turned over to operational agencies.

Research is also paying off in ARPA's being able to respond quickly to a call for assistance from our forces in Korea. Based upon experience with border control systems in Vietnam, Thailand, and elsewhere, we were able to provide technical assistance in the design of better systems to counter the

land and sea infiltration of South Korea by North Korea.

One of the ARPA projects for which we have the highest hopes is the Small Independent Action Force (SIAF) program. The idea of this program is to apply the systems engineering methodology used in the design of complex weapons systems to the design of reconnaissance patrols, a new approach to an old problem. In the past, all separate elements of the patrol have been treated by themselves -- weapons, pack, rations, radio, training, etc. The individuals in the patrol often were selected at random and each individual could choose his own complement of equipment. As long as the equipments were simple this approach was adequate. However, there are now many advanced technology items becoming available. The insurgent is also improving his technique and weapons. Thus, there is more and more a need to know how to design patrols to maximize their chances for superior performance before they go out on specific counter-guerrilla missions.

ARPA's role in SIAF is as a catalyst, working closely with the Services to test the feasibility of the systems approach, to help the Services develop that approach, and then to transfer the ARPA expertise to the Services.

5. ADVANCED SENSORS

5.1 Funding

Fiscal 1968 $25.5M

Fiscal 1969 $16.8M (Current Program including carry-over is $27.3M)

Fiscal 1970 $29.5M

The reprogramming action in Fiscal 1969 was to permit the accomplishment of additional Advanced Sensors R&D for the Vietnamese war. This particular kind of work will continue in FY 1970. The additional funds are to exploit development in drone reconnaissance helicopters, laser photography and tethered balloon radar technology.

5.2 Rationale for Major Programs

The Advanced Sensors Program is directed at achieving substantial technical improvements in sensing systems, and unconventional military device technology and to provide a quick reaction capability to Vietnam problems.

The conventional technique for destroying trucks and other comparable military targets in Vietnam is to employ manned forward controller aircraft, high performance strike aircraft and large, relatively inaccurate bombs. It appeared worthwhile to see whether a quite different approach might not be more effective, using relatively small, properly equipped drone helicopters. An existing, remotely controlled drone helicopter (QH-50) was equipped with a real time day-night battlefield reconnaissance capability including armor plate, and self-sealing, extended-range fuel tanks. The equipments were built and demonstrated in Vietnam. Having demonstrated, in combat, real time target reconnaissance, including directing of artillery fire on targets spotted, the next problem was armament. A small drone helicopter can not carry much weight and clearly can't carry a sophisticated weapon guidance system, although the helicopter can carry small guided weapons. We propose to continue the program for another year or so to achieve a successful transfer to the Services.

Several years of research in the Advanced Sensors project have led to a capability of taking, from the ground, laser illuminated photographs of high resolutions. This capability would be particularly useful if it could be done from an aircraft or a ship as well as from a fixed land station. The problems, however, in aiming the extremely narrow beam laser illumination from a moving platform are very difficult. We propose to investigate the practical feasibility of some proposed solutions to the problem.

6. ADVANCED ENGINEERING

6.1 Funding

FY 1969 $3.15M

FY 1970 $13.1M

The $9.9M increase is due to the initiation of programs in small arms and in surface effect vehicles.

6.2 Rationale for Major Programs

The office concentrates on selected tactical warfare problems of a multi-Service nature, particularly in areas involving mechanical, aeronautical, or hydrodynamic engineering.

One of the past efforts of this office resulted in the successful demonstration of a quiet aircraft for tactical reconnaissance and other missions in Vietnam. This demonstration led to the Services' adoption of the quieting techniques for various applications. ARPA is presently applying what has been learned in the quiet fixed wing aircraft program to a quiet helicopter program. Another program developed an individual flight machine (the jet belt) which has significant performance improvements in endurance, range, and fuel economy. A third example is a remote-controlled, head-coupled, television system currently finding application in several DoD development programs.

It became increasingly clear last year that R&D in small arms was inadequate considering the cost and extensive use of small arms, the importance of small arms in engagements with insurgents, and the lives that depend directly upon them. However, it was not so clear what should consitute a sound R&D program. At the request of ODDR&E, ARPA and the Army brought together an expert Small Arms Advisory Committee and tasked it to derive a forward looking national program which would have a good chance of being funded and implemented. The objective of the program is to put the United States in a superior R&D position in small arms within five years. It was recognized early in the Committee's discussions that the majority of the programs should be in the Army but that some of the more radical techniques might better be pursued by ARPA up to the point of feasibility demonstration. After iterations which included discussions with the Army/OCRD and ARPA top management on the funding possibilities, a program was derived which included $2.5M for ARPA and $17.4M for Army in FY 1970. For comparison, the total DoD small arms R&D program in FY 1969 was $9.9M.

Surface effect vehicle technology has several characteristics which make it suspect of containing a Sputnik-like surprise. It concerns technical fields that are being vigorously pursued in most of the foreign advanced countries, much more so than in the United States. It represents a technology which could drastically change our tactics on the sea and over land.

Twelve possible applications were studied. The studies showed that to be effective, the surface effect vehicles would have to have considerably greater range, endurance, and speed than the present generation. The technologies to achieve these results are in novel structures, propulsion, stability, and test facilities. None of these technologies were found to be under development in the U. S. It is ARPA's present intent to carry out as much of the SEV technology program as possible through the Navy, both in order to use efficiently the limited expertise available in this country and to minimize problems of later transfer. We will continue to work closely with the other Services and agencies on the technologies which would affect the applications of interest to them.

7. MATERIALS SCIENCES

7.1 Funding:

Fiscal 1967 $27.3M

Fiscal 1968 $ 3.6M

Fiscal 1969 $16.3M

Fiscal 1970 $17.295M

The pattern of funding for Materials Science is perhaps best explained by reference to the figure. Early funding was in excess of expenditures in order to build up forward funding to universities which had to make major long-term commitments themselves in order to carry out the work. Under funding pressures due to the Vietnam war, and as the university programs matured, the new obligational authorities were sharply reduced and the forward funds progressively used to cover the expenditures. The funding plan shows that new obligational authority will again match expenditures in FY 1972.

The same funding pattern applies, but less conspicuously, in the other Defense Research Sciences in ARPA: Information Processing Techniques and Behavioral Sciences.

7.2 Technical Functions

A comprehensive program is under way to develop new methods of non-destructive testing (methods of examining military hardware during the manufacturing process or in actual use to determine the existence of microscopic flaws which may have severe deleterious effects on performance or lifetime). A sizeable program of research has been undertaken to determine the mechanism causing laser rod failure at high power density levels and how to prevent this from happening; an attempt is being made to gain a better fundamental understanding of diffusion processes for such practical areas of application as high temperature oxidation of metals and the use of materials and oxides at extreme temperatures. Another program is a rather intense examination of the unusual properties of the rare earth alloys and compounds; certain of their characteristics appear to have a high potential for pay-off in DoD-related applications such as electronics and magnetics.

Major scientific resources, the interdisciplinary laboratories, have now been established for accomplishing material science research. The Materials Sciences Office is now concentrating on a further problem, that of reducing materials science to practice by demonstrating novel devices and new techniques. In contrast to the long-term core funding of the interdisciplinary laboratories, the separate programs exploiting the basic science will be relatively shorter term, on the order of three to four years each.

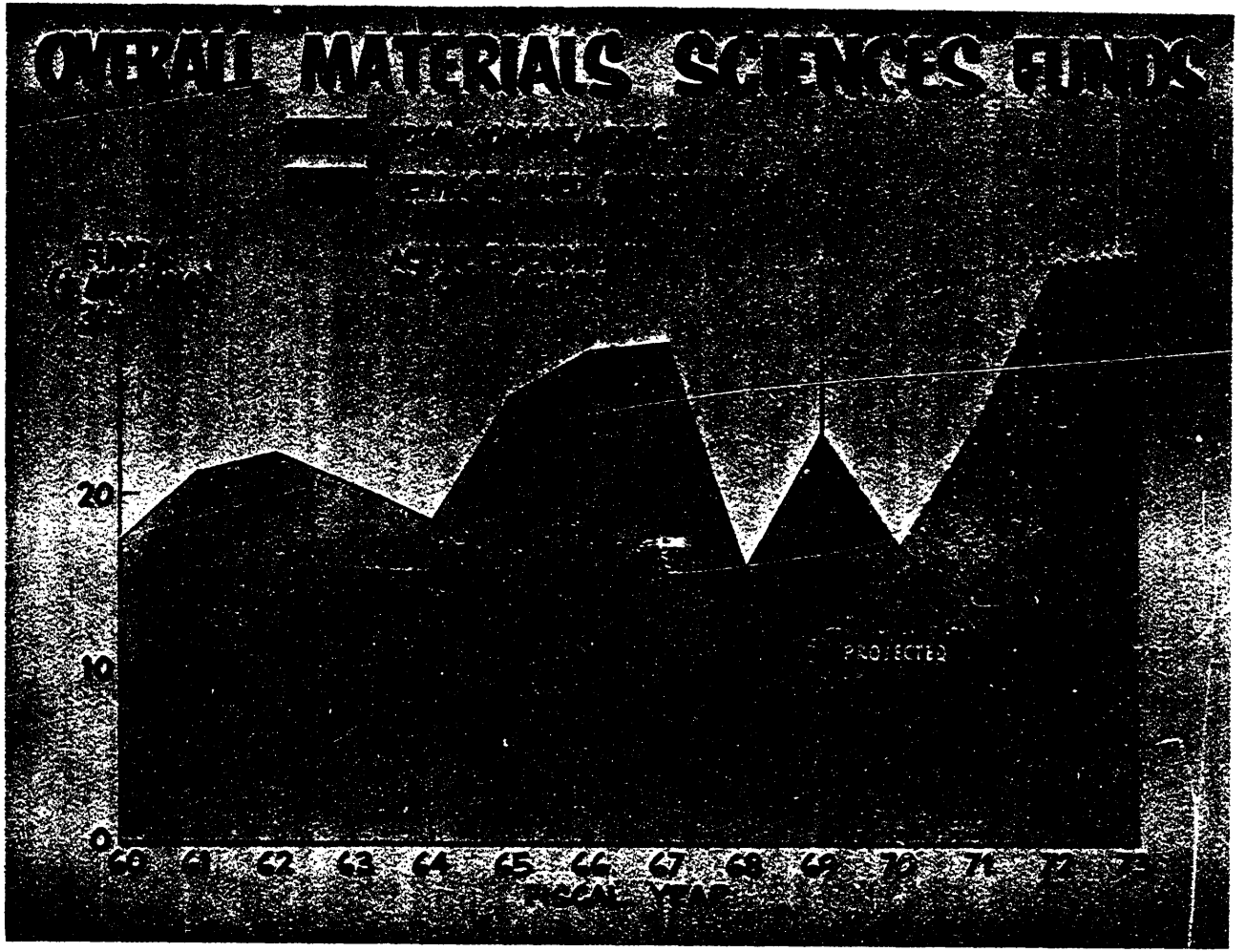
As an example, it should be possible to exploit some scientific observations in solid state electro-chemistry to produce metals of extremely low oxide content. Because oxides, as impurities, are known to

lead to fatigue failure, any process which can markedly reduce the oxide content will have far-reaching consequences. The technique is to place the liquid in a container or pipe of a material which causes the rapid passage of oxygen ions from the liquid through the container to the outside as an electrical potential is applied between the inside and outside surfaces. Appropriate ionically conducting materials already exist.

As another example, observations have been made that acoustic waves travel freely in the surface of various solid state materials. These waves can be controlled much like electrical signals are controlled inside solids. Frequencies in the gigahertz band can be used, leading to the possibility of amplifying, switching, and processing such frequencies in small solid devices, thus providing a possible alternate to conventional and much more bulky microwave technology.

A third example is the possible use of rare earths in alloys for permanent magnets which appear to have a potential of a 50% higher magnetization, and could therefore be used to produce equivalent reductions in size and weight of motors and generators. Such a change would be a major increase in capability compared to the more usual evolutionary development of other magnetic materials. Demonstrations have been made on a laboratory scale, but a practical device has not yet been demonstrated.

One of the most successful on-going research programs has been that of armor research at the Livermore Radiation Laboratory. Using mathematics derived from their hydrodynamic calculations for AEC purposes, LRL has been able to match theory and experiment in armor design in useful and dramatic ways. Such work will help put armor design on a much firmer footing. The results are already showing much improved potential effectiveness per pound of weight for body armor. As with most of the Defense research sciences, there are, of course, considerable civilian as well as military benefits.



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8. INFORMATION PROCESSING TECHNIQUES

8.1 Funding:

Fiscal 1967 $18.6M

Fiscal 1968 $19.693M

Fiscal 1969 $19.649M

Fiscal 1970 $25.95M

The increase for FY 1970 is due to an increase in the funding for the ILLIAC computer and the ARPA computer network that are entering a hardware procurement phase. There is also a funding pattern effect similar to that remarked upon in the Material Sciences part of this testimony.

8.2. Rationale to Major Programs

In the past year, ARPA's Information Processing Techniques Project has completed research on a computer software system for data management; ADEPT (the operating system) and TDMS (a set of user-oriented data management programs) will permit far more rapid and effective computer operations than were possible in the past. The systems are in trial use in the National Military Command Center and the Air Force Command Post. The intensive effort to develop software for the ILLIAC parallel processor has been successful. As a consequence an ILLIAC computer system has been specified oriented toward potential DoD users. The three primary users are the Army Ballistic Missile Defense Agency (ABMDA), the Prime Argus Project, and IPT computer science research. ABMDA is interested in the ILLIAC technique as one option for solving the multiple target problem which may be associated with a mid-to-late 1970's threat. Prime Argus is interested in ILLIAC as a way of approaching a climate modification problem. Computer science research is interested in problems in parallel processing software, cryptoanalysis, simulation of fluid flow, seismic array processing, economics and logistics.

The widespread and increasing use of computers to solve problems has resulted in increasingly severe cost and software development problems. Different users for different reasons buy different computers and are forced to develop different software. When one user wants to take advantage of another's developments, he presently has little recourse except to buy an appropriate machine or to convert all of the original software to his own machine. The ARPA computer network is addressing this question by electrically connecting a set of computers, permitting different users to use each others machines and software whenever the latter's capabilities matched the former's needs. Thus, each user would not need to have the data base, the software, or the machine computing capacity, himself. The network is constructed to make it possible for conversations between computers to take place at an extremely high data rate. If this concept can be demonstrated as feasible, it could make a factor of 10 to 100 difference in effective computer capacity per dollar among the users. The ARPA network will connect universities engaged in computer sciences research, the final DoD application would connect Defense installations. Initial success has been achieved.

The Information Processing Techniques research described above is open and unclassified.

9. BEHAVIORAL SCIENCES

9.1 Funding

Fiscal 1967 $4.8M
Fiscal 1968 $1.1M
Fiscal 1969 $5.2M
Fiscal 1970 $5.36M

The ARPA Behavioral Sciences Project operated prior to Fiscal 1968 at about the $4.5M level annually. The cut in the Fiscal 1968 budget reduced forward funding in university contracts in a manner similar to that discussed in the Materials Sciences part of this testimony. The Fiscal 1970 request is comparable in amount to that of Fiscal 1969 but with a major technical reorientation.

9.2 Rationale for Major Programs

As discussed earlier in this testimony, we are terminating almost all ARPA Behavioral Sciences Research work outside the U.S. ARPA has reoriented its Behavioral Science research work into a direction where there is broad agreement in the research and defense community that more promise exists -- the interdisciplinary combination of the computer and behavioral sciences in specific problem areas. The objective is to produce results to Defense user organizations within 5 years. Initially, we have extended support to three basic programs to be conducted at universitites where unique talent now exists. Simultaneously, we began a management inquiry to determine how to use an applied research organization to apply the results of the basic research to specific and immediate DoD operational problems. As the work progresses, and to the extent that the results of our management analysis warrant, we plan to phase down ARPA sponsorship of university participation in the three programs.

The first university program is the Cambridge Project which seeks to provide tools needed to determine trend and interaction effects in complex DoD systems. System examples include designing hardware for effective human operation, training and educating personnel, organizing manpower, and allocating resources. We have more than enough data, but we lack tools to enable us to extract patterns and draw inferences from them. The work takes advantage of existing ARPA-funded interactive computing capability to MIT and will have wide participation by MIT and Cambridge area scientists.

The second university program, the Center for Computer-Based Behavioral Studies at UCLA, seeks to construct a theory and practice of gaming in order to improve substantially its realism for training and prediction. As a good example, many vital DoD missions require that DoD people know how to bargain and negotiate effectively with counterpart members of other nations; help is needed in the appropriate training of military advisors, defense attaches, and staffs of alliance commands. Faced with analogous problems in labor relations, major schools of business administration and major corporations have turned increasingly to gaming (i.e., simulations) for training and prediction. We know that results in this area can be useful. For example, ARPA has provided assistance to the Paris peace talks in the form of a documented history of previous Southeast Asia

negotiations and the related activities away from the conference table -- some of which were learned years later.

The third university program, Quantitative Political Science, seeks to develop quantitative tools and data bases to improve our ability to predict national security needs. The work is accomplished at the University of Michigan, the University of Hawaii, the University of Southern California and Yale University. The data archive at the University of Michigan will be managed by the Inter-University Consortium for Political Research which currently distributes other types of social science data to faculty and students at 120 member universities. If successful, the tools would help us to distinguish between likely and unlikely future conflict situations. DoD must try to predict future security situations and needs in order to plan for logistics, force structure, strategy and research and development. Faced with analogous needs, government departments responsible for the domestic economy turned more than thirty years ago to the development of quantitative predictive tools and supporting data bases. DoD has made only fragmentary use to date of quantitative political science for conflict forecasting similar to the use made by other agencies of quantitative economics and sociology. However, even these limited efforts have been useful to JCS, DIA, and Service officials.

The basic university work in building the tools will all be unclassified and the results freely available. The later applications of the tools to operational DoD problems will be carried out elsewhere.

10. TECHNICAL STUDIES

10.1 Funding

Fiscal 1968 $6.3M
Fiscal 1969 $9.5M
Fiscal 1970 $7.3M

The increase in FY 1969 was primarily to fund new program planning during the transition from the DEFENDER transfer to new technical directions for ARPA. In 1969, these new program planning funds were primarily used to finance technical and system studies related to surface effect vehicles. This program has been discussed earlier in this testimony under the section for the Advanced Engineering Office. A smaller amount for new direction planning is requested in 1970.

10.2 Technical Functions

ARPA's technical studies budget funds specialized technical, scientific and engineering tasks in support of ODDR&E and ARPA at the Institute for Defense Analysis and RAND at the rate of about $6M per year. Studies elsewhere on strategic factors, national security issues, and Vietnam war problems are undertaken at about a $1M annual level. The remaining funds are for new program planning.

Considering new program planning, I have remarked earlier that it is ARPA's objective to carry programs to a certain stage and then transfer them to an appropriate Service. These transfer programs are then replaced by new research areas where there is an urgent need for investigation. In order to investigate the new research areas adequately enough for a decision to proceed into the areas, we include in Technical Studies funding for "New Program Planning". As we progress in the fiscal year, we determine in which of our project areas these new tasks would best be undertaken.

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