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Mr. SHEPPARD. If an agreement is signed under the premise that we are not in control ourselves and some other person's or country's property is involved, will you supply that for the information of the committee. We would appreciate it.

Mr. RORD. No questions.

Mr. SHEPPARD. Gentlemen, we appreciate your attendance.

TUESDAY, MAY 16, 1961.

MISSILE PROCUREMENT, AIR FORCE

WITNESSES

- LT. GEN. MARK E. BRADLEY, JR., DEPUTY CHIEF OF STAFF, MATERIEL
- MAJ. GEN. BRUCE K. HOLLOWAY, DIRECTOR OF OPERATIONAL REQUIREMENTS, DEPUTY CHIEF OF STAFF, OPERATIONS
- MAJ. GEN. THOMAS P. GEBBITY, COMMANDER, BALLISTIC SYSTEMS DIVISION, AIR FORCE SYSTEMS COMMAND
- MAJ. GEN. ROBERT J. FRIEDMAN, DIRECTOR OF BUDGET, CONTROLLER OF THE AIR FORCE
- LEWIS C. MEYER, CHIEF, RESEARCH, DEVELOPMENT, AND MISSILE DIVISION, DIRECTORATE OF BUDGET, CONTROLLER OF THE AIR FORCE
- COL. JOHN L. MCCOY, BALLISTIC SYSTEMS DIVISION, AIR FORCE COMMAND SYSTEM
- COL. SAMUEL C. PHILLIPS, BALLISTIC SYSTEMS DIVISION, AIR FORCE COMMAND SYSTEM
- COL. JOHN L. ZOECKLER, BALLISTIC SYSTEMS DIVISION, AIR FORCE COMMAND SYSTEM

Object classification

[In thousands of dollars]

	1960 actual	1961 estimate	1962 estimate
<b>AIR FORCE</b>			
<b>Direct obligations:</b>			
22 Transportation of things.....	659	13,400	12,000
31 Equipment.....	2,421,763	2,971,310	2,782,030
22 Lands and structures.....	7,700	30,440	6,970
<b>Total direct obligations.....</b>	<b>2,432,122</b>	<b>3,015,150</b>	<b>2,801,000</b>
<b>Reimbursable obligations:</b>			
31 Equipment.....		164,100	21,400
<b>Total Air Force.....</b>	<b>2,432,122</b>	<b>3,180,250</b>	<b>2,822,400</b>
<b>ALLOCATION TO BUREAU OF PUBLIC ROADS</b>			
22 Lands and structures.....		1,850	
<b>Total obligations.....</b>	<b>2,432,122</b>	<b>3,178,400</b>	<b>2,822,400</b>

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*Program and financing*  
 (In thousands of dollars)

	1960 actual	1961 estimate	1962 estimate
<b>Program by activities:</b>			
<b>Direct obligations:</b>			
1. Missile procurement and production.....	625,795	784,300	1,073,700
2. Ground support equipment.....	645,180	1,007,000	626,100
2. Development, test, and evaluation support.....	1,158,177	1,225,700	801,200
<b>Total direct obligations.....</b>	<b>2,432,152</b>	<b>3,017,000</b>	<b>2,801,000</b>
<b>Reimbursable obligations:</b>			
1. Missile procurement and production.....		84,500	12,700
2. Ground support equipment.....		60,600	5,700
<b>Total reimbursable obligations.....</b>		<b>145,100</b>	<b>18,400</b>
<b>Total obligations.....</b>	<b>2,432,152</b>	<b>3,171,100</b>	<b>2,822,400</b>
<b>Financing:</b>			
Unobligated balance brought forward.....			
Unobligated balance transferred from—			
"Aircraft, missiles, and related procurement (Air Force)" (74 Stat. 347).....	-127,450	-685,400	
"Procurement other than aircraft and missiles (Air Force)" (74 Stat. 347).....		-13,300	
Advances and reimbursements from—			
Military assistance orders.....	-84,200	-115,617	
Non-Federal sources (5 U.S.C. 173d-1).....	-123,255	636,039	605,639
Unobligated balance carried forward.....	2,465,560	2,618,120	2,792,000
<b>New obligational authority.....</b>			
<b>Total new obligational authority.....</b>	<b>2,540,550</b>	<b>2,618,120</b>	<b>2,792,000</b>
Appropriation transferred to "Salaries and expenses, Advanced Research Projects Agency, Department of Defense" (73 Stat. 377).....	-75,000		
<b>Appropriation (adjusted).....</b>	<b>2,465,550</b>	<b>2,618,120</b>	<b>2,792,000</b>

RELIABILITY OF MISSILES

Mr. MAHON. This morning we will resume our Air Force procurement hearing. We have had a very interesting discussion over a period of a number of hours with you on the airplane program.

Now we will consider the missile program.

A few years ago we understood, or we were led to believe the missile was the weapon of the future and that the long-range ballistic missile was almost invulnerable. Now we hear more and more that these missiles may not be reliable and we may have been oversold. Some are evidently not sure they are going to work as hoped. They say that, after all, none have been tested.

I realize after all this relates to the arguments that we must continue to have bombers, and I think we must agree we will have to have bombers in our inventory for a long time. We do need to know as much as we can about the reliability of our missiles.

I personally believe they are reliable within reasonable bounds and will become increasingly more reliable.

What do you think about that, General Bradley?

General BRADLEY. I concur with you. I am sure they will.

I would say with regard to the statement they are reliable today—they are not nearly as reliable as they must be, but they certainly will be in the future. I would say in my opinion their lack of flexibility will be more of a degrading factor than their reliability as time goes on and they become more developed.

Mr. MAHON. There is no doubt about it, a mixture of weapons gives you increased flexibility and greater security. That is certainly the prevailing view in the Pentagon and the Congress.

Mr. Sikes of Florida will be acting chairman today and tomorrow. I am very grateful to him for that. I have some other important matters to which I must give part of my time. However, I expect to be in hearing most of the time.

General Bradley will you proceed?

GENERAL STATEMENT OF DEPUTY CHIEF OF STAFF, MATERIEL

General BRADLEY. Mr. Chairman, the next appropriation to be covered is the "Missile procurement" appropriation. In this appropriation, funds are provided for procurement of ballistic missiles and other guided missiles required for the Air Force inventory of weapons. Included in the other guided missiles category are air-launched guided missiles and decoys; surface-to-surface and surface-to-air guided missiles; and drones used in combat crew training.

This presentation will be given in two parts. The first part will cover ballistic missiles. Major General Gerrity, Commander, Ballistic Systems Division, Air Force Systems Command, will present the details of the current fiscal year 1961 as well as the proposed fiscal year 1962 ballistic missile program. He will be supported by Brigadier General Welling, U.S. Army Engineers, Deputy for Site Activation. Major General Holloway will then present the second part which will cover the details of the other than ballistic missile category.

Our missile program amounts to \$2,792 million for fiscal year 1962. This is approximately \$736 million less than our fiscal year 1961 request. Much of the decline is attributed to the phaseout in fiscal year 1961 of the THOR and JUPITER from our production program. On the other hand, funding level for the TITAN is above the level of fiscal year 1961 as the delivery of missiles increases. Funds for the MINUTEMAN will be sharply increased from the fiscal year 1961 program as this missile moves into the production phase.

For missiles other than ballistic, the dollars programed in fiscal year 1962 are also slightly lower than those of the current fiscal year 1961 program. The decline in fiscal year 1962 has resulted from the buy-out of the GAM-77 in fiscal year 1962 with less than a full year's production—and completion in fiscal year 1961 of the IM-99 BOMARC, TM-76 MACE, and the GAM-72 QUAIL programs. We will continue to procure the GAM-83 BULLPUP air-launched missile and its training version.

Next is the planned procurement of Q-2C target drones which are used principally for training of our combat crews.

The direct support request provides the same type of support for missiles as previously explained for aircraft—that is, spares and spare parts for operational missiles, common ground support equipment for inservice missiles, modification, component improvement, and industrial facilities activities.

In summary, the estimated total program cost in the "Missile" appropriation is \$2.792 billion.

I would now like to present General Gerrity who will discuss the ballistic missile program.

Mr. SIKES. Very well, General Gerrity, you may proceed.

1961	1962
784,200	1,073,700
907,000	926,100
225,700	801,200
1,017,000	2,801,000
84,500	12,700
69,500	8,700
184,100	21,400
171,100	2,822,400
-378,302	-634,039
-683,400	
-13,300	
-115,017	
634,039	603,439
1,615,120	2,792,000
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GENERAL STATEMENT OF COMMANDER, BALLISTIC SYSTEMS DIVISION,  
AIR FORCE SYSTEMS COMMAND

General GERRITY. Mr. Chairman and members of the committee, it is a pleasure to meet with you today to discuss the Air Force ballistic missile programs, ATLAS, TITAN, and MINUTEMAN.

As the responsible field manager for these important endeavors—development through turnover to the Strategic Air Command—I will present to you a complete fiscal year 1962 budget package covering the funds required for the missile procurement appropriation and noting that required for research, development, test, evaluation, procurement, and construction areas.

Before beginning, however, I would like to comment briefly on our revised management structure administering these programs. As you are undoubtedly aware, the former Air Research and Development Command and certain elements of the Air Material Command were merged last month. The resultant Air Force System Command embraces within its organizational structure all of those functional activities and resources involved in acquiring a new weapon system. Accordingly, as commander of the Ballistic Systems Division, one of four functional divisions of the new command, I have control and authority over field direction of the ATLAS, TITAN, and MINUTEMAN programs. Also, by interservice agreement, the Army Corps of Engineers, CEBMCO (Corps of Engineers Ballistic Missile Construction Organization), is under my operational control. This organization is under the direct supervision of my deputy for site activation, General Welling. General Welling, a Corps of Engineers officer, has both Army and Air Force personnel under his supervision.

This new organizational arrangement enhances our management ability in that it provides clear control and authority over all aspects of the programs.

Since presented to your committee last year, there have been two changes in the force objectives of our programs. Both of these changes were reported by the President in his March 28 message to Congress.

The changes involve deletion of the previously planned last two TITAN squadrons and deferral of the mobile MINUTEMAN system in favor of adding three more MINUTEMAN squadrons (50 missiles each) in sheltered sites underground. Additionally, as reported in the President's message, we propose to augment the MINUTEMAN production capability to provide the potential for rapid inventory increases later if such is determined to be desired.

Our programs have matured appreciably in the past year. Some major highlights were:

Additional free world IRBM and ICBM forces were fielded, ahead of the schedules originally established 5 years ago, and very close to the schedules as accelerated in early 1958. They constitute a noteworthy contribution to our deterrent posture. To date, in addition to Vandenberg AFB, ATLAS missiles and launchers have been delivered to operational status at Warren and Offutt Air Force Bases, completing deployment of the early D series ATLAS. This missile is far superior in performance than was specified or originally anticipated as feasible.

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Success of the completed ATLAS D series flight test program provided full confidence in its capability. Among the significant accomplishments were flights at ranges up to 7,860 nautical miles, and achievement of accuracies better than five times the original design specifications.

Highly successful flight tests of operational prototype missiles demonstrated that TITAN will meet its range and accuracy specifications.

Development work on TITAN II, the storable-fuel, advanced version, progressed satisfactorily, and initial tests of the engines have been encouraging.

All major technical challenges in the MINUTEMAN program were overcome, culminating in the first test launch from the Atlantic Missile Range, a flight which was spectacularly successful. This initial test, unique in ballistic missiles development history, embodied successful operation of a complete missile and all its subsystems other than the warhead.

Data indicated that the reentry vehicle impacted very close to the aiming point, and gives us great confidence that the operational accuracy will be well within specifications.

A box score of missile launches conducted during the period, which I will show later in my briefing, reflects an impressive record of success which speaks for itself.

Our military ballistic missiles have laid a firm base for national space activities. Of the U.S. satellite programs to date, 46,139 of the total 47,367 pounds of payload weight placed in orbit were launched by either THOR or ATLAS boosters.

Firm and effective working relationships were maintained with all other military and civilian agencies concerned with missiles and space research and development.

In the briefing which follows, I will give you a report on each of our programs and will describe in somewhat greater detail what has been accomplished to date, our present status, our schedules for completion of the program, and what lies ahead for the new fiscal year and is the basis for the funds we are requesting.

My presentation will also depict a rapid evolution toward greater effectiveness of missile and operational deployment configurations, from the initial ATLAS to the hardened and hardened MINUTEMAN. The result represents a truly significant increase in survivability and weapon system cost effectiveness.

Before I go into this presentation, I would like with your permission to introduce the members of the ballistic system team.

I would like to introduce Brig. Gen. Albert C. Welling, Col. John W. O'Neill, Col. John L. McCoy, Col. John L. Zoeckler, and Col. Samuel C. Phillips, of the Ballistic Systems Division, Air Force Systems Command.

With your permission, I will go into the briefing.

(First chart.)

Mr. Chairman, this first chart depicts the squadron buildup of the ATLAS, TITAN, and MINUTEMAN, including the missile buildup.

These are the squadrons coming in by quarters of each fiscal year [indicating]. (There is a total of 13 ATLAS squadrons, 12

(Next chart.) TITAN and 12 MINUTEMAN through the middle of calendar year 1964, or the end of fiscal year 1964, for a total of 846 missiles

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This chart depicts the location of our operational bases throughout the country. You will note here this is the ATLAS missile, the TITAN missile in this color code, and the MINUTEMAN in this color code [indicating]. There are some 21 bases involved, and of course we have given great attention to avoid populated areas, and to using existing bases in establishing the support bases for operational sites.

(Next chart.)

This chart just briefly indicates the national scale of the program involved in ballistic missiles. We have contractors throughout the country supporting this program. There are some 25 prime and associate contractors, 400 subcontractors, and many thousands of vendors, and some 48 military installations.

(Next chart.)

Here for ATLAS, TITAN, and MINUTEMAN, we have listed the principal contractors involved in propulsion, structure, re-entry, airborne guidance, ground tracking, and so forth. We have shown some of the architect engineer firms and some of the construction firms involved in building the bases.

(Next chart.)

This chart shows the number of personnel involved in supporting this program industrially, including all the prime and associate contractors, which amounts to 107,000 people. If we included all the subcontractors and vendor support, we estimate approximately 400,000 personnel are involved in the industrial support of this program.

(Next chart.)

This chart depicts the facilities investment in the ballistic missile program. You will note there is over \$2 billion invested through 1961. The greater proportion of this is involved in operational facilities.

You will note also there is over \$550 million invested in industrial facilities and that the contractors themselves have invested \$216 million, or about two-fifths of that cost.

It is also interesting to note here that considering the military test facilities and the industrial facilities; this program is not only contributing importantly to the ballistic missile effort, but also has provided us an important base for our space programs.

(Next chart.)

This is a rather busy chart, Mr. Chairman. It shows the base activation schedules for the ballistic missile program. Let me key it for you just briefly.

This line indicates the design for construction of the individual bases. The red line indicates the construction program effort and the blue line the installation and checkout.

Mr. SIXES. Your chart is not too clear from this distance.

Will you point out what years are involved, and whether calendar or fiscal year?

General GERRITY. Calendar years 1958, 1959, 1960, 1961, 1962 and 1963.

As I indicated, the blue line indicates the installation and checkout period, and the black arrow indicates the squadron turnover date to the Strategic Air Command.

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This chart indicates the amount of effort involved in the site activation program. You will note that we are at this point in time (indicating), and that the major program is ahead of us. Toward the end of 1961 we will be delivering launchers at the rate of approximately 10 WEEK. Toward the end of 1962, we will be doing this at the rate of approximately 1 A DAY. By 1963, we will be delivering launchers as we get into MINUTEMAN activation at a rate of 2 PER DAY.

The principal activity in the field in 1961 is in ATLAS, in 1962 in TITAN, and in 1963 in MINUTEMAN.

(Next chart.)

This chart depicts our new organization.

As you were told earlier in my statement, the entire acquisition responsibility now rests with the new command, the Air Force Systems Command, and this chart shows the Ballistic Systems Division and the normal command and administrative channels to the Secretary of the Air Force.

(Next chart.)

Now, in this reorganization we have retained the special channels that have always existed in the ballistic systems program. For example, the program director of our programs, such as the MINUTEMAN, has access directly to the Secretary of the Air Force through the Designated Systems Management Group, which was formerly called the Ballistic Missiles Committee. He informs intermediate commanders, but on this important program, and other important ballistic missile programs, he has the ability to go directly to the top level of the Air Force when required to get program decisions.

(Next chart.)

Now, to indicate we coordinate thoroughly in the Air Force and let the other major commands, who have great interest in these programs from an operational and support point of view, know what is going on and give them an opportunity to put their recommendations in program decisions, we have people from SAC, TAC, Air Defense Command, the Logistics Command, and the Air Training Command working right with the program director in Inglewood, Calif. These people put their command inputs into the program buildup and they also keep their commands informed of what is going on so that at the Joint Air Staff Review the Command recommendations of these other operating and support commands can be integrated into the program.

We also have resident representatives of the Army, Navy, and NASA at the Ballistic Systems Division to coordinate with those other agencies.

We feel a great weight of responsibility in insuring we are supporting these people and we work very closely with their people to insure that support.

(Next chart.)

This is a brief organization chart of the Ballistic System Division. There are two points I want to highlight.

The Deputy for Site Activation, General Welling, has the responsibility for all site activation activities in the field. We also have elevated to a top level the important NIKE-ZEUS target office.

We have a responsibility in the Ballistic Systems Division to provide the targets for the NIKE-ZEUS development program. We are giving this the top priority attention it deserves.

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(Next chart.)

Now we come to the ATLAS program. I would like to briefly review that.

(Next chart.)

This chart I will not go into in detail. The top line shows the squadron operational dates. The next important line shows the more significant development milestones, but the main point I want to show you is the buildup of missiles for the program to a total of 421 of these missiles are for space programs. Of course, there will be others to follow. 213 are for operational programs. The other point to note on this chart is our production rate builds up to 14 per month, which occurs toward the end of calendar year 1961.

Mr. SIKES. What does "special" include other than space?

General GERRITY. These are space boosters.

General BRADLEY. And NIKE-ZEUS shots.

General GERRITY. It would include NIKE-ZEUS too.

(Next chart.)

Mr. LIPSCOMB. How many launching pads would the last chart indicate?

General GERRITY. I believe the figure is 132 launchers. The additional missiles over the 132 are for spares and for combat training launches.

Mr. SIKES. Proceed.

General GERRITY. This chart depicts the rapid evolution of the ATLAS configuration. The first squadron is a 3 by 2, radio inertial guidance, and 2 additional squadrons with 3 by 3, radio guidance, but the primary force, 3 squadrons, coffin configuration, 25 hardened, and 6 squadrons of the silo configuration.

(Next chart.)

These are the highlights of development milestones for 1961. You may recall last year we successfully completed development testing on the ATLAS missile, that is, the D series, and we also completed the first inertial guidance flight which was a first in the intercontinental ballistic missile program.

We also flew a 9,000-mile flight with one missile.

The highlight this year is that we completed certification of the E series missile in development, and we had another successful flight on the E just last Friday.

Other things to note are that the operational system test facility at Vandenberg for the ATLAS E is completed in May of this year, and the operational test facility at Vandenberg for the F missile is completed in October.

We also will launch 258 R. & D. missiles, and 26 space boosters in calendar year 1961.

(Next chart.)

In the operational milestones, last year, you will recall, we turned over the first operational squadron at Warren in August. We turned over the 2 remaining D squadrons in March AT WARREN - OFFENT

We also plan to turn over this year the 3 E series squadrons AT FAIRCHILD

We will complete this calendar year all of the construction for the 3 F silo squadrons. IN AUGUST

(Next chart.)

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This is a bulls-eye chart to show the results of the missiles that were fired into the splash net downrange near Ascension Island.

Mr. WEAVER. How many flights does that include?

General GERRITY. There are 15 flights here, and the CEP on these flights is less than 1 mile. We are very happy and confident of the operational capability of this missile system as a result of these test flights.

(Next chart.)

Next is the TITAN program.

(Next chart.)

Similar charts will show again the operational squadrons, the TITAN I and TITAN II and some of the important development milestones, the buildup of the missiles in production, a total of 287 missiles that have evolved, 188 of which will be operational.

The production rate this year reaches its peak of 8 PER MONTH

(Next chart.)

This chart shows some of the operational characteristics of the TITAN I and TITAN II missiles. You note here that in every important characteristic, with the exception of CEP the TITAN II is substantially better than TITAN I. 350 p.s.i. hardness, exposure time reduced from 10 to 1 1/2 MINUTES, the reaction time down to 1 MINUTE, additional flexibility in range and payload, it can carry a 9 MT warhead as opposed to 5 MT for TITAN I.

(Next chart.)

This is just a brief description of the facilities as established for TITAN I and TITAN II. Of course, you will recall TITAN I is a radio-guided system. It is in a 3 by 3 complex, three missile silos per each control center.

ON A ONE LAUNCHER BASIS FOR CONTROL

The TITAN II is a greatly simplified system since it has storable fuels on board, and it is fully dispersed. Through this we have reduced vulnerability, because in this case we have one launcher per missile target and in the other case we have three launchers per target.

(Next chart.)

The highlight of TITAN development milestones in 1961, are indicated here. Last year, of course, we had a successful operational test of the missile and it flew its first full range test. This year we intend to complete all our flight test objectives in the program for TITAN I. We also plan to have the first squadron operational in AUGUST of 1961 here at Lowry Air Force Base. We will launch 14 missiles from the Atlantic Missile Range and from the Pacific Missile Range in the development program.

In the case of TITAN II, one of the noteworthy milestones was accomplished on May 3 when we fired the first missile out of the silo at Vandenberg.

Colonel McCoy, the TITAN program director, has a very short film I believe you will be interested in seeing later. WE ALSO PLAN TO LAUNCH

(Next chart.) THE FIRST NON CRYOGENIC MISSILE IN NOVEMBER OF THIS YEAR.

The results here, out of 7 missiles fired into the splash net on the Atlantic Missile Range again are very encouraging. We have a CEP of less than 1/2 mile as a result of these tests.

(Next chart.)

This shows the MINUTEMAN program.

(Next chart.)

The first flight of 10 missiles will come in in October of 1962. The first squadron to be completed in February of 1963. Twelve squadrons of 600 missiles to be completed by the end of fiscal year 1964.

As you know, our objective here was to secure on the basis of experience a greatly advanced missile which would be far more efficient than our earlier missiles, the range to be intercontinental, the warhead CEP to be within 1 mile, to be hardened and dispersed and have flexibility for each launch control center to launch a number of missiles, and to have maximum life and maximum reliability.

(Next chart.)

The development program consists of some <sup>10</sup> <sup>60</sup> missiles to be fired from the Atlantic Missile Range and from the Pacific Missile Range.

(Next chart.)

This chart depicts the operational buildup of our hardened squadrons.

At this point, we will be at a rate of production which achieves the goals approved by the Secretary of Defense which is double the earlier

(Next chart.) <sup>approved rate</sup>

This is a picture to depict the relative simplicity of the MINUTEMAN missile in its dispersed and hardened site. Here is the launch tube with the MINUTEMAN missile installed [indicating].

Here is a small generator plant for standby use during peacetime, and a small pad here for removal and installation of missile.

(Next chart.)

This is a launch control center for each 10 missiles. There are only 2 people operating this center.

Aboveground here we have some facilities for maintenance people and for security guards.

(Next chart.)

In 1960, you may recall for MINUTEMAN we completed our silo testing plan at Edwards. It was so successful we completed it with eight firings instead of 18 originally planned.

This was the primary highlight of the 1960 program.

(Next chart.)

In 1961, as you recall from my earlier statement, we had our first successful firing from the Atlantic Missile Range on February 1.

In 1961, we plan to have the first launching—as you will note, we call it a tube—from the Atlantic Missile Range. The reason we call this a tube in the case of the MINUTEMAN is that the hole is much smaller and less complex than the TITAN and ATLAS silos. Hence, we have designated it a "tube" because of its smallness.

(Next chart.)

These are the highlights of the first MINUTEMAN flight of February 1 from the Atlantic Missile Range. It was a complete missile with all subsystems functioning. All test objectives were 100 percent achieved. All systems and subsystems performed normally. The range was 1000 MILES OF 2.3 MILES LONG AND .4 MILES LEFT

This impact here gives us confidence we will achieve our operational goal.

(Next chart.)

In summary, these are the overall results we have had from our flight tests of our total missile effort, ATLAS, TITAN, MINUTEMAN, and THOR.

There have been a total of 231 <sup>159</sup> fired; 34 partially successful; 1 unsuccessful.

Here is a breakout of the R. & D. category and the space booster category.

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11 This is so far a 70 percent complete success, or, if you include the partial success, the batting average here is about 84 percent. In the space booster area, our percent of completely successful runs about 80 percent so far.

Mr. WEAVER. In the unsuccessful launches, was the problem determined?

General GERRITT. Yes, sir.

In each case where we have a failure of a missile in flight, or on the stand, we go through a very thorough investigation to pinpoint the cause of failure. This gives us a basis for improving our reliability for future missiles.

Mr. SIKES. Can you say as a result of the study of unsuccessful tests you have definitely been able to avoid subsequent unsuccessful tests from the same cause?

General GERRITT. That is true; yes, sir.

Mr. ANDREWS. Where would your 8 unsuccessful shots fall with reference to the total of 61 for space? Would it be in the first half, or second half, or the first 25 percent?

General GERRITT. I would have to supply that information to you a little later. They do occur over the complete time period of this effort.

As to what the weight was in the first and second half, I could not tell you exactly, but we can furnish the information.

(The information to be supplied follows:)

SPACE LAUNCHES

The 61 launches in support of space objectives occurred over the period August 1958 through April 1961. Of the eight that were unsuccessful due to booster malfunctions, one occurred in the first third of the program, three in the second third of the program, and four in the last third of the program.

Mr. FORD. This reliability figure seems to be substantially better than what witnesses in the past have indicated they expected. I can recall General Irvine several years ago indicating that 50 percent, or somewhere near, would be a figure he anticipated. Others have confirmed his forecasts.

This figure of 70 percent completely successful and 84 percent if you include completely and partially successful, is far above any previous forecast.

Now, does that mean if General Irvine was here, or would General Bradley now upgrade that figure?

General BRADLEY. No, sir. These are test launches. I would still say General Irvine's figures for the ones out on the pad, 50 percent is about right.

Mr. FORD. These are unusual circumstances?

General BRADLEY. These are test launches of development programs, and under careful circumstances. Very few configurations are exactly the same. We have been fortunate and it is a good result, but we do not feel quite this good about the ones we are putting on the pads. We hope to have them higher than that, but right now I would say 50 percent is not an overstatement.

Mr. FORD. That initial forecast more or less still stands?

General BRADLEY. Yes. I do not think he was referring to the test programs.

*ice. 702 complete success for R & D shots (see bottom of page 524) - 1*

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Mr. WEAVER. Why should that disparity exist?  
It seems to me as you get these on the pads, you are building on what you have learned in the past, and I would think you would get better.

General BRADLEY. We have a combination of pad design, test equipment, production equipment, and the operating personnel of Strategic Air Command all to be put together with a missile. The test firings were with people born with it and who grew up with it. That is another reason.

Mr. FORD. How would these figures compare with your aircraft reliability?

General BRADLEY. It is very difficult to compare them.

In an airplane, when we have these troubles, we fly it out and have a bunch of people aboard to fix them. With these, we have to analyze them. We do not shoot airplanes this way. It would be very difficult to compare, Mr. Ford.

Mr. FORD. A plane is more reliable than a missile then?

General BRADLEY. At the present time it is more reliable.

Mr. SIKES. If an airplane does not function properly, the chances are you can fly it back? Is that the difference?

General BRADLEY. Yes.

General GERRITY. We are continually correcting areas we find in the missile that are giving us difficulty to improve this reliability curve as we go along. We have a very active program in this, and a very deliberate one. Since Mr. Mahon mentioned the committee's interest in this program at the outset of these hearings this morning, we have a special presentation which we can put on later in the day to describe this program to you more thoroughly.

Mr. SIKES. How long will that require?

General GERRITY. I would say it would require about 15 minutes.

Mr. SIKES. I think we should have it. When do you want to show it?

General GERRITY. We can show it any time you desire.

Mr. SIKES. Why do we not have it at the conclusion of this discussion?

Are you going to show us a film?

General GERRITY. At your discretion, sir, whatever time you would choose. I think it will take a little time to set up the movie projector.

Mr. SIKES. After you have completed what you are doing now, go ahead with either of the one you can get into most readily and follow with the other.

General GERRITY. All right.

(Next chart.)

We summarize the funds required for fiscal year 1962. The procurement appropriation for the individual weapons, \$201.6 million for ATLAS, \$1 billion; \$129.8 million for TITAN, and \$923.8 million for MINUTEMAN, and that comes out to a total of \$2.255 billion.

These are the dollars required in construction, and R.D.T. & E. This is the appropriation we are presenting to the committee this morning [indicating.]

Mr. FORD. Is this the amended budget, or something different?

General GERRITY. This is the amended budget, sir, as presented by the President in his March 28 budget message.

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Mr. Ford. Does this conclude the funding for ATLAS?  
General GERRITY. There will be some followon funding for support in the ATLAS program in fiscal year 1963.

Likewise, there will be substantially more in the TITAN program. With the chairman's permission, I could go right into this reliability presentation.

Mr. SIKES. Very well, that will be good.

General GERRITY. I would like to say at the outset, at the beginning of the ballistic missile program, we recognized these unmanned weapons would require a much higher order of reliability than manned weapons. Therefore, we set out with a deliberate plan to achieve that reliability by calculating from the very basic components on up, the degree of reliability required to achieve our objective, which is a 90 percent reliability for the missile system. [First chart.]

This is generally how we have gone about it. Our objective for the weapon system itself is 90 percent reliability. To obtain this, of course, for the individual—

Mr. SIKES. Why did you select 90 percent?

General GERRITY. This was a figure that was decided upon on a cost effectiveness basis, considering many elements.

Mr. SIKES. In other words, did you consider that you could achieve 90 without excessive costs? That you probably could not achieve 100 percent at any cost?

General GERRITY. That is correct. 90 percent appeared to be about the point which would give us the reliability we needed to insure we had effectiveness and deterrence, and above that the cost would be too great. However, as you go down—

Mr. SIKES. If you had dropped to 80 percent, would the saving have been sufficient to justify not going beyond 80 percent?

General GERRITY. No, sir; it would not have been substantial.

You will note to achieve this 90 percent reliability, the subsystems have to have a higher order of reliability.

For example, the airframe, 99.4 percent; the control, 98.8 the propulsion, 97.4.

Nose cone as shown here, and so on down the line.

As we go down through a subsystem, in the guidance system, each major component had to have a reliability factor established.

For example, the power supply had to be 99.8 percent reliable.

As we went down below the major components of the system to the individual items installed, such as electrolytic capacitors, we had to achieve a reliability of 99.97. This is the deliberate approach we used to achieve the reliability of the end weapon system of 90 percent.

Mr. SIKES. Before you leave that chart, Mr. Shepard just posed an interesting question.

You are seeking a weapon system that is 90 percent perfect. Where do you lose the 40 percent so that you anticipate only a 50 percent perfect shot off the pads?

General GERRITY. Mr. Chairman, I believe I will come to that later, if I may defer the question at this time. [Next chart.]

Here again is the approach we use in testing. When we have the individual component tests, we make literally millions of tests at this level to achieve reliability on such things as capacitors and resistors.

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We have many tests at the subassembly level and the subsystem level, and in the captive test of the missile on the stand.

Now, this is the part we normally see at the top of this triangle [indicating]. This is the part of the iceberg that shows, when you get to the flight test itself. All this testing that goes on beneath it is done in literally the back room where people do not see it.

There is a great effort in this area [indicating] to achieve the results we have up here [indicating]. [Next chart.]

Now, this chart I believe gets to the chairman's question, or Mr. Sheppard's question.

As we develop our reliability program, we start with an individual component, and we test it to achieve a higher reliability. Then we combine that component with other components to form a subsystem.

Mr. SHEPPARD. You just stated you have a higher reliability than the requirement. What percentage do you use as a matter of safety?

General GERRITY. I may have misstated that, Mr. Sheppard. I did not intend to say we overrequired. We require a degree of reliability for each component which is very high because when you combine that component with a number of other components, the overall reliability drops as a result of multiplying the reliability of each one of the components you put together. You get a lower reliability when combined, and that is the reason you get this drop here.

Then you work on the overall subsystem after you put these components together, and you gradually achieve the degree of reliability that you desire out of that subsystem so that you get the end desired reliability in the total system.

Then as you go into the captive missile test, you have a further drop in reliability because you are now operating in a somewhat different environment. You have the combination of all the subsystems going into the total missile, so we work on this area then [indicating] in our reliability program until we achieve the reliability desired.

Then again, because we are going into another environment of the actual flight test, we do encounter some dropoff in reliability. We continue through our development testing to refine this program until we achieve the degree of reliability required.

Then, as General Bradley pointed out, you get the operational phase where you combine the missile and the ground system with the SAC personnel out in the operational environment, and you again have a drop in reliability.

Again, working with SAC, we hope, as they gain experience, to achieve a greater degree of reliability through refinements in operational procedures, and improvements in the missile and ground equipment itself.

Mr. SIKES. That is a very good chart. It is very illustrative.

General GERRITY. You could use this chart on missile reliability, or any other weapon system reliability. It is a generalized chart.

Mr. FORD. How much variation has there been in that chart from what you forecast, or what you anticipated?

General GERRITY. We believe we are pretty close to exactly what we anticipated. We figure the growth in reliability will start at about 50 percent and we will finally achieve, when we have the weapon systems shaken down and proven, something approaching 90 percent.

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Mr. Ford. How does that tie in with what I recall General Irvine said, and what I believe General Bradley said here a few minutes earlier, 50 percent?

General BRADLEY. No, sir. I think we will make 70 percent.

I was talking about the present time, the present ATLAS's in the field, we are at better than 50 percent right now on the THOR's in the field.

Mr. Ford. The 50 percent is what you thought would be the case today, it is not what you are anticipating 3 years from now?

General GERRITY. I am not at all sure we anticipated 50 percent today, but I think that is about what we would say we have.

Mr. SIKES. Is there a standard which you require, percentagewise, at each of these stages?

For instance, do you require 90 percent perfection in components, or 100 percent? Do you require 90 percent perfection in missile captive tests, or 100 percent?

Is there a percentage level in these various stages that you require?

General GERRITY. We have an objective, but it is not a firm objective. As long as the reliability is roughly 70 percent or above, we will go ahead with the program while we are working out the detail problem areas.

Mr. SIKES. The missile flight is 70 percent adequate for that stage?

General GERRITY. At the outset it is.

Mr. SIKES. When you come to the stage that is operational, what percentage of perfection do you expect in missile flight tests?

General GERRITY. I should say we should be approaching 97 percent in missile flight tests.

Mr. WEAVER. On this chart where you are showing reliability growth, if you figure 50 percent you are figuring about ONE-HALF will do the job. Is that right?

General GERRITY. That is correct.

Mr. WEAVER. Nowhere in this chart have you taken into consideration reliability as far as the CEP is concerned. Would that not reduce it somewhat?

General GERRITY. No, sir. That is figured in. The reliability that we are talking about computes in the reliability from the standpoint of: Will the missile get off the ground combined with, Will the missile complete its flight successfully and land on target? That is the reliability we speak of.

Mr. WEAVER. I should think that would be very important.

General GERRITY. That is a very important part of the reliability.

Mr. ANDREWS. General, your ultimate objective is to have 90 percent of the missiles on pad reliable; is that correct?

General BRADLEY. Yes, sir. I believe he showed the objective is 90 percent, and I believe we may get a little better than this.

Mr. ANDREWS. When do you expect to reach that objective in your presently planned schedule of production?

General BRADLEY. This will vary as we go along because we have series after series coming in. We do not have a specific date. Let us ask the ATLAS project officer when he thinks he will have it 90 percent.

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General GERRITY. Colonel Zoeckler.

Colonel ZOECKLER. Sir, our current contract for the ATLAS "F" missile, the third version of the ATLAS which goes into the field, has a reliability goal in it calling for ~~85~~ percent in that particular missile. The objective for the program, as General Gerrity properly stated, is 90 percent, but because of the status of the ATLAS program—it begins from the original ATLAS "D"—it is unlikely, without expending substantially greater proportions of funds to the point of diminishing returns, that the ATLAS itself will obtain the 90 percent reliability which is desired in the program. There is no doubt in my mind, however, that Col. Sam Phillips, behind me here, will be able to obtain this through the experience that we have gained in the ATLAS, and the THOR, and the TITAN.

Mr. FORD. Does that mean when we have ~~13~~ ATLAS squadrons fully operational we will not reach 90 percent?

Colonel ZOECKLER. Sir, it is very unlikely at the time the missiles are installed in the field, at the first installation of each of these missiles, that we will attain 90 percent reliability. I am sure you recognize, however, that there are programs within the Air Force to constantly update the reliability and performance of each of its weapons systems. By virtue of these programs we are able to attain reliability figures over a span of years which improve rather than degrade the actual performance of each of our systems, and it will include the ballistic missile programs. Eventually we will probably attain some sort of reliability factor beyond the ~~85~~ percent figure which I have quoted for the contract goal for our installation.

Mr. FORD. But you will have ~~13~~ ATLAS squadrons.

Colonel ZOECKLER. Yes, sir.

Mr. FORD. I gather from what you are saying only the last several squadrons will achieve the maximum reliability you are talking about.

Colonel ZOECKLER. Will initially attain that reliability. Through the modification programs which may be required or desirable, we can improve that. Here again, I am sure you agree that we must evaluate the value of these missiles against that same amount of money expended for some other type of equipment.

Mr. SIXES. Suppose you put a missile on the pad and it is part of an ~~85~~ percent reliable system, do you mean that particular missile on that particular pad is going to have further improvements which will help to increase the reliability of the whole system after it is installed?

Colonel ZOECKLER. It is very likely, sir, that should it be decided that these missiles are to remain in the inventory for some period of time, we would desire to have a higher degree of reliability, and if funds can properly be applied to such a missile better than to some other system, the Air Force may elect to expend funds in this way.

Mr. SHEPPARD. I interpret from the gentleman's statement that you are actually performing a modification after the missile is on the pad. Is that correct?

Colonel ZOECKLER. Yes, sir.

Mr. SHEPPARD. Canaveral and Vandenberg are two of our outstanding facilities within the Air Force; is that correct?

General GERRITY. That is correct. That is for flight testing. We have many other facilities for ground testing.

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Mr. SHEPPARD. I grant you that. But for flight operation when the missile finally goes on the pad, assuming your ground facilities are adequate, the flight aspect of that missile is predetermined at the testing ground insofar as its accuracy, its operational ability, et cetera, when it comes off the pad at Canaveral or Vandenberg.

General GERRITY. Yes, sir.

Mr. SHEPPARD. So, insofar as the missile itself—I am not addressing myself to the ground environment but the actual missile itself—when you created the percentage, did you include the missile exclusively or did you include the missile plus the ground environment insofar as its 70 percent of reliability? Was it all-inclusive or just the bird itself?

General GERRITY. We included the missile and the ground environment, too. However, we started out initially in our testing at Patrick to test the missile itself. We first put it together with its operational ground environment equipment at Vandenberg. So it is a step program.

Mr. SHEPPARD. Taking your experience as you have it today as background for your response, what estimated—I assume it would be approximate—percentage would be involved in ground environment failure and that of the missile itself in the total percentage of success that you have quoted?

General GERRITY. From my knowledge of the program I would estimate—and I would like to correct this for the record—

Mr. SHEPPARD. Certainly. That is permissible. I understand it has to be approximate under the circumstances.

General GERRITY. In some programs in the phases I have looked at, that has been as much as a 50-50 factor.

Mr. FORD. If I might pursue this point further with Colonel Zoekler, in the ATLAS instance you will have 13 squadrons. I gather you have said that the first squadron would be less reliable than the others, and you would build up your reliability to the 13.74 squadron. Each of the squadrons would have a different degree of reliability. Furthermore, you are saying that if you want to improve the reliability through the first six or seven, you must come back and get more money in order to do more work to accomplish that objective. Is that correct?

Colonel ZOECKLER. If we decide that the reliability must be greater, yes, sir, this is true.

Mr. FORD. Perhaps that is understandable with ATLAS, it being the first of the weapons systems of this kind. What do you anticipate will be the curve, so to speak, on TITAN and MINUTEMAN in this regard?

General GERRITY. Could I ask Colonel McCoy to talk on TITAN and Colonel Phillips on MINUTEMAN?

Colonel MCCOY. Like the other programs, the TITAN I and II provided transition into a more reliable weapon system. For example, the TITAN II has half as many valves. There is a dramatic improvement in reliability in going from TITAN I to TITAN II. That is one of the prime reasons for having a program that includes later squadrons of the new weapons systems. We expect TITAN I to start with about 50 percent flight reliability from launch on, and go up about 70 percent with that version of the weapon sys-



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General GERRITY. Mr. Chairman, to answer a little better the question Mr. Sheppard asked earlier, covering the entire scope of the program, Mr. Sheppard, from its beginning, I believe the proper way to proportion ground versus air reliability would be 75 percent of the failures, roughly, have taken place in flight as opposed to about 25 percent with the ground environment.

Mr. SHEPPARD. How many actual operational systems do you have at the moment?

General GERRITY. We have a total of 27 ATLAS operational and 22 are at the moment in commission ready to fire.

Mr. SHEPPARD. Is that all you have of the different systems that are presently operational?

General GERRITY. If you included the THOR —

Mr. SHEPPARD. I want to include everything that you have that is operational in the missile field.

General GERRITY. We have 60 THOR in place in the United Kingdom, of which 51 are in commission ready to go.

Mr. SHEPPARD. With respect to the systems, General, what differential, if any, do you find in the percentage of successful operations, taking each system to itself and then weighing them according to your experience? If you do not have the answer now, supply it for the record; will you, please?

General GERRITY. I will, sir, but I can say that the THOR, which was the earliest of our missiles, has been very successful in recent firings, including the operational combat-training launches.

Mr. SHEPPARD. Is that not more or less due to a series of events comparable to the tests by which you would evaluate a plane or other mechanical devices? The length of time it has been in production, the exposure you have had to its idiosyncrasies, is a motivating factor in the evaluation you have given me.

General GERRITY. That is true. The THOR and the JUPITER are good examples of the point that you improve the reliability as you get some operational experience.

Mr. WEAVER. Can someone tell me how many operational missiles we will have when ATLAS, TITAN, and MINUTEMAN are all ready to go? 132 Atlas, 114 TITAN, 600 MINUTEMAN thru the MINUTEMAN 12

General GERRITY. —squadron program which is the limit of its approval

Mr. SIKES. Plus THOR and JUPITER.  
General GERRITY. Plus THOR and JUPITER. THOR is 60  
and JUPITER is 45.

Mr. SIKES. As of what date?

General GERRITY. This program would extend through fiscal year 1964. In other words, this would be our posture at the end of 1964, for a total of 951 missiles at the point.

Mr. ANDREWS. Are you considering POLARIS? You have 32 of them now ready to go.

General GERRITY. No, sir, I did not consider POLARIS.

Mr. ANDREWS. I know you did not, but in the overall picture you are getting 951 of the ICBM's and IRBM's. How many POLARIS missiles will you have ready to go?

General GERRITY. I cannot answer that question. Can you, General Holloway?

Over in Italy we have one squadron of JUPITER in place and the second one in the latter phase of its installation and checkout. We have a total of 17 missiles there operational and ready to go. That would be a total of 104.

General HOLLOWAY. No, sir, I cannot. I will have to furnish that. (The information was furnished to the committee.)

Mr. WEAVER. In the past, I believe testimony by the Air Force and others has disclosed that X number of ICBM's, referring specifically to ATLAS, TITAN, and MINUTEMAN, are needed to do the job. Is that correct?

General HOLLOWAY. Yes, sir, we feel there are. As you remember, we feel particularly that more MINUTEMAN missiles are needed than are currently programed. This recently has been upped to 600. We think it ought to be upped to 800 missiles. That is the way the Air Force has testified the last 2 years.

Mr. WEAVER. I would like to ask you then, if that is true, then are all procurement requests for ATLAS, TITAN, and MINUTEMAN based on this same <sup>50%</sup> reliability factor? In other words, when we get all through here will we have as many as we would need if we had a 100-percent reliability factor, or are the justifications based on an improved percentage factor of reliability for these three systems as a whole or improved reliability of individual systems?

General HOLLOWAY. Mr. Weaver, it is based on a combination of expected overall reliability, as has been discussed here this morning, and, as General Bradley pointed out, superimposed on that, the average number you will be able to keep on the alert. As in aircraft, you will not be able to keep 100 percent of your programed operational missiles on the alert all the time.

Mr. SIKES. Does this take into consideration anticipated losses from enemy action?

General HOLLOWAY. Yes, sir, it does, but that point varies also with the missile. Of course, on the soft ones we discount heavily what we might lose. On the harder ones, such as the MINUTEMAN particularly, that is a fairly low factor.

Mr. SIKES. In the <sup>50%</sup> overall reliability figure, are losses from from enemy action included?

General HOLLOWAY. No, sir. This is just operational reliability as expressed by General Gerrity in the chart.

Mr. SIKES. I wanted to be sure that is clear. If you had <sup>200</sup> additional MINUTEMAN, would they replace other missiles, or would this be an add-on?

General HOLLOWAY. We think we need <sup>200</sup> more, Mr. Sikes, in addition to what we already have.

Mr. WEAVER. If they are not all operational, which I can understand, when you have all these ready, referring just to MINUTEMAN, TITAN, and ATLAS, what percentage will be operational and on alert all the time?

General HOLLOWAY. This also will vary with the missiles. I would like to ask the respective project officers if they would give their estimates.

General BRADLEY. It will vary with the missile and with time. At the start of each program the reliability would be lower, and as time goes on the reliability will go up in all of these programs.

Mr. WEAVER. In other words, when we get these three programs all operational, we will not really have that many missiles to fire at one time.

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General BRADLEY. Undoubtedly the total as written down on a piece of paper would not be dependable at any one particular period; that is right, sir. It would be some reduced number.

General GERRITY. If I might add, Mr. Weaver, the figures I gave earlier were the actual missiles ready to go on pad. For example, we said that ATLAS missiles on the pad were ready to go. That is an in-commission rate. THORS are ready to go. This gives you an approximation of what sort of in-commission rate we can maintain at this time.

Mr. SIKES. Is that built into the <sup>50</sup> percent reliability figure? <sup>50</sup>

General GERRITY. No, sir. This is just the in-commission. Out of those that are in commission, you would achieve this <sup>50</sup> percent reliability, or whatever the figure is for each individual weapon.

Mr. WEAVER. Any time someone compares our ICBM's ready to go with those of the Soviet, it seems to me that is really not a fair comparison.

General BRADLEY. It all depends on what they have ready to go.

Mr. WEAVER. If we each have 500 in inventory, really neither one has 500 ready to go.

General HOLLOWAY. That of course depends, sir, on how you state your question. If you make the statement that at any particular time we would have 500 or X number ready to go, it would take into consideration these factors that we have just discussed, all of them, the combination. If you say we have so many operational missiles programmed, then that means the exact number we expect to have to put on pads, and does not take into consideration this in-commission factor.

Mr. WEAVER. Thank you.

Mr. ANDREWS. General, you have stopped producing THOR and JUPITER; have you not?

General BRADLEY. Yes, sir; for operational deployment.

Mr. ANDREWS. You have those missiles in place overseas. How long will those missiles be good and operational?

General GERRITY. I would expect they would be good for a number of years if we decide to keep them in the operational inventory and we maintain them and overhaul and repair them as is required.

Mr. ANDREWS. In the event you replaced them, with what would you replace them? Would you replace them with the MINUTEMAN?

General HOLLOWAY. As you probably know, in the case of the THOR and JUPITER, I do not remember the exact date on JUPITER, but in 1964 the British will furnish all the support of the THOR missile from then on. To the best of my knowledge, there is no date set now where these missiles will phase out. It is indefinite.

Mr. ANDREWS. My thought is this: If you put the missile out there, I hope you will never have to use it. I hope you never have occasion to see how accurate you are in your forecasts as to reliability. But the missile is sitting out there ready to go. It cannot sit there forever. In 8, 10, 12, or 15 years it probably will be gone. You cannot replace them with new weapons of that type.

General HOLLOWAY. That is what I am getting to, sir. First, we do not know when this would phase out but, second, it would not be replaced, in all probability, with MINUTEMAN. We have several ideas of a better type of follow-on generation IRBM missiles. These

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are IRBM's. In other words, they are not 5,500-mile missiles. They would not work in the United States if you were mad at somebody very far away outside of the United States.

Mr. ANDREWS. My question is, could you use the MINUTEMAN, which is an ICBM, as an IRBM? Could you cut it down in range?

General HOLLOWAY. We could. Some thorough studies have been done already with respect to what would make sense as an IRBM. One of the considerations was a two-stage missile. We do not think that is the best way to go at the moment.

Mr. ANDREWS. You are foreseeing now the time when you will phase out of production with ATLAS and TITAN; is that correct?

General GERRITY. Yes, sir.

General HOLLOWAY. Yes, sir, we can foresee that we will, particularly some of the earlier ones.

Mr. ANDREWS. Your ICBM of the future will be the MINUTEMAN.

General HOLLOWAY. Yes, sir. We fully subscribe to this Mr. Andrews. As far as we can foresee, this is the best approach to the ICBM problem, and we intend to refine the basis on which it is designed insofar as we can see the future now.

Mr. ANDREWS. Thank you.

General BRADLEY. I would add to that that the TITAN and the ATLAS will remain in the inventory. They have a much bigger warhead than the MINUTEMAN, and they have very specialized uses which we still need. We may in the future see the need for something like this other than the MINUTEMAN because they are a different kind of weapon. They go about the same distance.

Mr. ANDREWS. They tell us the POLARIS is a mighty good missile.

General BRADLEY. Yes, sir.

Mr. ANDREWS. You could replace the THOR and JUPITER, if the time came, with POLARIS. They will be with us a long time. I would like to see one good ICBM and one good IRBM, putting the emphasis on those two for everything, reliability and everything else.

Mr. WEAVER. General Bradley, you are concentrating on MINUTEMAN as the ultimate. Might not your views change if Russia came up with an antimissile missile?

General BRADLEY. There are a lot of things that might add to the reasons for having big missiles. That is the reason I wanted to point out I would not confine ourselves in the future to the MINUTEMAN.

General GERRITY. If I could add one more point before starting the movie, Mr. Chairman, if we went into the type of IRBM that we could build today beyond the THOR, I think we would find it much more efficient costwise and in combat effectiveness to design a new IRBM beyond the POLARIS, taking advantage of the state of the art we have achieved to date.

Mr. FORD. Using storable liquid?

General GERRITY. Undoubtedly using, not liquids but solids.

Mr. ANDREWS. We have had improvements in missiles through the years just as we have had in automobiles and everything else. You must keep abreast of the times. My point is that if you kill a man with a .22, he is just as dead as if you kill him with a .45. For practical reasons, an IRBM is just as good for us as an ICBM would be if we have a pad from which we can launch it.

AS YOU SAY WE MIGHT NEED DECOYS AND THINGS OF THAT NATURE.

AND YOUR FEELINGS GROW STRONGER FOR SOMETHING LIKE TITAN WHICH CAN CARRY DECOYS

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General GERRITY. That is correct.

General HOLLOWAY. May I add one thing, please, because this point, I think, is important. In the studies I mentioned a while ago of the IRBM and what we do as a follow-on, we have looked at everything that could be mentioned that might have application. I mentioned the two-stage MINUTEMAN. We have looked at an adaptation of the PERSHING. We have looked at several adaptations of the POLARIS with other guidance systems. We have looked at various hybrids, mixtures of these three I have mentioned. Each time we have looked at it, which has been done pretty thoroughly, we conclude that a new missile would make more sense and, in the long run, not very long run, would be more economical and more reliable. Primarily the reason for this conclusion is that we now know how to build a guidance system which would be much improved over any of those that could be adapted to an IRBM type.

Mr. SIXES. Is R. & D. actually working on this?

General HOLLOWAY. Yes, sir.

General GERRITY. Mr. Chairman, Colonel McCoy, the TITAN program director, will narrate this brief movie. It is just about 3 minutes long.

LAUNCH OF TITAN MISSILE FROM SILO

Colonel McCoy. Mr. Chairman, before the movie starts I would like to say two things: First, what the test meant to us, why we conducted it; and secondly, to give you a preview of what you are going to see, what is going on while you are watching the very short 2 1/2-minute film.

First, initially in the TITAN program it was desired to reduce the reaction time, to increase hardness, and to reduce the vulnerability. However, the question of whether a large liquid-fueled ICBM could actually be fired from a silo successfully, whether we could design and develop the components to withstand the acoustic vibration and the high temperatures, was a question which we were not ready to answer with sufficient firmness to commit the first squadrons to production.

Working on this problem, however, through calculations, through analysis, through scale model testing of one-sixth scale models, and through captive testing, holding down this missile in the silo at Vandenberg, we confirmed the theoretical work which was done, and launched on the 3d of May with perfect results. From telemetry and from our land line instrumentation we confirmed that indeed the predictions of the decibel levels and the temperatures at various points were within the limits which we had calculated, and almost exactly confirmed our calculations.

Therefore, not only was there visible evidence of success, the missile got out of sight and made its trip successfully, but even more important to us were the measurements. Now the data have been reduced and we have confirmed at each level, particularly in the guidance bay, that we have safe margins.

If you will start the film, please. Initially you will see a view of the surface of the silo. Now you are down in the launch-control center where the military and civilian personnel are preparing for the launch.

FOR THE GUIDANCE DEPARTMENT AND  
SOUND DAMAGE, AND THE OTHER  
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From ignition, after 2.9 seconds the thrust is built up to the point that the missile is released, and 5 seconds later flies out of the silo. It seems that 3 seconds was almost an eternity. Then in the first 9 seconds after launch, the roll of 50 degrees at about 10 degrees per second is started. After the 30 degrees of roll in the vertical position, 20 seconds after launch, the missile starts pitching over to approximately a 45 degree angle, and at the end of about 140 seconds the first-stage engine's liquid oxygen supply is depleted.

The second stage was filled with water and was not planned to be ignited because there was no need to spend the money necessary to prepare the second stage for flight. There was no guidance system there, for example. Instead we had instruments to measure what vibrations the guidance system would feel. *IN TERMS OF SOUND DAMAGE*

As an assist to the Pacific Missile Range to test their destruct system, we prearranged, if everything was satisfactory, after 160 seconds we would give the signal to the Navy range safety officer to press the destruct button, and on his radar it was confirmed that the PMR range safety system for TITAN did in fact work.

This is a real time shot of the missile coming out. You can see the umbilical cord carried up with it. That was land line instrumentation for the first 100 feet. Cable is still the surest way to get data, when feasible, although telemetry is the only way soon after lift off.

This slow-motion film, is an interesting observation of what that missile does when it is flying out of there. The flame deflector at the bottom of the silo is in the shape of a U. The flame from the engine goes down and is turned up to almost 180° and flared out the side.

Mr. SHEPPARD. Do you or do you not get greater value by compression in the silo firing as against open atmosphere firing?

General GERRITY. The real value, sir, of the firing out of the silo is in reducing vulnerability. You have a very short period of about a minute of vulnerability in this TITAN II silo.

Mr. SHEPPARD. I understand that was the original idea in having them placed in silos, but again I am asking whether or not by exit capability in a silo as compared with atmospheric reaction from ground, you get a greater thrust ability from the ground silo than you do from open atmosphere pads.

General GERRITY. No, sir. There is no significant difference. However, there are many other aspects besides vulnerability that make the silo valuable.

Mr. SHEPPARD. I realize that.

General GERRITY. If you have the missile above ground, you must protect it from the atmosphere and the deterioration which would take place. In silos it is in a controlled environment.

Mr. SHEPPARD. In other words, the thrust exit does not have a choking effect.

General GERRITY. No, sir, not significantly.

Mr. SHEPPARD. It does not increase the power factor on takeoff in silos.

General GERRITY. No, sir.

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Colonel McCoy. Mr. Chairman, may I comment about the design of this silo from the point of view of air entrainment or the air brought in from the atmosphere and exited from the duct. We did in fact have to design this so there was almost a 3-to-1 ratio of air coming in versus gases generated by the rocket engines, so the heat would be pulled away from the base of the missile and pulled out. But from thrust augmentation there is no significant difference. There was great concern on our part for the surface winds at Vandenberg. The day this missile was launched we felt 35 knot gusts would be the maximum, and they reached 33. So we were on the edge. We feel 52 knot winds will be the limit for this. You rarely have that. The missile, as you saw, was quite steady. I think we are safely past any concern about surface winds on silo launch.

Mr. STUBBS. How quickly can you use that silo again?

Colonel McCoy. If we had not gotten all the data, we would indeed have gone back in and fired other missiles to get more data. We were pleased with the condition of the silo, and think that probably 3 WEEKS work would have put it back in commission for a second firing. This would be 3 WEEKS work not planned ahead of time. It would not be an operational kind of limitation.

Mr. WEAVER. Will you have many modifications to TITAN II because of the information you gained on this test firing?

Colonel McCoy. No, sir. That is one of the happy results of the information. Data reduction indicates to us the work we have been carrying on concurrently has been validated by this firing.

Mr. MAHON. Colonel, I was interested in your statement about how you controlled the air when the missile is being fired from the silo. Would you explain that a little bit more in detail?

Colonel McCoy. Actually, sir, the rocket engine of an ICBM which has to fly outside the atmosphere where there is no oxygen carries its own liquid oxygen, but the air entrainment that I mentioned is actually bringing in air from the atmosphere at ordinary temperatures to cool off the 5000 Fahrenheit exhaust gases of the rocket engine so it pulls those exhaust gases away from the missile's base and out the ducts, because the missile sits there for 3 seconds before it builds up enough thrust to lift off. Until it builds up a thrust equal to the weight of the missile, it is held down.

Mr. MAHON. In other words, it is not a matter of having any air in the silo insofar as the firing is concerned.

Colonel McCoy. That is correct.

Mr. MAHON. But you do have to have some place for this exhaust to go.

Colonel McCoy. That is right, and to take the heat away from the base of the missile, which would be overheated. It would be very expensive to design the missile to withstand 5000 degrees heat at its base. It is cheaper and more sensible to design the air intake so the exhaust gases of the rocket engine pull air in when they exhaust down and out. So you pull it in from the center of the silo down.

Mr. MAHON. How big are the exhaust tubes or ducts?

Colonel McCoy. I will have to get the measurement. They would be about 15 feet long and about 5 feet wide. There is an exit on each side.

Mr. MAHON. Does the exit go all the way?

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Colonel McCoy. All the way to the surface. The flame you saw coming out was exhausted through those ducts.

Mr. SIKES. Two tunnels 5 feet by 15 feet, one on either side of the silo.

Colonel McCoy. Yes, sir; from the base on up to the top.

Mr. MAHON. How close is the exit to where the missile is fired out?

Colonel McCoy. It is only about 5 feet from the side of the silo.

Mr. MAHON. That is not too close?

Colonel McCoy. No, sir.

General GERRITY. As a matter of fact, is it not correct, Colonel McCoy, that the highest temperature that the missile itself encountered in silo firing was about ~~170~~ degrees?

Colonel McCoy. I have two vugraphs here. If the projector will show this, I think it would be easier to describe it and discuss it.

[Slide.]

Mr. Chairman, these five positions of the missile are significant points of measurement for the temperatures here and at this point, but to describe the way in which the silo is constructed, perhaps it is easier to see it here where the missile is sitting at rest with its two engines which, when ignited, exhaust their gases down. The gases are turned up outside the silo circle through the exhaust ducts, which then are flared out slightly and give divergence to the flames as they come out. You will recall in the film actually you could see that the flames were slanted away from the missile. So they exhaust and go up and out the silo. This is the way in which both the noise and the exhaust gases are carried away from the TITAN II version of the missile launched from a silo. The silo is lined with acoustical material, both in the silo itself and the duct. This material deadens the sound to the point that it is controlled within that which we can design the components to withstand.

#### ATLAS MISSILE PROGRAM

Mr. SIKES. General Gerrity, the estimate for ATLAS ground support equipment in fiscal year 1961 changed from \$367.2 million in the budget submission to \$480.6 million in the amended budget to \$606.6 million as shown in the fiscal year 1962 budget. Will you explain those increases?

Mr. SIKES. These are rather large increases, and we wonder why it is necessary.

Mr. MEYER. These increases are due to a variety of things. In the initial budget estimate our ground support equipment was based on the 1 by 9 ATLAS. We went to the 1 by 12 ATLAS. We also received some price increases in the installation and checkout function which is included in the cost of the GSE. This resulted in the increases as shown in the 1961 initial submission. The figures you gave included the air defense reorientation and as we show them now in the 1961 budget column.

Mr. SIKES. Supply for the record a breakout showing what those increases were, with the major items that are included.

Mr. MEYER. Yes, sir.

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(The information requested follows:)

*ATLAS GSE increase*

I. Fiscal year 1961 President's budget.....	\$367.2
1. Increase 6 squadrons from 1 x 9 to 1 x 12 and changes as reflected in air defense reorientation.....	+113.4
II. Revised program reported to Congress.....	480.0
1. Increase in I. & C., technical data, and ground support equipment costs.....	+98.0
2. Transfer work from factory to field.....	+30.0
III. Fiscal year 1961 GSE in fiscal year 1962 budget submission.....	606.6

Mr. SIKES. Will the funds requested in the amount of \$115.2 million complete the ground support equipment requirement?

Mr. MEYER. For the ATLAS, sir, the GSE procurement will be about 85 percent complete. 1963 funds on an incremental financing basis will complete the procurement of the last sets and pay the installation and checkout costs for the last squadrons coming in during 1963.

Mr. SIKES. In the reprogramming of March 10, 1961, approved by the Department of Defense April 21, 1961, you added \$30 million to ATLAS for increased confidence. On April 19 in two reprogrammings, also approved by the Department of Defense April 21, you decreased ATLAS by \$41 million. That is a little difficult for us to understand. Does this mean just switching money from pocket to pocket? Did you know what you were doing? What is the meaning of this situation?

Mr. MEYER. On the first reprogramming which you mentioned, this was increased GSE confidence funds that were required during fiscal year 1961.

Mr. SIKES. For what?

Mr. MEYER. We transferred a lot of the work which we had been doing in the factory in the installation and checkout functions to the field. This made for a more efficient operation but did require funds in fiscal year 1961.

The second reprogramming you referred to was the utilization of ATLAS full financing funds which were appropriated in 1961 but which are required for 1962 contracting, using these, kind of borrowing them, for the MINUTEMAN additions which Mr. McNamara recommended, \$24 million for the R. & D. program and the \$17 million for industrial facilities. This will be replaced to the ATLAS full financing in fiscal year 1962 when the funds are appropriated for the MINUTEMAN.

Mr. SIKES. What type of contract do you have for ATLAS?

General GERRITY. At the present time we have cost-plus?

Colonel ZOEGLER. We have three or four separate contracts in the ATLAS program, sir. At the present time we have a CPEF contract for the production of certain of the earlier missiles. We are converting those to cost-plus-incentive-fee contracts in the later versions of the missile, and for our ground support equipment, which now is more standardized in design, we are negotiating with Convair in particular, attempting to get a fixed-price contract. This, however, is extremely difficult, as you may recognize, due to the fact that we