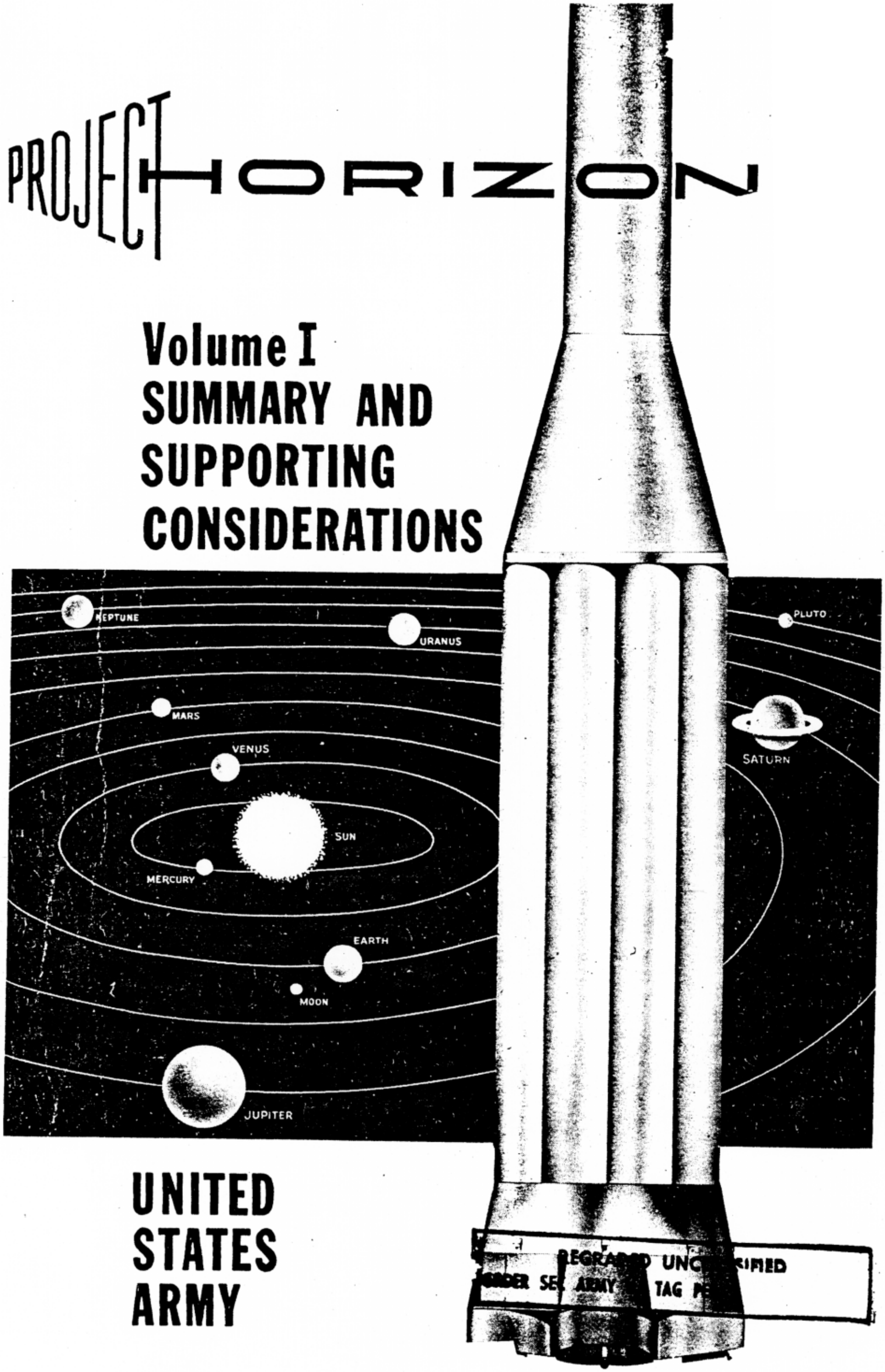
PROJECT HORIZON

Volume I
SUMMARY AND SUPPORTING CONSIDERATIONS



UNITED STATES ARMY

UNCLASSIFIED
SECRET

CRD/I (S) Proposal to Establish a Lunar Outpost (C)

Chief of Ordnance CRD 20 Mar 1959

1. (U) Reference letter to Chief of Ordnance from Chief of Research and Development, subject as above.

2. (C) Subsequent to approval by the Chief of Staff of reference, representatives of the Army Ballistic Missiles Agency indicated that supplementary guidance would be required concerning the scope of the preliminary investigation specified in the reference. In particular these representatives requested guidance concerning the source of funds required to conduct the investigation.

3. (S) I envision expeditious development of the proposal to establish a lunar outpost to be of critical importance to the U. S. Army of the future. This evaluation is apparently shared by the Chief of Staff in view of his expeditious approval and enthusiastic endorsement of initiation of the study. Therefore, the detail to be covered by the investigation and the subsequent plan should be as complete as is feasible in the time limits allowed and within the funds currently available within the office of the Chief of Ordnance. In this time of limited budget, additional monies are unavailable. Current programs have been scrutinized rigidly and identifiable "fat" trimmed away. Thus high study costs are prohibitive at this time.

4. (C) I leave it to your discretion to determine the source and the amount of money to be devoted to this purpose.

Signed
ARTHUR G. TRUDEAU
Lieutenant General, GS
Chief of Research and Development

Regraded Unclassified
by authority of Form DA 1575
dtd 21 Sep 1961
by Lt. Col. Donald E. Simon, CS

Draft

~~SECRET~~
UNCLASSIFIED

Requirement for a Lunar Outpost

1. General

There is a requirement for a manned military outpost on the moon. The lunar outpost is required to develop and protect potential United States interests on the moon; to develop techniques in moon-based surveillance of the earth and space, in communications relay, and in operations on the surface of the moon; to serve as a base for exploration of the moon, for further exploration into space and for military operations on the moon if required; and to support scientific investigations on the moon.

2. Operational Concept.

Initially the outpost will be of sufficient size and contain sufficient equipment to permit the survival and moderate constructive activity of a minimum number of personnel (about 10 - 20) on a sustained basis. It must be designed for expansion of facilities, resupply, and rotation of personnel to insure maximum extension of sustained occupacy. It should be designed to be self-sufficient for as long as possible without outside support. In the location and design of the base, consideration will be given to operation of a triangulation station of a moon-to-earth base line space surveillance system, facilitating communications with and observation of the earth, facilitating travel between the moon and the earth, exploration of the moon and further explorations of space, and to the defense of the base against attack if required. The primary objective is to establish the first permanent manned installation on the moon. Incidental to this mission will be the investigation of the scientific, commercial, and military potential of the moon.

3. Background of Requirement.

a. References:

(1) NSC policy on outer space.

(2) OCB Operations Plan on Outer Space.

b. Reason for Requirement.

(1) The national policy on outer space includes the objective of development and exploiting US outer space capabilities as needed to achieve scientific, military, and potential purposes. The OCB Operations Plan to implement this policy establishes a specific program to obtain scientific data on space environment out to the vicinity of the moon,

Regr~~aded CONFIDENTIAL~~
13 March ~~1962~~.

including the moon's gravitational and magnetic fields and to explore the characteristics of the moon's surface. There are no known technical barriers to the establishment of a manned installation on the moon.

(2) The establishment of a manned base of operations on the moon has tremendous military and scientific potential. Because invaluable scientific, military, and political prestige will come to the nation that first establishes a lunar base, it is imperative that the United States be first.

(3) The full extent of the military potential cannot be predicted, but it is probable that observation of the earth and space vehicles from the moon will prove to be highly advantageous. By using a moon-to-earth base line, space surveillance by triangulation promises great range and accuracy. The presently contemplated earth-based tracking and control network will be inadequate for the deep space operations contemplated. Military communications may be greatly improved by the use of a moon-based relay station. The employment of moon-based weapons systems against earth or space targets may prove to be feasible and desirable. Moon-based military power will be a strong deterrent to war because of the extreme difficulty, from the enemy point of view, of eliminating our ability to retaliate. Any military operations on the moon will be difficult to counter by the enemy because of the difficulty of his reaching the moon, if our forces are already present and have means of countering a landing or of neutralizing any hostile forces that has landed. The situation is reversed if hostile forces are permitted to arrive first. They can militarily counter our landings and attempt to deny us politically the use of their property.

(4) The scientific advantages are equally difficult to predict but are highly promising. Study of the universe, of the moon, and of the space environment will all be aided by scientific effort on the moon. Perhaps the most promising scientific advantage is the usefulness of a moon base for further explorations into space. Materials on the moon itself may prove to be valuable and commercially exploitable.

4. Organizational Concept.

The establishment of the outpost should be a special project having authority and priority similar to the Manhattan Project in World War II. Once established, the lunar base will be operated under the control of a unified space command. Space, or certainly that portion of outer space encompassing the earth and the moon, will be considered a military theater. The control of all United States military forces by unified commands is already established and military operations in space should be no exception. A unified space command would control and utilize, besides the lunar base, operational military satellites and space vehicles, space surveillance systems, and the logistical support thereof. Other space commands might be organized as our operations extended to translunar space.

5. Degree of Urgency.

To be second to the Soviet Union in establishing an outpost on the moon would be disastrous to our nation's prestige and in turn to our democratic philosophy. Although it is contrary to United States policy, the Soviet Union in establishing the first permanent base, may claim the moon or critical areas thereof for its own. Then a subsequent attempt to establish an outpost by the United States might be considered and propagandized as a hostile act. The Soviet Union in propaganda broadcasts has announced the 50th anniversary of the present government (1967) will be celebrated by Soviet citizens on the moon. The National Space policy intelligence estimate is that the Soviets could land on the moon by 1968.

6. Maintenance and Supply Implications.

The maintenance and supply effort to support a lunar base will be high by present standards. Continued delivery of equipment and means of survival will be required and each delivery will be costly. Every conceivable solution for minimizing the logistic effort must be explored. Maximum use of any oxygen or power source on the moon through regenerative or other techniques must be exploited. Means of returning safely to earth must be available to the occupants of the outpost.

7. Training and Personnel Implications.

The number of personnel on the base itself will be quite small, at least initially, but the total number of personnel supporting the effort may be quite large. Until further study is made a realistic qualitative and quantitative personnel estimate cannot be provided. The training requirements of earth based support personnel would resemble those of personnel in long range ballistic missile units and radar tracking systems. For the relatively small number of personnel actually transported to the moon base, training requirements would be exacting in many fields.

8. Additional Items and Requirements.

A complete family of requirements and supporting research and development projects will be necessary to develop all of the supporting equipment to establish a lunar base. Very high thrust boosters, space vehicles, intermediate space stations, space dwellings, clothing and survival gear to be used on the moon, means of transportation to the moon, and equatorial launching site, tracking equipment and many other developments will be necessary. Eventually concepts of military operations on or in the vicinity of the moon will have to be developed and, from these, supporting requirements for special weapons and equipment will be developed. Research in weapons effects, mapping, and extraction of oxygen, water, and other useful materials from the natural environment will be required.

9. Additional Comments.

a. Two broad problem areas must be considered in meeting the requirement. One is the design, and construction of the outpost. The other is the transportation required to establish and support the outpost.

b. The outpost itself could have one of several forms or be a combination of them. Holes or caves could be covered and sealed with pressure bags. By this means temperature extremes are alleviated and vulnerability to meteorites is lessened. Expansive bags or folding sections could be set on the surface. The rocket transport vehicle itself or used fuel tanks saved for the purpose could be used. Tanks now planned will be from 160" to 256" in diameter. A number of solutions to providing power and sustaining life are possible. By using solar or nuclear power oxygen and water may be extracted from the natural environment should be attainable.

c. The transport could be accomplished either by direct movement by multistage rocket to the moon, or by the use of intermediate orbiting space stations. The first solution imposes enormous power requirements to lift a load of any significance but should not be overlooked. The second solution has promise of early success because it can be accomplished with rocket engines now under development. By the use of vehicles with 1.5 million pound thrust first stage and high energy upper stages significant loads can be placed in orbit and assembled for further travel to the moon and return. Fifteen such vehicles can place enough equipment in orbit to assemble a vehicle approaching 500,000 pounds in weight. A series of 500,000 pound space vehicles is adequate to establish and support the outpost.

SECRET

HEADQUARTERS
DEPARTMENT OF THE ARMY
Office of the Chief of Research and Development
Washington 25, D.C.

20 Mar 1959

SUBJECT: Proposal to Establish a Lunar Outpost (C)

TO: Chief of Ordnance
Department of the Army
Washington 25, D. C.

1. The Army is engaged in determining objectives and requirements for outer space operations. The most challenging and perhaps the most urgent objective is that of establishing a manned lunar outpost on the moon.

2. This lunar base is needed to protect United States interests on the moon, develop techniques in moon-based surveillance of the earth and space, in communications relay, and in operations on the surface of the moon. When established, the lunar station would be utilized as a base for exploration of the moon, for further explorations into space, and for military operations if required. The base is also needed to support scientific investigations on the moon. It is considered of the utmost importance that the moon be first occupied by the U. S. so that the U. S. can deny Soviet territorial, commercial, or technological claims. If a permanent base can be established first by the United States, the prestige and psychological advantage to the nation will be invaluable.

3. You are therefore requested as a matter of urgency to make a preliminary investigation to determine the probable means and techniques of accomplishment and to develop a plan, including estimated time scheduling and costs, for establishing a lunar base by the quickest means possible. The investigation should include a determination of the feasibility of landing a manned vehicle by 1966 and of establishing a permanent base as soon thereafter as possible. This preliminary investigation will be the first of a series of steps to establish a lunar base program and will be used by the General Staff as background information for making a firm proposal to higher authority. If approved, the lunar base program would become a major part of the National Space program.

4. Your investigation will be classified SECRET and will be made known only to those persons required to have knowledge of the project.

Regraded ~~CONFIDENTIAL~~ 13 Mar 1962
(Appropriate Clasisifcation) (Date)

Regraded Unclassified
by authority of Form DA 1575,
dtd 21 Sept. 1961
by LtCol Donald E. Simon, GS

T/F Cy #3

No contacts with agencies outside the Army will be made until after the results of the preliminary investigation have been presented to the Department of Defense. The findings of the initial investigation will be made through my office to the Chief of Staff. No additional distribution will be made and no public release will be made concerning this project. Because of the sensitive aspects of this proposal it is essential that this project not be disclosed prematurely.

5. Your plan of accomplishment should include full utilization of the other technical services and combat arms to the extent feasible and necessary. In the accomplishment of this investigation the Chief of Engineers will be responsible for the design, construction, and maintenance of the base and the Chief Signal Officer will be responsible for communications and other support for which he is peculiarly qualified. Specific emphasis should be given to the Army-wide capability to contribute to this project. The results of this preliminary investigation are requested by 15 May 1959.

6. Reproduction of this letter to the extent you deem essential is authorized. All copies will be recorded.

1 Incl
Draft Requirement

ARTHUR G. TRUDEAU
Lieutenant General, GS
Chief of Research and Development

VOLUME I

SUMMARY AND SUPPORTING CONSIDERATIONS (U)

9 JUNE 1959

PROJECT HORIZON REPORT

A U. S. ARMY STUDY FOR THE ESTABLISHMENT
OF
A LUNAR OUTPOST

VOLUME I

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(S) CHAPTER I: INTRODUCTION

A. GENERAL

HORIZON is the project whose objective is the establishment of a lunar outpost by the United States. This study was directed by letter dated 20 March 1959, from the Chief of R&D, Department of the Army, to the Chief of Ordnance. Responsibility for the preparation of the study was subsequently assigned to the Commanding General, Army Ordnance Missile Command. Elements of all Technical Services of the Army participated in the investigation. This report is a limited feasibility study which investigates the methods and means of accomplishing this objective and the purposes it will serve. It also considers the substantial political, scientific and security implications which the prompt establishment of a lunar outpost will have for the United States.

B. JUSTIFICATION

1. The Broad Requirement

The US national policy on space includes the objective of developing and exploiting this Nation's space capability as necessary to achieve national political, scientific, and security objectives. The establishment of a manned outpost in the lunar environment will demonstrate United States leadership in space. It will also provide a basis for further explorations and operations on the lunar surface as well as a supporting capability for other US operations in space.

2. Purpose of the Lunar Outpost

The establishment of a manned US outpost on the moon will:

Demonstrate the United States scientific leadership in outer space.

Support scientific explorations and investigations.

Extend and improve space reconnaissance and surveillance capabilities and control of space.

Extend and improve communications and serve as a communications relay station.

Provide a basic and supporting research laboratory for space research and development activity.

Develop a stable, low-gravity outpost for use as a launch site for deep space exploration.

Provide an opportunity for scientific exploration and development of a space mapping and survey system.

Provide emergency staging areas, rescue capability or navigational aid for other space activity.

3. A Realistic Objective

Advances in propulsion, electronics, space medicine and other astronautical sciences are taking place at an explosive rate. As recently as 1959, the first penetration of space was accomplished by the US when a two-stage V-2 rocket reached the then unbelievable altitude of 250 miles. In 1957, the Soviet Union placed the first man made satellite in orbit. Since early 1958, when the first US earth satellite was launched, both the US and USSR have launched additional satellites, moon probes, and successfully recovered animals sent into space in missiles. In 1960, and thereafter, there will be other deep space probes by the US and the USSR, with the US planning to place the first man into space with a REDSTONE missile, followed in 1961 with the first man in orbit. However, the Soviets could very well place a man in space before we do. In addition, instrumented lunar landings probably will be accomplished by 1964 by both the United States and the USSR. As will be indicated in the technical discussions of this report, the first US manned lunar landing could be accomplished by 1965. Thus, it appears that the establishment of an outpost on the moon is a capability which can be accomplished.

4. Scientific Implications

A wealth of scientific data can be obtained from experiments conducted at a lunar outpost. Without doubt, the scientific community will generate many new and unique applications as man's actual arrival on the moon draws nearer reality. The very absence of knowledge about the moon and outer space is scientific justifications to attempt to breach this void of human understanding.

It is to be expected that civilian efforts to advance science for the sake of science will parallel the military efforts. It is also expected that the National Aeronautics and Space Administration will treat those subjects in greater detail than is either possible or desirable in this study, and that such action will further strengthen the requirement for earliest possible establishment of an extra-terrestrial outpost.

5. Political Implications

The political implications of our failure to be first in space are a matter of public record. This failure has reflected adversely on United States scientific and political leadership. To some extent we have recovered the loss. However, once having been second best in the eyes of the world's population, we are not now in a position to afford being second on any other major step in space. However, the political implications of being second in space activities accomplished to date have not been nearly as serious as those which could result from failure to be the first in establishing a manned lunar outpost.

The results of failure to first place man on an extra-terrestrial base will raise grave political questions and at the same time lower US prestige and influence. The Soviet Union has announced openly its intention that some of its citizens will celebrate the 50th anniversary of the October Revolution (1967) on the moon. The US intelligence community agrees that the Soviet Union may accomplish a manned lunar landing at any time after 1965. Judging from past experience, it is not difficult to visualize all manner of political and legal implications which the Soviet Union might postulate as a result of such a successful accomplishment nor the military advantages it might achieve thereby.

6. Security Implications

The extent to which future operations might be conducted in space, to include the land mass of the moon or perhaps other planets, is of such a magnitude as to almost defy the imagination. In both Congressional and military examination of the problem, it is generally agreed that the interactions of space and terrestrial war are so great as to generate radically new concepts.

Admittedly, the security significance of the moon, per se, in the context of offensive and defensive operations, is a matter for conjecture at this time. From the viewpoint of national security, the primary implications of the feasibility of establishing a lunar outpost is the importance of being first. Clearly the US would not be in a position to exercise an option between peaceful and military applications unless we are first. In short, the establishment of the initial lunar outpost is the first definitive step in exercising our options.

7. Summary

Unquestionably, there are other applications of space (i.e. reconnaisance, meteorology, communications) which will permit an earlier attainment of meaningful accomplishments and demonstrate US interest in space. Individually, however, these accomplishments will not have the same political impact that a manned lunar outpost could have on the world. In the still vague body of fact and thought on the subject, world opinion may view the other applications similar to action on the high seas, but will view the establishment of a first lunar outpost as similar to proprietary rights derived from first occupancy. As the Congress has noted, we are caught in a stream in which we have no choice but to proceed. Our success depends on the decisiveness with which we exercise our current options. The lunar outpost is the most immediate case. It is the basis for other more far-reaching actions, such as further interplanetary exploration.

C. CONCLUSIONS

Four major conclusions summarize the more detailed deductions which may be drawn from the entire report:

1. Political, scientific, and security considerations indicate that it is imperative for the United States to establish a lunar outpost at the earliest practicable date.

2. Project HORIZON represents the earliest feasible capability for the U. S. to establish a lunar outpost. By its implementation, the United States can establish an operations lunar outpost by late 1966, with the initial manned landings to have taken place in the Spring of 1965.

3. The importance of an early decision to proceed with the program, coupled with adequate funding, must be clearly understood. Inordinate delay will have two inescapable results:

a. The program's ultimate accomplishment will be delayed, thus forfeiting the change of defeating the USSR in a race which is already openly recognized as such throughout the world.

b. Delayed initiation, followed later by a crash program, which would likely be precipitated by evidence of substantial Soviet progress in a lunar outpost program, will not only lose the advantage of timeliness, but also will inevitably involve significantly higher costs and lower reliability. The establishment of a U. S. lunar outpost will require very substantial funding whether it is undertaken now or ten years hence. There are no developments projected for the predictable future which will provide order of magnitude type price reductions.

4. The U. S. Army possesses the capability of making significant contributions in all aspects of such a program.

D. ORGANIZATION AND CONTENT OF THE REPORT

The Project HORIZON report has been divided into two volumes which are entitled as follows:

Volume I - Summary and Supporting Considerations
Volume II - Technical Considerations and Plans

Volume I is, as indicated, a document which gives a short summary of the other volume, a discussion of non-technical considerations, and a resume of the resources and facilities of the Army Technical Services which can lend support to this program.

Volume II is a technical investigation of the problem. It includes practical preliminary concepts for all elements of the program and, in many cases, relates actual hardware available from current programs to the solution of specific problems. It includes a broad development approach and a funding breakout by fiscal year. Also included are personnel and training requirements for all segments of the operation together with the policy of the US with respect to space and the legal implication of a lunar outpost. This volume was prepared by a unique working group, comprized of a special segment of the Future Projects Design Branch of the Army Ballistic Missile Agency (ABMA), which was augmented by highly qualified representatives of each of the seven Technical Services of the Army. These representatives were carefully selected for the specific task and, during the course of the study, became resident members of the aforementioned ABMA group. The resident representatives of the Technical Services were supported by their respective services with a group of the highest caliber specialists who were made available exclusively to support the project. Thus, it is believed that the depth of experience, knowledge, and judgement brought to bear on the problem by this group is commensurate with the task of accomplishing the report objectives.

Throughout the preparation of the entire report, and especially within this technical volume, the guiding philosophy has been one of enlightened conservatism of technical approach. Briefly stated, this philosophy dictates that one must vigorously pursue research to "advance the state-of-the-art", but that paramount to successful major systems design is a conservative approach which requires that no item be more "advanced" than required to do the job. It recognizes that an unsophisticated success is of vastly greater importance than a series of advanced and highly sophisticated failures that "almost worked." Established engineering principles, used in conjunction with the best available design parameters, have been applied throughout in order to remove the elements of science fiction and unrealistic planning.

(S) CHAPTER II: TECHNICAL CONSIDERATIONS AND PLANS

A. OBJECTIVES AND SCOPE OF THE STUDY

This part of the study presents applicable technical information which substantiates the feasibility of the expedited establishment of a lunar outpost, and it relates U. S. capabilities and developments to the accomplishment of the task. It is comprehensive in its scope, covering the design criteria and requirements for all major elements of the program including the lunar outpost, the earth-lunar transportation system, the necessary communications systems and the considerable earth support facilities and their operation. The technical assumptions concerning design parameters for this program are realistic yet conservative. Likewise, the assumptions which concern the scope and magnitude of other U. S. programs which will support HORIZON are reasonable and in line with current and projected programs.

B. RESUME OF THE TECHNICAL PROGRAM

The basic carrier vehicles for Project HORIZON will be the SATURN I and II. The SATURN I, currently being developed under an ARPA order, will be fully operational by October 1963. The SATURN II, which is an outgrowth of the SATURN I program, could be developed during the period 1962-1964. The SATURN II will utilize improved engines in the booster and oxygen/hydrogen engines in all of its upper stages.

By the end of 1964, a total of 72 SATURN vehicles should have been launched in U. S. programs, of which 40 are expected to contribute to the accomplishment of HORIZON. Cargo delivery to the moon begins in January 1965. The first manned landing by two men will be made in April 1965. The buildup and construction phase will be continued without interruption until the outpost is ready for beneficial occupancy and is manned by a task force of 12 men in November 1966.

This buildup program requires 61 SATURN I and 88 SATURN II launchings through November 1966, the average launching rate being 5. 3 per month. During this period some 490,000 pounds of useful cargo will be transported to the moon.

During the first operational year of the lunar outpost, December 1966 through 1967, a total of 64 launchings have been scheduled. These will result in an additional 266,000 pounds of useful cargo on the moon.

The total cost of the eight and one-half year program presented in this study is estimated to be six billion dollars. This is an average of approximately $700 million per year. These figures are a valid appraisal and, while preliminary, they represent the best estimates of experienced, non-commercial, agencies of the government. Substantial funding is undeniably required for the establishment of a U. S. lunar outpost; however, the implications of the future importance of such an operation should be compared to the fact that the average annual funding required for Project HORIZON would be less than two percent of the current annual defense budget.

C. OUTPOST

The lunar outpost proposed for Project HORIZON is a permanent facility capable of supporting a complement of 12 men engaged in a continuing operation. The design of the outpost installation herein is based on realistic requirements and capabilities, and is not an attempt to project so far into the future as to lose reality. The result has been a functional and reliable approach upon which men can stake their lives with confidence of survival.

1. Location

The exact location of the outpost site cannot be determined until an exploratory probe and mapping program has been completed. However, for a number of technical reasons, such as temperature and rocket vehicle energy requirements, the area bounded by $\pm$ 20° latitude/longitude of the optical center of the moon seems favorable. Within this area, three particular sites have been chosen which appear to meet the more detailed requirements of landing space, surface conditions, communications, and proximity to varied lunar "terrain."

A rather extensive lunar mapping program is already underway in order to satisfy existing requirements in Astro-Geodesy. Maps to a scale of 1:5,000,000 and 1:1,000,000 are planned for completion by December 1960 and August 1962, respectively. Larger scale mapping will then be undertaken for several specific site selections.

2. Design Criteria

The design of the lunar outpost facilities will, of course, be dominated by the influence of two factors - the lunar environment and the space transportation system capabilities. A few of the more pronounced primary lunar environmental parameters are listed below:

a. Essentially no atmosphere.

b. Surface gravity approximately 1/6 earth gravity.

c. Radius of approximately 1000 miles is about 1/4 that of earth. (This results in a significant shortening of the horizon as compared to earth.)

d. Surface temperature variations between a lunar day and night of +248° F to -202° F.

e. Maximum subsurface temperature at equator is -40°F. These and many other unfamiliar environmental conditions require that every single item which is to be placed on the lunar surface have a design which is compatible with these phenomena. However, a careful determination has been made of man's requirements to live in this environment, and it appears that there is no area which cannot be adequately solved within the readily available state-of-the-art.

3. Outpost Facilities and Their Installation

The first two men will arrive on the lunar surface in April 1965. They will be guided to an area in which the cargo buildup for future construction has already begun. Their landing vehicle will have an immediate return-to-earth capability; however, it is intended that they remain in the area until after the arrival of the advance party of the construction crew. During their stay, they will live in the cabin of their lunar vehicle which will be provided with necessary life essentials and power supplies. For an extended stay, these will be augmented by support from cargo previously and subsequently delivered to the site by other vehicles.

The mission of the original two men will be primarily one of verification of previous unmanned environmental investigations and confirmation of the site selection and cargo delivery.

Figure I-1 shows the HORIZON outpost as it would appear in late 1965, after about six months of construction effort. The basic building block for the outpost will be cylindrical metal tanks ten feet in diameter and 20 feet in length. (Details of typical tanks are shown in Fig. I-2.) The buried cylindrical tanks at the left-center of Fig. I-1 constitute the living quarters of the initial construction crew of nine men who will arrive in July 1965. (Details in Fig. I-3.) During the construction period, this force will be gradually augmented until a final complement of 12 men is reached. The construction camp is a minimum facility and will be made operational within 15 days after the beginning of active work at the outpost site. Two nuclear reactors are located in holes as shown in the left portion of Fig. I-1. These provide power for the operation of the preliminary quarters and for the equipment used in the construction of the permanent facility. The main quarters and supporting facilities are shown being assembled in the open excavation to the right-center of the figure. These cylinders will also ultimately be covered with lunar material. Empty cargo and propellant containers have been assembled and are being used for storage of bulk supplies, weapons, and life essentials such as insulated oxygen/nitrogen tanks. Two typical surface vehicles are shown: one is a construction vehicle for lifting, digging, scraping, etc., the other is a transport vehicle for more extended distance trips needed for hauling, reconnaissance, rescue, and the like. In the left background, a lunar landing vehicle is settling on the surface. A lightweight parabolic antenna has been erected near the main quarters to provide communications with earth.

The basic completed outpost is shown in Fig. I-4. Significant additions beyond the items illustrated in Fig. I-1 are two additional nuclear power supplies, cold storage facility, and the conversion of the original construction camp quarters to a bio-science and physical-science laboratory.

A number of factors influenced the decision to locate the main structures beneath the surface. Among these were the uniform temperature available (approximately -40°F), protection from meteoroids, security, good insulating properties of the lunar material, and radiation protection. Each of the quarters and cylinders will be a special double-walled "thermos bottle type" vacuum tank with a special insulating material in the space between the walls. (Vacuum is easily maintained simply by venting the tank to the lunar void.) Despite the ambient subsurface temperature of -40°F, the heat losses from these special tanks will be remarkably low. Investigations show that the

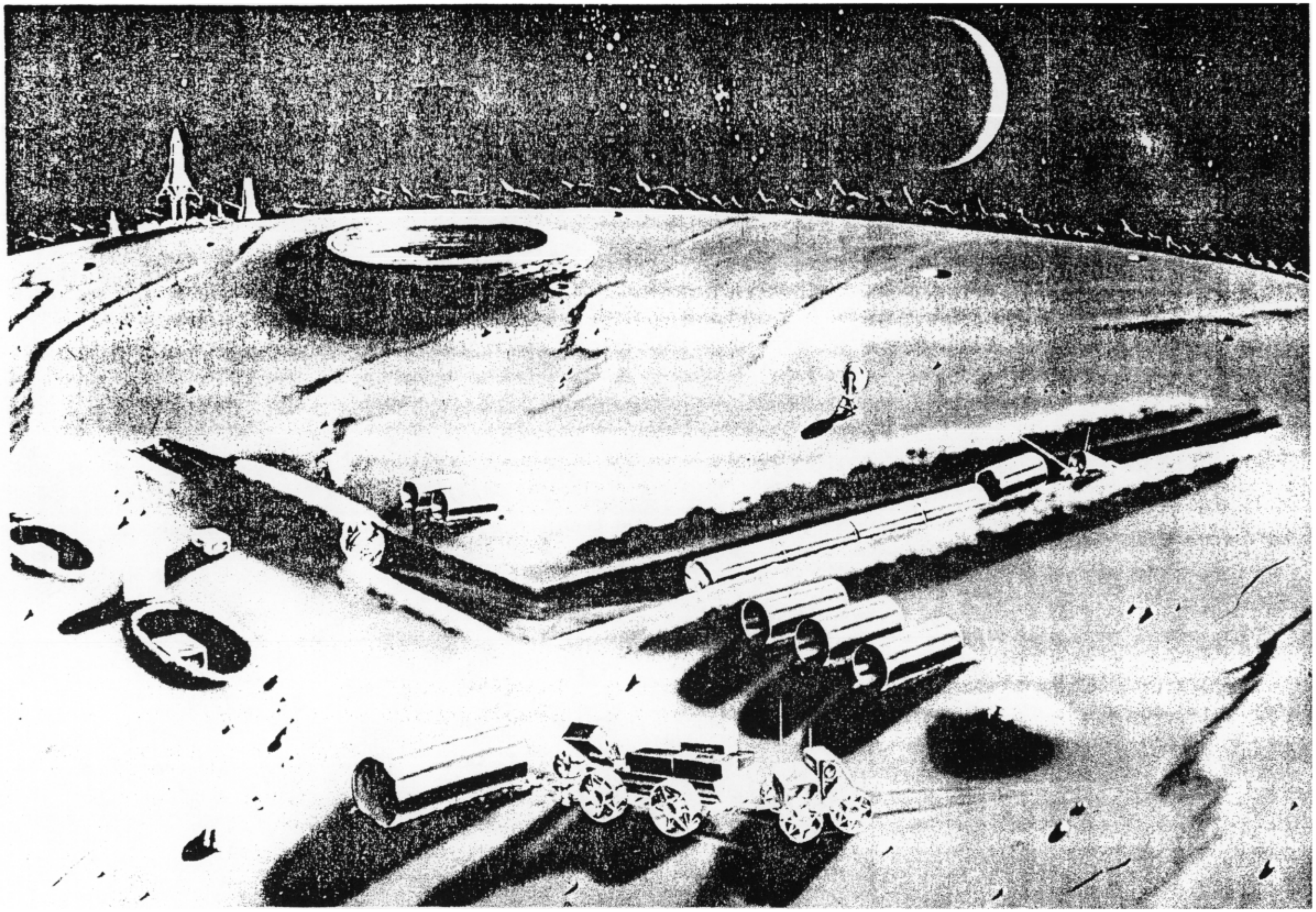


Fig. I-1. HORIZON Outpost in Late 1965

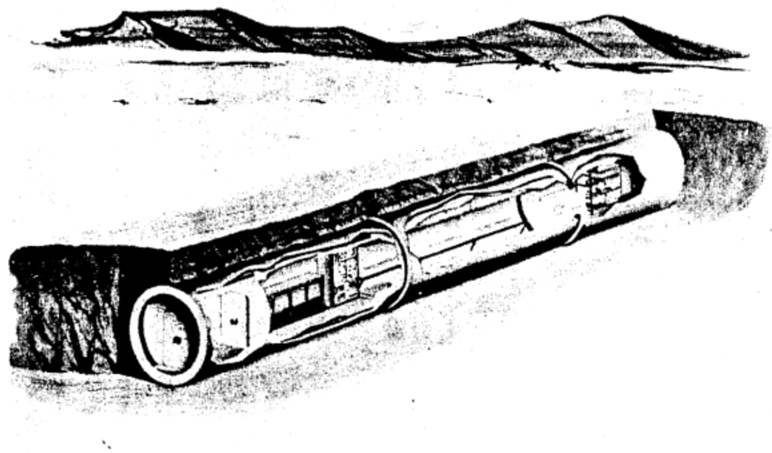


Fig. I-2. Cross Section of Typical Outpost Compartments

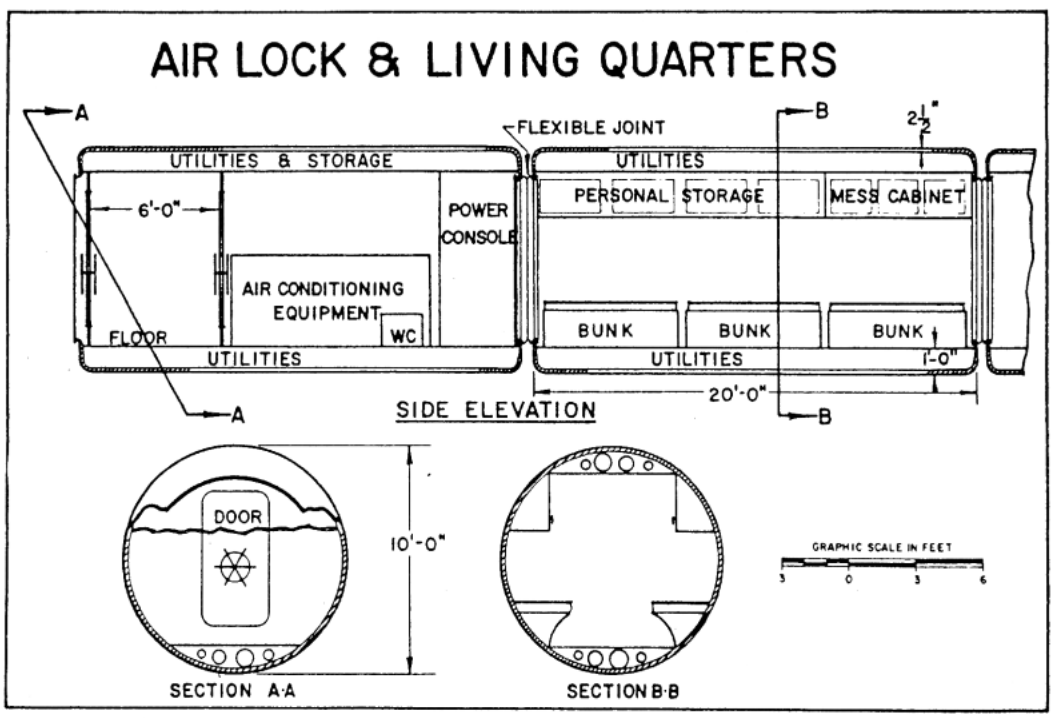


Fig. I-3. Overall View of Initial Construction Camp

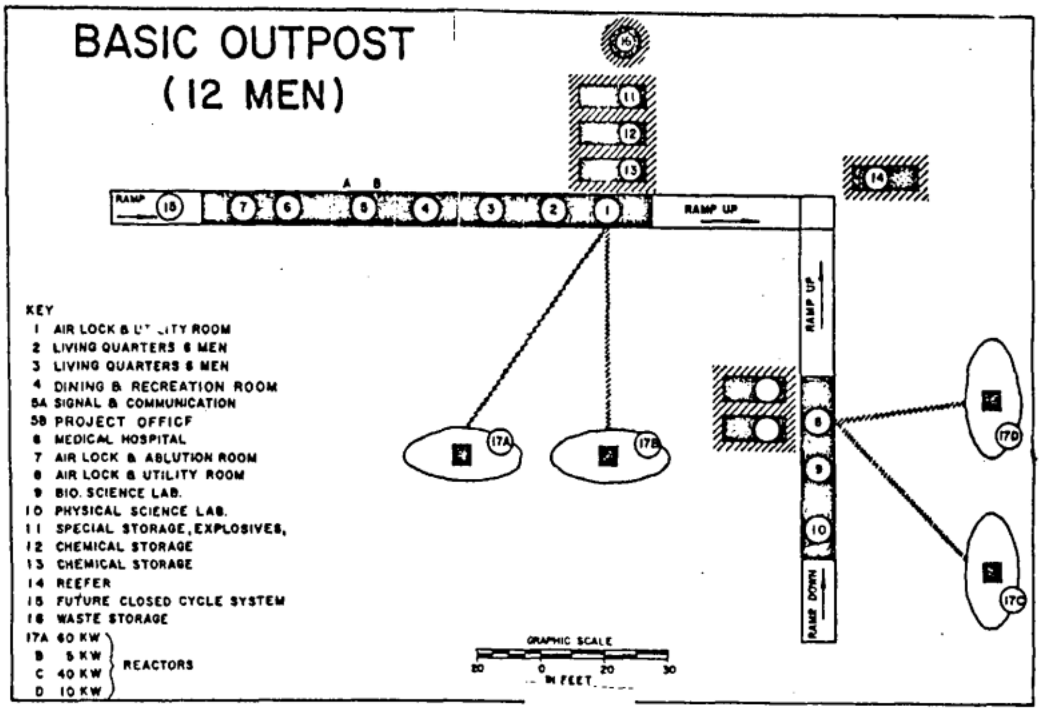


Fig. I-4. Layout of Basic 12-Man Outpost

incidental heat given off by an adequate internal lighting system will nominally supply essentially all of the heat required to maintain comfortable "room" temperature in the outpost quarters.

A suitable atmosphere will be provided within the quarters. The basic gas supply will stem from special insulated tanks containing liquid oxygen or nitrogen. The nitrogen supply needs only to provide for initial pressurization and replacement of leakage losses; whereas, the oxygen is, of course, continuously used to supply bodily needs. However, the weights and volumes of both gases are quite reasonable and presents no unusual problem of supply. Carbon dioxide and moisture will be controlled initially by a solid chemical absorbent and dehumidifier. Such a scheme requires considerable amounts of material; therefore, a carbon dioxide freeze-out system will be installed later.

4. <u>Personnel Equipment</u>

For sustained operation on the lunar surface a body conformation suit having a substantial outer metal surface is considered a necessity for several reasons: (1) uncertainty that fabrics and elastomers can sustain sufficient pressure differential without unacceptable leakage; (2) meteoroid protection; (3) provides a highly reflective surface;

(4) durability against abrasive lunar surface; (5) cleansing and sterilization. Figure I-5 shows a cutaway and "buttoned up" concept for such a suit. It should be borne in mind that while movement and dexterity are severe problems in suit design, the earth weight of the suit can be allowed to be relatively substantial. For example, if a man and his lunar suit weigh 300 pounds on earth, they will only weigh 50 pounds on the moon.

A comprehensive program will be undertaken to provide special hand tools, load-handling gear, and dining equipment to meet the unusual requirements. Initially, all food will be pre-cooked; however, as water supplies increase with the introduction of a reclaiming system, dehydrated and fresh-frozen foods will be used. Early attention will be given to hydroponic culture of salads and the development of other closed-cycle food product systems.

5. Environmental Research

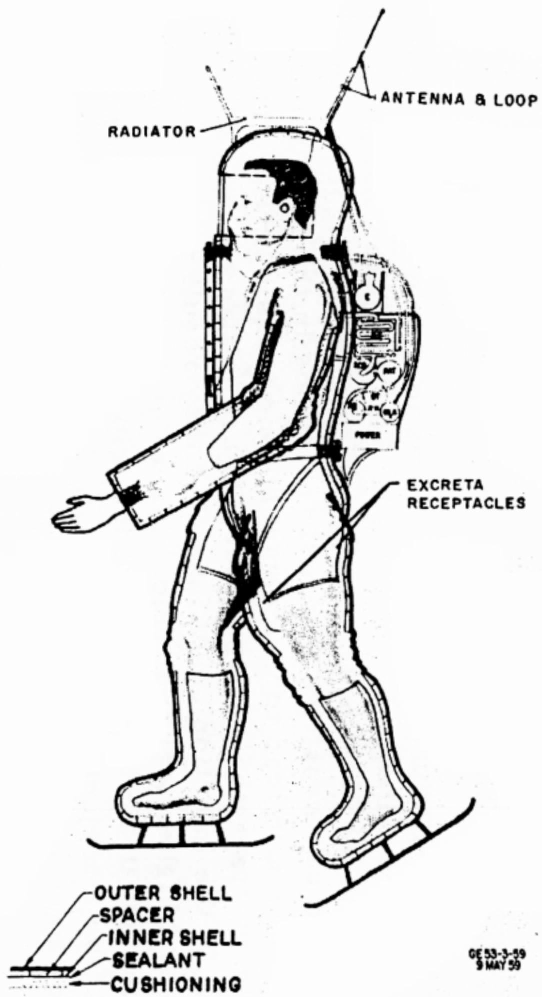
In order to corroborate essential environmental data, a series of unmanned experiments are planned. There are early data requirements in the areas of radiation, meteoroid impacts, temperatures, magnetic field, surface conditions, ionization, radio propagation and biological effects.

D. SPACE TRANSPORTATION SYSTEM

1. Flight Mechanics

In choosing appropriate trajectories to use in this program, one must strike a balance between the low-energy paths and the high energy curves. The low energy trajectories give the highest payload capability, but are sensitive to small variations in the injection conditions and can also lead to unacceptably long transit times. The higher energy trajectories are faster and are not as sensitive to deviations in the injection conditions, but they result in payload penalties and higher terminal velocities which in turn require greater braking energy at the termination of the trip. A good compromise appears to be a trajectory which will yield a transit time from earth to moon of approximately 50 to 60 hours.

Several different trajectory schemes will be used in Project HORIZON. They include trajectories for transit: (1) direct from the earth to the moon, (2) from earth to a 96-minute (307 nautical mile



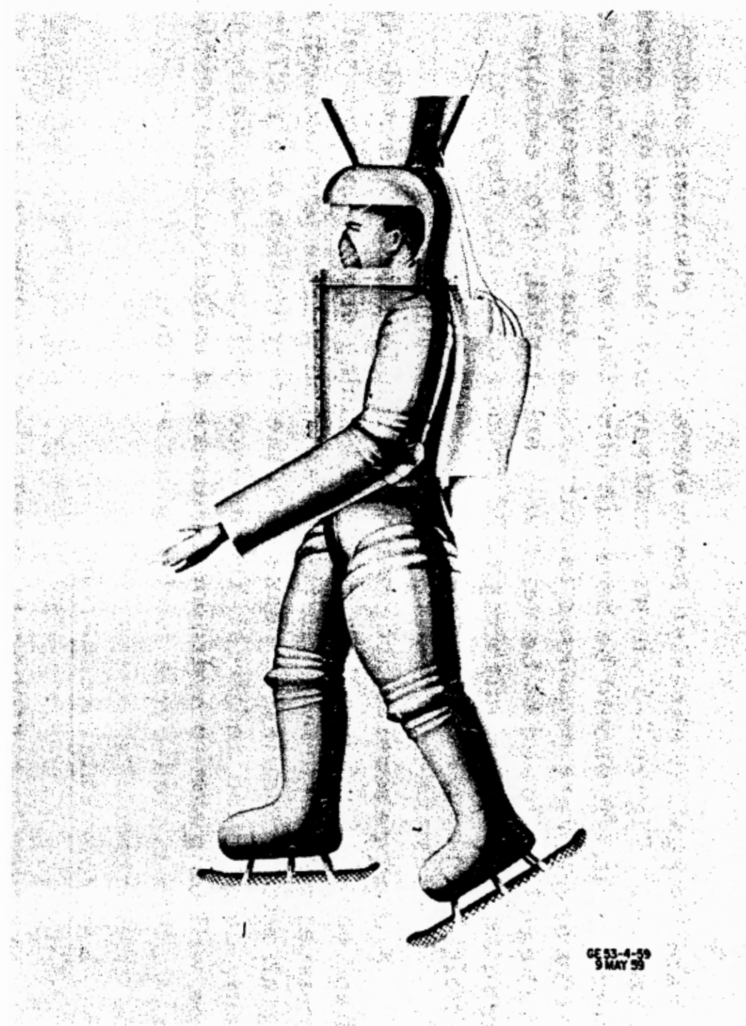


Fig. I-5. Typical Lunar Suit

altitude) orbit of the earth, (3) from this 96-minute earth orbit to the moon, and (4) direct from the moon to earth. In addition, there are special considerations for the terminal phase of each type trajectory.

Figure I-6 illustrates the two basic schemes of transporting man and cargo from earth to the moon.

The first scheme (1 above) is the direct approach, that is, a vehicle would depart the earth's surface and proceed directly to the lunar surface using a retro-rocket or landing stage for the final landing maneuver. Since the moon has no appreciable atmosphere, a rocket type propulsion system will be required for the landing. The second scheme (2 and 3 above) shown is that for proceeding first into an earth orbit and later departing the orbit for the flight to the lunar surface, again using a landing stage. In either scheme, the flight time from the earth or earth orbit to the moon will be the same.

The direct scheme, which is the most straightforward, has two advantages: first, it offers the shortest flight time from the earth's surface to the lunar surface since an orbital stopover is not required.

In the orbital scheme, much larger payloads can be transported into orbit, assuming the vehicle size to be constant, and by accumulating payloads in orbit, it is possible to transport a payload to the moon on the order of ten times (and more if desired) the capability of a single vehicle flying directly to the moon.

To illustrate this point, it has been assumed in the study that the first men arriving on the moon will be provided with an immediate return capability. Figure I-7 depicts the vehicular requirements for the two schemes.

The direct approach would require a six stage vehicle with a lift-off thrust of 12 million pounds, as compared to a two-million-pound thrust vehicle for the orbital schemes. By placing the upper stage and payload of two-million-pound thrust vehicle into orbit, and with additional vehicles as shown, performing a fuel transfer and checkout operation, the same mission, that of transporting two men to the moon and returning them to earth, could be accomplished.

It should be pointed out, however, that if the United States is to have a manned lunar outpost by 1966, and at the same time provide the first men arriving on the moon with the desired return capability,

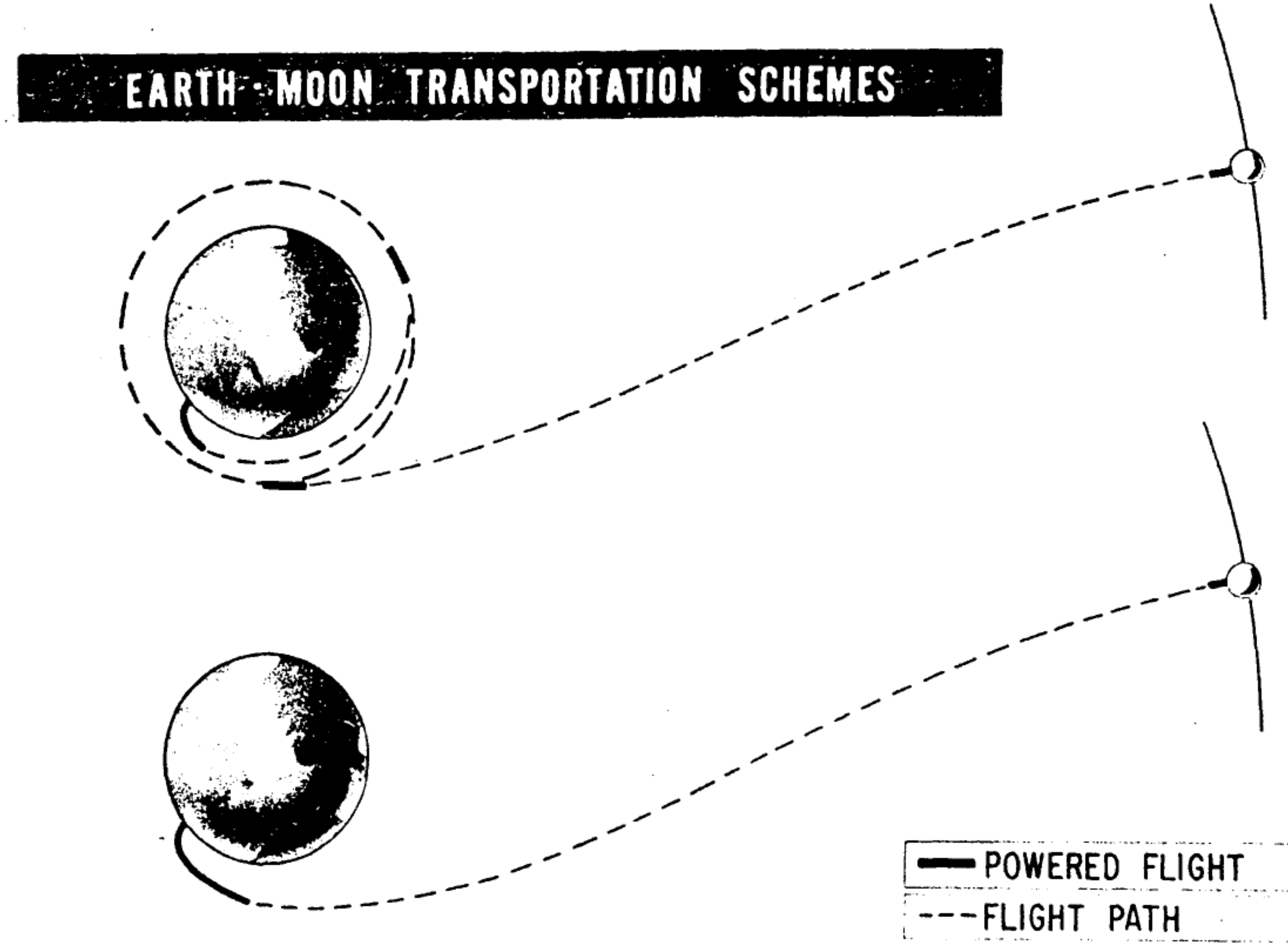


Fig. I-6. Earth - Moon Transportation Schemes

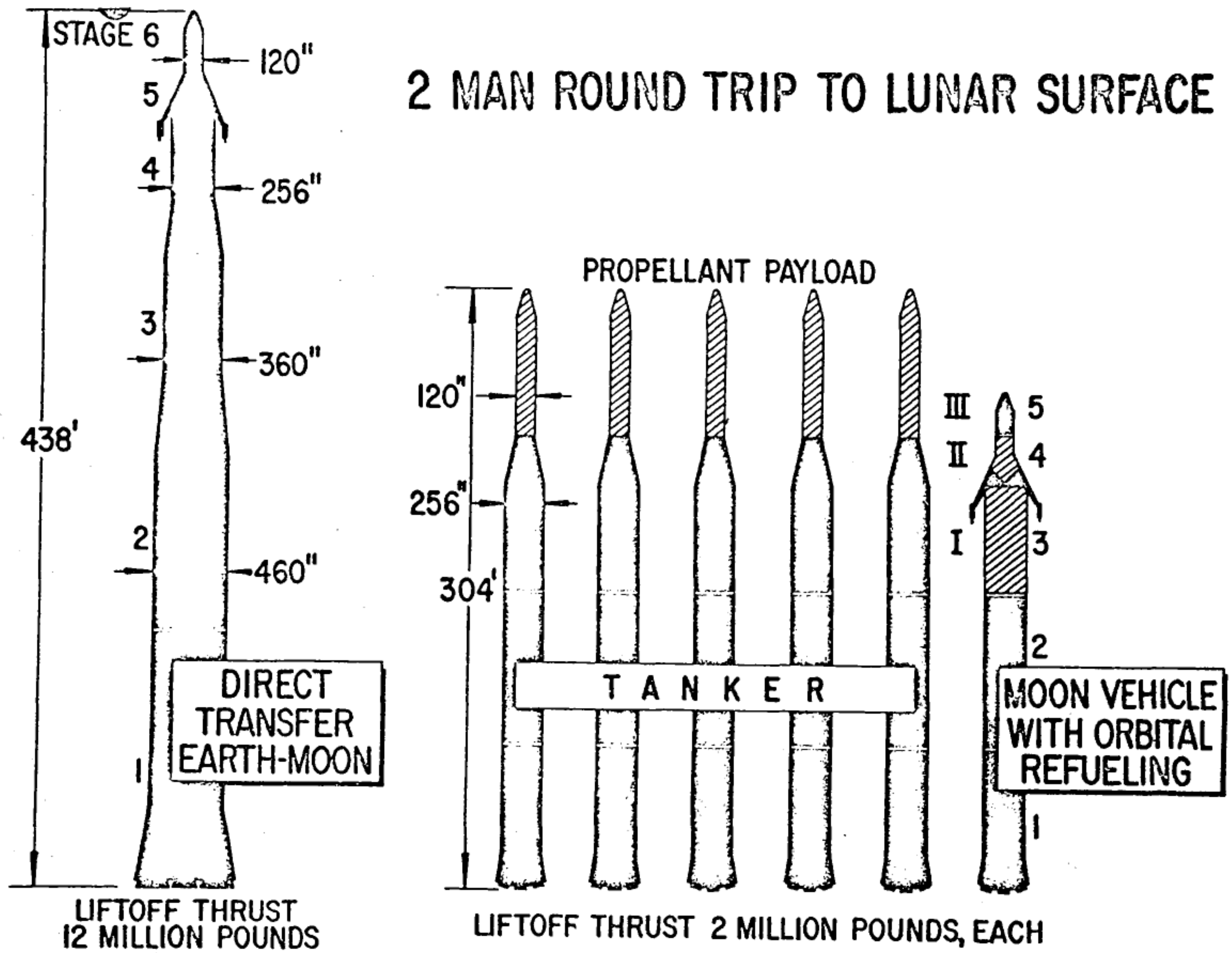


Fig. I-7. Two - Man Round Trip to Lunar Surface the orbital approach is mandatory, since a 12-million pound thrust vehicle will not be available to meet the required schedule.

For the return to earth, from either the earth orbit or the lunar surface, aerodynamic braking will be used, since it allows significant overall payload increases when compared to rocket braking. The aerodynamic braking body used for this study is similar in shape to a JUPITER missile nose cone modified by the addition of movable drag vanes at the base of the cone. Though the size varies, the same basic shape was considered for use from the lunar surface to earth as was for use from the 96-minute orbit to the earth's surface. Studies show that, within acceptable limits of entry angle, the vehicle can make a successful descent which is well within the physical tolerances imposed by man's presence, and which can be guided with acceptable accuracy for final recovery. The recent successful flight and subsequent recovery of two primates aboard a nose cone further substantiates the validity of this approach to earth return braking. This test vehicle was fired to IRBM range and, due to the steep re-entry angle, the decelerative forces associated with this operation were many times greater than expected for project HORIZON trajectories.

2. Orbital Carrier and Space Vehicles

Only two basic carrier vehicles are required to carry out Project HORIZON - SATURN I and a further development, SATURN II.

The SATURN I vehicle, shown in Figs. I-8 and I-9 consists of a clustered booster with a lift-off thrust of 1,504,000 pounds, a twin engine second stage of about 360,000 pounds of thrust, and a lox/hydrogen (O_2/H_2) third stage of 30,000 pounds of thrust. The initial performance of this vehicle will enable it to place 30,000 pounds of net payload in a 96-minute orbit and 7,500 pounds of net payload to earth escape velocity. It will be powered by eight North American H-1 engines which are a greatly simplified version of the engine used in JUPITER, THOR, and ATLAS. The second stage is a modified version of the TITAN booster. The third stage is a modified CENTAUR vehicle currently under development by Pratt & Whitney and Convair.

The SATURN II vehicle (Figs. I-10 and I-11) is based on a modified SATURN I booster. The North American H-1 engines of the original version will be replaced by H-2 engines which will up-rate the total thrust by 1/3 to a sea level value of 2,000,000 pounds. The second stage will incorporate two 500,000-pound thrust H_2/O_2 engines, a

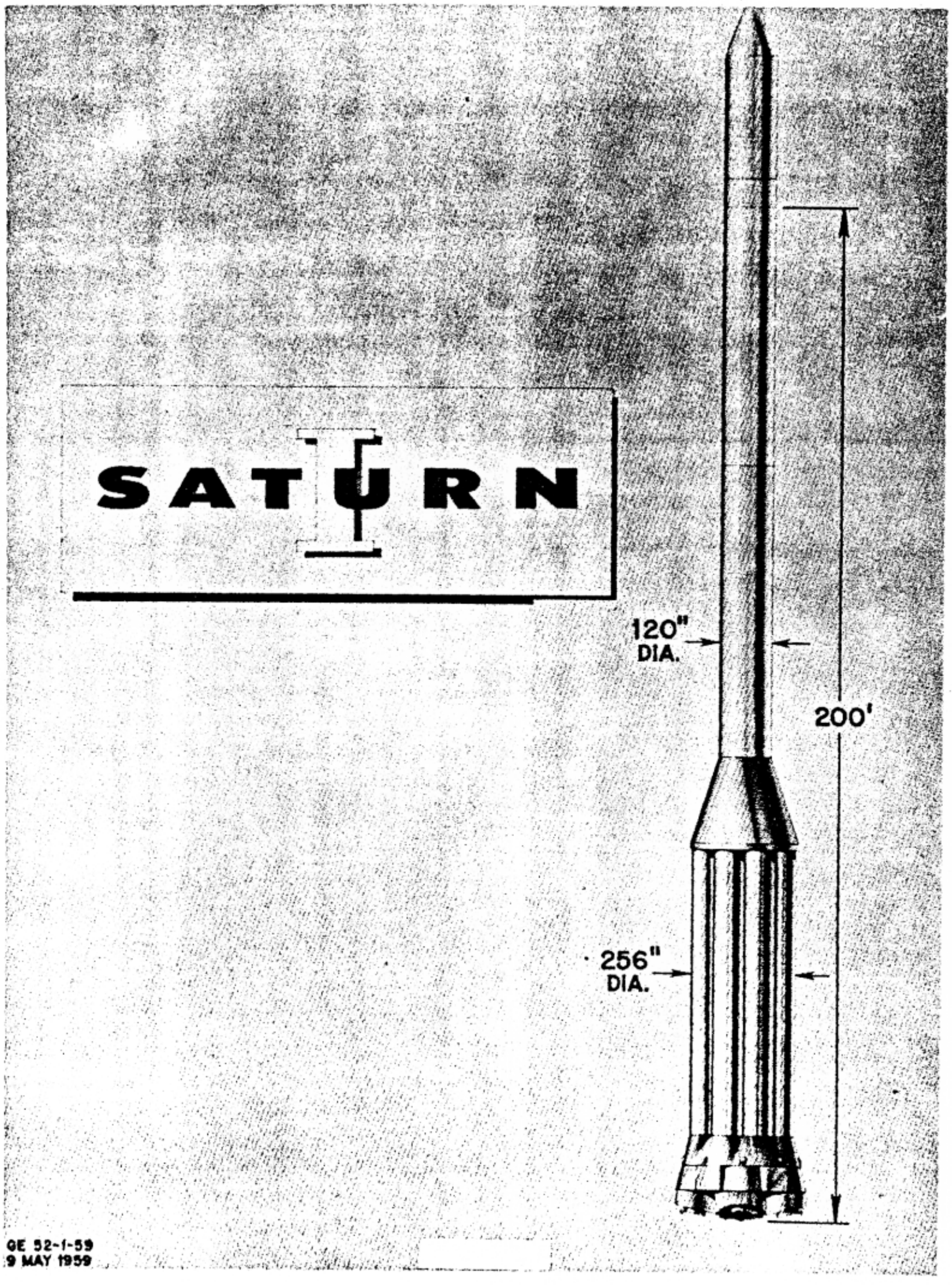


Fig. I-8. SATURN I

SATURN

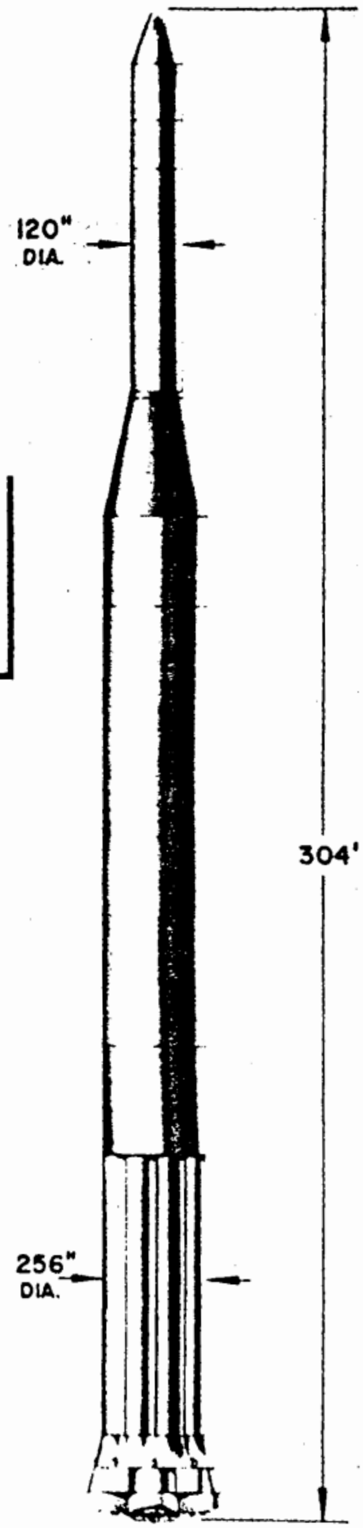
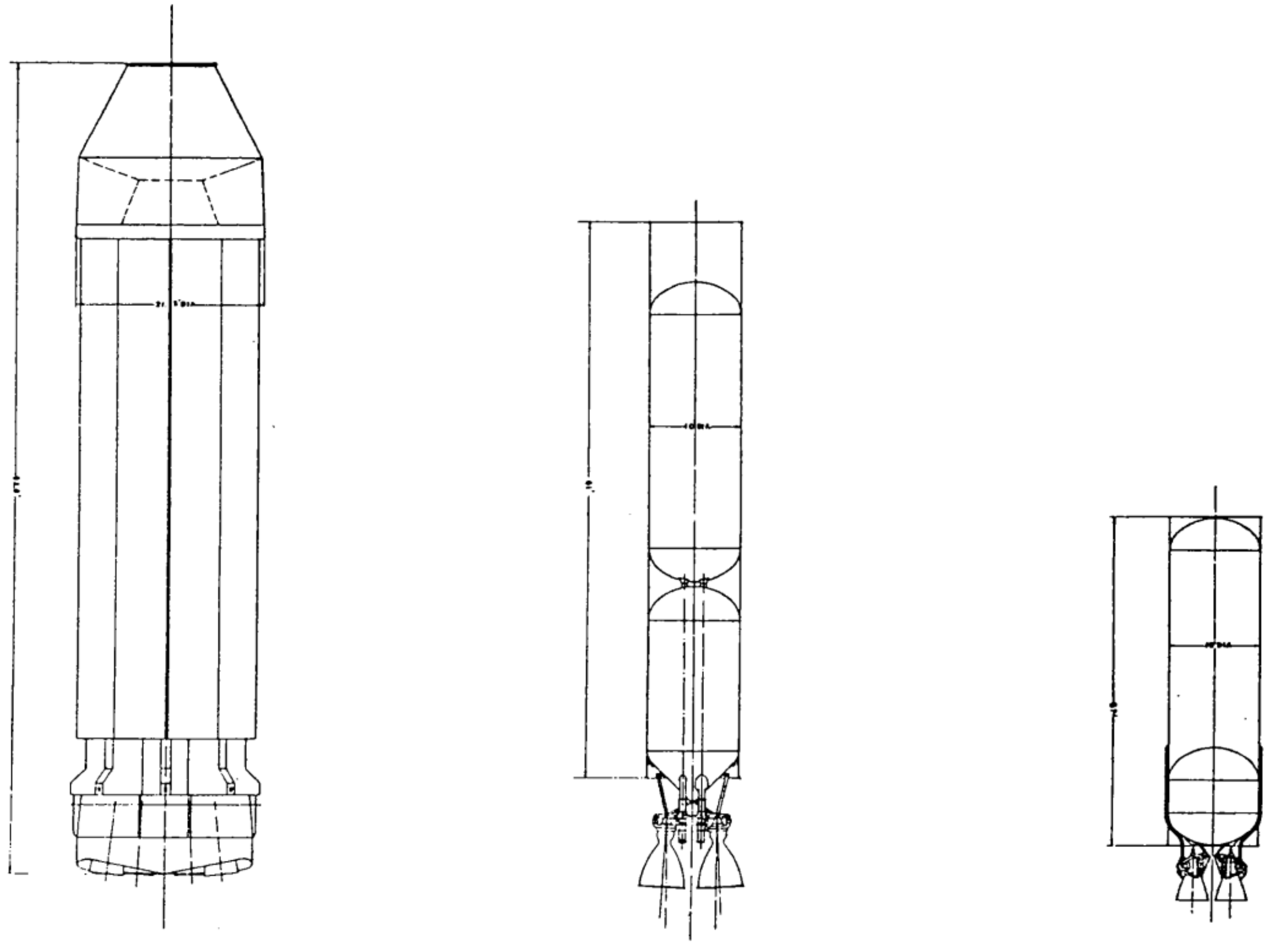
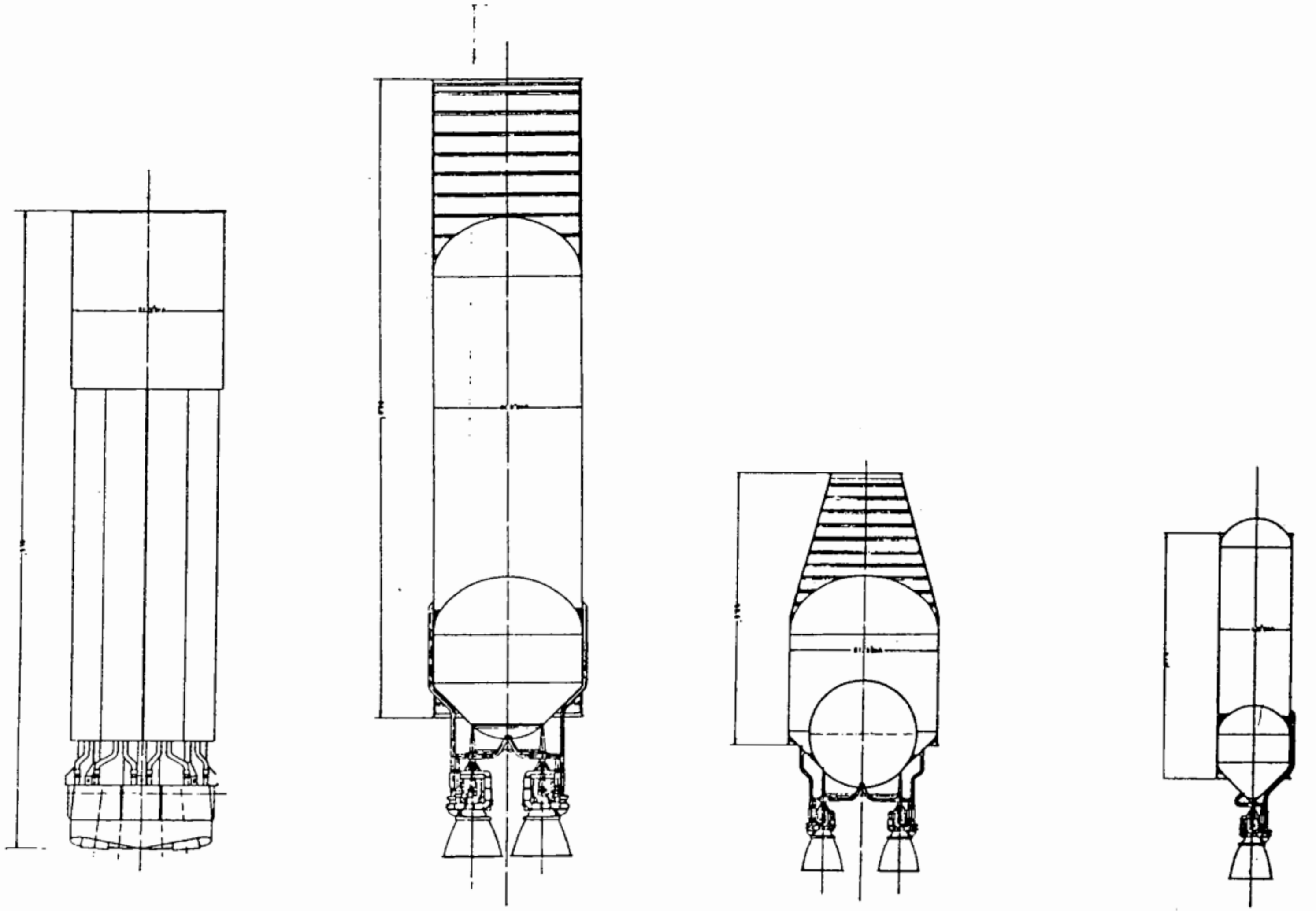


Fig. I-10. SATURN II



First Stage (Booster)   Second Stage   Third Stage

Fig. I-9. SATURN I, Stages 1 through 3



First Stage (Booster) Second Stage Third Stage Fourth Stage

Fig. I-11. SATURN II, Stages 1 through 4

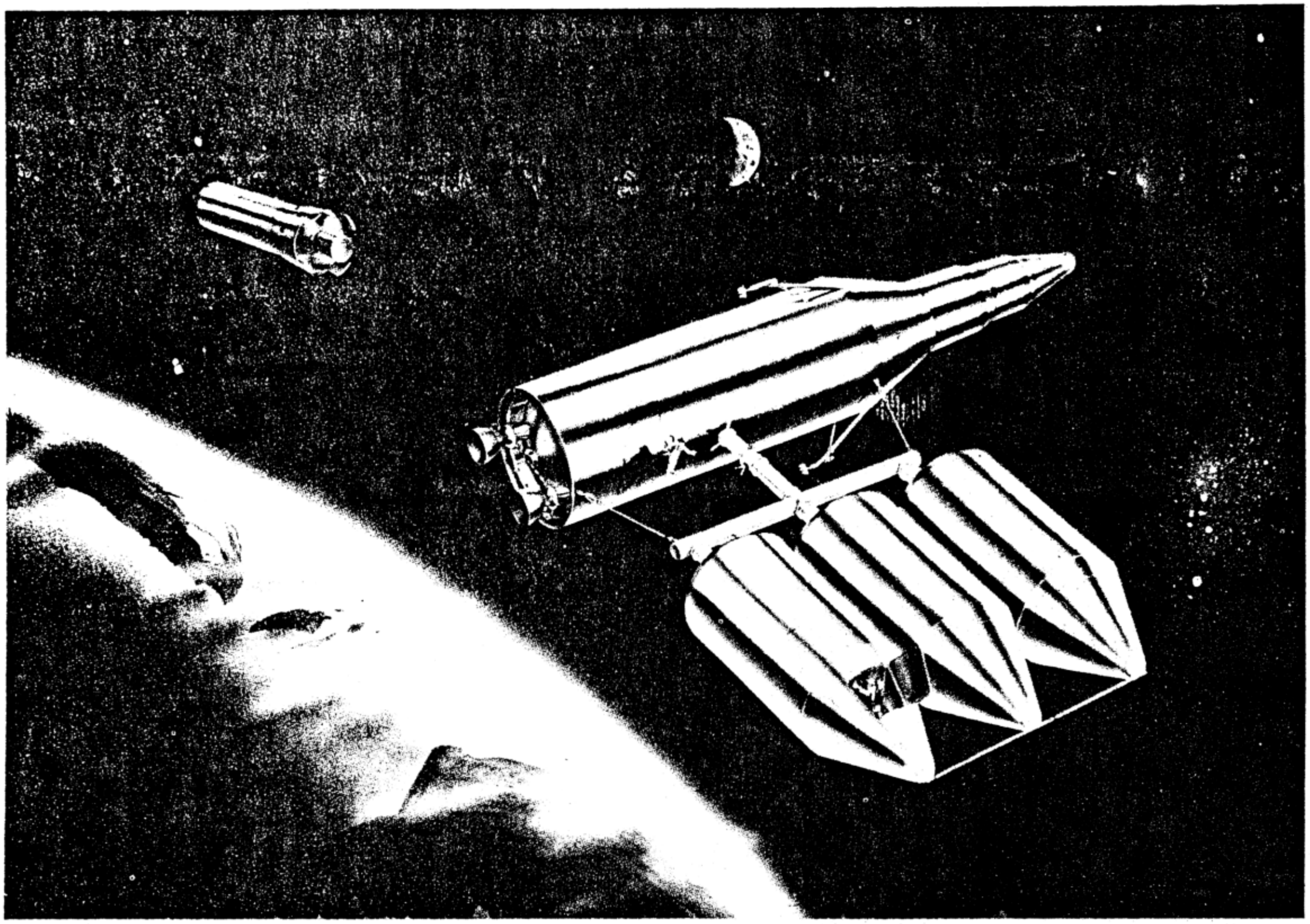


Fig. I-12. Equatorial Earth Orbit

third stage will utilize two 100,000-pound thrust H_2/O_2 engines, a fourth stage will use one such engine. Present feasibility studies inducate a SATURN II payload capability of 70,000 pounds into a 96-minute orbit using three stages and 26,750 pounds to earth escape velocity using four stages. The development of such a vehicle will provide the nation a new-optimum vehicle for the utilization of the SATURN booster. The prime requirement for the development of such a vehicle is an expansion of current high-energy O_2/H_2 engine programs to include development of 100 K and 500 K engines.

As mentioned earlier, 6,000 pounds of useful cargo can be soft-landed on the moon with the direct method. As presented herein, only cargo will be transported in this manner, although there is a discussion of how personnel could also be transported to and from the moon utilizing the direct method. The second form of conveyance requires two steps. Initially the required payloads, which will consist of one main lunar rocket vehicle and several additional propellant tankers, will be placed in a 96-minute orbit of the earth. At this time, the propellants in orbit will be transferred to the main lunar rocket vehicle.

Figure I-12 is a conceptual view of the operations in the equatorial earth orbit. The operation in orbit is principally one of propellant transfer and is not as assembly job. The vehicle being fueled is the third stage of a SATURN II with a lunar landing and return vehicle attached. The third stage of the SATURN II was used in bringing the combination into orbit and has thus expended its propellants. This stage is fueled in orbit by a crew of approximately ten men after which the vehicle then proceeds on the moon. It is planned to send all personnel and approximately 1/3 of the cargo to the moon by the orbital method.

Using this orbital system, individual payloads of 48,000 pounds may be soft-landed on the moon. This value is especially significant, since it represents the approximate minimum weight required for a complete earth return vehicle, which is already assembled and loaded with propellants and is capable of returning several men. Thus, in order to provide a preassembled return vehicle on the lunar surface during the time frame under consideration, it is mandatory to go through an initial earth orbit. In addition to providing a large individual payload capability, the orbital transportation system offers other important advantages. Among these are that the total number of firings to deliver the same amount of payload to the moon is less and

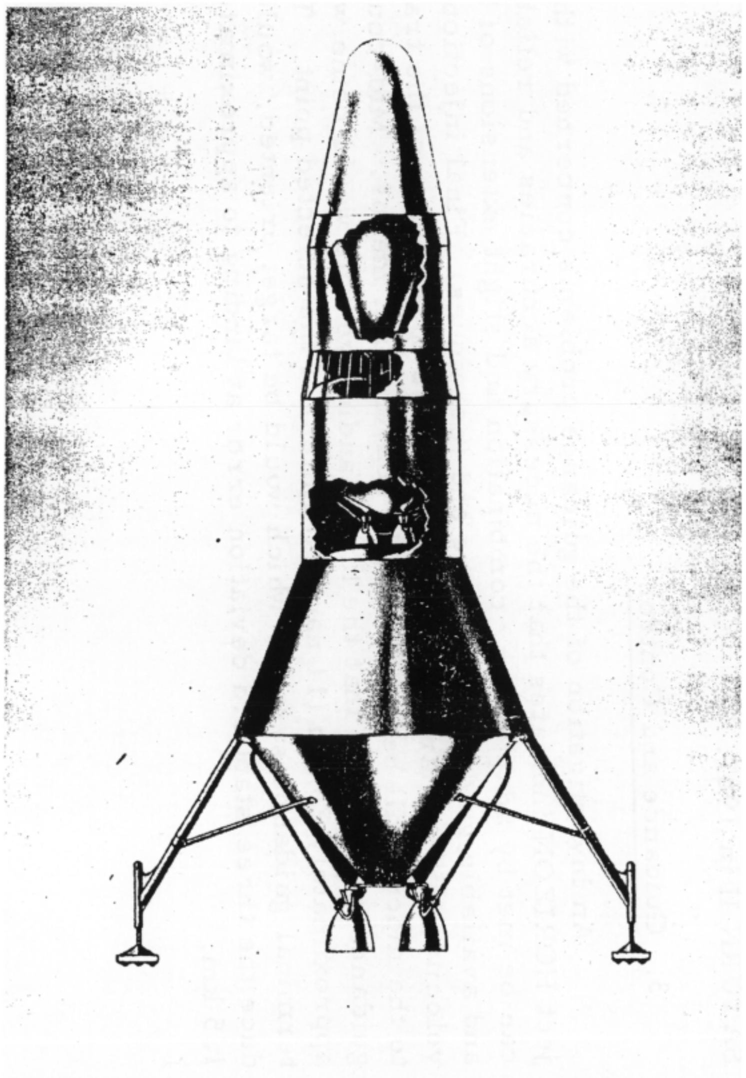


Fig. I-13. Lunar Landing Vehicle

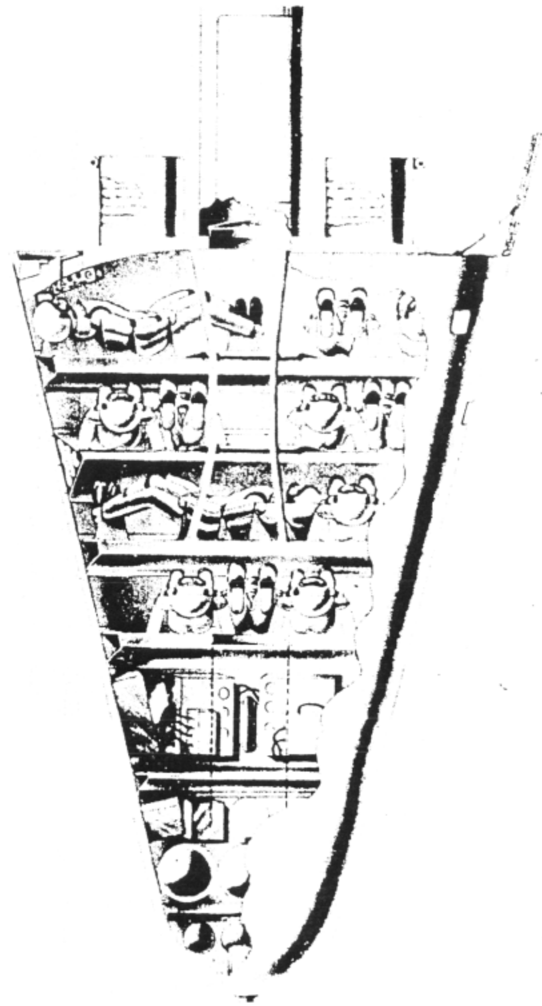


Fig. I-14. Orbital Return Vehicle

payloads may be fired for orbital rendezvous at any given pass every day of the month. This alleviates the launch site scheduling problems which are associated with the restricted firing times of direct flights.

There are two versions of the lunar landing vehicle. The first type will be used for direct trips from earth to the lunar surface. This vehicle has a gross weight of 26,750 pounds and will soft land some 6,000 pounds of payload. The second vehicle will be used for flights via orbit. It will have a gross weight of 140,000 pounds which gives it a capability of soft landing approximately 48,000 pounds of payload on the moon. Each type of vehicle will have suitable payload compartments to accomplish different mission requirements. The lunar landing vehicle shown in Fig. I-13 has an earth return vehicle as a payload. For such return vehicle payloads, the structure of the expended braking stage will serve as a launching platform when it is time to begin the return journey to earth.

To sustain the orbital station crew and to provide for their safe return to earth, an orbital return vehicle such as shown in Fig. I-14 will be provided. This vehicle may be used in conjunction with another established United States orbital station, or it may be used as a basis for a minimum orbital station needed to support Project HORIZON. It is capable of carrying from 10 to 16 men. It will be carried into orbit by a SATURN I during the first part of the program and replaced by a SATURN II in 1967.

3. Guidance and Control

An investigation of the guidance problems concerned with Project HORIZON indicates that the necessary accuracies and reliabilities can be met by adaptations, combination and slight extensions of known and available guidance hardware and techniques. Final injection velocity, which marks the beginning of the coast phase of the trajectory to the moon, will be controlled by conventional means. Mid-course guidance will assure that the lunar landing vehicle would come within approximately 20 km (11 nautical miles) of the selected point. The terminal guidance system, which would be target oriented, would reduce the three standard deviation error at landing to approximately 1.5 km.

E. TRANSPORTATION SYSTEM INTEGRATION

The development and integration of the space carriers to support HORIZON have been carefully outlined and various considerations as to compatibility, size, development schedule, and overall mission have been included and discussed in detail in Volume II.

Personnel space transportation requirements to support HORIZON are shown on Fig. I-15. By the end of 1967 some 252 persons will have been transported into an earth orbit, 42 will have continued to the moon, and 26 will have returned from the moon. The orbital station strength is approximately ten; however, the crew will be rotated every several months. The space transportation system will deliver some 756,000 pounds of useful cargo to the lunar surface by the end of 1967. In order to accomplish this, 229 SATURN vehicle firings will be required. A schedule of launching and the broad mission assigned each vehicle is shown in Fig. I-16. It should be noted that, due to the savings incurred by the booster recovery system which will be used, the total number of SATURN boosters required to support the program is not 229 but only 73.

F. COMMUNICATIONS ELECTRONICS

The communications required for Project HORIZON are logically divided into an earth-based and lunar-based complex. Each of these complexes may be considered as having two functions - communications and surveillance. Of particular significance for the earth-based complex is the 24-hour communications satellite system presently under development. As illustrated in Fig. I-17 such a system will provide the capability of constant communications with both space vehicles in transit and the lunar outpost.

In addition to the 24-hour communications satellite system, the current development program of a world-wide surveillance net will provide space surveillance for the United States during the 1960 era. The basic hardware and techniques used in this net are directly applicable to HORIZON. Figure I-18 illustrates schematically how such a world net station could be expanded to support HORIZON by the addition of two additional 85-foot antennas and other equipment.

Communications on the lunar surface will pose special problems due in a large part to the lack of atmosphere and the relatively high curvature of the surface. However, careful investigation reveals no

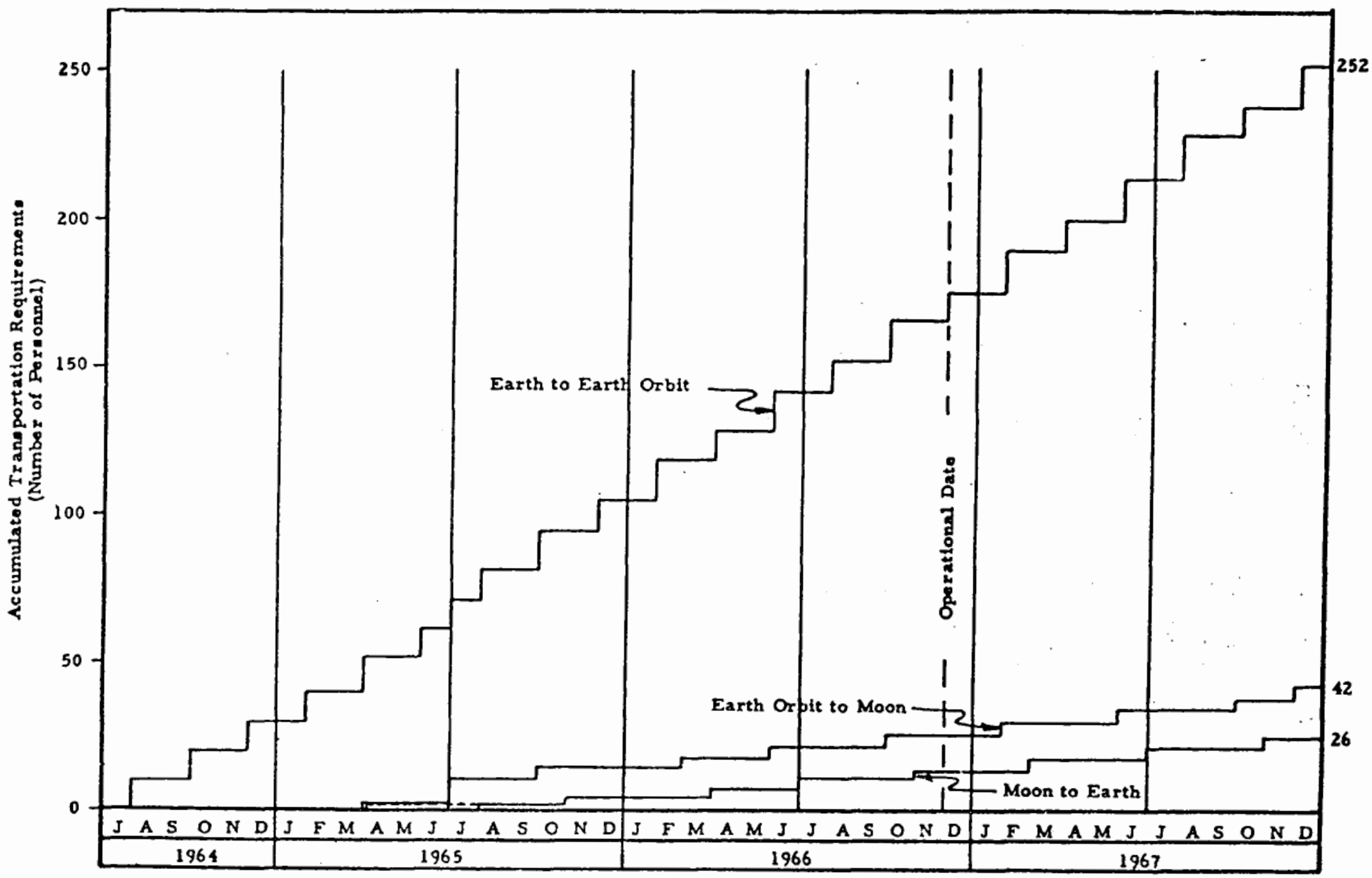


Fig. I-15. Project HORIZON Personnel Space Transportation Requirements

PROJECT HORIZON VEHICLE REQUIREMENTS AND LAUNCHING SCHEDULE

Number of Flights for Designated Dates

Vehicle and Mission	1964						1965												1966												1967												Total Flights
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
Lunar Soft Landing Vehicle (Direct)																																											
SATURN II							1	1	1	1	1	2	2	2	2	1	2	2	2	2	2	2	2	2	3	2	3	2	3	2	3	2	2	3	2	2	3	2	2	3	2	2	73
Earth-Orbit and Return (Manned)																																											
SATURN I		1		1		1		1		1		1	1	1		1		1		1		1		1		1		1		1													16
SATURN II																																1		1		1		1		1		1	6
Earth-Orbit (Cargo)																																											
SATURN I		1	3	1	3	3	4	3	3	2	2	3	2	3	3	2	2	1	1	1		1		1		1				1													47
SATURN II				1				1	1	1	1			1	1	1	1	2	2	3	3	2	3	2	3	3	3	3	3	2	2	2	3	2	2	3	2	2	3	2	2	3	71
Emergency Vehicles																																											
SATURN I							1	1			1							1					1				1																6
SATURN II													1				1		1			1		1				1				1			1			1			1		10
Orbit-Lunar Soft Landing (Cargo)							1												1							1				1													4
Orbit-Lunar Soft Landing (Manned)										1			1			1					1			1				1					1			1			1			1	10
Lunar-Earth Return														1			1					1			1			1						1			1			1			8
Total																																											
SATURN I		2	3	2	3	4	5	5	3	3	3	4	3	4	3	3	2	3	1	2		2	1	2		2	1	1		2													69
SATURN II				1			1	2	2	2	2	2	3	3	3	2	4	4	5	5	5	5	5	5	6	5	6	6	6	4	5	6	5	6	5	6	5	6	5	6	5	6	160
Total Carrier Vehicles for Project HORIZON		2	3	3	3	4	6	7	5	5	5	6	6	7	6	5	6	7	6	7	5	7	6	7	6	7	7	7	6	6	5	6	5	6	5	6	5	6	5	6	5	6	229

OUTPOST OPERATIONAL DATE

Fig. I-16. Project HORIZON Vehicle Requirements and Launching Schedule

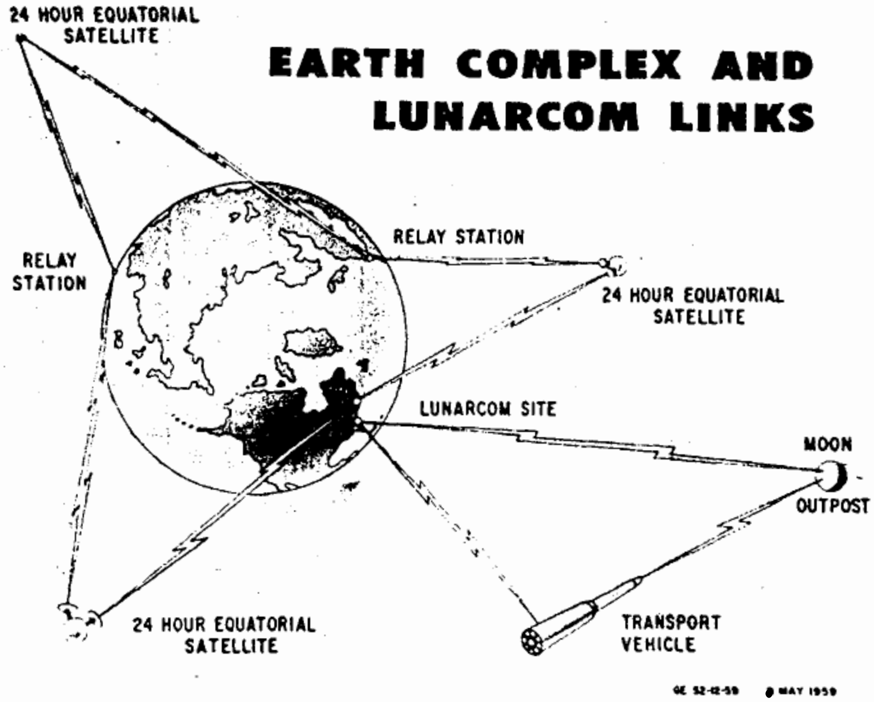


Fig. I-17. Earth Complex and Lunarcom Links

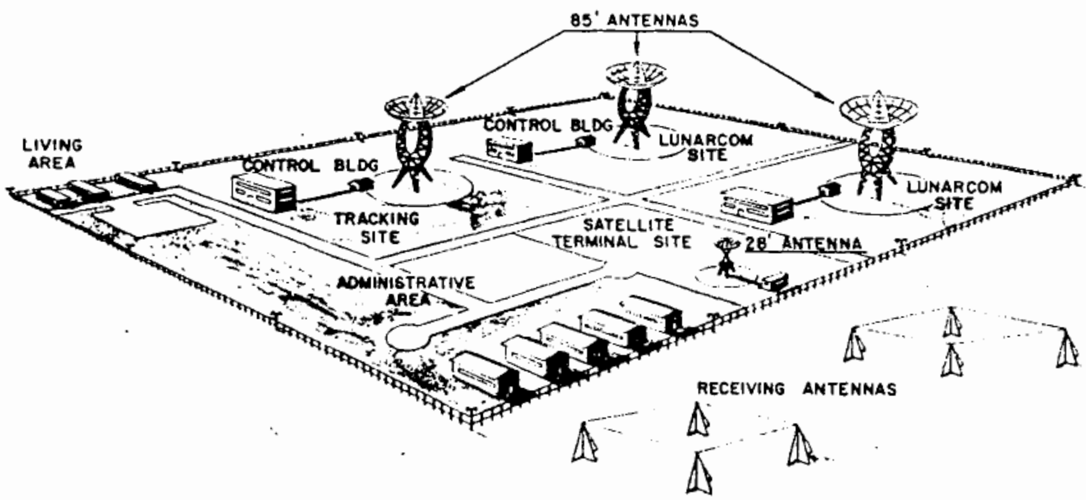


Fig. I-18. Typical Tracking and Lunarcom Site problems which cannot be solved by an appropriate research program. In a number of areas, current developments appear almost directly applicable; for example, the small helmet-mounted radio currently in production and troop use. A microminiaturized version of this, presently in advanced development, will provide a basis for personal communication between individuals clad in lunar suits. As the lunar outpost expands, radio relay stations will extend the radio horizon as conceived in Figure I-19.

In addition to voice communication between members of the lunar party, a number of other electronic devices will be used at the outpost. These include TV receipt and transmission, transmission of still photographs, homing and location devices, instantaneous self-contained emergency communications packs (for distress signals to earth), infrared detectors, and radar detectors.

G. LAUNCH SITE

ok!

A survey was made to determine the adequacy of the Atlantic Missile Range and Pacific Missile Range for the accomplishment of Project HORIZON. The results of this survey indicated that, all things being considered, neither site was suitable. Since a new launch site will be required, a study was made to determine the optimum location and requirements for such a site.

No!

The results of this study are discussed in detail in Volume II and illustrated in Fig. I-20. A total of eight launch pads are required. This facility will support the requirements of HORIZON and would also provide additional capacity for other United States programs.

The equatorial location of the new launch site would provide very real advantages in terms of payload capability, guidance simplicity, and operational launching schedules in terms of increased latitude of appropriate firing times. Two sites stand out when compared to others - Brazil and Christmas Island. Both of these locations appear feasible; however, more detailed criterial will have to be established to make the best choice. Cost and early availability may ultimately be the governing factors. It is emphasized that site acquisition and initiation of launch site construction is one of the most critical items in the program with respect to leadtime. For the purposes of this study it has been assumed that the Brazil site would be used.

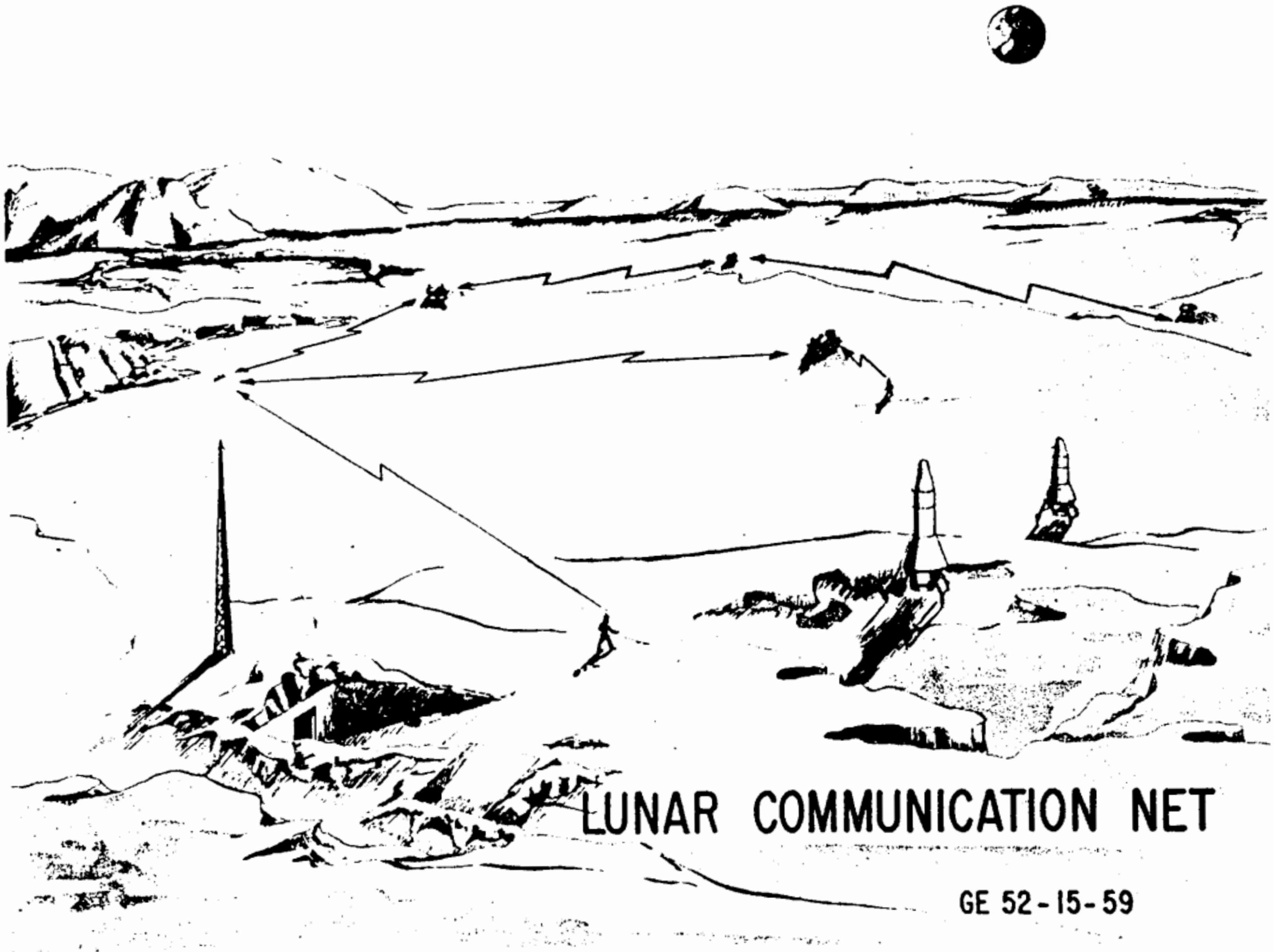


Fig. I-19. Lunar Communication Net

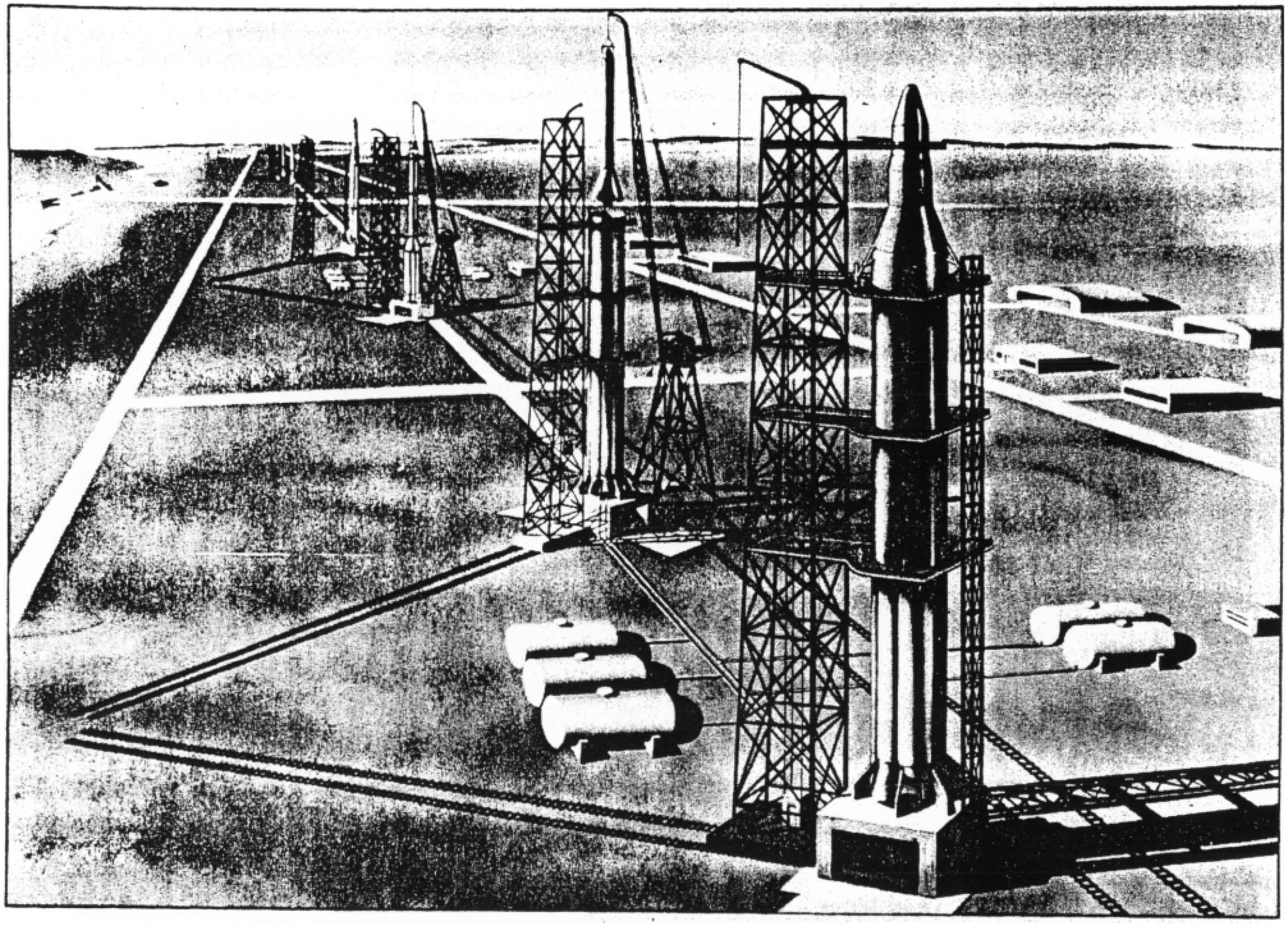


Fig. I-20. Terrestrial Launch Site

H. PROGRAM LOGISTICS

The logistic support for Project HORIZON has been studied in overall scope as well as detailed investigations of specific areas such as manufacturing considerations, transportation considerations, personnel, and personnel training.

The results of the studies show very clearly that military participation in the logistic portion for Project HORIZON is not only desirable, but mandatory. No attempt has been made to determine the level of military participation since such items as the world-wide political situation will play an important part in the ultimate decision.

I. RESEARCH AND DEVELOPMENT

Project HORIZON has been divided into six phases which include R&D as well as the operational aspects of the overall program. The schedule for each phase is illustrated on Fig. I-21 and discussed below:

Phase I - The initial feasibility study was completed on 9 June 1959 and is contained in this two volume report.

Phase II - The detailed development and funding plan will require a more detailed study with limited experimentation. This phase will require approximately eight months to complete and will cost $5.4 million.

Phase III - The hardware development and system integration phase constitutes the majority of the development effort. In Phase III all:

Systems (space transportation, communication outpost, etc)

Sub-systems (space vehicles, communications, ground and relay stations, etc.)

Components (rocket engines, communication transmitters & receivers, etc.)

Schemes and procedures (orbital rendezvous, orbital fuel transfer, etc.)

required to accomplish the project objectives will be developed.

Phase IV - The construction of the lunar outpost involves the utilization of the systems and procedures developed in Phase II and is in actuality an operational phase of the program. The completion of this phase will accomplish the initial objective of the program - "establish a manned lunar outpost."

Phase V - The initial period of outpost operation will begin in December 1966 and will constitute the first completely operational phase of the program.

Phase VI - The expansion of initial outpost operational capabilities could begin at any time after December 1966. For the purpose of this study it has been assumed to begin in January 1968.

1. Basic and Supporting Research

The importance of a strong basic and supporting research effort in support of a project of this nature cannot be over stated. Typical areas requiring attention are food and oxygen, clothing, chemical, biological, radiological, bio-medical, vacuum conditions, weightlessness, meteoroids, lunar-based systems, moon mapping, explosives in lunar environment, power generation, material and lubricants, liquid hydrogen production and handling, and lunar "soil" mechanics.

2. Project HORIZON Development Program

As mentioned above, a strong basic and supporting research program will be required to accomplish the HORIZON development program, and ultimately the project objectives. The development program for this project is basically covered by the first three phases of the project outlined above, the first of which has been completed. Phase II, the next step in the development program, must be accomplished in the time scale indicated in Fig. I-21 if the United States is to succeed in establishing the first lunar outpost. The development plan, generated in Phase II will spell out in considerable detail the developments required in Phase III, as well as requirements for later phases.

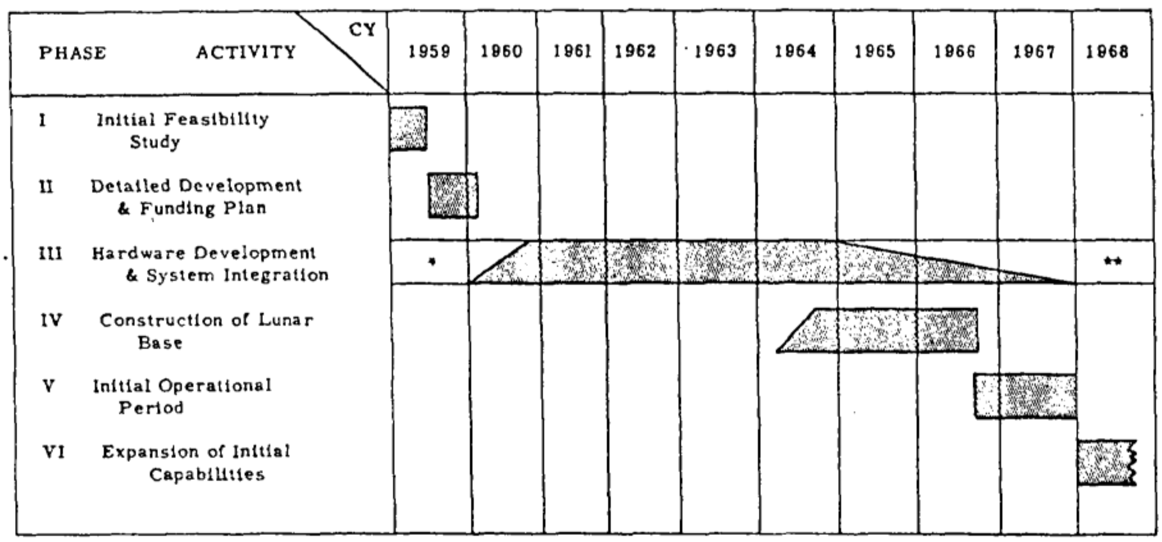
Basically, Phase III will be the development portion of the project. During this phase, all development required to accomplish the project objectives will be satisfied.

3. Research and Development Facilities

Several unique facilities will be required to support HORIZON. Figure I-22 is a view of a large lunar environmental simulator which will provide a capability for research, development, testing and training for HORIZON as well as other projects in the national space program. Figure I-23 illustrates a space flight simulator which will provide for research and training of effects associated with boost acceleration, coasting, weightlessness, and braking deceleration. In addition, medical research facility is located in conjunction with this site.

PROJECT HORIZON

RESEARCH AND DEVELOPMENT PROGRAM



* Hardware and Systems being developed for other programs that will have direct application in Project HORIZON.

** Development required for expansion of capability.

Fig. I-21. Organization for Research and Development

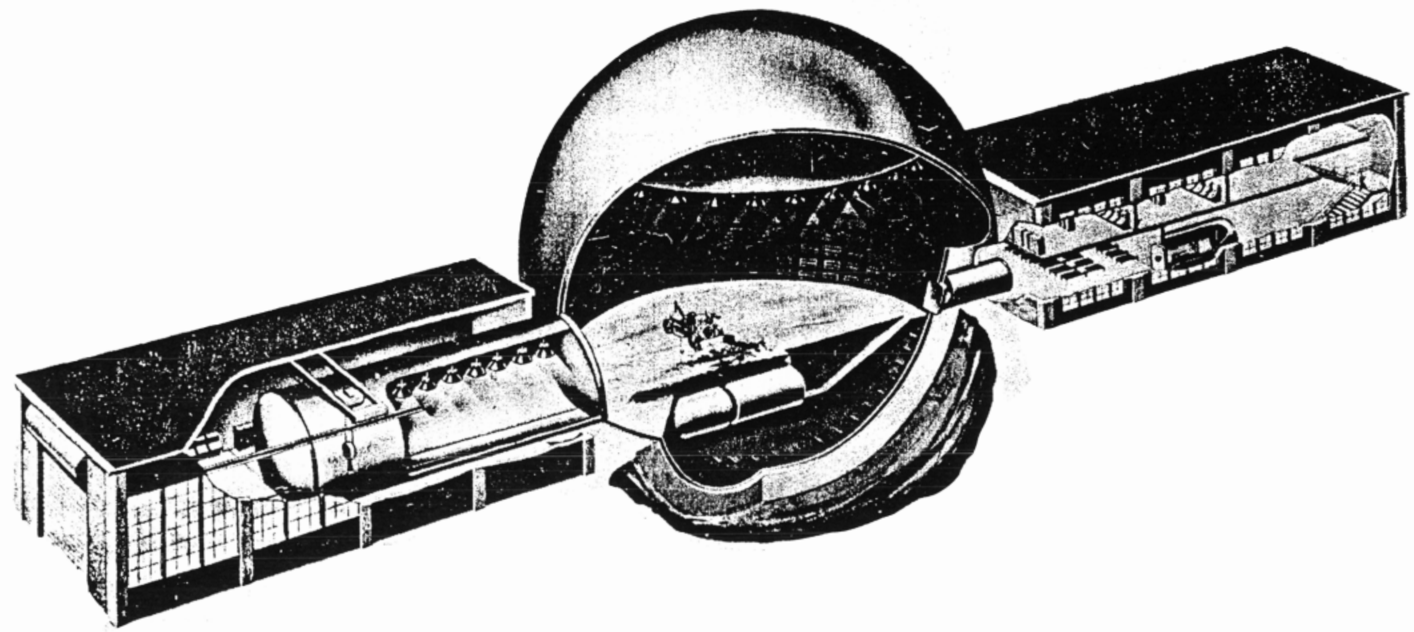


Fig. I-22. Cross Section Through Main Facility LERUT

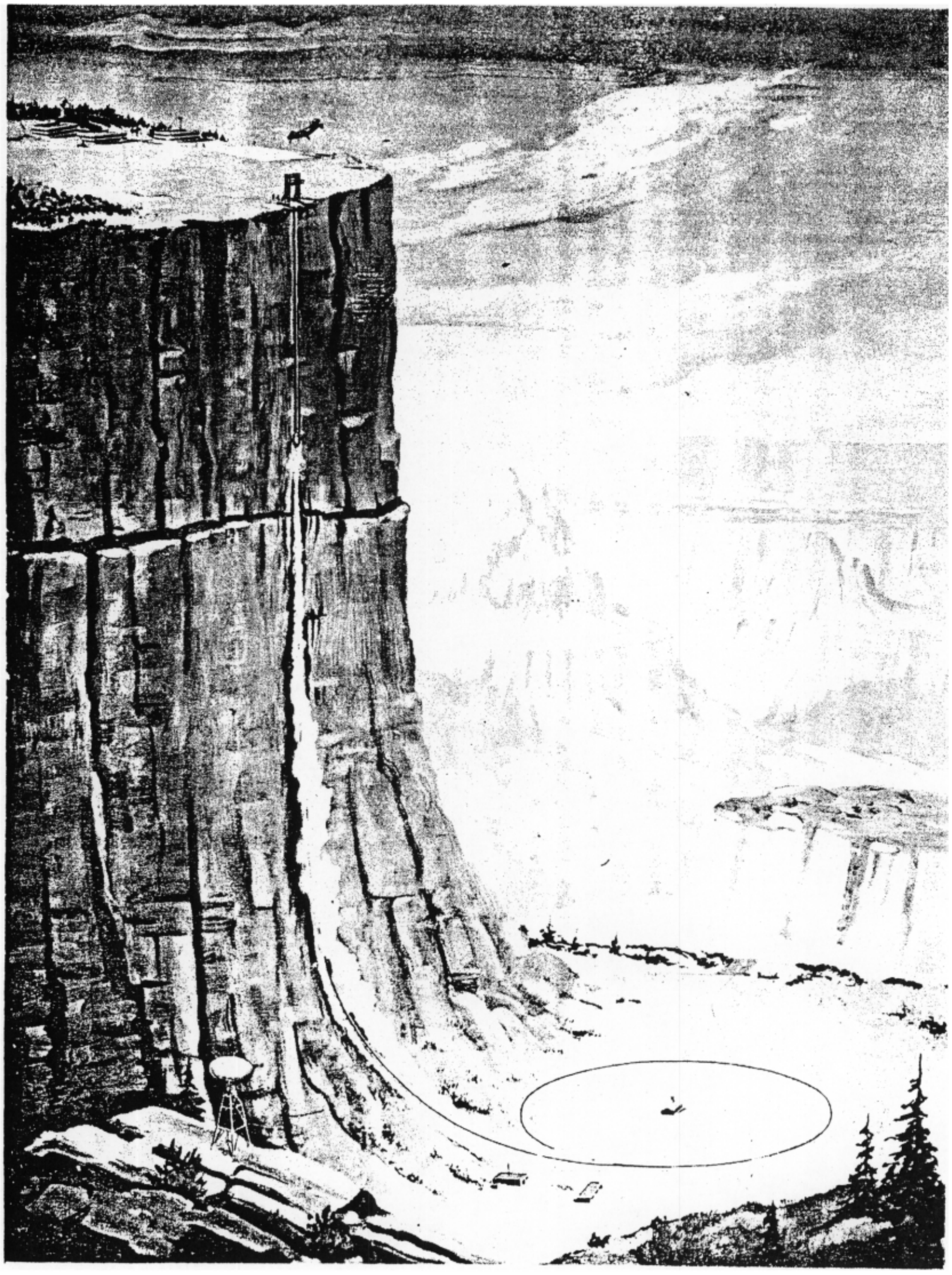


Fig. I-23. View of Flight Simulator

(S) CHAPTER III: MANAGEMENT AND PLANNING CONSIDERATIONS

A. SCOPE OF OPERATIONS

1. General

Having developed a requirement for the establishment of a manned lunar outpost, we may discuss the operational concepts and facilities necessary to fulfill that requirement. From these, an organizational structure can be evolved. The treatment of the technical concepts and facilities in this chapter will be limited to that detail absolutely necessary to establishment of an organizational/operational structure.

2. Terrestrial Launch Site

In order to accomplish any space mission, a terrestrial launch site will be required. Use of any of the existing sites controlled by the United States has several disadvantages. Among these is the fact that all of these bases are geographically located as to limit firing times to but a few days each month and to require wasteful expenditure of available energy to achieve success. This latter results from the fact that none of the existing launch sites are located close to the equator. Furthermore, once human beings are either placed in orbit or dispatched on planetary missions, there can be no interfering problems regarding scheduling of firings, either regular or emergency; physical space difficulties resulting from supply build-up or other logistic considerations, etc. The terrestrial launch site is expected to evolve into an operational complex supporting both continued R&D and firing by operational units with orbital or other space missions. Existing United States launching complexes are devoted primarily to R&D firings of weapons systems. Most such complexes are rapidly becoming saturated with such firings in the confines of their present areas. It rapidly becomes evident that a separate site will be required in order to support this nation's space efforts in a most economical manner.

There are a great many factors involved in this requirement. They are discussed at length in Chapter V. Three major factors influencing requirements are:

a. Operational need for having an orbital station in an equatorial orbit to simplify the rendezvous problem.

b. High payload penalty and complexity of trajectory problem involved in "dog-legging" into equatorial orbit from a non-equatorial launch site.

c. Magnitude of effort requred to implement the objectives of this operation.

In addition, of course, there are other factors influencing the attainment of such a site. For example:

a. Diplomatic and political implications involved at some suitable sites.

b. Military vulnerability and security requirements at all suitable sites. (These are relative choices not necessarily consistent with the best diplomatic or political choice.)

c. Cost: It may be reasonably assumed here, based on the above mentioned factors and detailed technical considerations in Volume II that an equatorial launch site will be selected. It will be the terrestrial site from which this nation dispatches its first man destined to set foot on the lunar surface. This site will provide a capability to conduct additional space missions in fulfillment of other requirements.

For this site to be operational in sufficient time, action is demanded immediately in negotiations required for acquisition. Build-up of facilities must begin at an early date in order to meet the desired operational readiness date.

A terrestrial launch site, which supports the lunar outpost project during the early technical effort, should also support it during the operational phase. There will be practical requirements for the utilization of the launch site for other projects possibly involving military R&D, military operations, and the National Aeronautics and Space Administration. Practical problems thus raised are subsequently treated under organizational considerations.

3. Orbital Station

In order to successfully accomplish lunar soft landings in the time frame under consideration, firings may be undertaken either directly from the earth's surface to the destination or by means of an intermediate station in orbit about the earth. The former approach requires the expenditure of tremendous amounts of energy for relatively small payloads. Therefore, it cannot provide an immediate return capability in the proposed time frame, using the boosters then available. Under those conditions, the orbital station, providing larger payloads and immediate, emergency, return capability from the moon is the most desirable choice for transport of personnel.

During early transit operations through the orbital station, facilities in orbit will be on a minimum essential, austere basis. It will have rendezvous, refueling and launch capabilities but not a vehicle assembly capability. During this period, it will be little more than an interim assembly of fuel tanks and other hardware in orbit. Personnel involved in its operation will utilize their earth-to-orbit-to-earth vehicle as living quarters for the duration of their stay in orbit. Until an orbital station is developed to a higher order of operational autonomy in support of this and perhaps other operations, it will be under the immediate operational control of the terrestrial launch site.

Throughout the operation, assembly of equipment in orbit must be directed toward the eventual establishment of more sophisticated orbital stations. As indicated previously, an early improved station may be constructed from 22 vehicle shells. Prior to any expansion of lunar outpost operations, sufficient tankage will have been placed in orbit to permit construction of two or three such stations. Having more than one station in orbit enhances future operational capability and flexibility by increasing number of possible firing times per month.

Although it is considered premature in this preliminary feasibility study to establish an exact schedule for assembly of more sophisticated orbital stations, the operational requirement must be recognized now. Some considerations which affect implementation of this requirement are that:

a. No other program is likely to make available a similar amount of material, in orbit, without a previously established purpose.

b. The demands of this program will use a considerable fraction of foreseeable or predictable large booster resources.

c. The economy of using otherwise wasted resources to a constructive end.

Early attainment of more advanced operational capability in the orbital station will contribute to other space activities as well as to this specific operation. Examples of such contributions are:

a. Space laboratory, acclimatization, and training capability for personnel.

b. Space laboratory for equipment.

c. Materiel storage space.

d. Low-altitude communication relay.

e. Earth surveillance (perhaps a security consideration in this specific operation).

f. Space surveillance.

g. Meteorological surveillance.

h. Survey/geodesy data collection.

i. Instrumentation for test of earth-to-space weapon effects.

As the scope of operations at the orbital station increases, so will the interactions with other national space activities increase. therefore, it can be expected to evolve into an independent agency supporting this terrestrial launch site, and possibly others.

4. Lunar Outpost

This goal of the project is envisioned as falling into several basic areas as follows:

a. Life Support and Preliminary Exploration.

In the first outpost phase, lasting from 30 to 90 days, concern of those landed revolves primarily about life support and the human verification of many details of information previously generated by unmanned satellites or probes. Permanent site selection will also depend upon such verification.

b. Construction

During the second outpost phase, we find personnel and cargo located in the vicinity of the permanent site capable of contructing habitable structures. There will be a rotation of personnel during this phase which will last approximately 18 months. Maximum tour will not be more than one year. Titular head of the outpost during this period will be one whose primary speciality is construction.

c. Benefical Occupancy and Initial Operational Capability

This is the goal for Project HORIZON as set forth in this study. The outpost at this point can comfortably support 12 men, six of whom will spend a large part of their time in general maintenance and life support.

These volumes have focused on the goal of establishing a lunar outpost capable of supporting 12 people. This represents a large capital expenditure. Once established, the cost is shown decreasing as a result of eliminating the capital expenditure and continuing only the life support resupply. In order to realize a full return on the investment involved, it will obviously be desired to establish additional equipment at the outpost in quantity. For example, the use of the moon as a launching site for manned or unmanned planetary expeditions will be highly desirable. As such requirements multiply it is obvious that construction, equipment, and personnel requirements will also multiply.

There exists an immediate requirement, therefore, to initiate an early industrialized expansion of the outpost giving it a capability of self-regeneration, to the greatest extent possible, from materials at hand. Each returning vehicle will bring physical and biological materials and samples back for analysis. Each sample must be critically analyzed to determine its utility. Methods must then be determined and equipment transported to the lunar outpost which will contribute to a self-regenerative capability. During this secondary/expansion/construction period, the operational outpost will acquire an industrial self-regenerative capability and capabilities will evolve which manifestly justify the entire effort. In addition, this nation will be in the position of having contributed in an early and timely manner to the extension of man's horizon.

B. ORGANIZATIONAL AND OPERATIONAL CONCEPTS

1. General

As indicated earlier, it is expected that the terrestrial launch site and the orbital station will have applications in both R&D and operational activities of other projects. The potential scientific applications of the lunar outpost cover a broad spectrum of activities.

The scope of activities which must occur at the locations of the essential elements of this specific operation call for a full range of support including military, technical R&D; civilian (NASA) scientific research; operational logistics; operational space activity. This involves full Military Air Transport Service and Military Sea Transportation Service type support plus possibly civil air lift and merchant marine. One or more of these requirements will overlap assigned missions of major existing unified commands extending over broad geographical areas.

There will be requirements for support from and to other elements of government. Such requirements will affect both technical and operational elements of any organization set up for the accomplishment of this specific mission. One case, in point, is support of NASA scientific programs. Examples of other support or guidance requirements from or to governmental departments other than Defense are as follows:

a. Operations Coordinating Board, National Security Council; overall inter-departmental coordination.

b. Central Intelligence Agency, National Security Council; National Intelligence.

c. Department of State; relations with other interested nations.

d. Federal Bureau of Investigation, Department of Justice; security matters.

e. U. S. Coast and Geodetic Survey, Department of Commerce; survey and geodesy.

f. U. S. Geological Survey. Department of the Interior; selenology.

g. Atomic Energy Commission; power plants.

Even though some of the complex inter-relationships with other organizations may be handled as routine transactions through channels, many of them will require a standing working relationship by the most direct channels.

Political and diplomatic considerations evolving from site requirements could easily lead to a situation demanding a combined operation involving one or more countries. This would, of course, involve both the State Department and the Congress where treaty requirements arose. Alternative plans might include the lease in perpetuity of some land rights. The Panama Canal Zone is an example of this type approach. This approach does not necessarily solve outlying special instrumentation land requirements. Another alternative is outright purchase of land rights. Any combination of these different approaches which finally evolves will have an effect on organizational structure. Negotiations and decisions involving several departments of government are prerequisites to determination of a final answer. This subject merits further serious study.

Obviously, discussions on organizational and operational concepts are somewhat tentative until some of the points discussed above are resolved. We will proceed to further discussions on those subjects, tenative though they may be.

2. Over-all Management Structure

Some of the operational requirements which are indicative of over-all management requirements are:

a. Over-all authority and capability to direct the major operations of this specific project from certain state-side (United States) support through launch site, orbital station, and lunar outpost.

b. Sufficient depth and breadth in organization to assume responsiblity for all operational planning and implementation actions in relation to other space activities.

c. Sufficient stature to handle the day-to-day working relationships with military and civil departments of government both in obtaining their support and in supporting their space activities.

d. Sufficient representation to and from military and civil departments of government to provide suitable mutual working relationships with them. (Army and Navy representation at the Atlantic Missile Range and Army and Air Force representation at the Pacific Missile Range might well be studied in this connection.)

Consideration of the above factors in the environment of the general situation leads to the conclusion that a project management agency is required. For purposes of proximity to the seat of government convenience in handling over-all coordination and control of all project activities, joint coordination and inter-departmental coordination, a United States location is probably preferable.

Directly subordinate to the project management agency would be several co-equal activities (See Fig. I-24.) Those would include:

a. Terrestrial launch site.

b. Orbital station (fully operational).

c. Lunar outpost.

d. Training agencies where environmental requirements dictate location.

e. Specialized technical support activities, for which geographical location and/or distribution is dictated by technical considerations, for example, communications and tracking nets.

f. Possibly, to include specialized field offices at locations such as:

(1) Military air transport service terminals.

(2) Transportation terminal commands.

(3) Major depots or research and development activities.

Each subordinate agency would have specific mission responsibilities to project management. Each would have specific responsibilities to the other commands just as is the case in other tactical organizations.

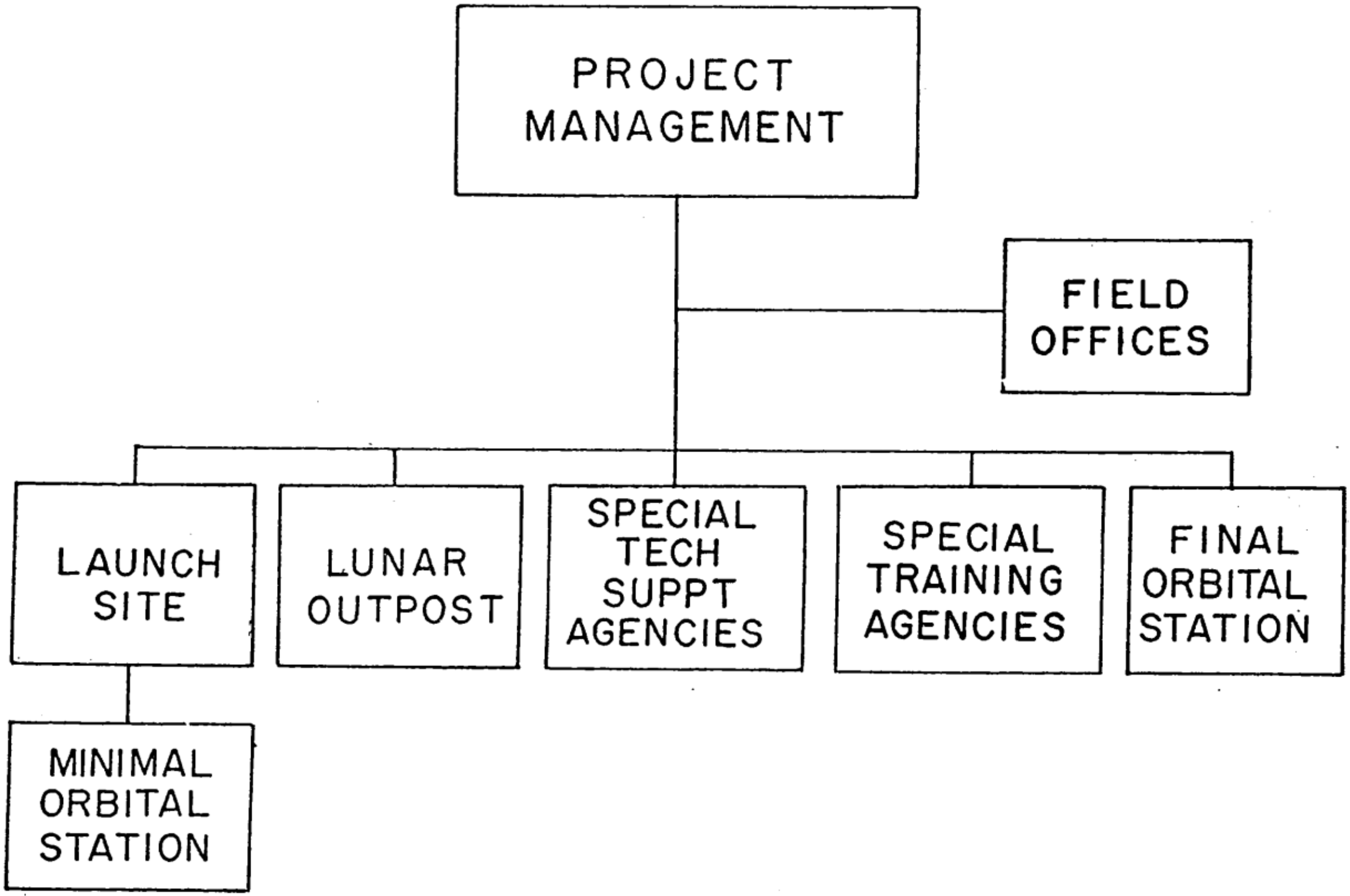


Fig. I-24. Project Organization

Some would have special responsibilities and delegated authorities peculiar to their particular operational situation. For example, the launch site may have major responsibilities in inter-departmental operations approaching that of one of the existing National Missile Ranges; the orbital station may have a major communications responsibility to the entire project, etc.

Both the project management and terrestrial launch site will require a full range of conventional and space-peculiar operational technical support. Technical support at the launch site must have the capability of cross service support to military and civil departments of government. Technical channels of communication should prevail on technical matters without abrogating or diluting responsibility.

3. Staff Organization

As previously noted, a full range of technical staffing and support is required. However, special space-peculiar operational requirements exist and must be clearly identified and treated in future planning documents. It must be recognized that all planning factors for an operation of this magnitude and significance are not firm particularly during the early stages of feasibility demonstration and for the operational as opposed to the purely technical.

At least in the early stages of operation of the orbital station and the lunar outpost, a different staffing pattern will prevail. Individuals must have a wide range of carefully selected skills. While this poses no insurmountable problems, it does require very careful coordination in all phases of operation from first concept approval until expansion of operations to a considerable degree at some yet undetermined date.

The preceding discussions suggest that early activation, staffing and training of the various agencies is mandatory. Full, optimum, most-economical operations will result from a carefully planned activation program. Waiting until the full requirement is imminent would, in any given instance, delay or hazard some facet of operations.

(S) CHAPTER IV: NON-TECHNICAL SUPPORTING CONSIDERATIONS

A. GENERAL

From the viewpoint of national security, the primary implication of the feasibility of establishment of a lunar outpost is the importance of being first. Clearly, we cannot exercise an option between peaceful and military applications unless we are first.

For political and psychological reasons, anything short of being first on the lunar surface would be catastrophic. Being first will have so much political significance that no one can say at this time what the absolute effects will be. However, it is apparent from past space accomplishments that being second again cannot be tolerated.

B. POLICY

Any new venture of the magnitude of this study creates an immediate requirement for both general and specific policy guidance. Policy is a product of times and circumstances. Man's experience in space matters is short, and the circumstances of his space activities are extensions of all the complex relations which preceded them. Accordingly, we have not evolved a comprehensive body of even controversial, much less agreed, policy.

Both the Executive and the Legislative branches of the United States Government have devoted considerable attention to the subject for approximately one and one-half years. The policy which has evolved from Legislative or Executive action is still quite general. No specific policy directed at the subject of this study was found.

An effort has been made to analyze existing general policy and to summarize it in a form suitable as background for this study. That summary is in Appendix A. There has been no conscious effort at abstraction of points of policy pertinent only to this subject. Rather, the effort was to summarize the general policy. This subject will require an early and continuing effort aimed at development, correlation, and codification of policy.

For the present, then, the policy, as the requirements, must be judged against the background of contemporary international political and military situations. The general policy, however, is sufficiently clear in stating the urgency of the situation.

The intelligence estimates which support statements of national policy credit the Soviet Union with a capability of accomplishing the objectives of this study any time after 1965. Therefore, we may infer a requirement from national policy.

C. POLITICAL, PSYCHOLOGICAL AND SECURITY IMPLICATIONS

1. Political and Psychological

The political and psychological implications of our failure to be first in space are a matter of public record. This failure has reflected adversely on United States military, scientific, and political leadership. To some extent we have recovered the loss. However, once having been second best in the eyes of the world's population, we are not now in a position to afford being second on any other major step in space. We have already stretched our luck in being second with the space probe and sun satellite. However, the political implications of the space activities accomplished to date have not been nearly as serious as those which will result from failure to be first in this operation.

The results of failure to first place man on extra-terrestrial, naturally-occurring, real estate will raise grave political questions and at the same time lower United States prestige and influence in dealing with this and related problems. The Soviet Union has announced openly its intention that some of its citizens will celebrate the 50th anniversary of the present government (1967) on the lunar surface. The United States intelligence community agrees that the Soviet Union may accomplish a manned lunar landing at any time after 1965. Judging from past experience, it is easy to visualize all manner of political and legal implications which the Soviet Union might postulate as a result of such a successful accomplishment. As is so often the case in points of law, the effect is the derivative of the precedent.

There are possibly other applications of space which will permit earlier derivation of meaningful military capabilities than will a successful lunar outpost provided these applications are pursued vigorously. Individually, however, they will not have the same political impact. In the still vague body of fact and thought on the subject, world opinion may be expected to view the other applications similar to actions on the high seas and also to view the establishment of a first lunar outpost similar to proprietary rights derived from first occupancy. As the Congress has noted, we are caught in a stream in which we have no choice but to proceed. Our success depends strongly on the decisiveness with which we exercise our current options. The lunar outpost is the most immediate such case. It is the basis for others more far-reaching such as further inter-planetary exploration.

More detailed coverage of legal and political implications may be found in Appendix B. They are directly related to policy discussions in Appendix A.

2. National Security

Volume II of this study indicates that it has the objective of treating the subject up to and including the establishment and maintenance of a twelve-man outpost of which approximately fifty percent (six men) would have the continued functions of life support operations. This would include operation and maintenance of equipment with perhaps minor technical improvements in the outpost. While it may be granted that this achievement will have been a major national accomplishment from the political and diplomatic viewpoint and will provide the know-how for expansion, it will not satisfy all of the foreseeable national security requirements. It is, therefore, merely a point of departure for security considerations.

The total extent of the military applications, which may evolve after the establishment of the initial outpost, is a function of variables which require operational and/or technical evaluation beyond the scope of this study. Some entail National Security Council type evaluation. Examples are:

(1) Evaluation of the actual or potential threat to the continued operation of the outpost and policy on countering the threat. This must include a study of interactions with other space activities.

(2) Evaluation of the significance of lunar operations within the broader framework of the total national defense.

(3) Military evaluation of the operational and technical requirements to implement any National Security Council policies which are specified.

(4) Cost of implementing military operational and technical requirements.

(5) Utilization of knowledge gained during first phases of outpost operation.

(6) Extent to which national policy requires attainment of specific military or scientific capabilities.

(7) State-of-the-art improvement in rocket booster engines, particularly in specific impulse, thrust, and weight.

APPENDIX A: POLICY OF THE UNITED STATES WITH RESPECT TO ACTIVITIES IN SPACE

The following policy statements have recently been made by the Executive and Legislative Branches of the Government.

1. Statements by the President of the United States:

a. In the State of the Union Message of 9 January 1959, the President said:

> "To achieve ... peace we seek to prevent war at any place and in any dimension. If, despite our best efforts, a local dispute should flare into armed hostilities, the next problem would be to keep the conflict from spreading, and so compromising freedom. In support of these objectives we maintain forces of great power and flexibility.
>
> * * *
>
> "We have successfully placed five satellites in orbit, which have gathered information of scientific importance never before available. Our latest satellite illustrates our steady advance in rocketry and fore-shadows new developments in worldwide communications."

b. In his Budget Message of 19 January 1959 dealing with Fiscal Year 1960, the President said:

> "For the fiscal year 1960, research and development expenditures will be increased still further, with emphasis on space exploration, peaceful uses of atomic energy, and basic science. Extensive space exploration investigations are being initiated, utilizing satellites and probes. Development work is going forward on high-energy fuel rockets, a million-pound thrust engine, and a nuclear rocket engine.

"Space flight. - The National Aeronautics and Space Administration, organized in 1958, is initiating extensive scientific investigations with satellites and space probes to increase our understanding of the earth's gravitational, magnetic, and electric fields; radiation from space; and other phenomena. Programs in the field of meteorology will look toward the ultimate establishment of a worldwide system of satellite weather observation, and in the field of communications will continue to experiment with the use of satellites to serve as relays for the intercontinental transmission of messages, voice, and television. Projects to increase our ability to place heavy objects in space include development of high energy fuel rockets, a million-pound thrust engine, and a nuclear rocket-engine."

c. In a message to the Congress dated 2 April 1958 entitled National Aeronautics Space Agency, the President said:

"Recent developments in long-range rockets for military purposes have for the first time provided man with new machinery so powerful that it can put satellites into orbit, and eventually provide the means for space exploration....

"In a statement which I released on March 26, 1958, the Science Advisory Committee has listed four factors which in its judgment give urgency and inevitability to advancement in space technology. These factors are: (1) the compelling urge of man to explore the unknown; (2) the need to assure that full advantage is taken of the military potential of space; (3) the effect on national prestige of accomplishment in space science and exploration; and (4) the opportunities for scientific observation and experimentation which will add to our knowledge of the earth, the solar system, and the universe.

"These factors have such a direct bearing on the future progress as well as on the security of our Nation that an imaginative and well-conceived space program must be given high priority and a sound organization provided to carry it out. Such a program and the organization which I recommend should contribute to (1) the expansion of human knowledge of outer space and the use of space technology for scientific inquiry, ... (3) the development of vehicles capable of carrying instruments, equipment, and living organisms into space, (4) the preservation of the role of the United States as a leader in aeronautical and space science and technology, (5) the making available of discoveries of military value to agencies directly concerned with national security, ...

"I recommend that aeronautical and space science activities sponsored by the United States be conducted under the direction of a civilian agency, except for those projects primarily associated with military requirements....

* * *

"It is contemplated that the Department of Defense will continue to be responsible for space activities peculiar to or primarily associated with military weapons systems or military operations. Responsibility for other programs is to be assumed by the new Agency. In this connection, I commend to the attention of the Congress the comments of my Science Advisory Committee, in its statement of March 26, 1958, on the military applications of space technology."

2. Policy Declarations by the Congress:

a. Senate Report Number 1701, dated 11 June 1958, and House Report Number 1770, dated 24 May 1958, and Conference Report Number 2166, dated 15 July 1958, dealing with the National Aeronautics and Space Act of 1958 (HR 12575), stated in pertinent part:

"Aeronautics is making what is called a 'quantum jump', and is going through a mutation into the new science of astronautics, a science concerned with manned travel or controlled instrumented flight beyond the effective atmosphere into the reaches of outer space.

"The Soviet sputniks have been a visible symbol, warning that the United States may not be leading in the vital field of space research and in the development of astronautics. This country is not unmindful of what these Soviet achievements mean in terms of military defense, of international prestige, and of general scientific advance. At the same time, a properly developed United States program to explore the potential uses of space must and can stand on its own rights. The program must be soundly conceived and soundly administered. It must not falter, then rush ahead only when prodded by some spectacular Soviet success, but rather must advance as a broad-based, sustained, long-range effort to use the properties of space, and to explore space either by proxy through instruments, or by sending man himself.

* * *

"The United States must have a strong capability in the use of outer space, both as a deterrent to military use of space vehicles against this country and as an aid in developing anti-missile techniques. Satellite reconnaissance and communications will have important implications for guarding the peace. On the one hand they are adjuncts to weapons systems related to the deterrent power, and on the other they represent important techniques for inspection and policing, in accordance with any disarmament scheme which may be negotiated in the years to come.

* * *

"It would be unfortunate, to say the least, for the United States to renounce an opportunity for sharing in astronautics discoveries which are bound to be made. Yet this unfortunate result could follow from current failure to organize a sound program to exploit easily proven techniques which can carry men and instruments into outer space.

"The Soviet lead in astronautics has made clear that 'business as usual' is not going to close the gap between United States and Soviet capabilities. Nor can even an intensive program of 'me too' do more than keep this country following behind the Soviet Union. This is particularly true when one considers the long lead times required for many astronautics programs, and the series of surprises the Soviets have already accomplished in the scientific area. The United States must leapfrog these Soviet accomplishments. This will take some years, and will require a genuine mobilization, on a national scale, of the vast scienfific and technical capabilities of this country. It would be most serious, and self-defeating in results, to choose some few isolated projects with the hope of influencing world opinion as to the superiority of our technology. Although the Soviet demonstrations in one sense could be viewed as tricks designed to sway world opinion, such an assessment tragically underestimates the Soviet approach to astronautics. The Soviet advance presupposes a broad scientific effort of many years' standing. It is based on a long-range plan of scientific education and research. It has combined, since World War II, the military development of rockets and missiles with the scientific resources of the country. In 1955, three years ahead of the United States, the Soviet Union set up a strong civilian astronautics agency, able to command all the resources of the nation. That agency is the Academy of Sciences, which sits at the same level as the Presidium of the Supreme Soviet, announced detailed plans for its satellites of varying weights, and also announced its plans for moon exploration and instrumented probes of Mars and Venus. These announcements were made two or three years ago. We have similar plans, still under discussion or only this year being specifically authorized for the years ahead.

"Whatever the United States may think of other aspects of the Soviet political system, there is little doubt that a single coordinated agency offers tremendous advantages over the fragmented, uncoordinated effort which the United States has made to date. A haphazard effort involves the dangers of duplication and incompleteness, together with competition for funds and headlines, to the detriment of rapid attainment of national goals. This is not to say that there is not room for alternative approaches, and for the development of different teams and facilities, but all these should be pointed toward the fulfillment of a well-rounded, comprehensive national plan.

* * *

"The establishment of a national space program is a matter of the highest urgency both for reasons of immediate national defense and to insure that in the long run outer space is effectively utilized for peaceful purposes ... the decision to enter into the space age is not one the United States can ignore or defer. Our national survival requires it."

b. HR No. 1758, 85th Congress, Second Session, dated 21 May 1958, stated in relevant part:

"The establishment of a national space program is a matter of the highest urgency both for reasons of immediate national defense and to insure that in the long run outer space is effectively utilized for peaceful purposes. The United States is behind the Soviet Union today in its ability to use outer space, and only much hard work and intelligent planning and organization will overcome this lag in the years ahead.

* * *

"The control of our national astronautics program must be in civilian hands, and oriented toward the broadest interests of the Nation. The head of the national space agency (under the President) must be the supreme arbiter of astronautics policy, except as he shares in the deliberations of the National Security Council, where space is but one aspect of national policy. Such responsibility centered in the national astronautics agency carries with it the obligation for continuous liaison with the Department of Defense because of the vital interest of the Nation in insuring full exploitation of the military potentials of space so long as rival states are striving to develop such military uses. No easy separation of military and civilian uses of astronautics is possible at this stage.

This makes it doubly urgent that coordination and cooperation between the Department of Defense and the new national agency be thoroughgoing and specifically provided for by law, not left to the chance good intentions of particular administrators.

"The Department of Defense has its Advance Research Projects Agency to coordinate but not to centralize detailed operation of the many astronautics programs of the individual services. It should continue to carry primary responsibility for those projects which are principally military in character. Because the bulk of our national resources in astronautics are found either in the military services or in their contractors, every precaution must be taken to insure that scientific and technical contributions extending beyond easily identifiable military requirements continue to be made and to be fully available to the national astronautics organization. But this is not the same thing as surrendering control of space exploration to the Department of Defense. The Advanced Research Projects Agency has primarily a military mission to perform; in this it should not be restricted. But the Department of Defense cannot be the sole arbiter of what is military and what is civilian when particular activities are in dispute. Such disputes must be reconciled at least on the level of the National Security Council, with an equal chance to be heard by both the military agency and the national civilian agency. The national astronautics agency must be more than just a repository for projects the Advanced Research Projects Agency is not interested in.

* * *

"The studies of the committee made clear that exploration of space is no longer hypothetical and remote. It is underway in a comprehensive fashion by the Soviet Union, and is being undertaken in a wide range of projects in this country. Coming rockets of high thrust will enable the placing of large instrumented satellites around the earth for military reconnaissance, weather prediction, navigation, and communications. Both the United States and Soviet

Union will probably have the capability of making lunar probes and probes to Mars and Venus in the immediate and foreseeable future.

"Man will move into space both for military reasons and for scientific exploration. Advances in instrumentation, however successful, are unlikely to take the place of voyages by man himself to other parts of the solar system.

* * *

"Although space development will be expensive, particularly as the hardware phases are reached, it will pay tremendous dividends. The experience of the past demonstrates that a succession of discoveries and inventions have always had economic advantages far greater than the dreams of their developers....

"In conclusion, it is clear that the decision to enter into the space age is not one the United States can ignore or defer. Our national survival requires it. If we meet the challenge, we will only then have the option of directing the use of outer space toward peaceful purposes for the benefit of all mankind."

c. The National Aeronautics and Space Act of 1958, Public Law 85-568, declared the policy and purposes of Congress in the following message:

"Sec. 102. (a) The Congress hereby declares that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind.

"(b) The Congress declares that the general welfare and security of the United States require that adequate provision be made for aeronautical and space activities. The Congress further declares that such activities shall be the responsibility of, and shall be directed by, a civilian agency exercising control over aeronautical and space activities sponsored by the United States, except that activities peculiar to or primarily associated with the development necessary to make weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provision for the defense of the United States) shall be the responsibility of, and shall be directed by, the Department of Defense; and that determination as to which such agency has responsibility for and direction of any such activity shall be made by the President in conformity with section 201(e)."

d. The report of the Select Committee of the House of Representatives on Astronautical and Space Exploration (HR 2710, 85th Congress, Second Session, dated 3 January 1959) included the following:

"It cannot be overemphasized that the survival of the free world - indeed, all the world - is caught up in the stakes. Outer space is fast becoming the heart and soul of advanced military science. It constitutes at once the threat and the defense of man's existence on earth. Only a bold and dynamic program employing the total talents and the greatest strength of the United States and its friends is competent to meet a challenge so overwhelming.

* * *

"It would be highly impractical not to face the reality that space technology, like nuclear energy, can be used for war as well as for peace. The United States is dedicated to insuring that outer space be devoted to peaceful purposes for the service of all mankind. The 85th Congress voted such a resolution, and this has been the stand of our delegates before the United Nations. Scientific knowledge itself is neutral; the men who use it determine its results for good or evil. If others would use it for evil, they cannot be countered by a better-intentioned country which lacks such knowledge and power itself.

"The United States must continue to strive for conditions which will make it possible for all space research to benefit mankind. But this effort is meaningless unless such striving is accompanied by an American and free-world effort to develop space devices of the highest order of versatility. Failure to do so would deny the free world not only the peaceful benefits of space, but also the capability to detect hostile moves against these nations (including the violations of agreements) and the further ability to counter such threats.

* * *

"The military potentialities of space technology, which the United States would prefer to see channeled to peaceful purposes, are greater than general public discussion to date suggests. Military space capabilities are technically inseparable from peaceful capabilities which are well worth pursuing in their own right. Reconnaissance for merchant-ship land patrol and for peaceful mapping of resources can also be used to locate military targets. Communications to improve global relations can also be used to control military forces. Rockets for cargo and passenger delivery can also carry thermonuclear weapons. Satellites designed to return men from an orbit to a preselected point can also deliver bombs.

"The decision to undertake a space program cannot be made in the context of domestic conditions alone. Whether the United States undertakes such a program or not, the Soviet Union has already launched a massive program with considerable momentum. The Soviet effort has a long record of study and popular and governmental interest behind it. The Soviet program has been vigorously pursued since the time of World War II, and has been assigned a high priority of scientific manpower, material, and coordinated organization. Soviet leaders implicitly believe that they will be the first to explore and to use outer space. They doubt that others will be in a position to follow."

APPENDIX B: LEGAL AND POLITICAL IMPLICATIONS

1. GENERAL

There are no principles or legal rules which can be said to recognize or create any rights in or duties on the part of states operating beyond the atmosphere in outer space or on the lunar surface. Rules of international law, as we know them, deal with the relations of nations on earth. Further, such rules of international conduct as may be said now to exist, were not devised or stated with a view to their applicability to what was, up until only half a decade ago, an almost undreamed of area of application, outer space. Moreover, the plethora of writing on the subject and the variety of opinions expressed reveal that, as of this present, what is regarded as international law, and its presuppositions and prerequisites in the field of outer space activity, are nothing more than the wishes or pious thoughts or aspirations or fears of the writers. They cannot bind, control or even limit states and nations in the new dimension.

Even on earth, where it is more or less accepted that international law does exist, such law must be sought as a practical matter in treaties such as the United Nations Charter or the Protocol of the Potsdam Conference. Even when more or less clear statements of rights or duties, or privileges and immunities of the contracting nations can be read in such treaties, there is not only disagreement as to the meaning of the words thereof, but also difficulty in enforcing, as a matter of law, the rights or duties defined therein.

Law is a response to the necessities of time, place and peoples, and we should not be hasty in seeking to find or read law where none capable of being denominated law exists. There has been a marked tendency on the part of the United States in particular to do just this and with something less than happy results. We must recognize and resist, particularly in connection with activities in space, "the pronounced American tendency to transplant legal concepts from the domestic to the international field: to believe that international society could and should operate on the basis of general contractual obligation, and hence lay stress on verbal undertaking rather than on the concrete manifestations of political interest."[1]

We are bound to note the areas in which what can be defined as law

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1. Kennen, American Diplomacy, 1900-1950 (1951) 46, 95.

is available and clearly applicable. But, equally, for the present, we must recognize that there is no definable body of space law. In the premises, resort to uncertain rules is not compelled.

2. POSSIBLE PRECEDENTS

Precedents for operations in space or on the lunar surface have been sought by students and scholars in the experience of nations in acquiring title to otherwise unclaimed land by operation of the law of discovery and occupation without conclusive result or a clear determination of a requirement that what has heretofore been found to be applicable to earth is necessarily appropriate to the problems in space. There has, however, been recognition of the fact that force or war may be the ultimate determinant of the issue of control of space and surfaces in space.

It has also been recognized that to a very large extent the settlement of disputes as to land titles between nations is a function of the executive or political departments of government rather than the judiciary. In general, it can be said that, where a case or a dispute involves the dignity and rights of sovereign states, it is for settlement in the course of the conduct of foreign affairs by the political arm of the government based upon practical considerations rather than law. As Chief Justice Stone stated in the case of Ex Parte Peru, 318 U.S. 578, "Our national interest will be better served in such cases if the wrongs to suitors, involving our relations with a friendly foreign power, are righted through diplomatic negotiations rather than by the compulsions of judicial proceedings."

It has also been suggested that precedents for dealing with problems of occupation of and title to lunar surfaces may be found in American experience and policy with respect to claims in the Antarctic.

The basic policy of the United States with respect to the making of claims in Antarctica is at all times to reserve to herself whatever rights she may have under recognized principles and rules of international law, in view of the activities and actions of its citizens, but to refuse formally to lay any claims to the area on the basis of such activities and, further, to refuse to recognize the claims of other nations.

This policy is traceable to the action of Secretary of State Charles Evans Hughes who, in 1924, insisted that actual settlement was required for a valid claim to sovereignty over newly discovered territory. In this connection, Secretary Hughes, a Justice of the Supreme Court of the United States from 1910 to 1916 and Chief Justice of the United States from 1930 to 1941 and a former Governor of New York, who missed the highest office in the land only by the slenderest margin, wrote to the Norwegian Minister relative to the effects of activities by Amundsen in Polar regions:

> "In ... your letter you state that, in order to avoid any misunderstanding, you would add that possession of all land which Mr. Amundsen may discover will, of course, be taken in the name of His Majesty, the King of Norway. In my opinion rights similar to those which in earlier centuries were based upon the acts of a discoverer, followed by occupation or settlement consummated at long and uncertain periods thereafter, are not capable of being acquired at the present time. Today, if an explorer is able to ascertain the existence of lands, still unknown to civilization, his act of so-called discovery, coupled with a formal taking of possession, would have no significance, save as he might herald the advent of the settler; and where for climatic or other reasons actual settlement would be impossible, as in the case of the Polar regions, such conduct on his part would afford frail support for a reasonable claim of sovereignty. I am therefore compelled to state, without now adverting to other considerations, that this Government cannot admit that such taking of possession as a discoverer by Mr. Amundsen of areas explored by him could establish the basis of rights of sovereignty in the Polar region, to which, it is understood, he is about to depart."[1]

The United States has consistently followed Secretary Hughes' position and maintained that, althought she will reserve all rights granted her by the acts of her citizens through international law, she will assert no claim and will recognize no claims asserted by other nations in the absence of actual occupation. It appears certain that efforts by claiming nations to date have not been sufficient to constitute such occupation, and it would further appear that the

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1. Secretary Hughes to the Norwegian Minister, H. H. Bryn, 2 April 1924, MS Department of States, file 857.014/6. cf. Hall, International Law, 8th ed. by Higgins (1924) 124M; "As the regions of both the North and South Poles are incapable of permanent settlement, they do not appear to be 'territory' susceptible of acquisition by occupation." See also 1 Oppenheim's International Law, 5th ed by Lauterpacht, 440.

United States' position is not without wisdom. We have reserved to ourselves the right to make later determinations in our own interest and have avoided becoming obliged to accept arbitrary agreements or arrangements which may later prove a hindrance.

While such precedents need not and indeed would not be binding in the lunar realm, it may be said that, considering the Antarctic experience of nations, there is neither controlling nor governing law or principle to limit or circumscribe American activity, nor basis for any other nation asserting a bar to American activity in the new dimension.

We must, however, recognize the need for continued activity by the United States following the initial establishment of her base. The display of state activity should be continuous and should not be interspersed or followed by protracted periods of inactivity.[1]

At all events some practical actions are required to constitute a basis for America speaking at all or asserting arguments pro or con claims by ourselves or others in this area. America, without an operating base on the lunar surface, is, as a practical matter, entitled to no more right to speak, or claim for itself, or resist a claim of another state which is operational on that surface, than has Nepal or Ecuador. Such a position of weakness for America in the new dimension is unthinkable.

3. THE LAW OF SPACE

Since studies which have been made reveal no binding or controlling precedents to guide the present operation, the conclusion follows that there is nothing that is proposed in Project HORIZON which seriously could be said to constitute a violation or even disregard of settled international law or law generally. By the same token, there appears to be nothing that settled international law requires of the United States with respect to her activities in outer space, except to the extent that war is waged from outer space on a nation or nations on earth.

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1. In the Island of Palmas arbitration it was pointed out: "The intermittence and discontinuity compatible with maintenance of the right necessarily differ according as inhabited or uninhabited regions are involved, or regions enclosed within territories in which sovereignty is incontestably displayed, or again regions accessible from, for instance, the high seas." 22 AJ. J. I. L. (1928) 867, 877.

In view of these things, we should determine our aspirations and needs and proceed with their prosecution, being content to face the technological difficulties without conjuring up possible legal impediments.

Undoubtedly, as we proceed, new and novel situations will present legal or quasi-legal problems, but we should wait on such practical presentation, lest in our haste to define rules, we compromise our national position in the future to find that a rule, which appears to be viable today, will in the future be something less than what we can live with in view of a new and unpredictable set of facts or circumstances that may then present themselves. Until we know what we or the potential users of outer space and lunar surfaces will require we cannot attempt definitions of controlling legal factors. To do so with insufficient facts might induce irreparable adverse effects upon our national interests.

Nor in so doing should we have any compunctions lest we be charged with dealing unfairly with other nations. At the present time, and in the ensuing period with which we are here concerned, we can assume that only the Soviet Union and we share the potential to operate in space. The Soviet Union employs law selectively when it is in her interest to do so. Soviet legal doctrine may therefore be expected to develop in response to Soviet technical achievements and Soviet political requirements. We need only remind ourselves that the Soviet Union is not likely to permit abstract principles of fairness, justice and law to hinder her practical and technological progress, and any uneasiness flowing from our adoption of a flexible position is bound to pass. On the other hand we can note that the Soviet Union will not hesitate, should we espouse or adhere to what might be called principles or rules of law, to bind us to them and thereby at least restrict our mobility and flexibility.

We should also not rely upon what individual Soviet citizens, however learned, may have written or said to try to reach an estimate of what the Soviet Union's position in a given situation will be. The statements of Soviet scholars, though they make interesting reading, can hardly be credited with authority to state the Soviet national position as of the time of writing, let alone on in the future.

Thus while the Soviet legal scholar, E. Korovin, has declared[1] that the sending of an American reconnaissance satellite through outer space over the Soviet Union would not be regarded as an act of

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1. International Life, January 1959.

war, but that shooting down another country's sputnik would be, he also indicated:

> "Two groups of acts should be differentiated from the standpoint of world relations and international law: actc in the Cosmos that are acts of war but which serve in international relations as expressions of mistrust, ill will, and similar cold war consequences.
>
> "Clearly one cannot lump together the destruction of another country's sputniks by means of anti-missile missiles with the presence of photo and TV equipment in a satellite, even if employed for reconnaissance."

Interesting though these thoughts may be, and they are statements clearly directed to activities in space, and not to those on the high seas or Antarctica, for example, they hardly constitute a basis for anticipating or predicting the action the USSR would take if she shot down another nation's satellite. It would also be reckless to rely on this statement to argue that the Soviet Union would view with equanimity an American satellite conducting effective reconnaissance over Soviet territory and air space.

The same thing may be said for the oft-reported statement of Doctor of Juridical Sciences G. Zadorozhynyi:[1]

> "The Soviet artificial satellite does not violate the air sovereignty of any state, if only because it does not fly into the space over other states. Instead the territories of these states, by dint of the earth's rotation, pass so to speak under the satellite's orbit, which is fixed in relation to the earth and the stars. Disputing the legality of the appearance of the satellite over the territory of one or another state would be just as absurd and ridiculous as disputing the appearance over a given territory of the moon, the sun or any other heavenly body."

In general, it can be said that outer space is open and a thing in common to all nations of the earth and incapable of ownership by any one state. There is no basis for another rule for orbiting vehicles in outer space or for lunar and like surfaces.

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1. Sovetskaia/Rossiia, 17 October 1957.

Though we recognize sovereignty with respect to earth surfaces and also with respect to atmospheric space, that within which aircraft fly, and, for the sake or argument, what Dr. John Cobb Cooper calls "Contiguous Space," our concern herein is with space beyond all of these. As to such space, rights have not been determined or defined. Nor can it be said that the rights and duties in space will or ought necessarily to be consequences of sovereignty on the earth or even in the atmosphere, troposphere or thermosphere. The law of space must be permitted to develop over the future as a web of arrangements appropriate to that milieu with full opportunity for promoting to the maximum the full use of the resources of talents of the nations which will use it.

4. POLITICAL IMPLICATIONS

In turning to the political implications of Project HORIZON observe, at the threshold, that the first duty of a state or nation is that it be durable. One need not go so far as Spengler in finding "an abstract idea of justice" only "in the minds of those whose spirit is noble and strong and whose blood is weak," to recognize his more significant conclusion that "the fact world of history knows only the success which turns the law of the stronger into the law of all. Over ideals, it marches without pity, and if ever a man or a people renounces its power of the moment in order to remain righteous - then, certainly, his or its theoretical fame is assured in the second world of thought and truth, but assured also is the coming of the moment in which it will succumb to another life - power that has better understood realities."[1]

We need to remind ourselves of this and also that, as Justice Holmes recognized, force is the ultimate sanction of the law.[2]

This is not the place to rehearse the decline and disappearance of the great powers of Western Europe and the Orient and the rise to preeminent power of the Soviet Union and the United States, armed

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1. 2 Spengler, The Decline of the West, 364 (knopf ed 1928).

2. "I do think that man at present is a predatory animal. I think that the sacredness of human life is a purely municipal ideal of no validity outside the jurisdiction. I believe that force, mitigated so far as may be by good manners, is the ultima ration, and between two groups that want to make inconsistent kinds of worlds I see no remedy except force." 2 Holmes-Pollock Letters, 36 (1942). He also stated, "... when man differ in taste as to the kind of world they want, the only thing to do is to go to work killing." 1 Ibid 116.

with nuclear as well as conventional weapons. Nor do we need to elaborate upon the Soviet position of protracted conflict or "peaceful coexistence," during which the aims of communism may be promoted.

Because international activity is a continuous struggle for power, we must bear in mind that resourcefulness and courage in time of peace, as in time of war, indeed in all things, are necessary to promote the national interest.

The current policy of the United States, with respect to activities in space recognizes that the nation's security is the first consideration; that to achieve peace America seeks to prevent war at any place and in any dimension; that our forces must be flexible; that advancement in space technology is urgent and inevitable in view of the need to assure that full advantage is taken of the military potential of space and the effect on national prestige of accomplishments in space science and exploration. American policy also recognizes that a space program to include the development of vehicles capable of carrying instruments, equipment and living organisms into space, and the preservation of the role of the United States as a leader in aeronautical and space science and technology, must have high priority; that projects primarily associated with military operations and requirements and weapons system development should be dealt with by the military and that space science activities should be dealt with by civilian agencies because "a civilian setting for the administration of space functions will emphasize the concern of our nation that outer space be devoted to peaceful and scientific purposes."

The Conference Committee Report on the National Aeronautics and Space Act of 1958 included the following:

> "This country is not unmindful of what ... Soviet achievements mean in terms of military defense, of international prestige, and of general scientific advance. At the same time a properly developed United States program to explore the potential uses of space must and can stand on its own rights. The program must be soundly conceived and soundly administered. It must not falter, then rush ahead only when prodded by some spectacular Soviet success, but rather must advance as a broad-based, sustained, long range effort to use the properties of space, and to explore space either by proxy through instruments, or by sending man himself."

It is recognized further that United States military capabilities in space are necessary to insure that space will not be used for military purposes against the free world; that man will move into space both for military reasons and for scientific exploration, and that, to quote the Conference Committee Report again:

> "The establishment of a national space program is a matter of the highest urgency both for reasons of immediate national defense and to insure that in the long run outer space is effectively utilized for peaceful purposes ... the decision to enter into the space age is not one the United States can ignore or defer. Our national survival requires it."

More recently the Report of the House Select Committee on Astronautics and Space Exploration said:

> "The military potentialities of space technology, which the United States would prefer to see channeled to peaceful purposes, are greater than general public discussion to date suggests. Military space capabilities are technically inseparable from peaceful capabilities which are well worth pursuing in their own right. Reconnaissance for merchant-ship lane patrol and for peaceful mapping of resources can also be used to locate military targets. Communications to improve global relations can also be used to control military forces. Rockets for cargo and passenger delivery can also carry thermonuclear weapons. Satellites designed to return men from an orbit to a preselected point can also deliver bombs."

It is believed that the foregoing shows that the policy of the United States requires "HORIZON"; that indeed the failure vigorously to prosecute such a program is to disregard the plain intention, if not direction, of the executive and legislative branches of the Government to take proper measures to insure our national survival.

5. SPECIFIC PROBLEMS

The following specific problems have been submitted by members of the committee on the Army Study for Establishment of a Lunar Outpost for legal analysis:

Problem 1:

What affect would the following Russian claims have on a U. S. program to put man on the moon:

(a) The Russians hard-land a vehicle on the moon containing the USSR flag, document, or monument and, based on that, claim the entire lunar surface for the USSR?

(b) The Russians soft-land a vehicle containing the USSR flag, monument, radio transmitter or light and, based on that, claim the entire lunar surface for the USSR?

(c) Same as "(b)" above except the vehicle contained men?

(d) Same as "(c)" above except the USSR states that the Russians on the moon have the capability to destroy any aggressor and will do so?

Opinion:

The hard or soft landing of men or flags or even a ship bearing a flag would have no affect upon territorial claims to the lunar sufrace as a matter of law. Symbolic occupation has never been recognized in international law.

Based upon our experience in the Antarctic which has been described above, it is believed that we would not claim or recognize the claim of another based only upon any of the events set forth. Our position would seem to be that as a matter of law, nothing short of actual settlement or actual occupation would be cognizable and only to the extent that a particular surface was in fact held and actually settled.

We could, of course, in the face of the threat described in "(d)", do nothing at our peril, for then a new principle of lunar law might be postulated based on that experience. Whether the principle would be one which we would find so harsh as to feel that we would want to fight to establish its unacceptability would be a political decision leading to resolution of the issue by the ultimate arbiter, force.

Problem 2:

Assuming the Russians land men on the moon prior to the U. S., and they claim a section of the lunar surface, would we be obligated to respect their claim assuming it was a reasonable area (approximately 2000 square miles)?

Opinion:

The answer to this question is the same as that to Problem 1. The reasonableness of the area sought to be controlled would not be the determinant. Rather, effective occupation which includes effective possession or actual settlement would seem to be required. Settlement on a fringe of an area would probably also not be accepted as vesting rights beyond the area actually occupied.

At all events, the determination of a dispute concerning areas of control is recognized to be a political question for resolution by the political agencies of government rather than the judiciary. In such matters, of course, national strength and even resort to war may be required for its determination.

Problems 3 and 4:

3. Assuming we arrive on the moon, before or after the Russians, and find a concentration (the only known concentration) of very valuable resources:

(a) Do we have a right to claim the subject area?

(b) If we rightfully claim the resources and the Russians trespass, what action would, or should be taken?

4. Same assumption as 3 only reversed (the Russians find and claim resources), would we ignore their claim and make them forcefully keep us out of the area?

Opinion:

The fact that valuable resources were present in an area, it is believed, would not alter the fundamental position of the United States that an act of discovery coupled with the taking of possession would have no significance once effective or actual occupation or settlement of the particular area was broken off or terminated. This is the position which the United States had adhered to with respect to Antarctica and while, as has been indicated, that is not necessarily binding in lunar activities it is cited as suggesting what may be regarded as the basic position of the United States in the premises.

As to part "(b)" of the question, it is believed that the power in actual possession of a particular area should be respected in its claimed position. Thus, if American forces are in possession of an area having resources of great and significant value, it is reasonable to anticipate that her peaceful occupancy or holding would be respected. So, too, with respect to a like holding by the USSR.

Trespass connotes an injury to possession as by simply entering upon another's land or by invading forcefully. Our hypothesis is of something more than peaceful entry. Trespass, as Anglo-American jurisprudence understands it, presupposes the right to enjoy what one possesses, and a right is either what a court, backed up with the necessary executive or compelling power, will enforce or ultimately what men will fight for.

Obviously, recourse to the courts in the solution of this problem is apocryphal. It must be recognized that there will probably be no tribunal to which the conduct of the alleged intruder could be submitted for judicial resolution. It is doubtful if even the facts of the case could be developed as a basis for judicial determination. It appears from this that, at best, the case would be one for diplomatic or political negotiation; more likely, and for the worst, it would be for resolution by the more violent form of political action known as war.

Problem 5:

Assuming both the U. S. and USSR occupy separate locations on the moon, and do so on a cold-war type basis:

(a) If a U. S. manned vehicle accidentally lands in the Russian sector, and they refuse to release the personnel or give any information as to the subject landing, what would we do?

(b) Same as "(a)" except the payload contained equipment rather than men?

(c) Same as "(a)" or "(b)" except the Russians destroyed the vehicle before landing and we knew that they had destroyed it?

(d) If a Russian or unidentified vehicle approached the U. S. sector, would we attempt to destroy it? If so, who would make this decision?

(e) What would we do it the Russians started movements, by ground, into the U. S. sector and would not respect our request to "stay on their side of the hill?"

(f) The Russians started intercepting and destroying our supply vehicle to the moon and claimed that it was a hazard or threat to their outpost; what would the U. S. do?

Opinion:

With respect to items 5a through 5e, it may be observed that, as a practical matter, the capture and refusal to release personnel or equipment of another nation is one ultimately for political action and not for judicial determination even in day-to-day dealings between nations on earth. And it may be observed that the outcome of such situations in which the USSR has been involved is not always predictable.

With respect to item 5d, it is a recognized principle of international law that a state at all times owes a duty to other states to protect them against injurious acts by individuals within or under its jurisdiction. It is to be hoped that this doctrine will find acceptance by nations operating in space or on the lunar surface.

It may also be considered that entry into air space of a nation under distress conditions is recognized. This had been defined by Professor Lissitzyn of Columbia University in the following terms:

> "Despite the unqualified assertions of the sovereignty of the subjacent states over the airspace and the express prohibitions of unauthorized entry of foreign state aircraft which are found in international conventions, there is a right of entry for all foreign aircraft, state or civil, when such entry is due to distress not deliberately caused by persons in control of the aircraft and there is no reasonably safe alternative. In such cases, the entry may be 'intentional' in the sense that the pilot knows he is entering foreign airspace without express permission, but the probable alternatives, such as crash landing or ditching, expose the aircraft and its occupants to such unreasonably great risk that the entry must be regarded as forced by circumstances beyond the pilot's control (force majeure). Foreign aircraft and their occupants may not be subjected to penalties or to unnecessary detention by the territorial sovereign for entry under such circumstances or for entry caused by a mistake, at least when the distress or mistake has not been due to negligence chargeable to the persons in control of the aircraft."[1]

Further, speaking generally, the question of the right of a state to destroy the ship or personnel of another state on the lunar surface involves questions of the permissible force which may be employed by a sovereign against another. In general, no more force may be used

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1. Lissitzyn, "The Treatment of Aerial Intruders in Recent Practice and International Law," 47 American Journal of International Law, 559, 588-589 (1953).

than is necessary to repel or resist the actual or apparent danger.

In view of these considerations it is believed that we would have no power or right to destroy an unidentified vehicle headed into an area held by our people. The right to take action against such a vehicle would turn upon establishment of a threat and the fact that the force used was appropriate to and required to deal with the particular threat. Again if the action taken was not in fact appropriate the remedy would have to be sought in political action with the risks of satisfaction inherent in such proceedings.

With respect to item 5e, as has been indicated, the mere claim to an area would not require recognition by other states of the claim. In the event, however, that a state actually occupying a particular area felt sufficiently strongly about its needs in the circumstances to resort to destruction of intruding craft and flight personnel to insure its exclusive position, it would probably have to risk the consequences of its violent action taken to exclude those which it regarded as intruders.

It will probably be the position of nations operating in space that there is no governing law and that space is beyond the point at which sovereignty can be exercised by nations on earth. The result is recognition that space is an area open and common to all nations. In view of this, interference with supply vehicles operating in space, regardless of the basis alleged to justify such action, would have no recognizable legal foundation. The wrong inflicted, nothwithstanding the lack of the right to inflict it, would be a matter for settlement in political or diplomatic channels or possibly by resorting to violent action simply because the nations of the world have provided no appropriate courts or tribunals to deal with such matters judicially. What the United States would do in the situation postulated is at all events a matter for political rather than legal determination.

Problem 6:

Assume that a U. S. lunar return vehicle accidentally landed in Russia and the USSR would release no information, or the personnel, what would the U. S. Government do?

Opinion:

This question is closer to reality and is a matter on which principles of international law governing it can be found. The question assumes that the landing was accidental. In such circumstances, the right of innocent passage or transit is recognized. It would seem that principles of international law would require the return of a vehicle which accidentally landed in another state to the state originating the flight. Here again, however, there are no tribunals which can enforce such a holding. Resort would have to be had to political or diplomatic action and in our dealings with the Soviet Union, it is idle to try to predict the outcome of such proceedings.

The review of the practical problems postulated serves further to show the uncertainty of any rights and duties in connection with operation by nations in space or on lunar surfaces. Experience rather than logic must, in the new dimension, as on earth, be recognized as the life of the law. The practical objectives of America, as has been suggested, must therefore be prosecuted to the fullest possible extent and can be without let or hindrance from principles or rules of general or international law.

APPENDIX C: TECHNICAL SERVICES SUPPORT CAPABILITIES

The exploration of space and the celestial bodies will require maximum utilization of all national skills and resources which relate to space technology. Prominent among these skills and resouces are those of the U. S. Army's seven Technical Services: Ordnance, Engineers, Signal, Quartermaster, Chemical, Transportation, and the Medical Service.

The Army Technical Services own and operate approximately one billion dollars worth of research and development facilities. The research and development resources of the Army include approximately 40,000 personnel, with a high percentage of scientific and engineering talent capable of conducting and controlling the most advanced efforts in research and development. These research and development personnel and facilities represent an annual operating expense of over $400 million. They are supported during the current fiscal year by an approximate $3/4 billion effort from industry and private institutions.

These activities include research and development in four general categories:

1. The development of missile weapons systems for land and air combat and for missile defense, and the development of space vehicles and payloads.

2. Research and development to maintain man's operating effectiveness, regardless of environmental conditions.

3. Electronics research applicable to both weapons systems and to space exploration.

4. Construction, mapping and engineering material.

Within the framework of these four categories, the Army Technical Services are conducting a significant portion of the United States' missile and space programs. These programs are being conducted for the Army, for other branches of the Armed Forces, for the Advanced Research Projects Agency of the Department of Defense, and for the National Aeronautics and Space Administration.

RESOURCES AND CAPABILITIES

Ordnance

The research and development skills and facilities of the Ordnance Corps have steadily increased in value, keeping pace with demands for sophisticated weaponry. Increasing Ordnance activity in missile system research and development has produced many specialized skills. (See Table 1.) Every major area of Ordnance research and development has been constructively influenced by this growth of missile and space technology.

The Diamond Ordnance Fuze Laboratory (DOFL) in Washington is one of the nation's outstanding research laboratories. It has extensive facilities for developing and testing Ordnance electronic systems, and has won nation-wide recognition for its successful micro-miniaturization program and for its adaptation of proximity fuzes to guided missiles. In 1958, DOFL won the top award in a nation-wide competition for having made the greatest advances in miniature electronics.

The Atomic Weapons Laboratories at Picatinny Arsenal operate as the nerve center for all activities in atomic munitions development for the Army. Picatinny also operates a wide variety of climatic test facilities, including high temperature ovens, altitude chambers, vibrators, cold-rooms, inertial machines, and oscilloscopes. The Packing Laboratory at Picatinny is well equipped to develop and test the most advanced techniques for assuring that materiel reaches its terrestrial or celestial destination in the best possible condition.

The Ordnance Tank-Automotive Command in Detroit has extensive facilities at its disposal for studying terradynamics, the science of land vehicle movement; and for developing and testing both combat and transport vehicles to meet special requirements.

The Ordnance Materiels Research Office at Watertown Arsenal studies all types of metals used in weapons and space vehicles. A nuclear research reactor for testing materials will be in operation at Watertown by December 1959.

The U. S. Army Ordnance Missile Command (AOMC) is assigned responsibility for the full range of rocket and missile management from concept studies to field support of weapons systems, and is responsible for broadly diverse programs of basic and applied research which

TABLE I-1

ARMY ORDNANCE RESERVES

R&D Skills and Facilities by Category

FY	1 Missile System Design, Testing and Evaluation	2 Land Vehicle Design	3 Ammunition Design	4 Conventional Weapons Design	5 Ordnance Electronics	6 Ordnance Materials Research	7 Ballistics
Dollar Value of Facilities (Millions)							
55	106.9	14.5	7.1	4.5	15.2	2.3	5.3
57	196.7	14.7	7.7	4.8	18.1	2.4	5.5
59	254.4	15.4	9.9	5.7	22.4	5.2	6.8
60 (est.)	311.0	15.8	10.4	6.2	23.7	5.3	6.9
Personnel							
55	5,457	1390	2401	1564	2399	441	1285
57	8,565	1085	2265	1197	1959	437	1020
59	10,178	996	2144	1310	1773	499	600
60 (est.)	11,510	1100	2330	1348	1285	511	600

FY 1959 Out-of-House Support by Category
(In Millions of Dollars)

	Industry	GOCO	Institutions
Other Ordnance	157.8	30.5	13.1
AOMC	470.9	5.1	1.9
Total	628.7	35.6	15.0

support national military and civilian space programs. To meet the requirements of its customers, AOMC management integrates the research, development, production and support talents of government, private institutions and American industry. The AOMC organization is staffed with members of Army Technical Services and the conbat arms. AOMC mission elements include the Army Ballistic Missile Agency, the Army Rocket and Guided Missile Agency, and the White Sands Missile Range.

The Army Ballistic Missile Agency has responsibility for all ballistic missile activity concerning long range rockets. Personnel of the Agency numbers approximately 400 military and 5000 civilian, of whom a high percentage are scientific, technical or professional personnel. The largest segment of ABMA is the Development Operations Division, under the technical direction of Dr. Wernher von Braun.

The Army Rocket and Guided Missile Agency is responsible for development, production and field support of surface-to-surface and surface-to-air weapons systems. This Agency employs about 3400 personnel, civilian and military.

The White Sands Missile Range is charged with the operation of an integrated missile range for use by all military services. It pursues research and development in electronic applications, and provides test and evaluation services for the Army's missile and rocket programs. White Sands personnel totals about 17,000 of whom 4200 civilians and 2500 military are part of the Army Ordnance Missile Command.

Laboratories operated under the Command include: Missile Firing Laboratory at Cape Canaveral, Aeroballistic Laboratory, Guidance and Control Laboratory, Missile Electronics Laboratory, Propulsion Laboratory, Rocket Vehicle and Warheads Laboratory, and many others.

AOMC has the established managerial and technical resources and capabilities to assist in developing, producing, and launching from earth and orbit, the space vehicles required to accomplish Project HORIZON.

Engineers

The Corps of Engineers is well equipped to assist the national space program. It is presently assigned the national mission of directing an engineering, construction, and real estate service for the Army, in addition, to developing, providing, and servicing engineer material. In keeping with this national mission , the Corps of Engineers has an important current role in supporting the national guided missile and space program.

The U. S. Army Engineer Research and Development Laboratories are the principal field agency of the Corps of Engineers devoted to the development of improved methods and equipment. The Laboratories are situated on a 240-acre tract of land bordering the Potomac River at the Engineer Center and Fort Belvoir. The Laboratories employ approximately 1300 civilian engineers, scientists, and technicians. In addition, enlisted men, including many in the scientific-professional category, are used at operational levels. These technical people represent numerous field, including chemical, civil, mechanical, electrical and sanitary engineering, and chemistry, biology, physics, and mathematics.

The Waterways Experiment Station is the principal facility of the Corps for research and engineering investigations in the scientific fields of hydraulics, concrete, soil mechanics, ground mobility, and flexible pavement design. It assists in the accomplishment of both the civil works and military missions of the Corps of Engineers. In addition to its own program, WES has technical supervision over all other hydraulic model investigations performed for the Corps, and over such soils and concrete investigations as may be directed by the Chief of Engineers.

The Army has been designated the cognizant agency for the Department of Defense for the development of nuclear power plants to produce heat and electricity. The Army responsibilities have been further assigned to the Chief of Engineers, who conducts a joint program with the Atomic Energy Commission. The Army Nuclear Power Program develops the nuclear power plants required by the military services, using both AEC and military funds. Funding for field plants is provided by the using service. The Army Nuclear Power Program has access to two major field facilities for the implementation of its assigned objectives. The Nuclear Power Field Office (NPFO) is located at Fort Belvoir. The Army Reactors Experimental Area is at Arco, Idaho. Several field nuclear plants are under construction.

The Snow, Ice, and Permafrost Research Establishment conducts basic and applied research in the fields of snow, ice, and frozen ground. The SIPRE carries out its basic mission through five main branches devoted to scientific research, and four other branches which provide services and support to the main branches. Its installations are located in Illinois, Michigan, Alaska, Greenland, the Arctic, the Antarctic, and Canada.

Its specialists, totaling some 102, include crystal physicists, crystallographers, cryophysicists, geologists, glaciologists, glacial geologists, soils engineers, structural engineers, meteorologists, physical chemists, engineering geologists, mathematicians, instrumentation physicists, and geophysicists.

The Arctic Construction and Frost Effects Laboratory has the assigned mission of carrying out investigations to develop and improve engineering criteria for military construction in areas of both seasonal freezing and permafrost. The ACFEL is located at Waltham, Mass., under the direction of the Corps of Engineers New England Division. The total number of employees at ACFEL is 45, of which 15 are in the professional categories of soil mechanics engineers, civil engineers, general engineers, geologists, and engineering aides and draftsmen. ACFEL maintains three field test sites: Frost Test Area at Limestone, Maine; Permafrost Research Area at Fairbanks, Alaska, for permafrost investigations; and Greenland Investigational Area for cold climate testing.

The Rigid Pavement Laboratory is responsible for the development and continued improvement of design, evaluation, and construction criteria for rigid, rigid overlay, non-rigid (flexible) overlay, reinforced and pre-stressed airfield pavements. In addition, the laboratory supports the U. S. Army Ordnance Missile Command and other agencies in the field of blast deflection and refractory materials for blast resistant application. The Division Laboratories have a total complement of 95 people including civil, mechanical, materials, and electronic engineers; geologists; mathematicians; and chemists; many of whom are used in the Rigid Pavement Laboratory program. The Laboratory is supported by an accelerated traffic test track located at Sharonville, Ohio. Thermal effects studies are made to study the effects of exhaust gas velocities up to Mach 4.5 and temperatures up to 2800°F. Supersonic blast problems are studies with a Schlieren optical high-speed motion picture system.

The Marine Division, Philadelphia District, is responsible for the design and development of specialized floating plants. Among the items under design are new and improved dredges, surveyboats, launches, barges, and floating power plants. The office is staffed by general engineers, mechanical engineers, electrical engineers, naval architects, and draftsman.

In addition to the seven principal agencies for performing research and development activities within the Corps of Engineers, certain division and other laboratories are available. These exist primarily for testing purposes and have the ability to handle limited-scope research and development projects. They are 14 in number, and are located in various parts of the U. S.

Of the seven major research and development establishments of the Corps of Engineers, by far the greatest concentration of personnel and funds are in USAERDL, WES, ANPP, and SIPRE. Personnel and fiscal data for these four establishments, and for out-of-house support, are summarized in Tables 2 through 6.

Table I-2

PERSONNEL AND FISCAL DATA
U. S. ARMY ENGINEER AND DEVELOPMENT LABORATORIES

ITEM	As of 30 June 1955	As of 30 June 1957	As of 30 June 1959 (est)	As of 30 June 1960 (est)
1. Technical Personnel	520	515	454	500
2. Supporting Personnel	1042	1075	888	953
3. Total Personnel (1 plus 2)	1562	1590	1342	1453
4. Estimated Book Value	$43,700,000	$44,314,000	$41,813,000	$41,519,000

Table I-3

PERSONNEL AND FISCAL DATA
U. S. ARMY ENGINEER WATERWAYS EXPERIMENT STATION

ITEM	As of 30 June 1955	As of 30 June 1957	As of 30 June 1959 (est)	As of 30 June 1960 (est)
1. Technical Personnel	136	159	150	160
2. Supporting Personnel	566	599	539	530
3. Total Personnel (1 plus 2)	702	758	689	690
4. Estimated Book Value	-	-	$5,630,000	[illegible]

Table I-4

PERSONNEL AND FISCAL DATA
ARMY NUCLEAR POWER PROGRAM (ANPP)

ITEM	As of 30 June 1955	As of 30 June 1957	As of 30 June 1959 (est)	As of 30 June 1960 (est)
1. Technical Personnel	21	95	204	288
2. Supporting Personnel	5	9	21	25
3. Total Personnel (1 plus 2)	26	104	225	313
4. Estimated Book Value	0	$5,200,000*	$13,300,000*	$24,000,000*

*Includes AEC financing per AEC-DOD agreements

Table I-5

PERSONNEL AND FISCAL DATA
SNOW, ICE AND PERMAFROST RESEARCH ESTABLISHMENT (SIPRE)

ITEM	As of 30 June 1955	As of 30 June 1957	As of 30 June 1959 (est)	As of 30 June 1960 (est)
1. Technical Personnel	24	44	45	47
2. Supporting Personnel	35	59	57	62
3. Total Personnel (1 plus 2)	59	103	102	109
4. Estimated Book Value	$250,000	$1,375,000	$3,200,000	$3,600,000

The Army Map Service's operational mission is to collect and reduce geodetic control, to accomplish topographic mapping on a world-wide basis, to maintain and operate a topographic map library for the Department of Defense, and to produce Engineer intelligence. The AMS employs approximately 3500 people in its base plant and field office. Its personnel consists of professional engineers, mathematicians, geodesists, cartographers, photogrammetrists, and engineer intelligence and graphic arts specialists, many of whom are recognized authorities in their respective disciplines.

Table I-6

OUT-OF-HOUSE SUPPORT
CORPS OF ENGINEER RESEARCH ESTABLISHMENTS

Establishment	FY1959 R and D Out-of-house Support			
	Industry	GOCO	Institutions	Total
USAERDL	$8,150,000	0	$675,000	$8,825,000
WES	298,000	0	161,000	459,000
ANPP	24,559,000	663,000	40,000	25,262,000
SIPRE	31,500	53,000	214,300	298,800
Total	$33,038,500	$716,000	$1,090,300	$34,844,800

The Corps of Engineers is the largest single construction agency in the world. There are nine Engineer Divisions in the U. S. and two outside the U. S. Within the U. S., a force of some 15,000 officers and civilians perform the military construction functions, complemented by some 27,500 personnel performing civil works. In general, all construction for the Army is performed by the Corps, except for minor amounts in some overseas areas. The Engineer Corps is also performing about eighty percent of Air Force construction, all Army Reserve and most Air National Guard construction, and small amounts for the Navy and Coast Guard. Work is also performed for the Advanced Research Projects Agency and for the National Aeronautics and Space Administration. Work under the Military Assistance Program is being performed in Korea, Pakistan, and Iran. The estimated book value of the Military Construction-Civil Works Program is some $140 million. Out-of-house contracts total some $2.25 billion yearly. The operating budget is some $215 million yearly.

Signal

For over forty years the Signal Corps has maintained facilities for research and development in the fields of communications and other information devices. During this period, the Signal Corps' pioneering efforts in research and development have resulted in ever-improved devices and techniques. It has emerged as a foremost authority not only in communications but in components, electron devices, atmospheric research, radar, electronics, and other areas as well.

The Signal Corps Research and Development Laboratory, located at Fort Monmouth, New Jersey, is one of the nation's principal electronic research and development centers. The responsibilities of this Laboratory are broad; within its aegis are multiple electronic sciences that made up the network of communication and information devices which in turn form the nerve and control system of a modern military force. Charts 1 and 2 highlight the Signal Corps fields of technical competency. Conducting this work within the modern research facilities of the Hexagon Building and Evans Area are approximately 3500 military and civilian engineers, physicists, chemists, mathematicians, their laboratory and shop assistants, and other support personnel working together to advance the frontiers of science and technology. Of these personnel, 698 hold Bachelor's degrees, 109 have Master's degrees, 453 have Doctor's degrees, while 135 have partial credits leading towards a degree. These scientists are working in the more than 30 fields within the province of Signal Corps responsibility and have at their disposal complete laboratory equipment. These include not only up-to-date commercial devices, but extensions of these advances to meet

ANALYSIS of USASRDL CIVILIAN PERSONNEL

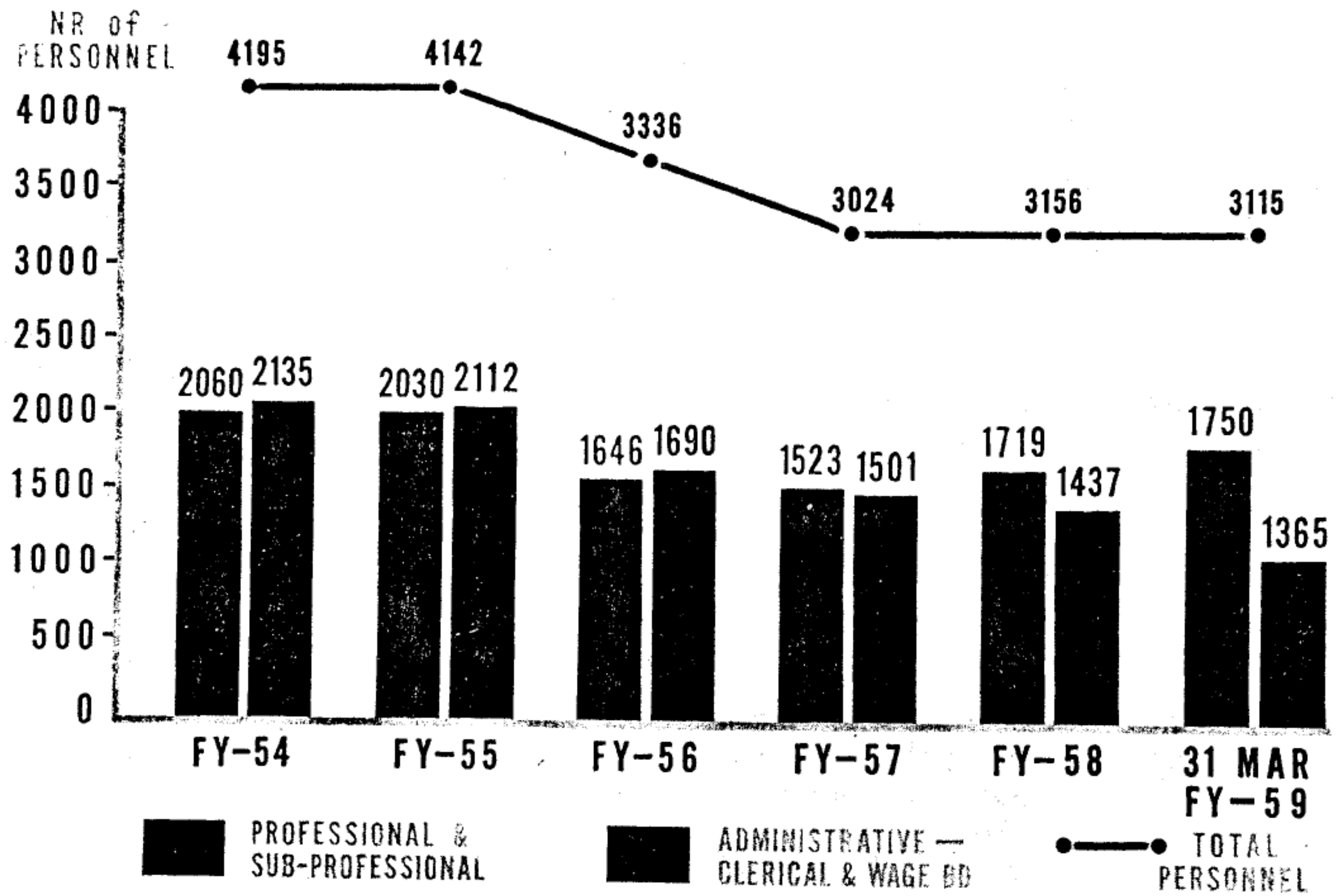


Chart 1

USASRDL IN HOUSE SKILLS & RESOURCES

* PERSONNEL INCLUDES GRADED AND UNGRADED

TECHNICAL DIVISIONS	* NR OF PERSONNEL	FACILITY VALUE	TECHNICAL DIVISIONS	* NR OF PERSONNEL	FACILITY VALUE
SYSTEMS	41	719,355	SOLID STATE DEVICES	57	996,030
COUNTERMEASURES	137	2,434,740	SYSTEMS ENG	34	608,685
APPLIED PHYSICS	141	2,490,075	TRANS FACILITIES	135	2,379,405
AVIONICS	62	1,106,700	SUPP & GEN'L ENG	88	1,549,380
METEOROLOGICAL	104	1,881,390	DATA PROC FAC	108	1,936,725
RADAR	95	1,660,050	ASTRO ELECTRONICS	81	1,438,710
ELCT. PARTS & MATERIALS	152	2,711,415	INST. FOR EXPLOR. RES.	163	2,877,420
POWER SOURCES	111	1,992,060	OTHERS NOT LISTED ABOVE	1,395	24,790,080
FREQ. CONTROL	77	1,383,375			
ELECTRON TUBES	134	2,379,405			

AS OF 31 MAR 59

USASRDL GRAND TOTAL: PERSONNEL 3,115 — FAC. VALUE 55,335,000

Chart 2

specialized needs. Also available are well stocked technical libraries and modern machine shop facilities capable of fabricating complex electronic equipment.

Supporting the efforts of the U. S. Army Signal Research and Development Lab are thousands of additional scientific and professional personnel, available through the more than 650 research and development contracts with the nation's leading industries, universities, research foundations, and other Government agencies. Charts 3 and 4 indicate the contractual activities of the various technical groups within the Laboratory.

Unique among the U. S. Army Signal Research and Development Lab contractors is the Electronic Defense Laboratory of Sylvania Electic Products, Incorporated, a facility working exclusively on projects submitted through the U. S. Army Signal Corps. Established in 1952 by the U. S. Army Signal Corps to conduct research and development in the special field of Electronic Countermeasures against surface target guided missiles and to produce special electronic equipment on a quick reaction capability basis, this facility has grown into an organization of approximately 660 people including 240 scientists and engineers occupying two buildings constructed by Sylvania at a cost of $2.5 million, with approximately 89,000 feet of floor space. The Electronic Defense Laboratory facilities provided by the Signal Corps and valued at approximately $2.5 million include: anechoic chambers, antenna range, high power tube test equipment, component test equipment, hydraulics test equipment, electronic test equipments and standards, GEDA analog computer, environmental test apparatus, and fabrication and model shops. Over the past seven years the combined R&D and quick reaction capability work has built up at Electronic Defense Laboratory a wide range of capabilities which has resulted in outstanding contributions in miniaturization, signal processing, versatile receiving, transmitting, and antenna equipment, systems engineering, and propagation research.

The Signal Corps consists of some 1,916 officers, 11,442 enlisted men and 23,786 civilian personnel. The Signal Corps' current annual budget is $700,000,000. These figures represent funds and personnel directly under the control of the Chief Signal Officer. An additional 5000 theater personnel perform work in Army world-wide communications net and the Signal Corps makes procurement with other funds. The total value of all Signal Corps facilities and activities is $2,250,000,000. The operational functions of the Signal Corps fall into a number of categories.

USASRDL CONTRACTUAL PROGRAM (R&D and PEMA)

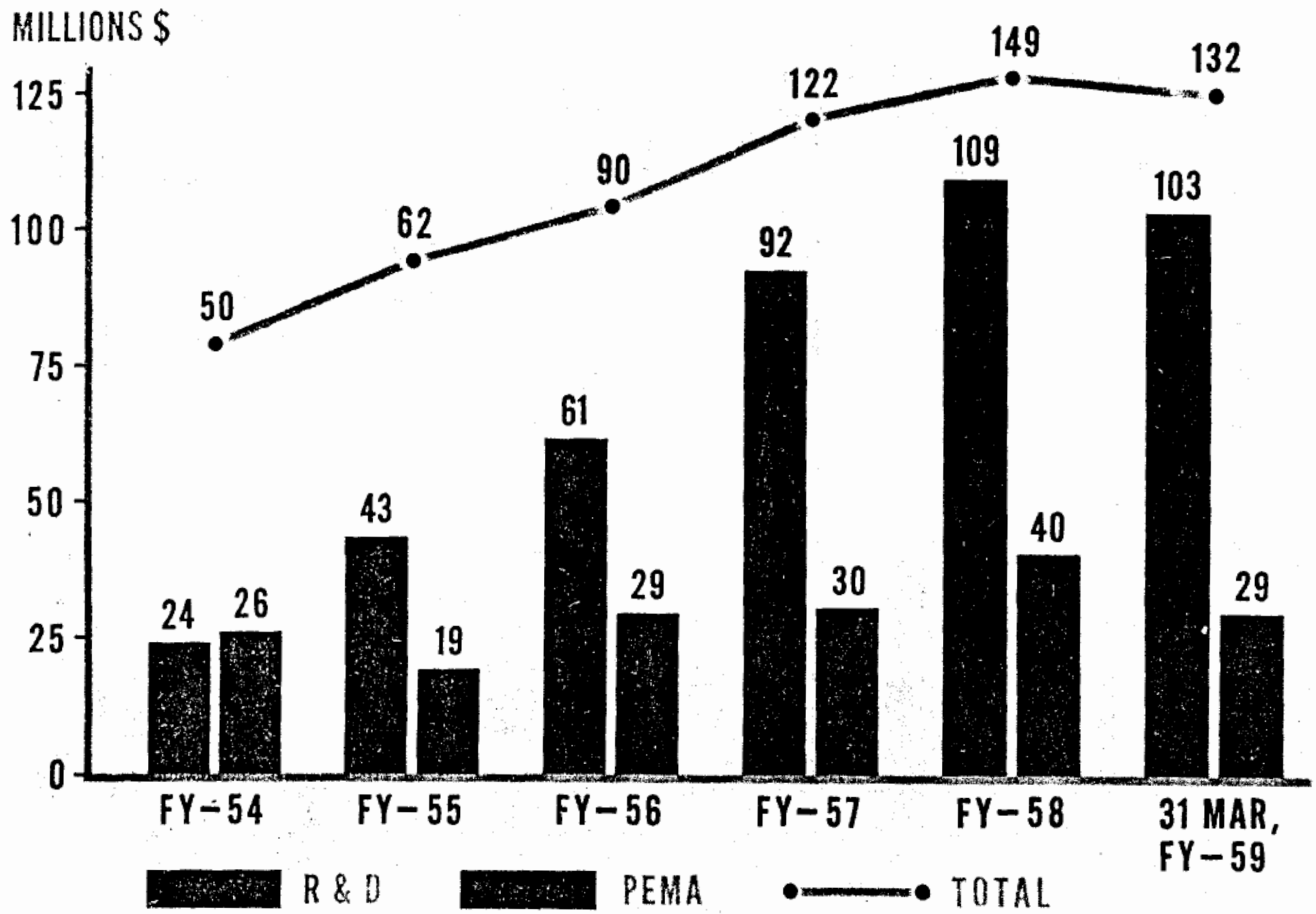


Chart 3

USASRDL OUT OF HOUSE SKILLS & RESOURCES

TECHNICAL AREA	VALUE OF R & D CONTRACTS IN THOUSANDS OF DOLLARS	VALUE OF PEMA CONTRACTS IN THOUSANDS OF DOLLARS	TOTAL NUMBER OF CONTRACTORS
COUNTERMEASURES	23,570	21,149	61
APPLIED PHYSICS	5,212	11,107	113
AVIONICS	4,487	74,510	26
METEOROGICAL	1,797	1,032	34
RADAR	8,662	63,036	56
ELCT PARTS & MATS	4,568	927	50
POWER SOURCES	1,428	1,814	32
FREQUENCY CONTROL	2,687	675	27
ELECTRON TUBES	9,238	2,501	41
SOLID STATE DEVICES	4,898	7,809	28
SYSTEMS ENG.	100	246	2
TRANS FACILITIES	4,251	33,081	32
SUPP & GEN'L ENG.	683	2,856	24
DATA PROC FAC	3,685	34,455	49
INST. FOR EXPLOR RES.	36,110	10,482	30
TOTAL	111,376	265,680	605

Chart 4

Probably the most vital single category of all in which the Signal Corps engages is the provision of a world-wide communications system to the Army. The Chief Signal Officer is responsible for planning, programming, designing, engineering, installing, operating and maintaining all fixed communications-electronics equipment, facilities, systems and networks for the Department of the Army. These fixed communications are provided from Headquarters, Department of the Army, down to the Field Army level. Included are special networks for intelligence and Air Defense. Facilities include wire (voice and teletype), radio and television. The annual expenditure for operation, modernization and improvement of this sytem totals approximately $165,000,000.

One of the largest areas of Signal Corps operations is Signal logistic support to the Army. A total of more than 13,000 Signal Corps personnel are engaged in this function. The U. S. Army Signal Equipment Support Agency is an 800-man organization located at Fort Monmouth, New Jersey, which writes and reviews production specifications, conducts sample testing, does production engineering and product improvement, and maintains gauges and standards for quality assurance and standardization purposes. The U. S. Army Signal Supply Agency is a 4400-man organization located at Philadelphia, Pennsylvania, which makes all Signal Corps procurements and exercises all of its stock control and record functions.

Because of the continuing rapid advancement in the electronic art, a decrease in the time-lag between development of new technical capabilities and their evaluation and application to military purposes is vitally necessary. The Signal Corps has established the U. S. Army Electronics Proving Ground (USAEPG), a 4700-man organization located at Fort Huachuca, Arizona. Its major mission is to conduct field tests and troop trial of new electronic systems and concepts in communications, electronic warfare, Army aviation, meteorology and combat surveillance, in the early development stages.

The Signal Corps operates the White Sands Signal Missile Support Agency, a 2200-man organization at the White Sands Missile Range. This organization operates an extensive radar tracking complex, interconnected by microwave links, complete with data processing and evaluation equipment. This sytem is used for determination of the exact trajectory of missiles fired on the range, for range safety and control, and acquisition data for other instrumentation at the range. The organization is responsible for the radar and communications complex, all frequency coordination, allocation and monitoring on the range, and is responsible for measuring data on various atmospheric parameters.

In fulfilling its pictorial mission, the Signal Corps operates the U. S. Army Pictorial Center, a 1000-man organization at Astoria, Long Island, New York. This organization produces the bulk of all training films used by the Army, aggregating some 400 per year. It also provides, on an average, some 14 motion picture production teams for on-site film production and two mobile TV units for on-the-spot coverage.

Army Medical Center

The present responsibility of the Army Medical Service is to service and maintain the highest possible level of health of the Army, specifically to:

1. Protect man against natural biological hazards.

2. Evaluate the physical environmental hazards to health, and cooperate with the appropriate agency or commander in the control of such hazards and the minimizing of their effects on man.

3. Provide medical care to military personnel, dependents of military personnel and Department of the Army civilians in overseas areas.

4. Determine the physical and emotional standards for selection, retention and elimination of military personnel and the conduct of examinations necessary to the application of such standards.

5. To conduct research to evaluate the physical and emotional standards for military personnel, the extent and mechanism of action of physical and biological health hazards, the means by which these hazards may be obviated, and, together with appropriate Army agencies develop better techniques of preventive and curative medicine.

6. Conduct biomedical experiments in space flight, exploiting opportunities for such research as may present themselves, with a view to contributing medically to the safe transport of man via ballistic missiles as a part of a probable Army operation of the future.

The Research and Development Program of the Army Medical Service utilizes 992 professional and technical, and 527 support personnel in eleven laboratories located from Washington, D. C. to Puerto Rico, to Malaya. Thirteen percent of the professional and technical personnel are MD's and PhD's. The 1519 people presently employed in research and development can be roughly grouped into the following program areas:

Nutrition and Metabolism	29%	430
Radiation	20%	303
Surgery	19%	297
Infectious Disease	13%	197
Environment	11%	167
Other	8%	125
	100%	1519

The U. S. Army Medical Research and Development Command plans, initiates, coordinates, supervises, executes and reviews the Army Medical Service R&D Program, designed to meet the needs of the Army in the fields of health. It commands Army Medical Service Research and Development Units, activities, and installations, and performs research and development staff functions for the Surgeon General as directed.

The Walter Reed Army Institute of Research conducts research and evaluation studies in the military aspects of the biological and medical sciences, correlates these findings with data from other sources, and disseminates the basic tenets derived therefrom in a graduate educational program as required for the national defense. It plans and conducts the Army Medical Service's medical, dental, veterinary, and allied sciences advanced technical and graduate educational programs required for the military aspects of professional practice in support of the Army's mission in national defense. The Institute plans and conducts research and development in relation to this program on approved projects as assigned by the Surgeon General and correlates those research activities within its sphere that are conducted by other Medical Service laboratories.

It also provides advisory services on problems in procedure or technique in military medicine, dentistry, and veterinary medicine; provides special technical quality control where required, and conducts development studies in relation to biologic products presenting problems of military importance. It acts as a diagnostic reference source for installations of the Army for difficult medical service problems and evaluations that require complicated analyses or tests not available in other Army installations.

The Medical Equipment Development Laboratory, Fort Totten, New York, accomplishes the design and development of new items of military medical equipment; plans and executes improvements to existing military medical equipment for the medical services of the Armed Forces. DOD Directive 5160. 23, 23 March 1957, vests the technical control and supervision of joint medical material development projects in the Armed Services Medical Material Coordination Committee.

The U. S. Army Prosthetic Research Laboratory conducts fundamental and applied research, development, testing, and training in the technique of fitting new devices in the field of orthopedic prosthetic appliances.

The U. S. Army Medical Research Unit, Malaya, provides an organization for special research activities being conducted in Malaya and North Borneo in collaboration with the Institute of Medical Research, Kuala Lumpur, Malaya, and other governmental services in that area.

The U. S. Army Medical Unit, Fort Detrick, Maryland, conducts studies of research problems of a sensitive and classified nature. The prime object of these studies being related to defensive aspects of biological warfare requires an effort between the Army Chemical Corps and the Army Medical Service.

The U. S. Army Tropical Research Medical Laboratory, Puerto Rico, conducts tropical medical research unencumbered by additional secondary missions.

The U. S. Army Medical Research Laboratory, Fort Knox, Kentucky, conducts basic and applied research on physiological, biochemical, biophysical, psychological, and psychophysiological problems that have military significance. This includes research on physiological and psychophysiological responses to various environment factors such as heat, cold, radiation, noise, vibration, and all other microenvironmental factors which affect the soldier's operating efficiency or ability to survive; the biological and medical aspects of ionizing radiation; research directed toward improvement of X-ray and photographic techniques used by the Army Medical Service; field research; and studies on human engineering problems arising from expanded global military operations.

The U. S. Army Surgical Research Unit, Brooke Army Medical Center, Fort Sam Houston, Texas, investigates problems of mechanical and thermal injury and the complications arising from such trauma; cares for patients with such injuries; and provides clinical research material for adequate studies. Teaches and trains other personnel in the management of injured patients. Conducts investigative studies at both the basic and clinical levels.

The U. S. Army Medical Research and Nutrition Laboratory, Fitzsimmons Army Hospital, Denver, Colorado, conducts basic research on nutrition and metabolism, assesses the health as related to nutritional status of troops in all environments, recommends nutritional measures designed to insure that the personnel are as healthy and fit as is compatible with local danger, disease, and environment; devises and recommends nutritional means to prevent disease and damage to troops under all conditions; and observes and makes recommendations on the nutrition and nutritional status of civil populations under military control. The laboratory also conducts research on medical and surgical problems of special interest to the Army.

The U. S. Army Medical Research Unit, Panama, in conjunction with other United States Governmental agencies, conducts research on medical and environmental problems of military importance in the Middle Americas.

The U. S. Army Medical Research Unit No. 1, Landstuhl, Germany, conducts research on military medical problems of importance to the maintenance of the effectiveness of Army personnel. Initial studies will be concerned with radioactivity in man.

The research and development budget for Fiscal Year 1959 was $12.5 million, and for Fiscal Year 1960 is $13.3 million. The total dollar value of the Medical Research and Development facilities is some $225 million. The yearly operating budget is some $6.3 million. Out-of-house contracts for Fiscal Year 1959 totaled $6.2 million, and involved the services of some 1550 professional scientists and 716 support personnel.

Quartermaster

The Quartermaster Corps develops, provides, and maintains food, clothing, individual equipment, petroleum (except field and higher echelon maintenance of pipelines) and general supplies, including aerial supply equipment. It provides maintenance and services support for the Army, and as assigned, for the Navy, Air Force, and Marine Corps. The Quartermaster General is the single manager for all the Armed Services for food and for clothing and textiles. In the field of general supplies, Quartermaster responsibilities range from housekeeping and office supplies, through warehouse materials-handling equipment, to special items used by the soldier in a variety of environments. The Quartermaster General provides for the care and disposition of the remains and personal effects of deceased personnel of the Army, and as directed or agreed upon of the Navy, Air Force, and Marine Corps. Since the Quartermaster Corps has a continuing responsibility for feeding, clothing, and equipping Army troops under many different conditions, it maintains a vigorous research and engineering facility.

The 1620 civilian and 617 military personnel in the Quartermaster Corps Research and Engineering organization form an integrated scientific and technological organization which vigorously supports the Quartermaster Corps mission. These personnel are located at the

Quartermaster Research and Engineering Command, Natick, Massachusetts; the Quartermaster Food and Container Institute for the Armed Forces, Chicago, Illinois; and the Quartermaster Field Evaluation Agency, Fort Lee, Virginia; and the Maynard Quartermaster Test Activity, Maynard, Massachusetts. Fig. I-25 portrays some of the professional skills of Quartermaster. The scientific skills of colleges and universities and industry are also used. (Fig. I-26) The Quartermaster Corps negotiated 385 research and engineering contracts in Fiscal Year 1958, 121 of which were with universities or non-profit organizations.

The no-cost agreement is a technique used extensively by the Quartermaster Corps to bring industry into the Corps research and development effort and to enable the Army to phase technical know-how into the civilian economy at an early date. At present, the Quartermaster Corps has 45 no-cost agreements; 20 in Foods, eight in Containers and Packaging, five in Chemicals, and 12 in Climatic Studies.

Among the Technical Services, the Quartermaster Corps has achieved the role of "Supply Specialist" of the Army. As the key military supplier, the Quartermaster General is the key depot operator, and commands a number of General Depots. These facilities accomplish the receipt, storage, issue, maintenance, and modification of hundreds of different items of equipment. Each depot is strategically located to serve not only soldiers, airmen, sailors, and marines stationed in the United States, but also the ports through which supplies move to our forces overseas. The Quartermaster depot system contains approximately 5500 well-qualified civilian logisticians, in addition to the officer and enlisted personnel of the Corps.

The Quartermaster General now manages the procurement and distribution of clothing and textile material for the Army, Navy, Marine Corps, and the Air Force through the Military Clothing and Textile Supply Agency located in Philadelphia, Pennsylvania. Each year, contracts awarded number approximately 3500 with a total dollar value of around $230,000,000. This effort has involved the merger of four separate supply systems and the control over supplies located in forty-six depots across the country, occupying nearly 20,000,000 square feet of storage space. The staff of trained clothing technologists and specialists maintained at a level to meet current and foreseeable peacetime requirements, constitutes a pool of personnel possessing the skills required to manufacture a variety of items.

In addition to supplying clothing for the Armed Services, the Quartermaster General performs the full job of meeting all food requirements

QUARTERMASTER CORPS

TECHNICAL AND PROFESSIONAL SKILLS

Anthropologists	Geographers
Aerodynamic Engineers	Home Economists
Biologists	Mathematicians
Bacteriologists	Mechanical Engineers
Chemists	Microbiologists
Chemical Engineers	Military Analysts
Clothing Technologists	Military Apparel Specialists
Container Technologists	Mycologists
Entomologists	Nuclear Effects Engineers
Equipment Specialists	Nutritionists
Food Technologists	Psychologists
General Engineers	Physicists

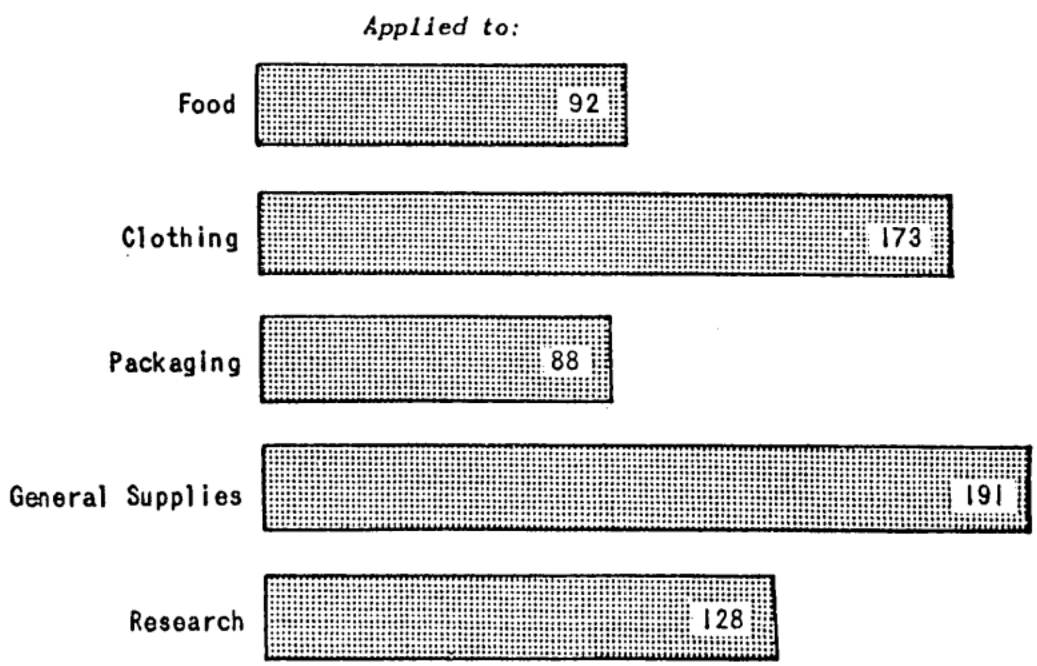


Fig. I-25. Quartermaster Corps

15 May 1959

	Food		Clothing & Allied		OTHER AREAS, Including Support Research	
	Industry	Non-Ind	Industry	Non-Ind	Industry	Non-Ind
Research	210,213	620,709	38,030	26,500	204,655	167,711
Development	26,942	77,888	286,738	139,191	691,779	244,241
Applications Engineering	6,000	1,124,660	249,908	18,092	71,336	68,348
ET/UT (O&MA & PEMA)	20,590	309,364	634,674	75,834	650,231	60,895
	263,745	2,132,621	1,209,350	259,617	1,618,001	541,195

Contract Research & Development Totals:

Food	$2,396,366
Clothing	$1,468,967
Other	$2,159,196
	$6,024,529

Fig. I-26. FY 1958 R and E QM Contracts

of military installations at home and abroad. To feed the members of the Armed Services, the Military Subsistence Supply Agency normally spends about $750,000,000 each fiscal year.

In the performance of his role as a supplier of the Army, the Quartermaste: General commands a number of general depots. Fifty-seven million square feet of covered storage space and sixty-two million square feet of open storage space are administered by Quartermaster depots in the United States. Quartermaster personnel also operate depots all over the world; in Europe, Korea, Alaska, and Panama, supplying Army Forces and those of the Air Force with necessities of life.

Transportation

The Transportation Corps' primary mission is to move personnel and material for the Army, and in many instances for the Air Force, Navy and other Government agencies. The Corps also develops, supplies and services transportation material for the Army and for the other services as required. At present, this responsibility involves the management of over a billion dollars' worth of equipment, about 30 percent of which is aircraft.

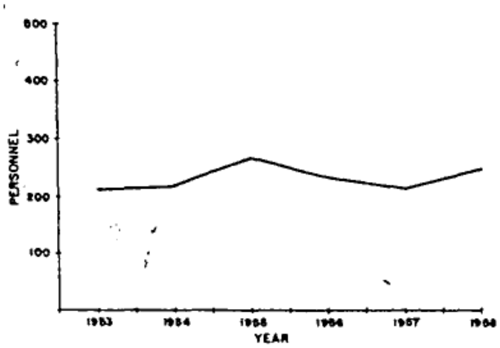
The Transportation Corps has a nucleus of research and development systems management personnel to derive the maximum benefit from present government resources and those resources available within industry and private institutions. Transportation Corps research and development organizations include the U. S. Army Transportation Research and Engineering Command and the Transportation Combat Development Group at Fort Eustis, Virginia (Fig. I-27). Both organizations perform special studies and projects pertaining to the transportation of missiles and supporting equipment. Transportation Research and Engineering Command provides a continuing consultant and research service to the Army Ordnance Missile Command pertaining to the compatibility of Transportation Corps equipment and missile systems. Transportation Research Engineering Command also assists in such matters as the evaluation of logistical-type missile.

The major portion of the Transportation Corps R&D dollar is spent out-of-house. Of each R&D dollar spent outside, well over 90 percent goes toward Army aviation research and development. Having worked in close relationship with the vast aviation industry, the Transportation Corps has established a very valuable out-of-house resource (Fig. I-28).

Universities, colleges, and non-profit research organizations have been utilized in areas of basic and applied research. These resources are utilized to develop the principles from which stem the decisions for design and development of prototypes.

R&D PERSONNEL RESOURCES

SCIENTIFIC AND TECHNICAL PERSONNEL ENGAGED IN RESEARCH AND DEVELOPMENT



RESEARCH AND DEVELOPMENT SKILLS AND EXPERIENCE MAY 1959

	NO. OF PERSONNEL	YR. OF EXPERIENCE
AERONAUTICAL	58	649
MECHANICAL	92	964
MARINE	39	534
ELECTRICAL	16	180
GENERAL	12	118
TOTAL	217	2411

INCLUDES: 52 SUPERVISORS WITH 437 YEARS OF SUPERVISORY EXPERIENCE

DEGREES HELD

PhD	3
MS	20
BS	173
BA	21

OTHER CATEGORIES

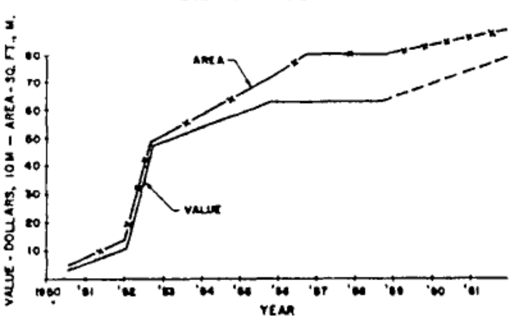
AN AVERAGE OF 750 PERSONNEL IN OTHER CATEGORIES ARE DIRECTLY INVOLVED IN THE TC R&D EFFORT

TOTAL

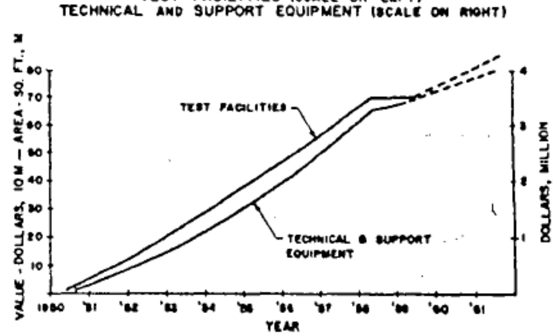
1,000 PERSONNEL ARE INVOLVED PRIMARILY IN THE TC R&D PROGRAM

R&D FACILITIES RESOURCES

RESEARCH FACILITIES

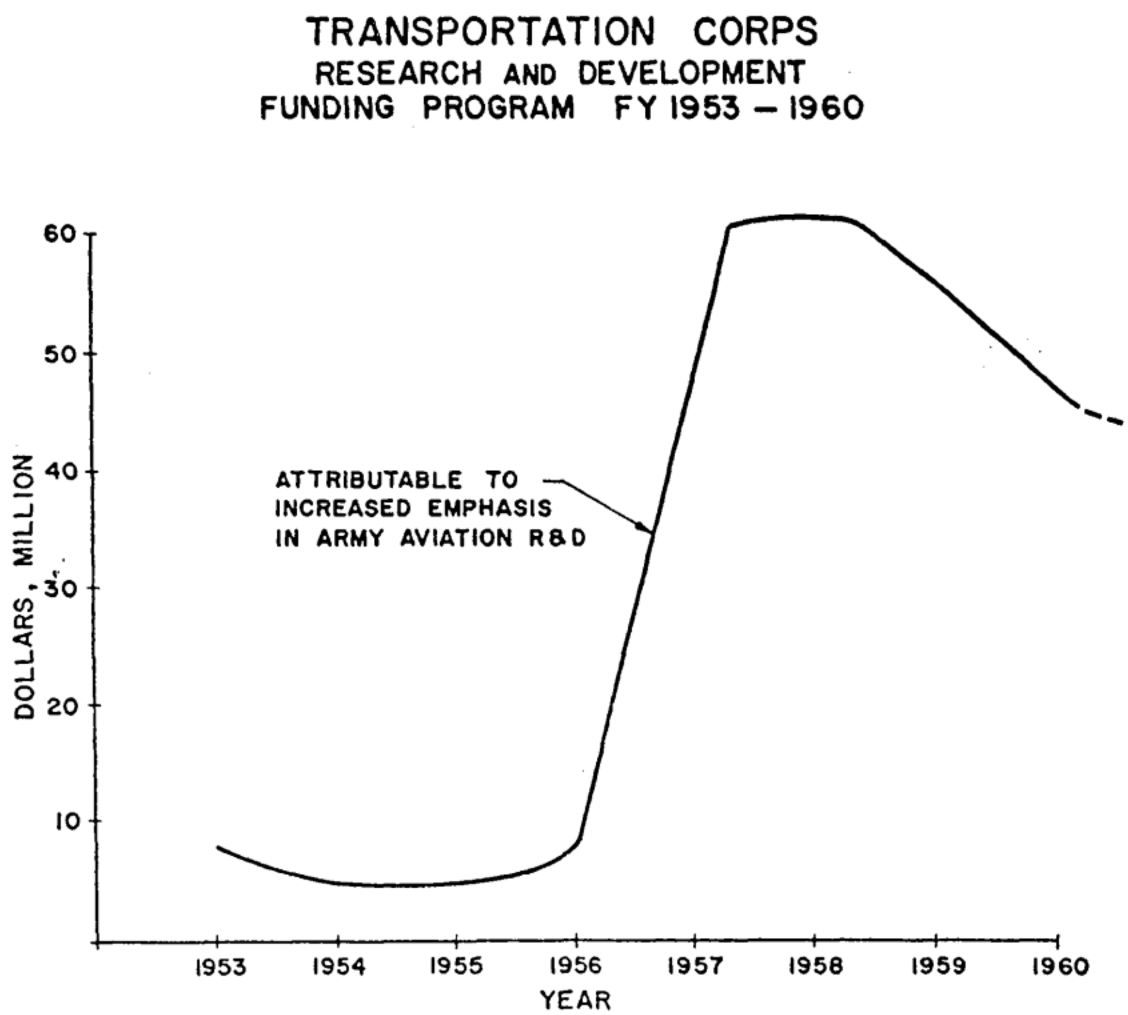


TEST FACILITIES (SCALE ON LEFT) TECHNICAL AND SUPPORT EQUIPMENT (SCALE ON RIGHT)



TOTAL "IN-HOUSE" R & D RESOURCES = $4,800,000

Fig. I-27. Transportation Corps Resources



FY 1959
R AND D PROGRAM

Appropriation	In House	Industry	Universities, Colleges, and Non-Profit Institutions	Total
R and D	3,622,097	10,488,002	3,140,101	17,250,200
PEMA	——	40,604,000	——	40,604,000

RECAP:

In House $ 3,622,097
Out-of-House $54,232,103

Fig. I-28. Research and Development Funding Program

Industrial resources utilized by Transportation Corps include the wide range of research and engineering "know-how" associated with all modes of transportation - from naval architects to aeronautical engineers. Industrial resources have been used primarily for design and development of prototypes.

In addition, the Transportation Corps retains the services of professional consultants on a continuing basis - both management and engineering consultants who participate regularly in research and development program planning and execution.

Transportation Corps facilities in the continental United States are valued at over 500 million dollars. The Corps' personnel strength is some 30,000. Its operational budget, exclusive of research and development activities, is some 283 million dollars.

Chemical

The Chemical Corps is presently engaged in research and development work on the following programs which relate to national space programs:

1. Alpha, beta, gamma, and neutron dose and spectrum measurements (probes and base site).
2. Evaluation of thermal radiation (probe).
3. Determination of radiation shielding requirements.
4. Nuclear weapons effect data.
5. Chemical oxygen production and atmosphere regeneration.
6. Toxicity studies of chemicals including propellants.
7. Personnel and equipment shelter and lock system.
8. Non-electronic signalling devices.
9. Wound ballistic studies on low pressure injury, high velocity missile effects, quasi-blast effects, and synergistic injury effects.
10. Decontamination of man and material from chemical, biological, radiological contamination.
11. Protection of man from biological, chemical, radiological hazards.

The U. S. Army Chemical Corps Research and Development Command Staff provides the direction for each of the agent-munitions systems, as well as defensive material development. The engineering talent is furnished by the central engineering group known as the U. S.

Army Chemical Corps Engineering Command. The U. S. Army Chemical Corps Engineering Command conducts the necessary operations to develop and produce items for delivery.

Chemical - Research and development work in the chemical category amounting to $17.4 million in FY 1959 is being conducted at two locations, Army Chemical Center, Maryland, and Dugway Proving Ground, Utah. There are two organizations at Army Chemical Center: The U. S. Army Chemical Warfare Laboratories and the U. S. Army Chemical Corps Engineering Command. Approximately 2250 people are employed in the Chemical work. The Chemical Warefare Laboratories comprise 860,000 square feet of laboratory space, supported by administrative and service facilities of the Army Chemical Center. Facilities used by the Chemical Warfare Laboratories represent a capital investment of $74 million. These facilities are located on an area of 2750 acres (including test areas). Some of the special facilities and equipment are chemical process laboratory, wound ballistics facility, dynamic aerosol exposure chamber, vapor-phase chromatograph analyzer, infrared spectrometer, nuclear magnetic resonance spectrometer, ultraviolet spectrometer, ultra-high speed photographic equipment, gassing chambers, and high-vacuum evaporating unit. The Chemical Corps Engineering Command operates as a central engineering agency for the Chemical Corps and supports the research and development as well as the production organizations of the Corps. They do engineering work on plants and processes, products engineering, maintenance engineering, specifications and drawings, basic engineering studies, and furnish consulting service for design criteria for necessary Chemical Corps construction. This organization comprises 340 civilians, 60 Enlisted Specialists Professional Personnel, and 24 Officers.

Biological - Research and development work in the biological category amounting to $18.9 million in Fiscal Year 1959 is conducted in two locations, Fort Detrick, Maryland, and Dugway Proving Ground, Utah. At Fort Detrick, over 1,600,000 square feet of laboratory space is supported by 1,140,000 square feet of administrative and service facilities, and at Dugway Proving Ground there is an additional 37,000 square feet of laboratory space. Over 90 percent of the laboratory facilities are designated "hot" and the personnel who work in these environments are protected from infectious micro-organisms by an extensive system of safe-guards. Approximately 2400 people are employed in the biological work. The fixed capital investment for laboratories and support facilities represents $93 million. The average increase in facilities has been $5 million annually over the past 6 years. These include plants for large scale production of micro-organisms, greenhouse for investigation of crop pathogens and chemicals affecting crop growth, a 1,000,000 volt X-ray instrument, huge animal holding and breeding rooms which can hold thousands of guinea pigs at one time, also test chambers, Horton test sphere, and pilot plants including one remote controlled biological warefare pilot plant.

Radiological - The Chemical Corps has complete laboratory facilities for radiological work at both U. S. Army Chemical Warefare Laboratories and U. S. Army Chemical Corps Dugway Proving Grounds. These laboratories are equipped with sources, hot laboratory, hot cells, and filtered exhausts. At Dugway there is a complete multi-mega curie capacity hot cell, waste holding facilities, and filtered exhausts. Health physics facilities exist at both locations. Approximately 80 people are working in the radiological field, and the capital investment is $5 million.

Activities of the Chemical Corps are carried on at five Class II installations. These installations are: Army Chemical Center, Pine Bluff Arsenal, Rocky Mountain Arsenal, Fort Detrick, and Dugway Proving Ground. They occupy 516,322 acres of land and the real estate and production equipment represent an investment of $408.3 million. Replacement of these facilities (exclusive of land) is estimated at $816.6 million.

The Chemical Corps has several reserve plants held for mobilization purposes. These include the Marshall Plant, Niagara Falls Chemical Plant, Alabama Phosphate Development Works, Rocky Mountain Arsenal Chemical Plant, Pine Bluff Arsenal Biological Plant, and Seattle Chemical Plant.

DATA SUMMARY
PERSONNEL, FACILITIES, AND FUNDING
U. S. ARMY CHEMICAL CORPS

	Category		
	Chemical	Biological	Radiological
Overall dollars (millions)	17.4	18.9	0.6
Number of people (R&D)	2250	2400	80
Private enterprise (millions)	1.7	1.0	0.1
Capital investment (millions)	73	93	5

CONCLUSIONS

The Army Technical Services' skills and resources in research and development constitute a substantial portion of that required for Project HORIZON. These capabilities exist today and have demonstrated their value to national programs.

(A considerably more comprehensive discussion of these skills and resources is contained in the publication "U. S. Army Capabilities in the Space Age.")