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AFBMD

WS 117L

DEVELOPMENT PLAN FOR PROGRAM ACCELERATION

CONTRACT AF 04(647)-97

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LOCKHEED AIRCRAFT CORPORATION
MISSILE SYSTEMS DIVISION
SUNNYVALE, CALIFORNIA

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REVIEW ON 31 Dec 2008

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LOCKHEED AIRCRAFT CORPORATION
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SUNNYVALE, CALIFORNIA

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WD 58-0007

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LOCKHEED AIRCRAFT CORPORATION [redacted] MISSILE SYSTEMS DIVISION

FOREWORD

Presented here is a plan for acceleration of the WS-117L program. The effort in preparing this plan was initiated in response to requests by AFBMD to consider attaining Pioneer reconnaissance capability by March 1960. Also included is the introduction of the Thor missile into the program as a booster vehicle.

Preliminary considerations of program acceleration were presented to Maj. General B. A. Schriever 5 December 1957. Mr. Robert Gross stated at that time that Lockheed would draw on its entire facility as necessary to expedite the WS-117L development.

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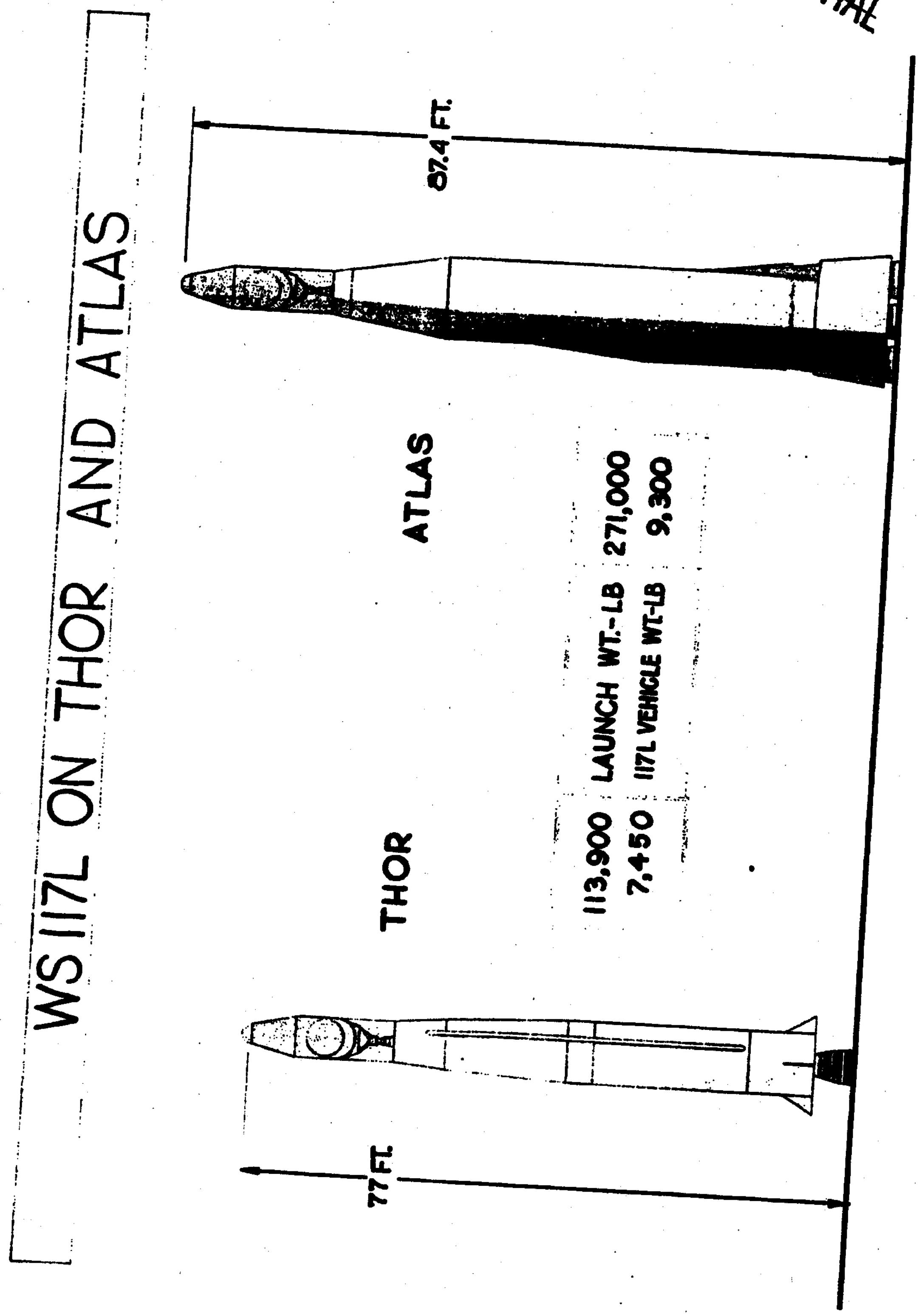

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INTRODUCTION

The WS-117L program now under development has as its objective the provision of complete reconnaissance systems utilizing satellite borne sensing devices. The material here represents a development plan for accelerating this program, and has been prepared by the Lockheed Missile Systems Division in its role as the WS-117L Weapon System Contractor.

In the course of negotiations on 12 to 19 November 1957 for the WS-117L definitive contract, it was requested by AFBMD personnel that Lockheed consider modification of the program for a potential acceleration. Included was consideration of increasing the tempo of vehicle firings to assure greater probability of program success and to reduce the development time scale of a first Pioneer Visual flight capability by one year to March 1960. Subsequently it was requested that consideration be given to developing the Pioneer Ferret system to a time scale comparable to that of the Visual.

In view of recent emphasis on missile weapon systems, it appeared appropriate to the Contractor to consider the inclusion of two alternate approaches in the development program: (1) The use of an IRBM missile as a booster, and (2) The physical recovery of reconnaissance photographs from the orbiting vehicle. Both approaches have been a part of the Contractor's over-all program concept from its inception but had been shelved due to initial funding limitations. The combination of the two approaches will provide a system attaining very early reconnaissance capability. This is quite similar to a method proposed recently by the RAND Corporation using the Thor as a booster and a panoramic camera, in a spin-stabilized recoverable capsule, on orbit.

The over-all program presented here is essentially the same as that presented to AFBMD on 27 November and 5 December 1957, but incorporates the RAND concept for early Thor-boosted reconnaissance flights.

The Contractor believes strongly that should additional funds be available for enhancement of the U. S. military program, consideration should be given to augmentation of the present WS-117L program in the manner and amount shown in Figure 1. This would allow capitalization of the established broad WS-117L base toward expeditious accomplishment of its military objectives. Expanding the vehicle firing rate from four to ~~24~~ 20 by Feb. 1960 will allow a more efficient utilization of the system, increase ultimate reliability, and bring about earlier reconnaissance capability.

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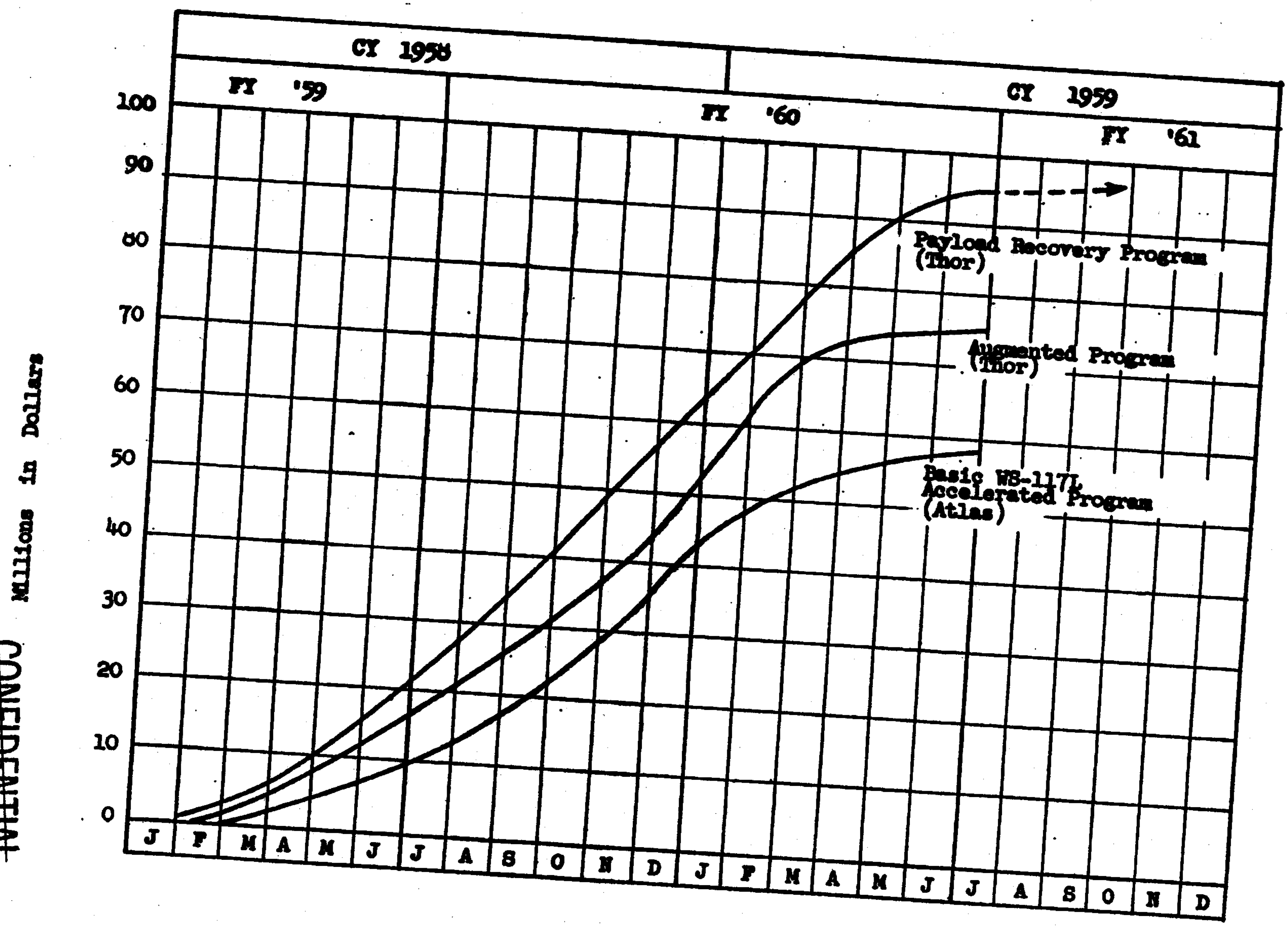

Fig. 1 WS-117L Program Cumulative Funding Requirements

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ACCELERATION OF WS-117L PROGRAM

The acceleration of developmental effort leading to earlier WS-117L operational availability embraces the following significant additions to the program:

Advance the first firing from June 1959 to October 1958.

Advance the first Pioneer Visual, high latitude firing from March 1961 to March 1960.

Advance the first Pioneer Ferret flight to April 1960.

Advance the move to IOC from March 1961 to March 1960.

Accelerate program via use of Thor IRBM as earliest available booster.

Initiate RAND-type visual-recce/physical-recovery program to advance availability of reconnaissance information with:

1 st flight January 1959

6 th flight (prototype) July 1959

Introduce use of UDMH fuel as product improvement to Hustler engine program. (Increasing Isp from 263 to 277).

Flight test (in period 1 January 1958-1 July 1959) eleven WS-117L vehicles instead of one.

Manufacture (in period 1 January 1958-1 July 1959) twenty-one WS-117L vehicles instead of original four.

SECTION I
PROGRAM SUMMARY

1.1 Development Plan

1.1.1 System Considerations

As a result of its previous WS-117L activities under the direction of AFBMD, the Lockheed Missile Systems Division is thoroughly familiar with the Air Force's requirement for developing earth satellites having the capability to perform reconnaissance of very strategic military significance. Primary categories of reconnaissance are visual, ferret and infrared-with priorities for operational requirement in that order. Long term efforts are aimed toward establishment of an Advance Reconnaissance System to become operational in the 1960-65 time period. However, efforts will also be undertaken to provide a limited reconnaissance capability as soon as possible.

The Air Force and LMSD have recently negotiated a program of effort toward these ends. The Development Plan herein presents ways and means to accelerate the existing program through increased effort and materiel-augmentation with the eventual result of earlier operational capability and increased overall effectiveness.

The program is planned to proceed from the simple to the more complex, with each point of capability embodying the best compromise between scientific state-of-the-art and early availability of Reconnaissance Weapon Systems for military use. To enhance this effort, the basic program would be supplemented by the development of an alternative Photographic Payload which can be physically recovered from a vehicle on orbit. In this case, the WS-117L vehicle would be boosted to orbit by a Thor Booster and would carry a recoverable visual payload similar to that described in recent Rand Corporation literature.

LMSD's overall activities are organized in the following phases:

1.1.1.2 Program I.

The objective of this program is the achievement of orbital capability on an accelerated time scale. The program calls for the design and development of a basic WS-117L vehicle utilizing a liquid-fueled orbit-boost engine and providing capability for carriage of various payloads. Vehicle design is based on a gross weight, with fuel and payload of 9300 pounds that allows the off-loading of fuel or payload for satisfaction of special flight objectives. Final Program I flight for demonstration of orbit capability is established for February 1960. The achievement of a reliable capability on an accelerated time scale requires the initiation of orbit flights by October 1958. The first four of these flights will utilize the Thor IRBM because of their early availability. The succeeding ten flights will be boosted by the Atlas ICBM in accordance with existing plans. All flights will be orbit-tries. Concurrently with the achievement of an orbital capability, a considerable effort will be spent during Program I in obtaining initial orbital testing of visual, ferret and infra-red reconnaissance payload components, partial subsystems and later, complete subsystems. These tests will provide the extremely important developmental phase of orbital environmental test conditions and will contribute to the acceleration of an early reconnaissance capability in later programs.

1.1.1.3 Program II.

The objective of this program is the achievement of pioneer visual reconnaissance capability which includes mapping physiographic features at a ground resolution at one hundred feet and a locational accuracy of one mile. Objectives of such reconnaissance are airfields, industry complexes and sea coast installations detectable at this scale. While Program II is not covered in detail in this Development Plan, it should be noted that the first Pioneer Visual Reconnaissance flight will be launched from I.O.C. in March 1960 as specifically directed by AFBMD.

Program II-A. The objective of this program is the early achievement of a Visual Reconnaissance capability through utilization of other techniques and sources than those incorporated in existing basic WS-117L Weapon System Program. This is done via utilization of panoramic camera techniques currently available from aerial reconnaissance state-of-the-art. A requisite part of this program is the utilization of recovery of the Visual Payload from the orbiting vehicle by utilizing techniques described by the Rand Corporation. In this program, basic WS-117L vehicles, each loaded to approximately 7200 pounds, would be boosted by a Thor IRBMs to orbit about 135 statute miles above the earth. Following acquisition of reconnaissance data, and at an appropriate point in its orbit, a command signal would initiate recovery of the Payload through utilization of retroactive rockets. The descending capsule would be recovered from a pre-selected point in the Pacific Ocean, North of Hawaii. Data thus collected would have approximately the same characteristics of resolution as that prescribed for Program II above. It envisioned that the objectives of this program could be satisfied by six firings the first of which would be performed in January 1959 and the last in July 1959.

1.1.1.4 <u>Program III</u>.

The objective of this program is the achievement of Pioneer Ferret Reconnaissance capability and will provide the ability to intercept electromagnetic emissions from the equipment of potential enemies; to return the intercepted information to an appropriate location in the continental United States, and to record and process this information into a form suitable for further processing. The first flight of the Pioneer Ferret Reconnaissance Program is scheduled to be launched from the I.O.C. in April 1960 in accordance with AFBMD's request.

1.1.1.5 <u>Advanced Development Programs</u>

Later development programs will be carried out in order to provide an advanced reconnaissance capability. Program IV, the Advanced Visual Program, will provide greatly increased ground resolution (20 ft.) with a locational accuracy of one half mile. The system may incorporate features to allow the programming of the camera to point to areas of specific interest. Program V, the advanced ferret program, will extend the operational capability of the Pioneer Ferret Program. Programs VI and VIII represent the development of continuous satellite surveillance systems utilizing advanced visual and ferret sensing systems.

1.1.1.6 Program VII

The Infrared Surveillance Program has as an ultimate objective, a system of satellites on orbit, placing unfriendly territory under continuous and complete surveillance. Initially the early system will be capable of detecting ICBM launchings and transmitting an immediate warning of an imminent attack.

1.1.2 <u>Subsystem Considerations</u>

1.1.2.1 <u>Airframe Subsystem</u>

The airframe Subsystem consists of the structure, propulsion tankage, outer skin, installation supports and certain mechanical and electrical equipments. The major portion of the development effort on this subsystem will be conducted at LMSD including design, fabrication, assembly, and ground support equipment development. LMSD will rely heavily upon outside purchase for small components.

1.1.2.2 <u>Propulsion Subsystem</u>

The Propulsion Subsystem consists of the main orbital thrust rocket engine with the associate propellant feed system and control mechanisms, the thrust producting system for vehicle attitude and roll control, the auxiliary rockets for ullage control together with all necessary ground based support equipment used for the testing, calibrating, checkout and servicing of the subsystem. All research, development and fabrication of the orbital thrust rocket engine will be performed by Bell Aircraft Corporation. LMSD will perform the over-all subsystem development activities.

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1.1.2.3 Auxiliary Power Subsystem

The APU Subsystem consists of the electrical power system for the complete satellite system together with the necessary ground support equipment. The subsystem design and development is being conducted by LMSD with appropriate subcontracting for specific battery and other subsystem developments.

1.1.2.4 Guidance and Control Subsystem

The Guidance and Control Subsystem consists of equipments required to fulfill functions associated with the initial boost, coast, orbiatl boost, reorientation, and orbital stabilization. LMSD is directing the over-all development of the necessary equipments required. Major components such as the inertial reference package and the horizon scanner will be developed by appropriate subcontractors. Both component and complete subsystem tests will be conducted by LMSD.

1.1.2.5 Visual Reconnaissance Subsystem

The Visual Reconnaissance Subsystem consists of the satellite-borne equipment required to collect, process, and store visual pictures and later to convert these pictures into video form for transmission to the ground with equipment which is a part of the Ground-Space Communications Subsystem. // This subsystem also includes the necessary ground data-processing equipment. // LMSD is planning and directing the development program with the major hardware development and fabrication of subsystem equipment being subcontracted to Eastman Kodak Company.

1.1.2.6 Electronic Reconnaissance Subsystem

The Electronic Reconnaissance Subsystem consists of the equipment required to collect radiations, store, process, and convert to appropriate form for transmittal to the ground via the Ground-Space Communications Subsystem. The subsystem also includes ground-based equipment for processing the data. The over-all development program is directed by LMSD with major subcontracting to Airborne Instruments Laboratory for specific equipment developments and to Haller, Raymond and Brown for Intelligence analyses.

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1.1.2.7 Infrared Surveillance Subsystem

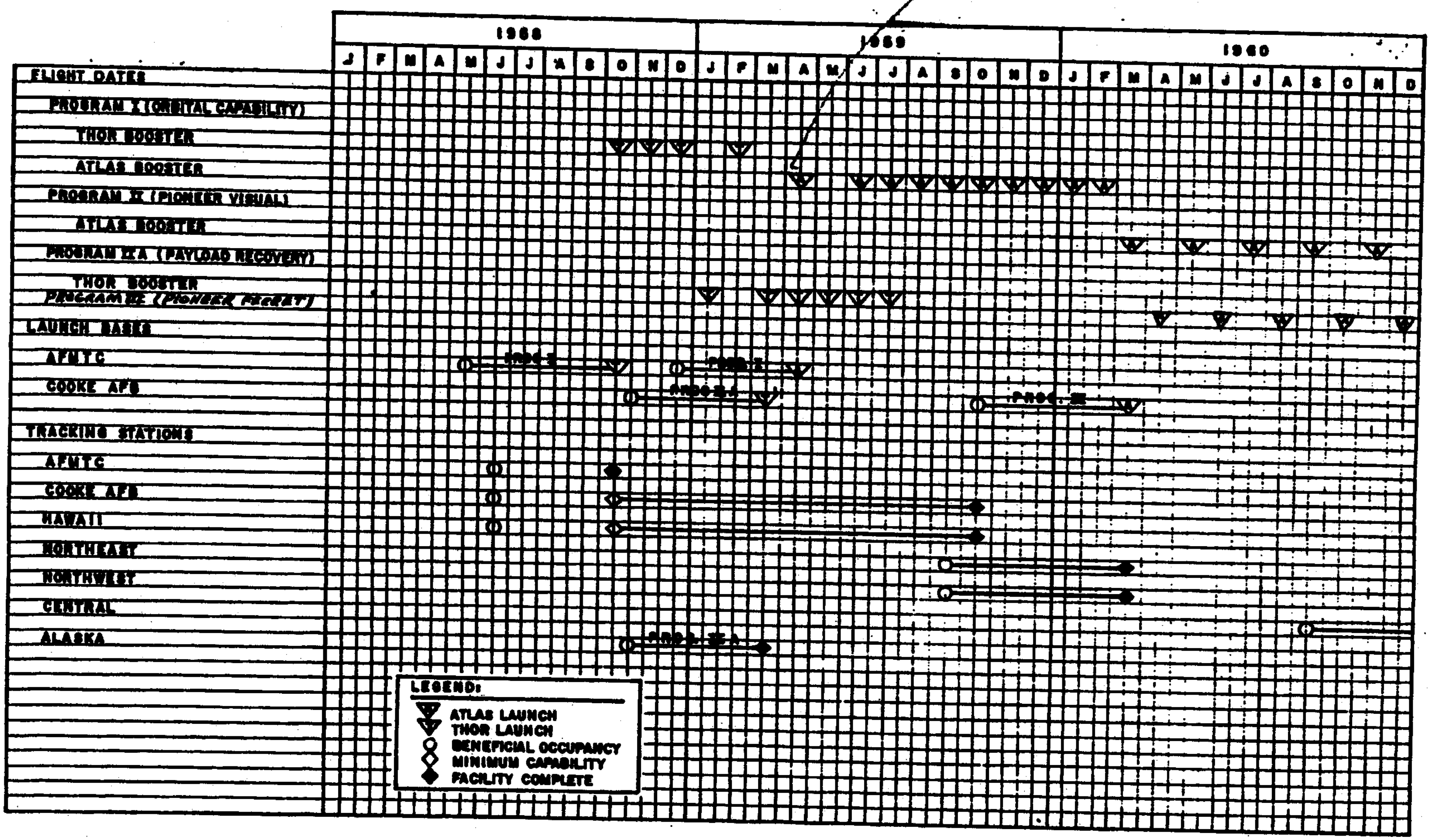
The Infrared Surveillance Subsystem consists of equipments for collecting infrared data from enemy ICBM's, and high-altitude jet aircraft and transmitting this data back to appropriate ground stations in order to provide warning of impending attack and surveillance of air traffic patterns. The over-all subsystem program is being directed by LMSD. Major subcontracts are underway for various phases of study and design work on components and subsystem equipment.

1.1.2.8 Ground-Space Communications Subsystem

The Ground-Space Communications Subsystem consists of equipments to perform the following functions: Acquisition and Tracking; Telemetry; Reconnaissance Data Link; Vehicle Antenna Systems; Ground Station Communications; Computers, Timers, and Command System. LMSD will direct the over-all design, development and test of these equipments. The Philco Corporation as the major subcontractor will have the responsibility for the development of the integrated subsystem together with specific developments as required.

1.1.2.9 System Management

The acceleration of this program will require the application of unusual measures in many cases to assure that an effective Weapon System is developed in the short time available. In the area of testing and operations, extensive captive testing of both subsystems and completely assembled flight systems will be necessary. Since it might not be possible to system-test each vehicle prior to flight, the test of one (1) complete vehicle out of selected production runs will satisfy necessarily reduced test requirements. In the manufacturing area, it will be necessary to stream-line procedures for drawing release, specification compliance, pilot line production, materiel procurement and other associated problems. Plans are now being laid to bring about these desirable end results. The acquisition and training of manpower presents a particularly imposing problem because of the unusual skills required and the heavy security requirements imposed. The immediate implementation of a program for acquisition of new personnel must be undertaken. Ground Support equipment for this program, as well as associated facilities, will be developed under an integrating plan by LMSD, although, extensive outside purchase of equipment is contemplated. Both the acceleration of the program and its enhancement of reliability will be accomplished by strong augmentation of testing for checkout and like equipments.



Summary Schedule - WS-117L Accelerated Program

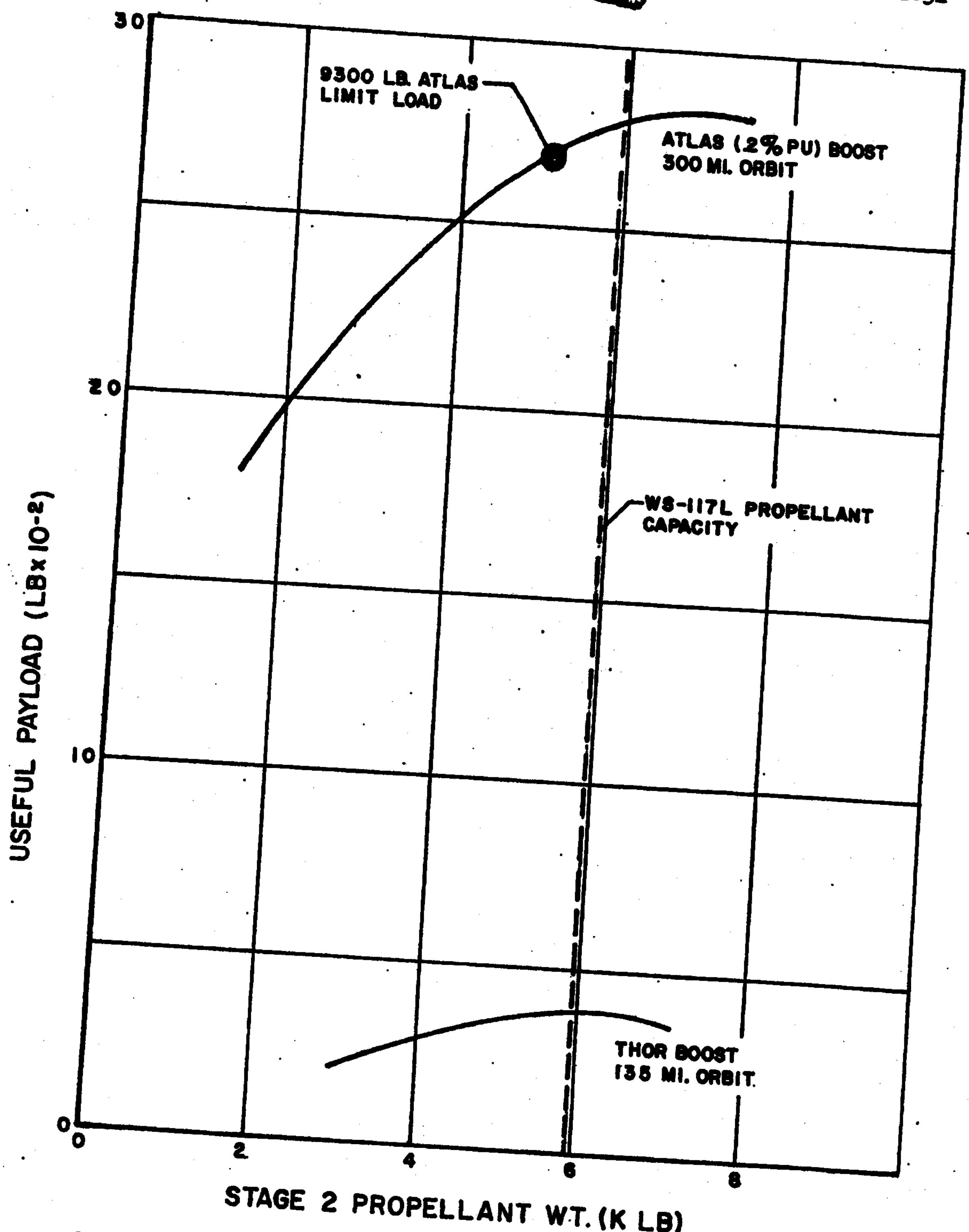


Fig. 1-1 Useful Payload vs Propellant wt. WS-117L Vehicle - Polar Orbit

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USEFUL SATELLITE PAYLOAD VS WT. OF STAGE (STAGES) ON THOR

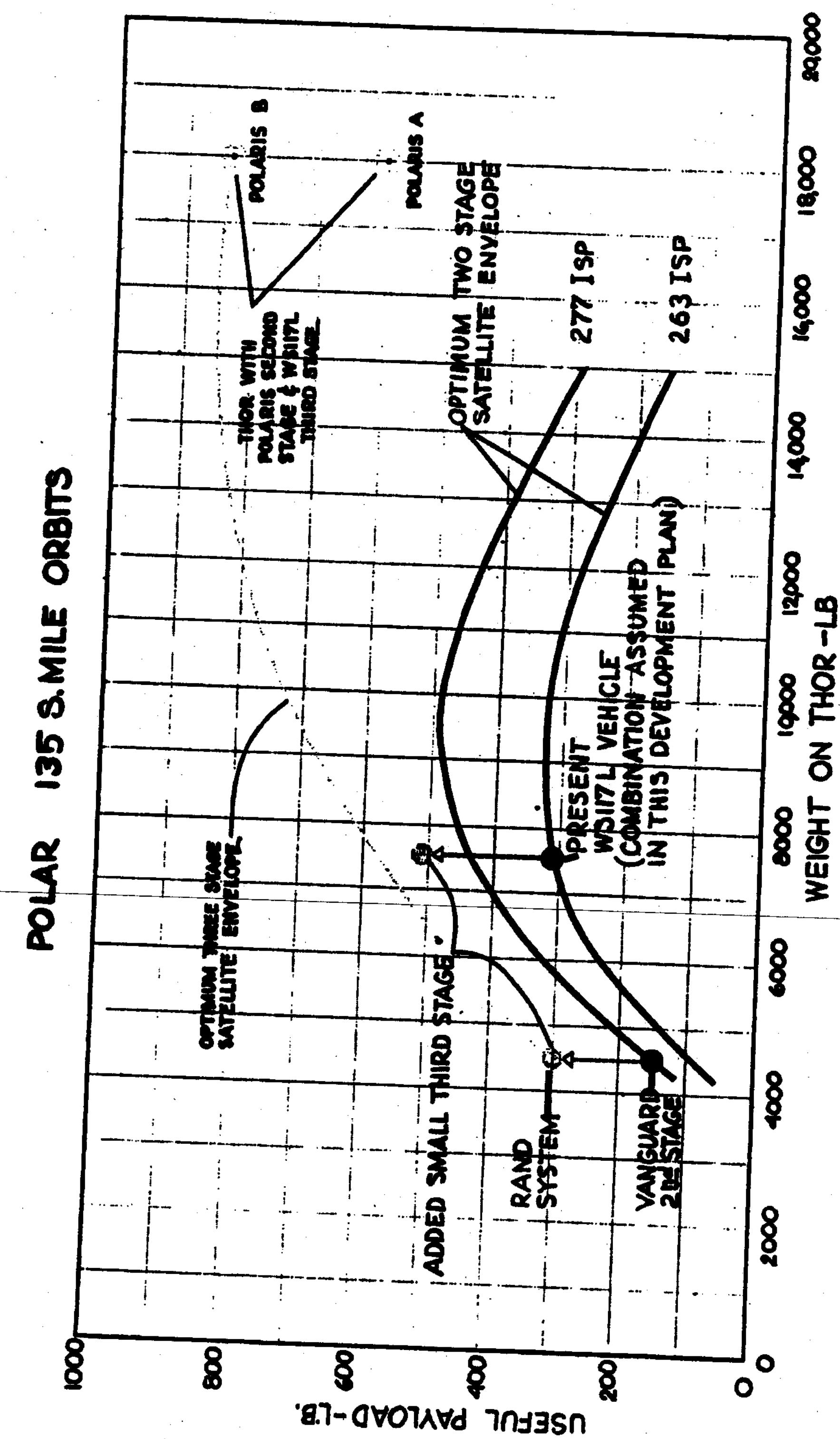

Fig. 1-2

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is indicated that the WS-117L has a higher payload capability than the Vanguard because the WS-117L is the proper size despite the higher specific impulse of the Vanguard engine*.

In order to launch a satellite the last stage must operate at orbit altitude. This means that a two-stage satellite must be launched on a less than favorable flight path from a performance point of view. If a small third stage is added it allows the second stage to be operated at lower altitudes and at a higher trajectory efficiency. Thus, although this small third stage does not contribute significantly toward the total impulse, it does allow considerably greater payloads. This point is illustrated in Figure 1-2.

RAND has assumed such a scheme in order to get enough payload capability to place their reconnaissance capsule on a useful orbit using the Vanguard second stage. Use of the small third stage versus a two-stage satellite is disadvantageous for reliability reasons and also because the last stage is not fired until the vehicle has coasted to apogee, which in the case of a three-stage vehicle is several thousand miles down range. For example, the RAND-assumed vehicle does not go on orbit until it is nearly in the Antarctic region. This introduces considerable difficulty in monitoring any functions while establishing the orbit. Furthermore, unless a guidance system is included in the last stage, great uncertainty is introduced in the type of orbit that is established.

On the other hand, the WS-117L vehicle will go on orbit within 900 miles of the launch point and this is considered to be quite significant for both guidance and instrumentation.

In the Teller Committee report, it was stated that the "WS-117L vehicle on a Thor would yield 200 to 400 pounds on orbit as proposed by Lockheed." Indeed, the material presented by Lockheed was based on the conditions that the payload would be placed accurately in an orbit with the latter useful for reconnaissance purposes (i.e., polar). The Contractor's

*The Vanguard engine does not have a pump and relies on tank pressures of 300 psi. At sizes commensurate with the WS-117L application, unfavorable Vanguard tank weights would offset the specific impulse advantage and would yield comparable performance only to the WS-117L engine.

performance figures were based on detailed designs, on rigorously optimized trajectories utilizing the 1103A computer, and on a large amount of system design data of satellite-type vehicles as a result of the WS-117L program over the last three years.

The Contractor has not been able to show on this same basis useful payloads of "400 to 800 pounds" for the Vanguard second and third stages as proposed by Douglas in the Teller report, or the large payload numbers presently being quoted by Ramo-Wooldridge. Part of this difference could be accounted for if the latter studies assume launching eastwardly from AFMTC. Under these circumstances the WS-117L vehicle would enjoy a similar increase in payload capability, but such an orbit is not useful for reconnaissance purposes. The remaining difference might be accounted for by more optimistic performance assumed for the Thor missile than is indicated by present WS-315A data available to Lockheed. Lockheed personnel have not been granted authorization by AFBMD to discuss in detail improved Thor performance with Douglas. If such improvements are in the offing it would be highly desirable to consider same in context with future applications of Thor to the WS-117L program.

The two-stage combination proposed by the Contractor is adequate to provide a useful reconnaissance mission in the time period prior to the WS-117L/Atlas reconnaissance systems. For this reason, the Contractor does not recommend for this early application the additional complexity of either a three-stage satellite or the development of higher performance propulsion systems. Higher performance systems will pay for themselves in the WS-117L program in the early Atlas boosted vehicles as well as in later applications of the Thor missile. For this reason, the Contractor is presently proposing to intensify the effort under the advanced WS-117L propulsion system that is already a part of the WS-117L development program. It is planned to sponsor development of a modified Hustler engine (providing 277 specific impulse) and the development of a high performance engine of 340 to 440 seconds specific impulse, using fluorine as the oxidizer. The utility of higher performance engines in the follow-on Thor reconnaissance systems is discussed later in this Summary Section.

1.2.3 Recoverable Reconnaissance System

The early Recoverable Reconnaissance System is based upon the concept of the physical recovery of high resolution photographs of enemy territory taken from a satellite orbit. Complete coverage of the USSR North of 45 degrees latitude is accomplished by a satellite orbiting at an altitude of 135 statute miles and scanning 45 degrees each side of vertical during a four-day period.

The method for the mechanization of this concept makes use of the dynamics of a rotating body to maintain proper orientation in inertial space as well as using the spin of the body to operate a transverse panoramic camera. This method results in a relatively lightweight reconnaissance package which is quite compatible with the performance of the Thor/117L System as previously discussed.

Figure 1-3 shows the general reconnaissance scheme and Figure 1-4 shows the sequence of events for a mission. It can be seen that immediately after establishment of orbit the vehicle and camera package are oriented for proper photography over the zone of interest. After attitude orientation the camera package is caused to spin at approximately 18 RPM and is then separated from the vehicle. This rotation is sufficient for stabilization purposes. At this rotation rate, camera operation on every third revolution over the zone of interest provides continuous coverage. Proper timing of the camera operation is obtained by combining joint operation of a timer and sun sensor.

After a sufficient number of passes have been made by a vehicle, the reentry and recovery phase of the mission is initiated as the package passes near the Zenith over a selected tracking station in Alaska. A signal is initiated which will cause a solid propellant rocket in the package to modify the orbit so that the package re-enters the earth's atmosphere. During passage through the atmosphere the vehicle slows to subsonic velocity. A heat shield on the forward end of the package, accomplished by use of a material ablation technique, will protect the reentry body and internal components from the intense heating