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WB-117L WORK STATEMENT
AFBM Exhibit 58-25
10 DECEMBER 1958

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AFBM Exhibit 58-25
10 December 1958

Supersedes WDT 57-18
14 May 1957

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WS-117L WORK STATEMENT

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WS-117L WORK STATEMENT

0. INTRODUCTION TO STATEMENT OF WORK

Lockheed Aircraft Corporation, Missile Systems Division, shall plan and conduct a program of research and development leading toward the ultimate attainment of a reconnaissance system which uses a satellite vehicle as the data gathering medium.

Subject to the overall management of the BMD/BMO team, the Lockheed Missile Systems Division shall fulfill responsible technical direction of the WS-117L in the role of Weapon System Contractor.

In that capacity, approval of the technical decisions of the Contractor by the Government shall not be required prior to implementation, except as specifically set forth elsewhere in this contract. This provision should not, however, be construed as in any way limiting the right of the Government to direct or redirect the technical aspects of the Contractor's efforts at any time. Where such direction affects costs or schedules, or is contradictory to the provisions of this contract, normal contract change procedures will apply.

0.1 MANAGEMENT

Contractor management of the WS-117L program shall be established to satisfy the requirements of paragraphs 0 (Introduction to Statement of Work), 2.3.1.6 (Technical Direction) and 2.4.1 (Research and Development Program). The management activities are defined as follows:

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0.1.1 Weapon System Management. This activity centralizes program direction in the Weapon System Contractor. The Contractor is supported in this effort by representatives of major associate contractors; technical consultants as appropriate; and immediate staff. The Contractor is responsible for the following endeavors and close coordination with associated contractors as well as Government agencies involved with the program.

0.1.2 Planning. This activity includes responsibility for developing, establishing, and maintaining the Weapon System Development Plan in accordance with Air Force Management Procedures ARDC 80-4; for revised program objectives; for investigation of new systems and applications related to the Sentry Program; for interpretation of Air Force requirements into WS-117L design criteria; and for the evaluation of developmental solutions to problems posed by the basic requirements.

0.1.3 Development. This activity includes the responsibility for providing overall technical direction (both inplant and subcontractor) for the program with regard to system and subsystem requirements. This technical direction encompasses all design, development, testing (except system testing), and producibility with respect to the indicated requirements.

0.1.4 Test and Operations. This activity includes the responsibility for the development and accomplishment of systems testing and the flight test program at government launch and tracking installations. This responsibility encompasses the operation, maintenance, and calibration of captive and flight test vehicles and ground support equipment; the training of personnel; site activation when required; planning and designing of facilities at these installations; and planning for logistic support.

0.1.5 Program Administration. This activity includes the responsibility for general administration and coordination of the project in accordance with the Weapon Systems Development Plan. This responsibility encompasses proposal preparation, the preparation of task statements, contract changes, work authorizations, schedules, budget determination and review, technical reports, coordination of scale models, evaluation of technical progress, maintenance of a program information center, and performance of liaison with WSPO and service areas outside the project. Also included is the responsibility for establishment of technical data submittal requirements.

0.1.6 Reliability. This activity includes the responsibility of establishing, coordinating and disseminating reliability programs of the Sentry Weapon System, both inplant and subcontract. This responsibility will provide that all parts, components, and subsystems within the Sentry Weapon System are designed, tested, evaluated, and applied within the limits of reliable performance, provide methods for establishing definitive reliability goals for the Sentry Weapon System, subsystems, and major components, and provide management with a method for monitoring reliability progress and demonstration.

1.0 SUMMARY OF ITEMS TO BE FURNISHED

Item	Description
I	Conduct a program of research and development directed toward the ultimate attainment of a satellite-borne reconnaissance system.
II	Complete fabrication and testing and make constructive delivery of the following satellite vehicles* to the extent herein specified:

* Satellite vehicles are defined herein to be inclusive of all vehicle airframe elements, all vehicle-borne equipment elements, and spare parts therefore, deemed necessary by the Contractor to be required in the attainment of the various flight objectives constituting paragraph 2.2.2.10 of this document or in attainment of non-flight objectives of the developmental test programs.

1. Program IIA
   a. Mockup
   b. Propulsion Test Vehicle Assemblies (PTVA).
      (1) Two (2) Test Vehicle Assemblies configured for testing JP-4/IRFNA propulsion system
      (2) One (1) Propulsion Test Vehicle Assembly configured for testing UDMH/IRFNA propulsion system.
   c. Captive and Flight Test Vehicles
      (1) One (1) Static Test Vehicle
      (2) One (1) Facilities Check Vehicle
      (3) Thirteen (13) Flight Test Vehicles, ten (10) of which have been expended in flight test operations, delivered to Vandenberg Air Force Base; launch readiness operations eighty percent (80%) complete on FTV 11, fifty percent (50%) complete on FTV 12, and one percent (1%) complete on FTV 13.
      (4) Two (2) Flight Test Vehicles; dynamic systems test operations in Contractor's facility at Santa Cruz Test Base ninety percent (90%) complete on FTV 14, and twenty-five percent (25%) complete on FTV 15.
      (5) Three (3) Flight Test Vehicles; modification and checkout operations in Contractor's facility at Palo Alto ninety-five percent (95%) complete on FTV 16, sixty-three percent (63%) complete on FTV 17, and nine percent (9%) complete on FTV 18.
      (6) One (1) Flight Test Vehicle; final assembly operations in Contractor's facility at Sunnyvale eighty-three percent (83%) complete on FTV 19.
2. Program I
   a. Mockup
   b. Captive and Flight Test Vehicles

(1) One (1) Static Test Vehicle

(2) One (1) Captive Test Vehicle

(3) Two (2) Flight Test Vehicles, one (1) of which has been expended in flight test operations, delivered to Air Force Missile Test Center; launch readiness operations not in process on FTV 2.

(4) One (1) Flight Test Vehicle; modification and checkout operations in Contractor's facility at Palo Alto twenty-nine percent (29%) complete on FTV 3.

(5) Two (2) Flight Test Vehicles; in Contractor's facility at Sunnyvale, final assembly operations thrity-three percent (33%) complete on FTV 4, continuous production assembly operations thirty-eight (38%) complete on FTV 5.

3. Program II

a. Flight Test Vehicles

(1) One (1) Flight Test Vehicle; detail fabrication operations in facilities of Contractors, subcontractors, vendors, and other outside sources seven percent (7%) complete.

III Prepare and submit data as defined in the following:

1. LMSD 6246, "Specification Submittal Requirements for the WS-117L Sentry Program".

2. WDT 57-19, "Report Requirements for the WS-117L Sentry Program".

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2.0 DESCRIPTION OF ITEMS AND SPECIFICATIONS

2.1 GENERAL OBJECTIVES

2.1.1 All work done under this contract shall be directed toward the ultimate attainment of a reconnaissance system which uses a satellite vehicle as the data gathering medium. The goal shall be to sense and locate, with a high degree of resolution, all electromagnetic radiation emitted by or reflected from the territory, installations, and equipment of potential enemies; to transmit this information back to our own forces in a form useful to the processing subsystem; and to record and produce these data, in a form of maximum utility, to intelligence agencies.

2.1.2 The system should possess the following characteristics as defined by approved specifications:

a. Sensitivity
b. Resolution
c. Location accuracy
d. Speed
e. Discrimination between useful and unusable information
f. Economy
g. Invulnerability to countermeasures
h. Reliability
i. Longevity
j. Maintainability
k. Producibility
l. Capability of assuming and maintaining desired orientation with respect to the earth's surface.

2.2 SYSTEM DESIGN OBJECTIVES

2.2.1 Orbital Capability Program. The objective of this phase of the program is the achievement of orbital capability on an accelerated time scale. Under this phase, the design, development, and test of a basic WS-117L airframe will be conducted. Scheduled flights, utilizing SM-75 and SM-65 missiles as boosters, have been programmed for orbital capability objective. These flights will, in specified instances, carry payloads as described in the following paragraphs.

2.2.1.1 A system for recovering capsules from WS-117L orbit will be designed and tested. Specified WS-117L vehicle flights shall be arranged for recovery of biomedical data through the utilization of a suitable re-entry capsule.

2.2.2 Operational Capabilities. A series of operational capabilities shall be attained as defined below. These shall be considered the minimum design objectives for operationally acceptable systems. The order of listing will not be construed as the chronological sequence of attainment.

2.2.2.1 Pioneer Visual Reconnaissance Program

2.2.2.1.1 The Pioneer Visual Program shall provide the ability to secure photographs of areas of potential military interest. These photographs, as initially reconstructed on the ground primary record, shall be of such quality as to permit the resolution of the standard Air Force medium contrast test pattern as defined in MIL-STD-150 with dimension W equal to 50 feet. Adequate exposure will be obtained at sun angles above 5 degrees and 100-foot ground resolution with medium contrast target will be achieved at all sun angles above 30 degrees. The medium-contrast target is specified to provide for atmospheric contrast reduction. The stated resolution is desired with a resultant object contrast of 2 to 1 at the vehicle altitude and to demonstrate this capability, all laboratory and ground tests shall be conducted using a low-contrast target with a density difference of 0.3.

2.2.2.1.2 The location of any point on any photograph shall be readily determinable with an error no greater than one mile. This accuracy will be based upon refinement and smoothing of orbital information with repetitive collection of data. Maximum use should be made of the Data Processing Subsystem refinement of location accuracy by ground checkpoint positioning. The film supply shall be sufficient to permit photographic coverage of 1.2×10^6 square miles per day. Total coverage required will be dependent upon the operational life (or for a period of 30 days, whichever is shorter), bandwidth of readout and the photographic installation, but it will be a maximum for the conditions existing in each flight.

2.2.2.1.3

2.2.2.1.4 The Pioneer Visual System shall include reconstruction and processing functions of visual information to the extent necessary to satisfy two requirements:

a. Production of usable data as an input to the Data Processing Subsystem

b. Sufficient provision for processing of data to allow evaluation of the output to perform quality control, design/re-design, and programming.

2.2.2.1.5 The Pioneer Visual System shall make available, at a central location, sufficient photographic records and auxiliary data in a form required by the Data Processing Subsystem. The time between data acquisition and receipt by the Data Processing Subsystem will be kept to a minimum.

2.2.2.2 Electronic Reconnaissance Program

2.2.2.2.1 Programs

a. The Interim Atlas Ferret Reconnaissance Program shall provide the ability to intercept high priority electromagnetic emissions from the equipment of potential enemies, to index and store the data, and upon command supply the stored data to Subsystem H for retransmission to an appropriate location in the Continental U.S.

b. The Pioneer Ferret Reconnaissance Program shall provide the ability to intercept electromagnetic emissions in the 50 to 18,000 mc/s spectrum from the equipment of potential enemies, to return the intercepted information to an appropriate location in the Continental U.S. or U.S. territories, and to record and index this information into a form suitable for further processing. The ferret intercept equipment shall be capable of receiving signals, locating the emitter and measuring signal parameters as specified by the intelligence requirements for ferret mission. The sensitivity of the receiving equipment will be such as to permit reception of signal levels from -90 to -34 dbm, subject to further evaluation of intelligence requirements and receiver design limitations.

2.2.2.2.2 All of the ferret information obtained shall be available at a central location as rapidly as technically feasible after receipt at any intercept station located in Continental U.S.

2.2.2.3 The Advanced Visual Reconnaissance Program

2.2.2.3.1 The Advanced Visual Reconnaissance Program shall provide a capability similar to the Pioneer Visual Program except that the maximum dimensions of the pattern to be resolved and the minimum ground lineal coverage to be obtained are reduced by a factor of six. The location accuracy will be increased to maximum error of $\frac{1}{2}$ mile. Since the area covered by the camera is reduced from that of the Pioneer Reconnaissance Program and since resolution will be improved to the extent to probably allow observation of aircraft and other movements of military importance, it may be necessary to incorporate features to allow the programming of the camera to point to areas of special interest which are removed from the nadir in order to most usefully apply and conserve limited area coverages afforded by this system.

2.2.2.4 Advanced Ferret Reconnaissance Program

2.2.2.4.1 This program will endeavor to extend the operational capability of the Pioneer Ferret Program and to include the 50 to 40,000 mc/s spectrum.

2.2.2.5 Infrared Reconnaissance Program

2.2.2.5.1 The objective of the Infrared Reconnaissance Program is a system of satellites on orbit placing unfriendly territory under continuous and complete surveillance. Such a system will have the capability to detect ICBM launchings whenever and wherever they occur and to immediately transmit this information to the ground to provide unambiguous warning of ICBM attack.

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2.2.2.6 Visual Surveillance Program

2.2.2.6.1 The Visual Surveillance Program consists of the development of a continuous surveillance system at ground resolutions equal to or better than that obtained with the Advanced Visual Reconnaissance Program.

2.2.2.7 Ferret Surveillance Program

2.2.2.7.1 The Ferret Surveillance Program consists of the development of a surveillance type ferret as well as a Quick Reaction Capability (QRC). It will be an integrated ferret system that provides the capability of varying the frequency bands and other signal parameters of interest by command through the ground-space communications link.

2.2.2.8 Biomedical Recoverable Capsule Program

2.2.2.8.1 The Biomedical Recoverable Capsule Program shall have the dual objectives of gathering biomedical data and establishing successful re-entry and recovery from orbit of selected living specimens.

2.2.2.10 FLIGHT OBJECTIVES [redacted]

FLIGHT NO.	FLIGHT OBJECTIVES
No. 1 (Prog. IIA) (December 1958 VAFB - Thor Booster)	(1) Demonstration of Orbit Capability (2) Test and evaluation of the operations and interactions of Sentry systems noted below during the coast, orbital boost, reorientation, and orbit phases, as applicable: (a) Propulsion, (b) Guidance and Control, (c) Auxiliary Power, (d) Communications, and (e) Airframe.
No. 2 (Prog. IIA) (January 1959 VAFB - Thor Booster)	Same as Flight No. 1 (Prog. IIA)
No. 3 (Prog. IIA (February 1959 VAFB - Thor Booster)	Same as Flight No. 1 (Prog. IIA) Items (1) and (2), plus, (3) Demonstration of ability to recover a biomedical capsule ejected from the orbiting vehicle (4) Determination of orbit parameters and evaluation of ability of guidance and control system to insure operation within parameters. (5) Evaluation of Thor Booster System (6) Evaluation of Thor Guidance System
No. 4 (Prog. IIA) (March 1959 VAFB - Thor Booster)	Same as Flight No. 3 (Prog. IIA)
No. 5 (Prog. IIA) (April 1959 VAFB - Thor Booster)	Same as Flight No. 3 (Prog. IIA), plus, (7) Test and evaluation of the Telemetry System (8) Advanced Engineering Tests.
No. 6 (Prog. IIA) (April 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)

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2.2.2.10 (continued)

FLIGHT NO.	FLIGHT OBJECTIVES
No. 7 (Prog. IIA) (May 1959 VAFB - Thor Booster)	Same as Flight No. 3 (Prog. IIA), plus, (7) Collection and compilation of Aeromedical Data and GRD Data. (8) Evaluation of the capsule design effectiveness in providing a suitable environment for the biomedical specimens.
No. 8 (Prog. IIA) (May 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)
No. 9 (Prog. IIA) (June 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)
No. 10 (Prog. IIA) (June 1959 VAFB - Thor Booster)	Same as Flight No. 7 (Prog. IIA)
No. 11 (Prog. IIA) (July 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)
No. 12 (Prog. IIA) (July 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)
No. 13 (Prog. IIA) (August 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)
No. 14 (Prog. IIA) (August 1959 VAFB - Thor Booster)	Same as Flight No. 7 (Prog. IIA)
No. 15 (Prog. IIA) (Sept. 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)

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2.2.2.10 (continued)

FLIGHT NO.	FLIGHT OBJECTIVES
No. 16 (Prog. IIA) (September 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)
No. 17 (Prog. IIA) (October 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)
No. 18 (Prog. IIA) (October 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)
No. 19 (Prog. IIA) (November 1959 VAFB - Thor Booster)	Same as Flight No. 5 (Prog. IIA)
No. 1 (Prog. I) (June 1959 AFMTC - Atlas Booster)	(1) Demonstration of Orbit Capability (2) Demonstration of the ability to achieve and maintain stabilized nose-down orientation (3) Test and evaluation of the operations and interactions of Sentry systems noted below during the coast, orbital boost, reorientation, and orbit phases, as applicable: (a) Propulsion (b) Guidance and Control (c) Auxiliary Power (d) Communications (e) Airframe (4) Evaluation of Atlas Booster System (5) Evaluation of the Telemetry System. (6) Test and evaluation on components of interim system/systems equipment.
No. 2 (Prog. I) (August 1959 AFMTC - Atlas Booster	Same as Flight No. 1 (Prog. I), Items (1) through (5), plus, (6) Test and evaluation of infrared thermal mockup.

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2.2.2.10 (continued)

FLIGHT NO.	FLIGHT OBJECTIVES
No. 3 (Prog. I) (October 1959 AFMTC - Atlas Booster)	Same as Flight No. 1 (Prog. I), Items (1) through (5), plus, (6) Test and evaluation of interim Ferret Reconnaissance System components and heat transfer performance (7) Test of VHF Narrow-band Data Link for interim Ferret Reconnaissance System.
No. 4 (Prog. I) (December 1959 AFMTC - Atlas Booster)	Same as Flight No. 1 (Prog. I), Items (1) through (5), plus, (6) Test and evaluation of interim Ferret Reconnaissance system. (7) Test and evaluation of: (a) Ultimate Guidance System Inertial Platform components (b) Orbital Attitude Damping System (c) VHF Narrow-band Data Link for interim Ferret Reconnaissance System.
No. 5 (Prog. I) (February 1960 AFMTC - Atlas Booster)	Same as Flight No. 1 (Prog. I), Items (1) through (5), plus, (6) Test and evaluation of interim Pioneer Infrared Reconnaissance System (7) Test and evaluation of VHF Narrow-band Data Link for interim Pioneer Infrared Reconnaissance System.
No. 1 (Prog. II) (February 1960 VAFB - Atlas Booster)	(1) Demonstration of Orbit Capability (2) Demonstration of the ability to achieve and maintain a stabilized nose-down orientation. (3) Test and evaluation of the operations and interactions of Sentry systems noted below during the coast, orbital boost, reorientation, and orbit phases, as applicable:

[redacted]

2.2.2.10 (continued)

FLIGHT NO.	FLIGHT OBJECTIVES
	(a) Propulsion (b) Guidance and Control (c) Auxiliary Power (d) Communications (e) Airframe (4) Evaluation of Atlas Booster System (5) Evaluation of the Telemetry System (6) Test and evaluation of components of interim Pioneer Visual Reconnaissance System.

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2.2.3 Subsystem Definitions The capabilities of the systems are obtained by different combinations of equipment. The overall system is broken down into a number of subsystems as defined below:

2.2.3.1 Airframe (Subsystem A)

2.2.3.1.1 The Airframe Subsystem will consist of the propellant and pressurization tankage, aerodynamic fairings, structural supports, brackets and fittings for the satellite, a destruct system, and all mechanical and electrical installations in the satellite not specifically included in the definition of other subsystems. It will include any systems for overall environmental control within the satellite.

2.2.3.2 Propulsion (Subsystem B)

2.2.3.2.1 The Propulsion Subsystem will consist of the rocket engine, pressurization, feed and loading systems (other than propellant and gas tanks), the engine gimbals (but not gimbal actuators) and the equipment required to start, stop, and control thrust magnitude in response to an electrical signal from the ground or from the guidance subsystem, and the equipment required to control the propellant flow mixture ratio. It will also include any auxiliary devices required to establish proper ullage orientation in the fluid system prior to and during start of the main rocket engine, including the equipment required to operate these devices.

2.2.3.3 Auxiliary Power (Subsystem C)

2.2.3.3.1 The Auxiliary Power Subsystem consists of that equipment required to supply electrical power to all subsystems within the satellite vehicle, from a time just prior to launch until the end of the vehicle's reconnaissance lifetime.

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2.2.3.4 Guidance and Control (Subsystem D)

2.2.3.4.1 The Guidance and Control Subsystem will be comprised of those items of equipment required to sense and direct vehicle attitude and velocity so as to establish a satisfactory orbit. In addition it will:

a. Provide self-contained means for the initial alignment and maintenance of the desired vehicle attitude during orbital operation.

b. Provide an indication of attitude, and rate of change of attitude, to other subsystems in the vehicle as necessary.

2.2.3.5 Visual Reconnaissance (Subsystem E)

2.2.3.5.1 The Visual Reconnaissance Subsystem consists of the satellite-borne equipment required to acquire visual information, to process and store this information and, at the proper time, to convert the stored information to a video signal for transmission to the ground by the Ground-Space Communications Subsystem. This subsystem also consists of the ground-based equipment required to take the output of the data link and reconstruct the video signal into photographic form, to reassemble the primary record photographs and handle the auxiliary data plus tracking data, and to perform the functions necessary to ensure adequate quality control of the operation.

2.2.3.6 Electronic Reconnaissance (Subsystem F)

2.2.3.6.1 The Electronic Reconnaissance Subsystem consists of the satellite-borne equipment required to collect intelligence information from radiation in the region of the electromagnetic spectrum between 50 to 40,000 mc/s, to store this information, to filter or index it as may be necessary, and, at the proper time, to reconvert the stored information into an appropriate electrical signal for transmission to the

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ground by the Ground-Space Communication Subsystem. The subsystem also includes the ground-based equipment required to decode the indexed information; i. e., reconnaissance data, time and vehicle position, to a form required by the Data Processing Subsystem.

2.2.3.7 Infrared Reconnaissance (Subsystem G)

2.2.3.7.1 The Infrared Reconnaissance Subsystem consists of the satellite-borne equipment required to collect intelligence information from that region of the electromagnetic spectrum from 1 to 12 microns wavelength, to process and store this information, and at the proper time, to reconvert this stored information to an appropriate electrical signal for transmission to the ground by the Ground-space Communication Subsystem. The subsystem also includes the ground-based equipment required to decode the indexed information; i. e., reconnaissance data, time and vehicle position, into a form required by the Data Processing Subsystem.

2.2.3.8 Ground-Space Communication (Subsystem H)

2.2.3.8.1 The Ground-Space Communication Subsystem is comprised of those items of equipment required to perform the following functions:

a. Determine the position of a satellite vehicle relative to the earth, as a function of time, by a process of observation and computation.

b. Command and program the functioning of the vehicle payload and auxiliary devices on a time-sequence basis or in real time.

c. Provide a means for communicating with the vehicle from ground stations and for receiving and encoding environmental, vehicle functional, and all reconnaissance data from other vehicle subsystems.

d. Provide communication facilities and reconnaissance data terminal magnetic tape recording equipment ground installations for efficient and reliable recording and transmission of received information.

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e. Provide a common time reference for the vehicle and ground complex and a reference date-time index for the orbital passes.

f. Provide vehicle-to-vehicle communications in advanced Infrared Surveillance Systems.

2.2.3.9 Data Processing

2.2.3.9.1 The Data Processing Subsystem includes the design, development, and implementation of the system, equipment, techniques and procedures to transform the recorded raw photographic, ferret, and infrared data into useful intelligence and to disseminate this intelligence to using agencies. It will receive input and provide feedback to applicable subsystems, primarily E, F, G, and H and is conceived to ensure the efficient production and availability of WS-117L derived intelligence of the type, form, frequency, and quality required by the various users.

2.2.3.10 Ground Support Equipment (GSE)

2.2.3.10.1 Ground Support Equipment (GSE). The term "Ground Support Equipment" refers to any or all non-airborne implements or devices which are required at the launch complex(es) to inspect, test, adjust, calibrate, appraise, gauge, measure, repair, overhaul, assemble, disassemble, service, transport, safeguard, record, store, actuate, or otherwise perform a function in support of the WS-117L airborne vehicle prior to launch.

2.2.3.11 Subsystem Ground Equipment at T/A Sites. Subsystem Ground Equipment at T/A Sites includes all non-airborne specialized equipment required to transmit, receive, checkout and test, record, process, store, reconstruct a video signal into photographic form, decode indexed information (reconnaissance data, time and vehicle position), safeguard, or otherwise perform functions at the T/A Sites immediately subsequent to launch and throughout its orbiting life. Any reference herein to Subsystem Ground Based Equipment shall be deemed to be within the scope of this definition.

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2.2.3.12 Biomedical Capsule (Subsystem L) [redacted]

2.2.3.12.1 The Biomedical Program consists of a satellite-borne capsule, suitable vertebrate specimens and equipment that will collect and transmit biomedical data by telemetering and ensure successful specimen survival after re-entry and recovery from orbit.

2.2.3.13 Personnel Subsystems. By definition, a personnel subsystem exists whenever any of the above subsystems, or the booster subsystem, requires the interaction of personnel. A properly designed personnel subsystem consists of the following components: (a) Human engineering to insure optimum man-machine compatibility. (b) Determination of the kinds and numbers of personnel required to operate and maintain the associated hardware subsystem. (c) Training and training equipment required to obtain suitably trained personnel. (d) Appropriate personnel supports in the form of technical manuals and other job aids.

To distinguish between personnel subsystems developed for Contractor personnel in contrast to Air Force personnel, the terms "Contractor Personnel Subsystems" and "Air Force Personnel Subsystems" are used.

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2.3 GENERAL REQUIREMENTS

2.3.1 Item I - Research and Development Program

2.3.1.1 Milestones. The program of research and development is to be conducted as part of the continuing effort. It is expected that this contract period will include the design, fabrication and test of the vehicles making use of the SM-65 and SM-75 as test vehicle boosters.

2.3.1.2 In order to ensure that a gage of progress will be available, the Contractor will provide a detailed schedule of milestones extending through calendar year 1960. Progress toward, and the attainment of, these milestones will be reported monthly.

2.3.1.3

2.3.1.4 Long Lead Time Items. The Contractor shall take further procurement action as required, and, consistent with funds made available, ensure that long lead time items will be available as required in the period following this contract. This action shall be guided by the future schedules listed under para. 3.1 beyond the cut-off date for this contract and, after approval by the Government, the schedules required by paragraph 2.3.1.2.

2.3.1.5

2.3.1.6

2.3.1.7 Report Requirements. The report requirements are covered in WDT Exhibit 57-19.

2.3.2 Item II - Specification Program. Specifications and specification trees shall be written and submitted to the Air Force in accordance with the following paragraphs:

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2.3.2.1 Levels of Specifications. The Contractor shall prepare four levels of specifications, i.e., Program Capability Specifications, Vehicle Specifications, Subsystem and GSE Specifications and Component Level Specifications.

2.3.2.1.1 Specifications for the following WS-117L Programs, i.e.:

I	The Orbital Capability Program (Atlas-Boosted)
IIA	The Orbital Capability Program (Thor-Boosted)
II	The Pioneer Visual Program
III	The Pioneer Ferret Program
IV	The Advanced Visual Program
V	The Advanced Ferret Program
VI	The Visual Surveillance Program
VII	The Infrared Reconnaissance
VIII	The Ferret Surveillance Program.

2.3.2.1.2 Specifications for the following WS-117L Subsystems, i.e.:

A.	Airframe
B.	Propulsion
C.	Auxiliary Power
D.	Guidance and Control
E.	Visual
F.	Ferret
G.	Infrared
H.	Ground-Space Communications
L.	Biomedical.

2.3.2.1.3 Specifications for Components, Assemblies and Subassemblies.

2.3.2.1.4 Specifications for the individual WS-117L vehicles and the Ground Station Complex(es).

[redacted]

2.3.2.1.5 Specifications for Ground Support Equipment.

2.3.2.2 Specification Trees. In addition to specifications, the Contractor shall prepare and submit to AFBMD a specification tree for each vehicle and for each subsystem. The specification trees will list components and assemblies that LMSD intends to cover by specifications showing the organization of the components into subsystems. Specification trees shall be submitted to AFBMD in accordance with LMSD Report 6246, "Specification Submittal Requirements for the WS-117L Sentry Program."

2.3.2.3 Approval of Specifications. The specifications for programs, subsystems, vehicles, ground station complex and ground support equipment shall be submitted to AFBMD for approval. Specifications for components and assemblies normally shall not be submitted to AFBMD for approval. However, for selected components as listed in the Delivery Schedule or as designated by AFBMD, submission for approval will be required.

2.3.2.4 Types of Specifications. The specifications for the levels stated above are each divided into types. Requirements for the different types of specifications, including their numbers and contents, are given in paragraph 2.3.2.7.

2.3.2.5 Scheduling of Specifications. Program and Subsystem Specifications, in general, will precede the Component, Vehicle, and Ground Station Complex Specifications, and performance requirements will precede the test requirements established to prove performance. Scheduling of specifications is covered in LMSD Report 6246, "Specification Submittal Requirements for WS-117L Sentry Program."

2.3.2.6 Revision of Specifications. In order to keep the specifications up-to-date, they will be reviewed and revised as specified in LMSD Report 6246.

2.3.2.7 Definitions and Requirements

2.3.2.7.1 A Program Capability Performance Specification shall be written for each of the WS-117L programs as listed above in para. 2.3.2.1.1. Each Specification shall be supported by analysis and test data to adequately establish validity. Each Specification shall express the performance requirements for the operational phase of the program it covers.

Although the booster is not the direct contractual responsibility of LMSD, performance requirements should be stated for the boost phase. In a similar fashion, tie-ins to Subsystem I and performance criteria for intelligence data at the interface should be stated.

The requirements section shall contain a complete description of the mission capability and the general design of the system.

The general design shall be broken down into its functional elements. Subsystems, both air and ground portions, facilities and support equipment shall be described. The function of each of these elements as they contribute to mission capability shall be described. Resultant performance of subsystems as a whole shall be stated.

Additional support functions such as manpower, training and organization may be described. The specifications for Programs IV through VIII shall contain a requirement that the ground elements of the system be fully capable of operating with vehicles of earlier reconnaissance programs unless such requirements are specifically deleted in whole or in part by AFBMD.

2.3.2.7.2 A specification shall be written for each subsystem listed in 2.3.2.1.2 The specification shall consist of a single document containing sections describing performance, performance compliance tests and detail model information. The specification shall be supported by analysis and test data to adequately establish validity. These supporting data shall

be presented in the Subsystem Analysis Reports required by paragraph IV J3 of WDT Exhibit 57-19. Successive revisions of this specification will incorporate these three types of data as they become available.

Where more than one significantly different subsystem design is programmed for system application, a different specification shall be written for each design.

2.3.2.7.2.1 The Performance Section of the Subsystem Specification shall state the function and resultant performance of the entire subsystem. It will describe the relationship of a subsystem to contiguous or dependent subsystems and indicate the condition of reconnaissance data and control signals at these interfaces. Environmental requirements, general arrangements, inboard profiles, design criteria, sizes, weights, moments, tolerances and limits will be included where feasible. A breakdown of the subsystem into functionally interrelated components shall be shown, accompanied by a statement of performance where feasible. The Contractor's judgment assisted by specific requests from AFBMD will be relied upon to determine the fineness to which this subsystem breakdown should proceed. In general, it should proceed to the level where new and very critical items which significantly affect system performance can be described.

2.3.2.7.2.2 The Performance Compliance Test Section of the Subsystem Specification will describe tests to demonstrate operability of the complete subsystem. These tests will be designed to show to the fullest extent practicable that the performance requirements have been met. This section will show the sequence of testing events, state test parameters and present a brief generalized picture of the test procedures.

Under this section, and when it is practicable to do so, the Air Force requires that at least one fully operational sample of each subsystem type be run up and tested as a complete unit. Appropriate interface simulation should be used where applicable.

[redacted]

2.3.2.7.2.3 The Detail Model Section of the Subsystem Specification shall include by summary or reference all details necessary to define and describe a specific subsystem design. It shall reflect the latest changes in subsystem design. Although it need not be sufficiently detailed in itself to permit production of the subsystem, it shall contain a list of those drawings and specifications required by LMSD and its subcontractors for this purpose.

2.3.2.7.3 A Vehicle Specification will be prepared for each vehicle. This specification shall consist of a single document containing sections describing performance, acceptance tests and detail model information. Successive revisions of this specification will incorporate these three types of data as they become available.

2.3.2.7.3.1 The Performance Section of the Vehicle Specification will describe the performance required of the particular vehicle and will contain descriptions of general arrangements and inboard profile, expected trajectory, weights, dimensions, lists of subsystems and portions of subsystems and description of functions of each. (May be done by reference to applicable portions of subsystem specifications.) It will tie the various subsystems together as a vehicle. Limits and tolerances will be included.

2.3.2.7.3.2 The Acceptance Test Section of the Vehicle Specification will describe tests to demonstrate that the vehicle, as built, will meet the performance required in the vehicle performance section. It will show sequence of testing events and general procedures.

2.3.2.7.3.3 The Detail Model Section of the Vehicle Specification will define in detail the vehicle being delivered. It will be essentially a bibliography or a listing which will refer to all previous documentation for the vehicle, lists of specifications and drawings, general arrangement

drawings and inboard profiles. It may get its strength by reference to other documents such as specifications and drawings.

2.3.2.7.4 Component Specifications. For each component which requires specification approval during Phase A development, a single specification shall be written to include performance, developmental test, and qualification test information. Successive revisions of this specification will incorporate these three types of data as they become available.

For each component which requires specification approval during Phase B production, a single specification shall be written to include production acceptance tests and detail model information.

2.3.2.7.4.1 The Performance Section of each Component Specification will define performance requirements for the component, list assemblies or parts comprising the component and give the function of each. Environmental requirements, weight, dimensions, general arrangement, tolerances and limits will be included. This performance section ties assemblies and/or parts together as a component.

2.3.2.7.4.2 The Development Acceptance Test Section of each Component Specification will describe tests to demonstrate operability of the component and compatibility of its assemblies and parts. It will contain limited environmental tests, as feasible. It will show sequence of testing events and general testing procedures.

2.3.2.7.4.3 The Qualification Test Section of each Component Specification will define requirements for tests needed to move the component from Phase A (prototype development) into Phase B (production).

2.3.2.7.4.4 The Production Acceptance Test Section of each Component Specification will be used only on items that have successfully completed

qualification tests or are standard off-the-shelf items. This section will consist of test requirements, general test procedures and sequence of testing events. This test section will conform to requirements of MIL-Q-5923C, Phase B. It will be used for items of an adopted design and will reveal fabrication errors not revealed by inspection.

2.3.2.7.4.5 The Detail Model Section of each Component Specification will be essentially a bibliography or listing which will refer to all previous documentation for the component (specifications and drawings). It will get its strength by reference to these documents.

2.3.2.7.5 For those specifications which do not require Air Force approval, internal LMSD specifications will suffice. These specifications may be requested by AFBMD for information.

2.3.2.7.6 Ground Station Complex Specification. A specification will be written for the total tracking, acquisition, and data reduction complex up to its interface with Subsystem I. This specification shall consist of a single document containing sections describing performance, acceptance tests, and detail model information. Successive revisions of this specification will incorporate these three types of data as they become available.

A new specification will be written to cover each of the following phases:

a. Orbital Capability (Program I and IIA)
b. Pioneer Visual and Ferret Reconnaissance (Program II and III)
c. Advanced Visual and Ferret Reconnaissance (Program IV and V)
d. Visual and Ferret Surveillance (Program VI and VIII)
e. Infrared Reconnaissance (Program VII).

The Ground Station Complex Specification covering Programs I and IIA will be limited to a statement of performance requirements. The specifications for Programs IV through VIII shall contain a requirement that the Ground Station Complex be fully capable of operating with vehicles of earlier reconnaissance programs unless such requirements are specifically deleted in whole or in part by AFBMD.

2.3.2.7.6.1 The Performance Section of the Ground Station Complex Specification will state the requirements for the entire Ground Station Complex. These requirements shall be substantially in accord with the applicable portions of the performance section of the Program Capability Specifications. A description of the Ground Station Complex shall be given showing a successive breakdown into facilities and major components.

The system function of each major component shall be described briefly. Environmental requirements, location, layout, drawings, weights, sizes and power requirements shall be shown or referenced, as applicable. The flow of reconnaissance and vehicle control data during reconnaissance operations shall be described. Subsystem component performance and the condition of reconnaissance and control data of subsystems and facilities interfaces may be described by reference to applicable performance specifications except for that reconnaissance data at the Subsysten I interface which represents the main mission capability.

2.3.2.7.6.2 The Acceptance Test Section of the Ground Station Complex Specification shall describe a method of data acquisition and analysis to determine whether Ground Stations meet performance requirements. The specification shall also state criteria for acceptance of ground station level of the entire Ground Station Complex. These criteria shall include a successful demonstration of vehicle tracking and acquisition, computation, vehicle command, and reconnaissance data output as specified in

[redacted]

the performance section of this specification and applicable portions of the Program Capability Specification.

2.3.2.7.6.3 The Detail Model Section of the Ground Station Complex Specification will be a bibliography of documentation covering ground-based portions of Subsystems E, F, G, and H (Specifications and Drawings). This section will get its strength by reference to these documents.

2.3.2.8 Military Specification Guidance. Applicable Military Specifications, especially MIL-S-8169A and MIL-S-6644A shall be examined for general guidance and format. For Ground Support Equipment MIL-G-9412C shall be used as a guide.

2.3.2.9 Specifications for Ground Support Equipment. Two types of specifications shall be prepared for Ground Support Equipment.

a. Performance Specification for test phase GSE.
b. Operational GSE Specifications.

2.3.2.9.1 Test GSE Performance Specification. A single performance specification shall be prepared covering all items of Test GSE. It shall contain the following data for each item: Name, a brief description, functions, performance requirements, area(s) where it will be employed and will reference all applicable LMSD design control specifications, top drawings and acceptance test criteria. This document will be revised each 120 days if necessary.

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2.3.2.9.2 Operational GSE Specification. A specification shall be prepared for all WS-117L GSE in and associated with the Launch Complex. It shall be a single document containing sections describing performance, acceptance test and detail model information.

2.3.2.9.2.1 The Performance Section of the Launch Complex GSE Specification shall state performance requirements for the WS-117L GSE at the Launch Complex and associated facilities. It shall describe the GSE and define, where feasible, its relationship to the entire WS-117L Launch Complex and Ground Station Complex. This description shall show a breakdown of GSE into facilities and major components. The location and system function of each major component shall be briefly described. Environmental requirements, location, layouts, drawings, weights, sizes, and utilities requirements shall be shown or referenced where applicable. The sequence of operations during vehicle checkout, countdown, and launch shall be shown or referenced. This specification shall serve to tie the GSE together into a vehicle checkout and launching system. It shall express the over-all efficiency requirements for this system, for example, requirements for minimizing the delaying effect of holds, interference between components, and human errors.

The requirements stated in this specification shall be substantially in accord with applicable portions of the Program Capability Specifications.

2.3.2.9.2.2 The Acceptance Test Section of the Launch Complex GSE Specification shall describe a method of data acquisition and analysis to determine:

a. Whether the GSE meets performance requirements
b. Where GSE performance merits improvement.

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[redacted]

This section shall also state criteria for Air Force acceptance of all Launch Complex GSE. These criteria shall include a successful demonstration of vehicle launch and orbit injection as specified in the performance section of this specification and applicable portions of the Program Capability Specificiations.

2.3.2.9.2.3 The Detail Model Section shall by summary or reference include all details necessary to define and describe the GSE being delivered.

It shall contain a bibliography of previous documentation and a list of those drawings and specifications required by LMSD and its subcontractors for production of the hardware.

The referenced drawings and specifications need not be delivered to the Air Force, but must be kept available to the Air Force on request.

2.3.2.9.3

2.3.2.10 In addition to the specifications listed in 2.3.2, the Contractor shall establish and maintain a 117L Equipment and Facilities List for each individual flight test. The 117L Equipment and Facilities List will list all items of materials, equipment, and supplies required to launch and maintain each flight test. The desired information and proper format shall be furnished to the Contractor by the Air Force.

2.3.2.10.1 The 117L Equipment and Facilities List described above with periods of submission indicated below, are herewith established as requirements in the LMSD schedule for accomplishing WS-117L flight testing.

a. Flight schedule date minus 6 months [redacted] [redacted] Submit to AFBMD for review a preliminary draft of the "117L Equipment & Facilities List". This will include all

		SECTIONS, all AREAS, and each major equipment system under each AREA.
b.	Monthly until flight test	Submit to AFBMD for review, revisions to the "117L Equipment & Facilities List."
c.	Flight schedule date minus 3 months	Publish, and submit to AFBMD the WS-117L flight test "Equipment and Facilities List."

2.3.3 Drawing Requirements. The Contractor's drawings shall be prepared in accordance with specification MIL-D-5028B. The drawings need not be delivered to the Air Force, but must be kept available to the Air Force on request.

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2.4 SYSTEM REQUIREMENTS

2.4.1 Item I - Research and Development Program

2.4.1.1 The Contractor shall perform project direction, operational analysis, system design studies, modification design and engineering liaison, provide technical support for the system integration for all subsystems being developed under this contract and perform all other tasks required to ensure an efficient approach to development of the satellite-borne reconnaissance system previously defined. The scope of such system activity will be sufficient to coordinate effectively the work further described under each subsystem, to reach the milestones enumerated under Item II, and to maintain a continuing review of the adequacy of both Contractor-prepared specifications and the detail requirements of this contract.

2.4.1.2 It shall be the responsibility of the Contractor to call to the attention of the Government any contractual requirement which is, or becomes in his opinion, inconsistent with the expeditious attainment of the basic objectives enumerated under Paragraph 2.1.

2.4.1.3 Air Force Personnel Subsystems The Contractor shall have systems responsibilities for the design, development, and test of complete Air Force personnel subsystems as needed to support the various WS-117L hardware subsystems being developed under this contract. Just as other subsystems undergo design on the basis of the best available information, R & D testing to develop and improve initial designs, and further testing to insure deliverable products, so shall personnel subsystems undergo parallel design, development and test.

The programmed date for the initial operation of the system by military personnel is October 1961. The Contractor shall plan and accomplish personnel subsystem efforts in accordance with this initial operational date.

Information regarding the work to be performed by Air Force personnel, i.e., duty and task information, serves as the basis for planning, programming, and developing every component of a personnel subsystem. Thus, work required under this contract and under the separate training preparation and services contract with ATC (see paragraph 2.4.1.3.4 below) is expected to be overlapping. To avoid duplication in the collection of duty and task information, AFBM Exhibit 58-7, "Development and Preparation of Task Analysis Data," provides guidance for organizing a central source of data. The Contractor shall submit a proposed system for meeting the objectives of AFBM Exhibit 58-7, i.e., a proposed method for assuring the collection of current, verified, and non-duplicative duty and task information.

It is also incumbent upon the Contractor to achieve an integrated personnel subsystem effort. For example, equipment should be designed to reflect a concern for Air Force manning, training, evaluation and human error problems. Likewise, technical manuals should reflect an understanding of the Air Force position types for whom these aids are intended.

A personnel subsystem test program shall be carried out by the Contractor in a manner parallel to that for any hardware subsystem. In addition to R & D verification and testing programs which provide for the further development of personnel subsystem components, the Contractor shall analyze human failures that occur during research and development so that corrective action can be taken. Adequate procedures shall be established for assuring that the R & D test program does in fact lead to improvements in personnel subsystems. Product acceptance testing at subsystem and system levels at the conclusion of Research and Development shall include personnel subsystems and their components.

For each hardware subsystem to be operated and/or maintained by the Air Force, personnel subsystem components shall be developed in accordance with the following guidance:

2.4.1.3.1 Man-Machine Design (Human Engineering) The Contractor shall perform human engineering on all elements of the system, as appropriate, to insure maximum man-machine compatibility in the design, operation and maintenance of unit items of equipment, subsystems, and the integrated operating system. WDT Exhibit 57-8A will be utilized for establishing design objectives for the program. Operational requirements for proficiency evaluation, job aids and training shall be forecasted from the earliest possible dates, so that, where feasible, such considerations can be incorporated in equipment design. Task analyses conducted in order to allocate functions to personnel and equipment and to meet other human engineering requirements shall be used where appropriate in the development of other personnel subsystem components.

2.4.1.3.2 Position Requirements The Contractor shall provide qualitative and quantitative information on Air Force personnel required to operate and maintain each WS-117L subsystem and its associated GSE (Qualitative Personnel Requirements Information, or QPRI), in conformance with AFBM Exhibit 58-18. This responsibility shall include direct monitoring of subcontractor QPRI activities, collection and integration of subcontractor produced data and pertinent Air Force data, and conduct of liaison as may be required with cognizant Air Force activities and other prime Contractors.

2.4.1.3.3 Technical Manuals and Other Job Aids Technical manuals required to support Air Force operations and maintenance shall be developed in accordance with WDT Exhibit 56-5C. The Contractor shall prepare a Technical Manual Program Proposal in accordance with Part II,

Exhibit 10 of WDT Exhibit 56-5C. These manuals are to emphasize specific operating and maintenance activities, and the Contractor shall derive such information from analyses of system designs, experiences from development testing activities, and product testing programs. Thus, although subsystem descriptions and much of the work to be performed by Air Force personnel can be developed for manuals from design information alone, extension and verification of the detailed analysis of man-machine interaction requires a more empirical and evolutionary approach. Any utility manuals prepared for Contract R & D personnel should be designed and revised in light of the requirements for manuals to be used by Air Force personnel.

Technical manuals alone do not always provide adequate support for personnel performance. Procedural checklists, film strips or audio-recordings of maintenance procedures, and many other job aids are within the state-of-the-art and should be utilized in optimum fashion. Whenever appropriate, the Contractor is expected to recommend job aids in addition to technical manuals.

2.4.1.3.4 Training The training program for Air Force personnel will consist of at least the following:

a. Individual Training The Contractor shall participate with the Air Force in the programming of requirements for training cadres and the main complement of Air Force personnel to man the operational system. The Contractor will be required to plan in detail, staff for, and conduct initial training under separate contract with ATC under AFR 50-9. Operational equipment that might be required for special training purposes will be provisioned by AFBMD under procedures similar to those described in WDT Exhibit 56-4.

b. Unit OJT Following individual training and prior to the initial operational date, Air Force personnel will be in on-the-job training under Contractor supervision. This training will be conducted so as to provide maximum support to the Contractor's R & D effort concurrently with satisfying the training requirement.

c. Unit Training and Proficiency Evaluation Unit training will be conducted by operational organizations on a day-to-day basis to develop and maintain operational effectiveness. Individual, team, and unit proficiency will be evaluated regularly to permit personnel actions such as skill upgrading, assignment to remedial training, and proficiency awards. A complete unit training and proficiency evaluation program is typically quite complex, involving such diverse elements as diagnostic evaluation of training need, upgrade training, and practice in emergency procedures. Whenever routine workloads in the operational unit are incapable of building and sustaining proficiency, or when regular performance of duties does not provide sufficient occasion for proficiency assessment, a requirement exists for special training and/or proficiency evaluation of one kind or another. The Contractor can expect to participate in studies and to furnish training equipment, prototype training programs, methods of proficiency evaluation, and other resources as needed to meet this requirement.

2.4.1.3.4.1 One or more specifications shall be prepared, using MIL-T-4857A as a guide, that will inform AFBMD of the training equipment required to train Air Force personnel in the operation and maintenance of the WS-117L system. Studies to determine training equipment requirements shall take adequate account of the following:

a. Contractor and Air Force personnel involved simultaneously in operations and maintenance.

b. Equipment undergoing operational utilization simultaneous with further research and development.

c. Small numbers of personnel required.

d. Continuous or highly repetitive nature of normal operations and maintenance.

Hardware delivery and data reporting dates in accordance with the above considerations and with MIL-T-4857A shall be included in the milestone schedule of paragraph 2.3.1.2.

2.4.1.4 The design objective shall be to develop as high a degree of reliability as practicable and consistent with system requirements. The contractor will conduct a program of engineering and analysis reliability adequate to satisfy the design objective.

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2.4.1.5 The subsystem reliability requirements will be derived from the system objective. Progress reports in achievement of reliability, including estimates where applicable, will be made quarterly.

2.4.1.5.1 The personnel subsystem reliability objective is to produce error-free human performance by means of man-machine design, training, technical manuals and other job aids, and development of operating and maintenance procedures. Wherever human errors are committed, appropriate steps shall be taken to insure that similar errors will not re-occur.

2.4.1.6 In carrying on the reliability program, the current editions of the following documents shall be used as guides only:

WADC Exhibit WCRE 56-60, "Choice Criteria for Electronic Components Parts"

WADC Exhibit WCLR-453, "Reliability Program for Reconnaissance Electronics Equipment"

WDT Exhibit 57-16, "Ballistic Missile Systems Logs"

WDT Exhibit 57-3, "Failure and Consumption Data Reporting System for Ballistic Missile Weapon Systems"

WADC Technical Report 57-1, "Techniques for Application of Electronic Component Parts in Military Equipment"

WADC Technical Report 56-148, "Design Factors for Aircraft Electronic Equipment"

RADC Technical Report 56-148, "Reliability Factors for Ground Electronic Equipment"

2.4.1.7 Contractor Personnel Subsystems The Contractor shall be responsible for human engineering, manning determinations, and the development of training plans for Contractor personnel. He shall establish and monitor training facility requirements, develop technical manuals and training aids requirements and the training necessary to assure provision of qualified Contractor personnel for flight test operations. Whenever possible, efforts put forth in developing Contractor personnel subsystems shall be applied to Air Force personnel subsystems and vice versa.

2.4.1.8 The Contractor shall determine, and provide in writing to the Geophysics Research Directorate, Air Force Cambridge Research Center, through the WS-117L Weapon System Project Office:

a. Requirements for geophysical data and design criteria, including justification for all such requirements.

b. The form or manner in which the Geophysics Research Directorate shall provide geophysical data and design criteria in those areas approved as valid requirements by the Weapon System Project Office.

c. The order of priority for geophysics data and design criteria which will most effectively meet the requirements for system design and development.

2.4.1.9 The Contractor shall, with the concurrence of the WSPO, provide to the Geophysics Research Directorate necessary facilities, telemeter channels, power source, vehicle design, technical information, and such other items as will enable the Geophysics Research Directorate to utilize systems test vehicles for collection of geophysical design data as defined in and required by paragraph 2.4.1.8.

2.4.1.10 Perform liaison with the Geophysics Research Directorate to ensure timely exchange of requirements and technical information.

2.4.1.11 The Contractor shall provide site selection and design criteria as follows:

a. Provide the site selection criteria to include technical requirements, logistical support requirements, the number of technical people required to operate each site, communication problems and requirements, power and water requirements, area required at each site, and geographical location requirements.

b. Provide technical assistance to the site selection teams.

c. Provide design criteria for each site and each item at each site as follows:

[redacted]

(1) Tracking Stations at Pt. Mugu, VAFB, Hawaii, Annette Island, Kodiak Island and NE, NW and Central U.S. Stations

(2) Downrange telemetry ship

(3) Administrative, assembly, checkout and launch facilities at AFMTC and VAFB

(4) Development Control Center at Sunnyvale, California

(5) Recovery Control Center at Hawaii.

In addition to delineation of logistic support requirements, the Contractor shall also provide the required logistic support. This shall include the formulation and maintenance of basic equipment and materiel lists, planning and fulfilling a supply program for test and operational bases, planning and monitoring transport operations, formulation of maintenance plans and programs (WDT Exhibit 57-3 shall be used as guide) and planning and operation of a spares provisioning program.

2.4.1.13 The Contractor shall establish, operate, and maintain a Development Control Center at Palo Alto to facilitate the overall direction and control of Program IIA flight test operations.

2.4.1.14 The Contractor shall plan, coordinate, conduct and evaluate component subsystem and system ground and flight tests conducted within Contractor facilities and Government field test installations. The Contractor shall also plan and conduct laboratory tests of combinations of systems and/or portions of subsystems, including qualification tests, and provide overall coordination in the performance of such tests.

2.4.1.15 The Contractor shall conduct systems ground test operations of captive and flight test vehicles within Contractor-operated test facilities and determine overall system performance at completion of tests.

2.4.1.16 The Contractor shall conduct systems flight test operations of flight vehicles specified for testing within the period of this contract. This activity shall include the management and operation of all WS-117L launch base and tracking station installations and equipments.

2.4.1.17

2.4.1.18 The Contractor shall perform studies of weapon system concepts, define preliminary operational concepts and plans to form a logical datum for system design criteria, and investigate alternate applications of the WS-117L system and its derivatives. The results and recommendations of these studies to be reported to BMD/BMO.

2.4.1.19 Perform all necessary activities required for the preparation of reports, proposals, bills of material and other publications. Interim reports covering the progress of studies, analyses, evaluation, and/or investigations which do not terminate under this contract period shall be prepared and submitted to the procuring agency noting the results of the work accomplished through the end of this contract period, June 1959.

2.4.2 Item II - Hardware

2.4.2.1 Vehicle Mockup

2.4.2.1.1 Two vehicle mockups will be constructed in which the external envelopes of all airborne subsystems, as applicable, will be simulated accurately. The mockup may be made of any suitable materials.

2.4.2.2 Propulsion Test Vehicle Assemblies

2.4.2.2.1 The propulsion vehicle test assemblies (PTVA) shall be constructed in accordance with applicable specifications and drawings employed in construction of captive test and flight vehicles and shall include all equipment necessary to demonstrate the capability of the main propulsive engine and propellant system combination. Two (2) assemblies shall be constructed in the JP-4/IRFNA, SM-75 boosted, orbital capability configuration and one (1) assembly shall be constructed in the UDMH/IRFNA, SM-75 boosted, orbital capability configuration.

2.4.2.2.2 The test specifications for these articles shall require, among other things, that the assemblies demonstrate with both JP-4 and UDMH fuel, insofar as feasible on the ground, adequate performance to place the vehicle described in Paragraph 2.4.2.3.1 on orbit. This performance shall be obtained with each assembly in at least four out of a series of five runs predesignated to demonstrate the attainment of the required velocity increment. In these runs change of head with acceleration shall be simulated or otherwise compensated for.

2.4.2.2.3 The test specification shall also call for demonstration of the required cut-off accuracy, acceptable variation of performance with temperature, and propellant composition.

2.4.2.3 Captive and Flight Test Vehicles

2.4.2.3.1 Captive and flight test vehicles shall be defined as those vehicles necessary to establish design integrity and reliability and to demonstrate the orbital capability of the WS-117L Weapon System. The vehicles programmed for these accomplishments shall be those enumerated in Section 1.0 of the Work Statement; the configuration and composition of each vehicle shall be as defined in Section 1.0 and in Paragraph 2.2.2.10 of the Work Statement.

2.4.2.3.1.1 Gas and fuel line identification shall be accomplished according to the instructions contained in AFBM Exhibit 58-20, effective on LMSD Vehicle Serial Number 2205-1025 (AF Serial Number assigned upon AF acceptance).

2.4.2.3.2 The captive test vehicle shall be used to demonstrate, as far as feasible on the ground, the compatibility of the four Subsystems (A, B, C, and D), the adequacy of the combination to perform its mission, and other features required by the vehicle qualification test specification.

2.4.2.3.3 The flight test vehicles called for under this item shall be given a preflight acceptance test designed to demonstrate that they are ready for flight. After acceptance test and prior to Air Force acceptance, the report shall be approved by the Government prior to release of any vehicle for flight.

2.4.2.3.4

2.5.1.2.1 Airframes will be produced to satisfy the requirements of the program as enumerated in Section 1.0 of the Work Statement.

2.5.1.2.2 Adapter Sections. The above airframes will include adapter sections required to satisfy the static, captive, and flight programs. They will be designed to attach to the appropriate booster vehicle (SM-65 or SM-75) at an appropriate construction point. They will also be designed to accommodate the increased fuselage and tank length resulting from conversion to UDMH fuel.

2.5.2 Propulsion - Subsystem B

2.5.2.1 Item I - Research and Development Program

2.5.2.1.1 Perform all phases of research, development, and testing to produce the propulsion subsystems to be delivered under Item II and defined in 2.2.3.2.1. A pump-fed rocket engine will be used substantially the same as the Hustler engine (LR-81). This will be modified during the program for the use of UDMH fuel and increased nozzle area ratio. Primary research, development, and fabrication of the rocket engine will be performed by Bell Aircraft Corporation; however, LMSD will be responsible for the overall subsystem development.

2.5.2.1.2

2.5.2.1.3 Perform analyses and design on propulsion systems to give improved performance for more advanced configurations of the WS-117L than defined under paragraphs 2.2.1 and 2.2.2.

2.5.2.2 Item II - Hardware Program

2.5.2.2.1 Propulsion subsystems shall be produced to satisfy the requirements of the program as enumerated in Section 1.0 of the Work

Statement. These shall also include sufficient subsystems to overlap the transition to modified types of propulsive engines.

2.5.2.2.2 Propulsion Subsystem Test Program. In addition to the tests required by MIL-E-6626A, the main rocket engine will be tested prior to its incorporation into ground and flight test vehicles with tankage which is hydraulically identical to the flight vehicle tankage, preferably in conjunction with tankage identical in all respects with the flight tankage. Other elements of the system shall be identical, except for restrictions imposed by the testing procedure itself, with those intended for use in flight vehicles. These tests shall be conducted with every type of engine used in flight vehicles, and may be combined with the tests specified under para. 2.4.2.2.2.

2.5.3 Auxiliary Power - Subsystem C

2.5.3.1 Item I - Research and Development Program

2.5.3.1.1 Auxiliary Power Subsystem Performance Requirements. The Contractor shall identify the electrical power which is required by airborne subsystems in the WS-117L vehicle and which is to be furnished by the Auxiliary Power Subsystem. Requirements for vehicles with different missions and payloads shall be established. Until these requirements can be more exactly established, the Contractor shall maintain interim analyses reflecting the best estimate's of power demands. These shall be reported in the Electrical Power Requirement Section of the Quarterly Technical Program Report. Estimates shall be broken down to show power consumed by specific components or types of components within each subsystem. Upper and lower limits, in addition to best estimates, shall be given for requirements which are not well defined.

The report shall tabulate both alternating and direct current outputs required, showing voltages, frequencies, voltage and frequency regulation, number of phases and wires, power factor, harmonic content, average and peak power, power-time profiles, and additional data as necessary.

2.5.3.1.2 The Contractor shall conduct a program of research and development leading to the production and/or system integration of appropriate Auxiliary Power Subsystems suited to the specific vehicle and mission in which employed. It is the design objective that the endurance of the Auxiliary Power Subsystem shall not be the limiting factor in the useful life of any vehicle system. Technical approaches to be pursued shall be determined by the combined considerations of energy capacity, lifetime compatibility, reliability, economy and development time. In particular, efforts shall be directed toward development of the subsystems described below.

2.5.3.1.2.1 Battery-Energized, Auxiliary Power Subsystems

Until other power supplies with significantly higher energy per unit weight are developed and until the longer lifetime associated therewith can be used to advantage by a weapon system of sufficient total reliability, battery-energized power supplies appear to be the simplest, most reliable, and earliest available interim subsystem.

2.5.3.1.2.1.1 Test Vehicle Battery Supply

The Test Vehicle Battery Supply (TVBS) shall be a battery-energized, Auxiliary Power Subsystem for test vehicles. Its use shall be continued in operational vehicles until longer-lived power sources are developed. It shall be complete with the conversion equipment necessary to furnish power in a form compatible with the associated load.

2.5.3.1.2.1.1.1 Modules. The batteries shall be packaged in modules to allow flexibility in weight and lifetime during vehicle testing phases. By addition or subtraction of parallel modular elements, the TVBS shall absorb changes in the weight of other payload components which cannot be finally specified in early stages of design. Module size shall be selected by appropriate compromise between the high specific energy of large modules and the convenience and flexibility of smaller ones.

2.5.3.1.2.1.1.2 Nomenclature. The restricted payload of Thor-boosted vehicles prohibits large battery modules and redundant conversion components and requires other changes which distinguish the APU from that used in Atlas-boosted vehicles. Accordingly, the designations TVBS-I and TVBS-II shall be utilized to identify units employed in the Atlas and Thor programs respectively.

2.5.3.1.2.1.1.3 Environment. Environmental limitations on battery operation shall be fully considered. The Contractor shall devise and conduct suitable ground and airborne tests to resolve critical questions concerning battery behavior. In particular, the Contractor shall investigate problems peculiar to the gravity-free environment, such as electrodal gas accumulation, and means for dissipating the heat generated in the battery pack in order to maintain temperature within tolerable limits. Components shall be selected and design features incorporated which minimize or eliminate undesirable environmental effects. This work to be accomplished under paragraph 2.3.2.7.4.3.

2.5.3.1.2.1.2 High Energy Electrochemical Power Supply. The Contractor shall conduct feasibility studies of high-energy electrochemical auxiliary power subsystems. When all components, including reactants, tankage, and installation hardware are considered, such subsystems shall have overall

specific energies of 150 watt-hours-per-pound or more. Hydrogen-oxygen cells, chlorine-depolarized cells, and other potentially useful gas-electrode systems, shall be investigated. A Feasibility report with conceptual design and recommendations will be furnished upon completion of these studies.

2.5.3.1.2.1.3 Secondary Batteries. The Contractor shall develop secondary batteries to become component parts of those auxiliary power subsystems which utilize non-battery energy sources, but which require secondary batteries to meet fluctuating power demands. Included among these energy sources are nuclear and solar power units. When operated between the limits of 20 percent to 80 percent of full charge over representative WS-117L duty cycles, secondary batteries shall, as design objectives, yield at least 10 watt-hours-per-pound, operate with a charge-discharge efficiency of at least 80 percent, and have a cycle life sufficient for one year of operation.

2.5.3.1.2.2 Auxiliary Power Subsystems Utilizing Nuclear Energy. Although contamination hazards and radiation damage are associated with nuclear power supplies, they are nevertheless attractive for satellite applications because of their very large energy content and resultant long life. The development of radioisotope and nuclear reactor supplies for WS-117L is proceeding under the direction of the Atomic Energy Commission.

2.5.3.1.2.2.1 AEC Liaison. The Contractor shall establish and maintain effective technical liaison with AEC and AEC contractors engaged in radioisotope and reactor power developments, and thermoelectric and thermoionic conversion research and development, to ensure that nuclear subsystem designs are compatible with weapon system requirements, and that problems of integrating these subsystems into the entire system are recognized at the earliest possible date. The Contractor shall accomplish the following:

2.5.3.1.2.2.1.1 The WS-117L prime contractor shall furnish performance specifications to the AEC contractors. Critical design criteria which must be frozen at an early date shall be identified and furnished to the AEC contractors sufficiently in advance of the complete and final specification to prevent standstills or abortive designs. Integration problems shall be resolved by appropriate design modifications and specification changes either to the power supplies themselves or to other system components.

2.5.3.1.2.2.1.1.1 Conduct periodic evaluations of the use of Nuclear Auxiliary Power Systems in relationship to future WS-117L requirements and alternative auxiliary power subsystems; these evaluations should lead to recommendations for incorporation or rejection, for continued study, or for uncommitted status of these power supplies. The performance, cost, reliability, toxicity, operational complexity, and system compatibility shall be considered in determining the effectiveness of the nuclear power sources in relationship to requirements and alternative approaches.

2.5.3.1.2.2.1.2 In conjunction with AEC contractors, specify all accessory ground equipment associated with complete reactor and radioisotope auxiliary power subsystems, and shall initiate development or procurement action to obtain long lead-time items which are not AEC responsibility. Also, in conjunction with AEC contractors, the Contractor shall determine ground facility requirements for nuclear auxiliary power subsystems. These requirements shall be included in projected budgets, schedules, and plans. Consideration shall be given to storage, test, and launch facilities, and to special precautions at these facilities to minimize radiation and contamination hazards.

2.5.3.1.2.2.1.2.1 Determine the architect-engineer specifications for design of storage, test, launch site, and static test site facilities. In conjunction with the AEC contractors, the Contractor shall develop factory-to-flight sequences and countdown and operational procedures. The Contractor, insofar as practicable, shall establish schedules and milestones for orderly integration of the nuclear auxiliary power subsystems into the weapon system flight schedule.

2.5.3.1.2.2.1.2.2 Conduct design studies for the integration of SNAP units with the WS-117L vehicles. Design and construct simulated loads with controls for use by AEC contractors in SNAP I test program.

2.5.3.1.2.2.2 Shielding Feasibility Study. (The Contractor shall submit a report showing status of this work as of 30 September 1958; further work shall be stopped as of that date.) Compatibility between the nuclear-reactor power source and other subsystems is critically dependent upon the extent to which local nuclear radiation can be reduced to tolerable levels. The amounts, types, and placement of shielding materials, and the choice and configuration of other components necessary to achieve compatibility are closely interrelated. If radiation damage considerations are to be included in component design throughout the vehicle, approximate design criteria must be introduced at the earliest possible stage of development. The Contractor shall, therefore, investigate the feasibility of complete system designs, in which radiation damage and noise introduced by the nuclear reactor do not seriously interfere with visual, infrared and ferret missions. This study shall be intended to establish optimum arrangements, approximate weight allocations, and general design features of feasible systems which adequately shield sensitive components. It shall be intended to establish which missions may utilize

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nuclear reactors and what design limitations must be imposed upon the reactor, and upon each subsystem, to achieve compatibility. The Contractor shall accomplish the following:

2.5.3.1.2.2.2.1 For the advanced and surveillance visual, infrared and ferret missions, identify critical components and assemblies likely to be adversely affected, during the operational life-time of the vehicle, by radiation from the nuclear reactor. Best available radiation damage data shall be used to estimate functional tolerances of the critical components and assemblies to neutron and gamma fluxes and integrated doses. Where data is insufficient, experimental measurements will be performed. Due consideration shall be given to the expected reactor-radiation energy spectra.

2.5.3.1.2.2.2.2 Perform optimization studies of practicable geometrical shapes and configurations of the airframe components mounted within it, and shielding materials which minimize both damage and weight. The total weight and distribution of shielding materials shall be determined as a function of undegraded operational lifetime.

2.5.3.1.2.2.2.3 Determine, by appropriate machine code calculations and experimental measurements, the magnitude at critical points of scattered fluxes from the vehicle skin, structural elements, and other material not screened by shielding. Estimate and verify, where practicable, by machine code calculation and experimental measurements, the magnitude of scattered fluxes from the atmosphere and environment during ground operation and ascent. Determine the extent to which such scattering limits preflight testing and operations.

2.5.3.1.2.2.2.4 Pursue detailed design and vehicle integration studies of those portions of shield which are not parts of the nuclear reactor as furnished by the AEC contractors for the advanced and surveillance visual, infrared and ferret missions.

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2.5.3.1.2.2.2.5 Conduct similar studies, calculations, and experimentation on shielding designs for the Radioisotope Auxiliary Power Subsystem.

2.5.3.1.2.3 Auxiliary Power Subsystems Utilizing Solar Energy. The Contractor shall conduct feasibility studies of the various technical approaches to solar auxiliary power supplies, and shall proceed with preliminary designs of models which appear sufficiently attractive. The Contractor shall accomplish the following:

2.5.3.1.2.3.1 Photovoltaic Solar Supply. Conduct theoretical and experimental studies as necessary to establish the efficiency and critical performance characteristics of photovoltaic solar cells in appropriately configured arrays and under expected environmental and orbital conditions. These studies shall include a thermodynamic analysis of cell temperature vs. time, with due consideration for the effect upon heat balance of the vehicle itself and the method of mounting, orienting, and providing protective cover for the cells. Results shall indicate criteria for optimized design. The photovoltaic material to be considered shall be the commercially available silicon solar cell unless other materials promise competitive performance. No effort shall be expended, however, on developing photovoltaic materials.

Furnish design concepts of operational vehicles performing visual, ferret, and infrared reconnaissance missions and utilizing photovoltaic solar APU's. Show integrated design of these vehicles, with configuration, mounting and mechanical details of collector-converter arrays, and space utilization to accommodate antennas and other payload components.

Devise suitable experiments to test photovoltaic collector-converter performance and lifetime under actual conditions. Make provisions for

such testing in early flight test vehicles. Design, procure and assemble solar panels and secondary batteries and install in vehicle. Provide for telemetering of solar cell performance by means of solar power after primary batteries have been exhausted.

2.5.3.1.2.3.2 Alternative Solar Converters. The applicability to WS-117L of thermoelectric, thermoionic, and thermomechanical methods of converting solar energy shall be investigated. No effort shall be expended, however, on materials development for such purposes. A report on the feasibility of these approaches shall be prepared. (The work implied in this paragraph will not be accomplished in this contract period except for those charges incurred through 30 September 1958. Work will be resumed as more funds are made available.)

2.5.3.1.2.3.3 General Considerations

2.5.3.2 Item II - Hardware Program

2.5.3.2.1 Auxiliary Power subsystems shall be produced to satisfy the requirements of the program as enumerated in Section 1.0 of the Work Statement.

2.5.4 Guidance and Control - Subsystem D

2.5.4.1 Item I - Research and Development Program

2.5.4.1.1 The program to develop the guidance and control for WS-117L will be carried out in conjunction with the following contractors, who will hold associate-prime contracts with the Government for portions of the work required.

Contractor	Responsibility
Convair - Astronautics	WS-107A-1 Autopilot Modifications
Douglas	WS-315A Autopilot Modifications
MIT	Perform overall design of the all-inertial, Atlas-boosted, Phase II ascent guidance, and the orbital attitude (attitude stabilization) damping portions of the subsystem. Develop prototype systems.
AC Spark Plug Div. General Motors	Provide study of feasibility of modifying the WS-315A Guidance System. (Note: Although it is anticipated that the ACSP equipment will not be utilized for the WS-117L application, the feasibility study is already underway by ACSP and should result in important information for possible future use.)
Ramo-Wooldridge Corporation	WS-107A-1 Guidance System modifications.
General Electric and Burroughs	WS-107A-1 Guidance System equipment modifications.

The Contractor shall accomplish the following:

2.5.4.1.1.1 Devise and develop a WS-117L "Interim Guidance System" for use in all Program I and Program IIA flights, with capaiblity of adquate performance for Program II and Program III flights. The Contractor shall monitor the development of an "All-inertial Guidance System" for the WS-117L by the MIT Instrumentation Laboratory.

2.5.4.1.1.2 Develop a "Flight Control System" for the WS-117L vehicle for all flights. This shall provide for attitude control of the WS-117L vehicle from termination of booster thrust through reorientation (initial attitude orientation in orbit.)

2.5.4.1.2 The Contractor, as a result of the system studies required by paragraph 2.4.1.1, will prepare and furnish to the MIT and the Government,

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not later than 60 days after contract initiation, performance requirements and all relevant data for the Guidance and Control Subsystem development. This will include orbital vehicle dimensions, mass moments of inertia, magnitude and axis of application of maximum disturbing torque impulses generated by vehicle equipment, location of center of mass, center of pressure and assumed drag force in orbit. The Government, through the MIT, will then furnish envelope mounting requirements, power requirements, and other technical data on a continuing basis as it becomes available.

2.5.4.1.3 The Contractor will maintain close technical contact with the contractors of 2.5.4.1.1 to provide for the efficient incorporation of their work into final hardware. Personnel will be assigned as needed to perform this task.

2.5.4.1.4 The Contractor shall devise and develop a basic system for orbital attitude control.

2.5.4.1.5 For advanced higher-resolution reconnaissance subsystems, a knowledge of instantaneous vehicle attitude to a greater precision than that to which the vehicle attitude is controlled (by damped stable configuration) may be required, for geographic correlation of visual reconnaissance data. The most promising means for acquiring this type of information appears to be a composite photograph, including 3 simultaneous horizon "shots" and/or a sun "shot" made in appropriate time relation to a reconnaissance pass. The Contractor, in conjunction with an appropriate subcontractor, will investigate the feasibility of this method of indication. Need for and feasibility of auxiliary methods of attitude indication, such as sun seekers, star trackers, or horizon scanners, will be investigated. These auxiliary systems are intended to supply to the higher-resolution visual and other reconnaissance subsystems

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a more accurate, continuous indication of attitude in the vehicle, relative to a known reference than can be obtained from the damped naturally stable vehicle configuration. The Contractor will ensure the availability of a night horizon scanner to meet the flight test program schedule.

2.5.4.1.6 The Contractor will investigate the problems of designing guidance and control equipment compatible with the environment of a nuclear APU. This work is to be performed in cooperation with MIT Instrumentation Laboratory.

2.5.4.1.7

2.5.4.1.8 Early determination of the expected operating environment for the Guidance and Control equipment is necessary to phase in with the nuclear APU. This data will be furnished to MIT.

2.5.4.1.9 WS-117L vehicle-orbit attitude-control conditions shall be established as required to permit the proper initiation of the Bio-medical Capsule re-entry described in paragraph 2.5.11.3.

2.5.4.2 Item II - Hardware Program

2.5.4.2.1 Guidance and Control subsystems shall be produced to satisfy the requirements of the program as enumerated in Section 1.0 of the Work Statement.

2.5.4.2.1.1 This article shall consist of all components of the Guidance and Control Subsystem required to guide the vehicle into orbit and to erect the vehicle in approximately the correct initial attitude once in orbit. It also includes that equipment required to maintain the vehicle in the correct attitude after initial erection.

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2.5.4.2.1.2 This equipment shall be tested under conditions simulating flight and shall demonstrate satisfactory compliance with the specifications prepared in accordance with the requirements of paragraph 2.3.2.2 of the Work Statement. The equipment shall be identical in design and construction with that to be furnished with the vehicles enumerated in Section 1.0 of the Work Statement.

2.5.4.2.1.3

2.5.5 Visual Reconnaissance - Subsystem E.

2.5.5.1 Item I - Research and Development Program.

2.5.5.1.1 Pioneer Visual Reconnaissance System. Conduct a program of research and development which will produce the space and ground equipment necessary to meet the requirements of the Pioneer Program. This work will also include operational and systems analyses to determine design criteria for reconnaissance equipment, establishing the technical requirements of the wide-band data link of Subsystem H which will be used for the photographic reconnaissance subsystem, constructing and testing those models and assemblies required for equipment design criteria, conducting a reliability program, and participating in a training program for operation of the photographic reconnaissance subsystem. This program will be sustained by the appropriate report and technical support effort. The contractor shall accomplish the following:

2.5.5.1.1.1 Vehicle Camera. Develop a 70mm nonsteerable camera with a film supply able to provide photographic coverage for the useful reconnaissance life of the vehicle. Means shall be provided for focus adjustment by command signals from the ground stations. The film-drive mechanism shall be able to be controlled by the programmer on the basis of command signals originating on the ground. Exposure control shall be included to

ensure optimum exposure for maximum resolution. A means for indexing the film with time-base and vehicle-attitude information shall be included to assist in providing positional accuracy to ± 1 mile. The camera will operate on an intermittent basis dependent upon orbital period and orientation, and photographic coverage should be planned for all daylight passes over the area of interest. The film supply should be sufficient to meet the reconnaissance requirements plus serving as leader when required. The amount of film which will be used only as leader shall be kept to a minimum by the functional operation and orientation of the components.

2.5.5.1.1.2 Vehicle Processor. Develop an automatic 70mm processor and the associated equipment necessary to process and dry the film in the satellite vehicle.

2.5.5.1.1.3 Vehicle Readout. Develop a line scan TV readout mechanism capable of scanning the processed film to generate a signal output from the video amplifier compatible with the data link of the Ground Space Communications Subsystem. The composite video signal output of the readout equipment shall include such synchronizing, blanking, and other information as required to properly record and process the visual data on the ground. The equipment shall have sufficient bandwidth to read out the recorded portions of a strip of 70mm by 30 inches in a period of five minutes and it shall be able to read out the total output from the camera and the processor on an intermittent basis as governed by the data acquisition cycle. The operation of the film readout equipment will be initiated and stopped by coded command signals from the data acquisition station.

2.5.5.1.1.4 Vehicle Control and Transport Equipment. Develop control, transport, and storage equipment capable of executing the command signals provided by the vehicle programmer and command control communications. The subsystem control mechanism shall provide proper command signals

for operation and sequencing of the subsystem components. The functions should include, but not be limited to:

a. Maintaining correct image motion compensation (IMC) in the camera and supplying programmed or commanded changes in IMC.

b. Exposure control and focus operations.

c. Film transport functions from the camera through the readout device.

d. Operation and sequencing of the film processing and drying.

e. Monitoring performance of the readout equipment.

2.5.5.1.1.5 Ground Reconstruction Equipment and Monitor (Primary Record). Develop the ground photo reconstruction and processing equipment to convert the video signal from the Ground-Space Communications Subsystem into photographic form. Further, develop equipment and the techniques to monitor the vehicle readout and ground reconstruction equipment.

2.5.5.1.1.6 The primary record formed in the operation described in 2.5.5.1.1.5 above, will contain the reconnaissance image plus the auxiliary data, and the monitor will provide the means for checking the performance of critical components in the subsystem and for initiating command control of the process.

2.5.5.1.1.7 Auxiliary Data Records. Develop the equipment and techniques required to extract auxiliary data from the primary record and to combine this with additional data from orbit computations. The collective information plus primary records and reassembled records, will be made available to the Data Processing Subsystem I in a form and quantity that will be of maximum utility. The exact nature and number will be determined by arrangements to be made between LMSD and Subsystem I.

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2.5.5.1.1.8 Reassembly Camera and Processor (Reassembled Records). Develop equipment for reassembly of the primary record photographs into a continuous strip form similar to an enlargement of the original vehicle photography. This will be a nonrectified photograph on a standard-width film. Auxiliary data as required by Subsystem I will be recorded on the photographs.

2.5.5.1.1.9 Subsystem Evaluation. Develop equipment, techniques, and procedures for monitoring and evaluating the quality of the system output in order to:

a. Check system operation and compare the results with performance requirements.

b. Evaluate the results in order to consider redesign of equipment for future vehicles.

c. Provide for programming and control of future data acquisition cycles.

d. Determine that the vehicle and orbit data accuracy is sufficient to meet the location requirements of the system. Maximum use should be made of data available from Subsystem I in the performance of the above functions.

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2.5.5.1.1.10

2.5.5.1.1.11 Photo Requirements. Subsystem E will provide three (3) primary record photographs to the data processing subsystem. Additional detail requirements will be determined under the requirements of paragraph 2.6.

2.5.5.1.1.12 Viewing and Handling Equipment. Develop or adapt from existing equipment such photographic viewing, processing, and handling equipment required to perform the ground processes existing within Subsystem E.

2.5.5.1.1.13 Experimental Photo Program. Conduct an experimental photo program for the purpose of simulating the quality output of the Visual Reconnaissance Subsystem. The simulated photography will be of such quality that its analysis will enable the production of useful design criteria for Subsystem E. The photography will also be made available for interpretation studies by the Data Processing Subsystem.

2.5.5.1.1.14 Architectural and Engineering Support. Prepare the plans, drawings, and studies required for the design of the visual payload facilities at the various test and operational launch, data acquisition, and processing stations.

2.5.5.1.2 Advanced Visual Reconnaissance Program

2.5.5.1.2.1 Develop the vehicle and ground equipment that will meet the requirements of the Advanced Program, such as:

a. Steerable mounts for aiming the camera
b. Long Focal Length Lenses in order to achieve better ground resolution
c. Improved camera design for the high image motion speeds.

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2.5.5.1.2.2 Study the advisability of using pulse operated frame type cameras in order to provide improved mapping accuracy and to permit higher shutter speeds with various types of films. Analyze the system effects of varying such parameters as focal length, film speed and size, type of camera, etc. The findings of such studies and analysis should result in the development of reconnaissance configurations which will have varied application in later systems.

2.5.5.1.2.3 Investigate the present state-of-the-art in television techniques with magnetic tape storage as a possible means for obtaining visual data in later vehicles. Emphasis should be on the application of such techniques to the WS-117L vehicle and not on the development of hardware to meet WS-117L requirements. Particular attention should be given to use of such a method in a nuclear environment.

Evaluate the merits of photographic and TV systems with regard to: the effects of nuclear radiation, shielding requirements, comparative resolution capability, reliability and other factors which might affect the choice of one method over the other.

2.5.5.1.3 Data Processing Subsystem Functions. The work described in 2.5.5.1.1.9 will be restricted to that which would not normally be done by the Data Processing Subsystem. Any work relating to ground checkpoint positioning and the rectification of photographs to a vertical or a grid system will be a Subsystem I responsibility.

2.5.5.2 Item II - Hardware Program

2.5.5.2.1 Visual Reconnaissance subsystems shall be produced to satisfy the requirements of the program as enumerated in Section 1.0 of the Work Statement.

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2.5.5.2.2 Program II - Pioneer Visual. Deliver the vehicle and ground portions of the subsystem for the Program II flights.

2.5.5.2.3 36-Inch Focal Length Lens. The 36-inch lens is a critical component of the Advanced System and is specifically called out for delivery to EKC. The purpose is to evaluate the lens and submit a test report that will describe the performance and expected capability of the lens in the advanced vehicle.

2.5.6 Ferret Reconnaissance- Subsystem F

2.5.6.1 Item I - Research and Development Program

2.5.6.1.1 Ferret Capability

2.5.6.1.1.1 The design objectives of the Ferret program shall be such that the information obtained will accomplish the following (no priority implied):

a. Provide guidance in the reiteration of the design of the ferret equipment from the environmental conditions encountered and/or functional suitability of previous or first vehicle flights.

b. Establish objectives for follow-on missions.

c. Insure that each mission will be predicated upon intelligence criteria and not necessarily upon equipment availability.

2.5.6.1.1.2 Determine the conducting and dielectric materials and techniques necessary to fabricate antennas which meet subsystem design goals. These antennas shall be capable of withstanding vehicle launching and orbital environments.

2.5.6.1.1.3 General types of antennas are:

a. Antennas to achieve locational accuracy of known signals, and

b. Antennas to optimize intercept probability for signals heretofore unknown.

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2.5.6.1.1.4 Installation of the antennas on the vehicle to be as required to obtain the desired bandwidth and directivity patterns.

2.5.6.1.1.5 Antenna pattern design criteria, e.g., horizon looking or downward looking, to be in accordance with the intelligence requirements for the specific mission to be accomplished.

2.5.6.1.1.6 Continuing analysis of programmer control mechanism requirements is required to insure maximum flexibility of vehicle ferret equipment functions as related to the vehicle mission requirement.

2.5.6.1.1.7 A design and development program on equipment is required to provide calibration signal analyses for examining the interrelationship between decoded and partially sorted ferret data, and the calibration signals previously injected into the ferret and other related subsystems.

2.5.6.1.1.8 A study program is necessary to establish methods and criteria for monitoring, and then evaluating, the end product ferret reconnaissance data to determine the effectiveness and general level of performance of each component of the chain, thereby establishing major design criteria for future systems.

2.5.6.1.1.9

2.5.6.1.2 The design objectives of the Interim Atlas Ferret Reconnaissance Program are in general:

a. The mission flown must satisfy a national intelligence objective.

b. The data obtained must provide guidance for the design criteria and techniques to be used in the Pioneer Ferret Subsystem.

c. The Atlas missions will provide a test of the total Subsystem F to establish ground operational procedures.

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2.5.6.1.3 Pioneer Capability

2.5.6.1.3.1 The design priority for the Pioneer Ferret Mission will be established by intelligence requirements. Necessary integration between the intelligence requirements and equipment design shall be accomplished to ensure that equipment design changes to accommodate changes in mission requirements will be minimized.

2.5.6.1.3.2 Detail Design. The Electronic Reconnaissance Subsystem as described will be developed in the following manner by means of the following activity:

a. Conduct a program of electronic reconnaissance intelligence and advanced system analyses through subcontract. This includes intelligence anlysis to maintain current knowledge of national intelligence objectives, determination of those objectives which can be achieved by an electronic reconnaissance system, determination of parameters required to achieve these objectives, and establishment of various emitter characteristics. The subcontractor will assist in establishing operational concepts and will explore techniques for the advanced and surveillance ferret reconnaissance system.

2.5.6.1.3.3 Conduct an equipment design and development program through a subcontract covering the following tasks:

a. Subsystem Analysis. Determine the equipment capabilities in terms of the state-of-the-art, and establish requirements for exploratory development of critical items. Establish detail design of the equipment thus analyzed with specifications to ensure compatibility of the mission and the subsystem goals.

b. Pioneer Ferret Reconnaissance. In the design of the Pioneer Ferret Reconnaissance equipment, to cover the spectrum from 50-18,000 mc/s, exploratory design will be conducted involving critical areas of receiver systems. Conduct research to determine the conducting and dielectric material and techniques necessary to fabricate

antennas which meet subsystem design goals and are capable of withstanding vehicle launch and orbital environments. Conduct exploratory design and development in critical areas of antennas and antenna feed systems which are designed for the priority bands established by intelligence requirements. Establish design criteria for the installation of these antennas on the vehicle as required to obtain the desired bandwidth and directivity patterns. Establish antenna pattern design criteria, e.g., horizon looking or downward looking, in accordance with the intelligence requirements for the specific mission to be accomplished. Conduct continuing analysis of programmer control mechanism requirements to ensure maximum flexibility of vehicle ferret equipment functions as related to the vehicle mission requirement. Design measurement and analysis circuitry for the Pioneer Program. This will include techniques for recording vehicle time signals and vehicle attitude signals with the ferret data received. Design programming control mechanisms for the Pioneer system and conduct continuing analysis of programmer control requirements pertaining to the ferret collection task. Analyze requirements for multiple-channel recorders. Analyze requirements for the ground equipment required to service the airborne and the ground-based portions of this subsystem.

c. Ground Data Handling. Analyze storage time requirements of ground data handling recording equipment; study the techniques and equipment design of the magnetic tape or other storage media provided by Subsystem H on the ground to ensure compatibility with the ferret requirements. Conduct a design and development program on equipment to provide calibration signal analysis for examining the inter-relationship between decoded and partially sorted ferret data and the calibration signals previously injected into the ferret and other related subsystems. Conduct a study program to establish methods and criteria for monitoring, and then evaluating, the end product ferret reconnaissance data to determine the effectiveness and general level of performance of each component of the chain, thereby establishing major design criteria for future systems. Feedback from Subsystem I will be utilized where possible to improve quality of calibration.

d. Ground Support. Design special test equipment for subsystem checkout and evaluation. Design special calibration test sets covering the priority frequency bands.

e. Test and Quality Assurance Program. Each equipment will undergo a series of tests to assure that the complete equipments will meet all specification and contract requirements.

2.5.6.1.4 Advanced Capability

2.5.6.1.4.1 Advanced ferret reconnaissance will provide basically three functional capabilities:

a. More accurately determine the radio frequency and other parameters of electronic signals.

b. Provide more sophisticated techniques for improved location accuracies.

c. Provide a Quick Reaction Capability (QRC).

2.5.6.1.4.2 The detailed advanced ferret analysis and study program is covered by the following tasks:

a. Analysis of the design of the advanced ferret measurement and analysis equipment.

b. Continuing analysis of programmer control mechanism requirements.

c. Design studies to investigate state-of-the-art developments and to indicate critical development areas of more sophisticated recording techniques such as wide-band single-channel magnetic tape or film techniques.

2.5.6.1.4.3 Analysis of the design of the advanced ferret measurement and analysis equipment is required to ensure minimum vehicle processing and vehicle storage compatible with mission requirements, where these functions can be added to the ground analysis equipment.

2.5.6.1.4.4 Continuing analysis of programmer control mechanism requirements is necessary to ensure maximum flexibility of vehicle ferret equipment functions as related to the vehicle mission requirements.

2.5.6.1.4.5 Reliability studies will be conducted in a manner compatible with the overall WS-117L program.

2.5.6.1.4.6 Surveillance Ferret Reconnaissance. Study and analyze equipment requirements for the Ferret Surveillance System. The specific requirements of the equipment to be designed and developed for ferret surveillance shall be dictated

by knowledge of the signal complexes gained from the earlier programs and by the intelligence requirements at that time. Basically, the equipment shall be designed to provide answers to specific intelligence requirements in the band of frequencies of known or suspected enemy activity. Each surveillance mission shall establish parameters that will require use of previously developed techniques or will generate development requirements peculiar to the mission.

2.5.6.2 Item II - Hardware Program

2.5.6.2.1 Ferret Reconnaissance subsystems shall be produced to satisfy the requirements of the program as enumerated in Section 1.0 of the Work Statement.

2.5.7 Infrared-Subsystem G

2.5.7.1 Item I - Research and Development

2.5.7.1.1 Feasibility of Infrared Mission. Establish, at the earliest possible date, target detection capabilities and limitations of a satellite-borne infrared-sensing system. Measure background and target infrared characteristics peculiar to the type of system to be employed and to its very high altitude. Interpret results in terms of operational performance which may reasonably be expected and design characteristics which must be incorporated in the system. Estimate the maximum range to which ICBM launchings may be detected to provide instantaneous and unambiguous warning of attack. Estimate the range and resolution which may be achieved in detecting airbreathing missiles and aircraft as well as boost-glide vehicles for early warning purposes, and for surveillance of air traffic patterns as an indicator of the imminence of hostilities. Investigate the capability of performing precision tracking and prediction of ICBM targets in such a manner as to be applicable to active AICBM systems.

2.5.7.1.1.1 Background Effects on Elementary System. Investigate limitations on a satellite infrared detection system which may be imposed by background radiation. Prepare equipment for balloon flight tests using elements of the system as initially conceived, with suitable spectral sensitivity, filtering, field of view, scan speed and chopping rate and provisions for variations thereto. Conduct a limited number of day and night balloon flights at maximum attainable altitude, in the vicinity of 100,000 feet, under representative and extreme terrain and cloud conditions. Correlate measurements of background radiation with significant features of observed areas. Determine the extent to which background constitutes a problem and means for minimizing it by refined choice of parameters.

2.5.7.1.1.2 Target Characteristics Viewed From High Altitude. Measure infrared radiation intensity emanating from appropriate types of missiles and aircraft as a function of their altitude. Make these measurements from an instrumented aircraft flying at 35,000 feet or higher. Design equipment with inflight calibration features to measure intensity in important spectral regions, placing particular emphasis on the 2-3 and 4-5 micron regions. Perform measurements on two target types as follows:

a. Airbreathing turbo-jet or turbo-prop aircraft with high horsepower engines, such as the B-47, B-52, C-130, F-102, F-104. Vary the target aircraft altitude from sea level to 45,000 feet with particular emphasis on altitudes above 20,000 feet. Vary the target aspect sufficiently to allow construction of approximate polar intensity plots.

b. Burning rocket engines of the ICBM type. Measure radiation intensity during ascent from sea level to burnout (approximately 300,000 feet) and beyond burnout, if possible

Using measurements made on U.S. aircraft, indicate radiation characteristics of Russian strategic aircraft, such as Bison and Badger, and estimate the range to which they may be detected from a satellite. Give careful consideration to the number and sizes of engines, engine-wing configuration, and other significant differences between U.S. aircraft and their Russian counterparts.

Pursuit of this investigation shall be contingent upon obtaining a suitable USAF aircraft with crew and such operational support as is necessary. Infrared equipment shall be designed, fabricated, and installed by the Contractor.

2.5.7.1.2 Preliminary System Design. Prepare detailed preliminary design of an infrared system including detecting elements, scanning optical system, data processing, recording, and transmitting equipment. Construct and bench test breadboard circuits. Complete preliminary design and submit specifications for experimental model.

2.5.7.1.2.1 Scanning Techniques. In order to locate small targets in a large field of view, utilize suitable scanning techniques such as rotating fan or pencil beams in conjunction with an electronically scanned linear array of detecting elements, or a solid angle of pencil beams emanating from an electronically scanned stationary mosiac of detectors. Investigate these and other arrangements which may appear advantageous. Provide necessary optical image correction for multi-element arrays. Consider problems of mechanical scanning arising from (1) temperature and other characteristics of the extreme environment, and (2) perturbing effects on vehicle stability of rotating components.

2.5.7.1.2.2 Detectors. Investigate all promising detector elements such as lead sulphide, lead telluride, lead sellenide, indium antimonide, gold-doped germanium, etc. Evaluate relative suitability of such detectors in terms of spectral response, sensitivity, time constant, cooling requirements, physical properties, nuclear radiation damage, and environmental compatibility. Select optimum cell type and configuration. Design cell cooling system with power requirements within allowable limits.

2.5.7.1.2.3 Satellite Data Processing. Incorporating essential changes, design satellite-borne data-handling components based upon similar equipment under development for Reconnaissance Payload Subsystems. The Infrared

Subsystem components include (1) a data processor with signal amplifiers and scanning coders, and (2) a narrow-band magnetic tape data recorder.

2.5.7.1.2.4 Nuclear Radiation Effects. Evaluate nuclear radiation effects on components under consideration for inclusion in the infrared system. Consider neutron and gamma radiation at flux levels and energies encountered in the vehicle with proposed reactor and radio-isotope auxiliary power units. Establish the order of magnitude of radiation tolerances. Indicate the extent to which performance and lifetime degradation may be expected. Select components and specify design features which will minimize or eliminate undesirable radiation effects without introducing other more serious penalties.

2.5.7.1.3 Experimental Model. When sufficient progress has been made on preliminary subsystem design, commence fabrication of subsystem experimental models for ground and orbital flight tests.

2.5.7.1.3.1 Fabrication. Complete design and submit specifications, proposed test program and quantities of ground and flight components required for AF review and approval.

2.5.7.1.3.2 Ground Test. Coordinate and conduct appropriate tests directed towards design limitations, reliability, and system life. Environmental tests will simulate, as much as possible, thermal, shock, vibration, acceleration, nuclear radiation, meteoric dust, and other conditions encountered on the ground, during launch and ascent, and on orbit.

2.5.7.1.3.3 Orbital Tests. Conduct appropriate orbital tests of the experimental system.

2.5.7.1.4 Prototype System. Although no work shall be started on the prototype subsystem during this contract period, it shall follow in the subsequent period. The prototype development program is, therefore, outlined for planning purposes.

2.5.7.1.4.1 Design. Utilizing results of experimental model tests, prepare detailed design specifications for a prototype system suitable for operation in an orbital vehicle. Reduce power requirements, heat generation, weight, and size to an absolute minimum by miniaturization and transistorization wherever possible. Exert a very substantial effort to achieve an extreme degree of reliability for the entire system. Consider redundant as well as improved components. Submit design to procuring agency for approval.

2.5.7.1.4.2 Mockup. Fabricate a mockup of the prototype system for integrated vehicle mockup studies. The mockup shall be identical in weight, size, and configuration to the prototype infrared system. It shall include monitoring provisions, cabling, fixtures, and data processing, data recording, and data read-out components.

2.5.7.1.4.3 Fabrication. When changes dictated by mockup studies have been incorporated in the specifications, and when the design resulting from subtask 2.5.7.1.4.1 has been approved by the procuring agency, fabricate the operational prototype system. The quantity of prototype units to be fabricated shall be determined by the scheduled number of flight tests which include the infrared system.

2.5.7.1.4.4 Ground Tests. Conduct thorough laboratory tests on all prototype systems fabricated. Important parameters and characteristics shall be scrutinized during these tests. Tests shall be performed twice on each equipment, once at the start and again at the end of a 300-hour operating period simulating the sequencing of a typical orbital operation of that duration.

2.5.7.1.4.5 Aircraft tests are not feasible under the present schedule and are therefore deleted.

2.5.7.1.4.6 Orbital Tests. Conduct orbital tests of the prototype system. Correlate known targets over the U. S. with satellite signals received at the readout station.

[redacted]

2.5.7.1.6 Feasibility of Advanced Applications. Investigate advanced applications of satellite infrared systems. Develop practicable operational concepts and study feasibility of equipment required to extend performance beyond that of the experimental model described in Paragraph 2.5.7.1.1.

2.5.7.1.6.1 Operations and Systems Analysis of Advanced Systems. Examine coverage of enemy territory as a function of orbital plane, orbital altitude, number of vehicles on orbit, and data transmission methods. Establish operational utility of very high altitude orbits and indicate vehicular and payload characteristics necessary to achieve them. Consider practicability of various multisatellite systems in terms of cost, coverage, complexity, and reliability. These efforts will be performed under Paragraph 2.5.7.1.1 and coordinated with the work performed under Paragraph 2.5.8.1.10.

2.5.7.1.6.2 Tracking Angle Reference. Investigate methods of obtaining an accurate ICBM tracking angle reference system, since the satellite is not expected to be sufficiently stable for precision tracking without such a system. Evaluate promising techniques such as using line-of-sight between satellites and celestial references. (The work implied in this paragraph will not be accomplished in this contract period except for those charges incurred through 30 September 1958. Work will be resumed as more funds are made available.)

[redacted]

2.5.7.1.6.3 Infrared Tracking Techniques. Investigate applicable infrared techniques for obtaining precision tracking information on ICBM's from satellite vehicles.

2.5.7.2 Item II - Hardware Program

2.5.7.2.1 Infrared Reconnaissance subsystems shall be produced to satisfy the requirements of the program as enumerated in Section 1.0 of the Work Statement.

2.5.8 Ground-Space Communications Subsystem

2.5.8.1 Item I - Research and Development

2.5.8.1.1 The work to be accomplished under this item is to be directed toward the satisfaction of communications requirements for an integrated program, progressing from early Thor-boosted launches through an advanced Atlas-boosted reconnaissance system. Initial launches will be from the Vandenberg AFB area involving southerly launches of a Thor-boosted system. All items of ground-space communication equipment peculiar to this operation will be provided by the Contractor except ascent tracking of the booster by IRBM guidance equipment (if used), and range safety equipment. Maximum possible use will be made of support equipment available on the range.

2.5.8.1.2 Initial launchings of the Atlas-boosted system will involve launchings from Patrick AFB in a generally easterly direction. The Contractor will be expected to make maximum use of available range communication facilities (tracking, telemetering, and other instrumentation) but to supplement these facilities as necessary with any special equipment required to gain maximum profit from the flight test program.

2.5.8.1.3 Launches of the advanced Atlas-boosted system will be made in a generally southerly direction from Vandenberg AFB and will progress in complexity until a final operational system is evolved. Communications equipment will be developed during this program to keep pace with the increasing sophistication of the airborne equipment.

2.5.8.1.4 Thor-boosted launchings from Vandenberg AFB and Atlas launchings from Patrick AFB will be of a developmental nature. Primary emphasis will be placed on communications equipment to determine vehicle and vehicle-equipment functioning, and upon development of equipment for the handling of reconnaissance data during the advanced phase of the program.

In the advanced phase, the objective will be to provide means for transmitting all of the information gathered by the vehicle to a central location within the continental limits of the United States with a minimum of delay.

2.5.8.1.5 The equipping of the required ground-space communication stations, except for the launch site items mentioned above, shall be the responsibility of the Contractor. The Contractor shall also be responsible for determining the facility (brick and mortar) space requirements for this equipment. Site determinations shall be made by the Government with the advice and assistance of the Contractor.

2.5.8.1.6 The "end product" of the Ground-Space Subsystem will be a permanent recording and means for reading and transmitting the recorded data; preferably, the end product will be a magnetic tape recording and a "hot-line" wherein all of the properly indexed reconnaissance data will be available. The Ground-Space Subsystem will be responsible for the generation and proper indexing on the reconnaissance data signal, the following;

a1. Unique date-time signals which relate vehicle time to real ground time, and in addition, provide a time "zero" for the reconnaissance data.

a2. Vehicle position data: Within the satellite vehicle, the Ground-Space Subsystem will be responsible for the following indexing signals:

b1. To accept from attitude stabilization or attitude indication equipment, an analog signal which will be encoded into the proper form and provided to the particular sensing subsystem(s) concerned for their recording on reconnaissance data. If the attitude sensing is to be performed by the Reconnaissance Equipment Payload, per se, the responsibility of the Ground-Space Subsystem will be limited or non-existent.

b2. To generate and provide in the proper form to the sensing subsystem(s) vehicle time signals.

2.5.8.1.7 The ground-space communication stations will contain, as required, the following items:

a. Acquisition and tracking system
b. Orbit computer and programmer
c. Programming encoder and timer
d. Command transmitter
e. Reconnaissance data receiving system
f. Telemeter receiving system
g. Magnetic tape recorder for visual, ferret, and infrared data storage
h. Connections to the inter-station communications net
i. Provisions for use of commercial power, if available
j. An independent standby power source with provisions for automatic switch-in.

2.5.8.1.8 Vehicles shall contain, as required:

a. Tracking radar transponder
b. Command receiver
c. Reconnaissance data transmitter
d. Telemeter transmitter and instrumentation
e. Command storage, sequence programmer, and decoder
f. Secondary time standard.

2.5.8.1.9 The recoverable package effort is covered under paragraph 2.5.11.

2.5.8.1.10 The following description defines the approach to be followed in the development of the above listed items of equipment.

2.5.8.1.10.1 Acquisition Equipment

2.5.8.1.10.1.1 For the Thor-boosted program, passive acquisition equipment will be provided by the Contractor that will provide visual indication to the operator of the vehicle's direction of arrival, and electrical signals to direct the tracking and telemetry antennas. The accuracy of this acquisition equipment will be such as to insure automatic acquisition by the tracking equipment.

For the AFMTC Atlas-boosted program, the acquisition equipment will be similar to that for the Thor-boosted program.

For the Vandenberg AFB Atlas-boosted program, vehicle acquisition will be accomplished by the precision tracker operating on instructions from an orbit computer and programmer. In order to assure acquisition under all situations, pedestal scanning capability will be provided either under the manual direction of the operator or as directed by the orbit computer. This equipment will be capable of passively acquiring the vehicle at maximum line-of-sight range by determining the location of a programmed electromagnetic transmission emanating from the vehicle.

2.5.8.1.10.2 Tracking Equipment. For the Thor-boosted and the AFMTC Atlas-boosted programs, precision tracking will be provided by a conventional transponder-beacon assisted pulse radar. The radar will provide angle and unambiguous range information for up to 1500 nautical miles for trajectory computation, and for use in the slaving of other antennas, provide a command function by pulse position coding of the transmitted pulses, receive a single ranging pulse from the transponder beacon, and, provide suitable displays for monitoring acquisition and tracking.

The following work program will be pursued:

a. Procure SCR 584 MOD II radars

b. Modify as required to perform the functions as described above

c. Design and fabricate an analog computer for enabling the radar to maintain lock when the orbital path passes through the zenith

d. Modify the antenna for circular polarization in addition to vertical and horizontal polarization. All three types to be selectable by the operator.

For the Vandenberg AFB Atlas-boosted program the tracking equipment shall consist of a sequential-lobe amplitude-comparison automatic-tracking device. This tracking device acquires and tracks on a telemetry signal in the 2.2 - 2.3 kmc frequency range and provides precision tracking data at and above 5 degrees from the horizon with a dynamic angular accuracy for 1.0 milli-radian. Hemispherical coverage will be provided. Range information will be obtained from a CW ranging unit utilizing the command and telemeter links. The ranging system will consist of a modulator supplying ranging tones which are transmitted to the vehicle via the command transmitter and retransmitted to the ground via the telemetry link. A precision phase meter with a digitized output will be provided to indicate vehicle range to an accuracy of 0.1 mm. Monitor equipment will be provided to enable the operator to evaluate equipment performance.

2.5.8.1.10.2.1 In the early Thor program, a beacon transponder compatible with the radar tracker considered above will be used as a part of the pulse tracking system. The transponder will aid in identifying the particular satellite, act as a radar reinforcement beacon, and serve as the vehicle-borne portion of the command control link. In this phase, on-the-shelf equipment shall be used to the greatest extent practicable, modified as required for the command function.

2.5.8.1.10.3 Trajectory Computing & Ground Programming Equipment. For the Thor-boosted program, all trajectory computations and coordinate conversions will be performed on existing computing equipment located at the Contractor's

facilities at Palo Alto, California. The computer must accept tracking data from each station in the form of local polar coordinates (elevation, azimuth, range, and time), perform an orbit computation giving vehicle position as a function of time, recognize acquisition points for each tracking station, and perform a coordinate conversion for each of these points. Continuing periodic reception of tracking data shall be utilized to modify and refine the orbit. The input-output of the computer facility will be compatible with interstation communications equipment.

The computing equipment bo be employed in the AFMTC Atlas-boosted program will be the same as that described above.

For Vandenberg AFB Atlas-boosted program, computer and programming equipment will be provided for the tracking stations to perform the functions outlined above, and, in addition, to convert ground time to vehicle time and in this fashion, to construct an ephemeris of vehicle position as a function of vehicle time in order to geographically index the reconnaissance data to ±0.5 n mi and to label commands with vehicle time. The computers must perform computations for use at the local site such as performing coordinate conversions, program antenna positions, perform parralax corrections, etc. Additional computations and data processing necessary to execute specific requests of Subsystem I must also be performed by the computers. The computing facilities must be capable of handling the computations as outlined above for several simultaneously operating vehicles as determined by system requirements. The distribution of the computing equipment among the tracking stations must be consistent with reliable and efficient autonomous system operation.

2.5.8.1.10.4 Ground Synchronized Timing Equipment. For all programs, synchronized timing equipment will be provided at each of the tracking stations. Consideration will be given, but not be limited, to a synchronized timing system using stable crystal oscillators and associated count-down circuits referenced to radio station WWV or some other suitable standard.

For Vandenberg AFB Atlas-boosted program, a time comparator will be provided to accurately correlate vehicle and ground time. Both the ground time and the difference between vehicle and ground time from the time-comparator are provided for use by the computer, in order to compute vehicle position to ± 0.5 n mi and to index commands with the proper vehicle time.

2.5.8.1.10.5 Vehicle Programmer & Decoder

2.5.8.1.10.5.1 A programmer is to be supplied as part of the vehicle equipment for providing an accurate clock, a program storage, and sequenced control for reading out and executing stored or real time commands. The clock shall be capable of furnishing timing signals for the programmer and shall furnish timing signals for vehicle position indexing. The following work program will be pursued:

a. Conduct a feasibility study of using either mechanical storage devices or nonmechanical storage devices, such as magnetic tape, magnetic cores, or dielectric memories.

b. Design, develop, fabricate, and test an elementary timer based upon either an electromechanical device, or a simple electronic system.

c. Design, develop, fabricate, and test a programmer utilizing a crystal-controlled clock and magnetic core memory.

2.5.8.1.10.5.2 Provisions will be incorporated to permit the periodic comparison of the vehicle timing with the ground timing system by means of telemetry and/or command circuits.

2.5.8.1.10.5.3 For each second of vehicle time, at least one timing mark shall be provided to the sensing subsystem.

2.5.8.1.10.5.4 The accuracy of timing will be such that overall system timing accuracy will permit geographical indexing of vehicle data to comply with mission requirements.

2.5.8.1.10.5.5 Vehicle equipment will be capable of initiating "lost bird" operation functions.

2.5.8.1.10.5.6 Provisions will be included for a vehicle-programmed command to minimize the possibility of the vehicle being taken over by an unauthorized transmitter.

2.5.8.1.10.6 Ground Command Control Equipment

2.5.8.1.10.6.1 In the Thor-boosted and the first few AFMTC Atlas-boosted vehicle programs, control commands will be transmitted by the pulse-radar tracking system through use of pulse position modulation. Verification of the receipt of these commands will be transmitted by the vehicle telemeter providing an indication of receipt at the tracking radar.

2.5.8.1.10.6.2 For the Vandenberg AFB Atlas-boosted program, command transmitting and encoding equipment will be provided to transmit operational program commands and time signals to the vehicle in the proper form, sequence, and quantity for both real time and programmed vehicular time sequenced execution. If a study program to determine the need for a destruct command indicates that this command is necessary, the command link will also serve to carry a destruct command in the event of faulty operation during power flight. Consideration will be given to the possible use of a common transmitter and/or antenna for primary tracking and command control purposes when a radar-transponder combination is used for tracking.

2.5.8.1.10.6.2.1 The equipment will be capable of transmitting commands to the vehicle at any range up to 2,000 nautical miles.

2.5.8.1.10.6.2.2 A high-gain directional antenna will be provided to increase the reliability and security of the system.

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2.5.8.1.10.6.2.3 An encoder will be employed to transform commands to a suitable form for modulation of the transmitter carrier. Command coding will be capable of being changed periodically for security purposes. A ground-based commands-monitoring receiving and recording system will be used to produce a recording of the commands preferably arranged in the order of sequence of execution.

2.5.8.1.10.6.2.4 Provisions will be included for a programmed command to minimize the possibility of the vehicle being taken over by an unauthorized transmitter.

2.5.8.1.10.6.2.5 Provisions will be made for comparison of command verification pulses from vehicle with the commands being generated (on the ground) to automatically indicate reception and decoding of the commands at the vehicle. The comparison may take the form of a combination parity and word-length check, or other suitable means.

2.5.8.1.10.6.2.6 Ground equipment will be capable of providing future growth of "building-block" possibilities, such as an increase in the number of command channels (or sub-carriers) for added command functions.

2.5.8.1.10.6.2.7 Ground equipment will be capable of initiating search to augment vehicle "lost bird" operation.

2.5.8.1.10.6.2.8 The interim command transmitting and encoding equipment will be achieved by the following work program:

a. Perform preliminary design studies which will be used in the detailed design, development, fabrication, and procurement of the interim ground-command control equipment. The operating frequency of the command-control transmitter shall be analyzed carefully and be chosen to provide maximum WS-117L security and minimum interference and jamming of other services. The use of a suitable modulator and transmitter shall not be prejudiced by a freezing on commercially available equipment which may not be modified readily.

b. Based upon the results of the above studies, procure and modify if necessary a suitable high-power FM command transmitter or wideband RF amplifier as specified in the attached Schedule D.

c. Procure and modify if necessary a suitable modulator.

d. Procure and modify if necessary, a suitable standard antenna and pedestal (if the study indicated above dictates the need for separate command control equipment).

e. Develop and fabricate an antenna feed system.

f. Assemble and conduct preliminary tests of complete command transmitter assembly in accordance with 2.5.8.1.10.6.3.

g. Install assembly and conduct final tests.

2.5.8.1.10.6.3 Advanced Ground Command Control Equipment

2.5.8.1.10.6.3.1 A feasibility study and a research and development program will be conducted leading to an improved command transmitter for achieving increased transmission reliability with decreased sensitivity to interference and jamming of the vehicle receiver, as well as providing low detectability.

2.5.8.1.10.6.3.2

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2.5.8.1.10.6.3.3 The method of encoding the transmitted intelligence will be determined on the basis of reliability and simplicity of the vehicle-borne decoding and storage equipment.

2.5.8.1.10.7 Vehicle Command Receiving Equipment

2.5.8.1.10.7.1 The advanced command receiver and decoder may be basically unlike that of the initial system because of increased complexity in vehicle functions. In addition, a new frequency band and form of modulation may be chosen to permit greater security and freedom from interference. Accordingly, the work program for an advanced command receiver and decoder will depend upon a feasibility and design study, the objectives of which will be simplicity of vehicle-borne equipment, increased reliability, and decreased sensitivity to interference and jamming. The operational version of the command receiver and decoder will be achieved for transistorized design. Thermal vacuum tube designs will be used where transistorization is not feasible. The command control equipment will consist of a receiver, decoder, or converter, programmer, and other equipment for subsystems which are to receive commands from the ground. An appropriate antenna is also a part of the command control link. The equipment will receive operational program commands, time signals, antenna orientational signals, and other ground-to-space control signals.

2.5.8.1.10.7.2 Vehicle Antenna System. Owing to interaction between antennas in the vehicle, antennas will be provided as integrated systems including not only ground-space communication antennas, but also all other radiating or receiving antennas which may form a part of the payload (as in the case of the ferret antennas). The antenna designs will provide an acceptable pattern compatible with the expected attitude of the vehicle in space in relation to the earth's surface. The following work program will be pursued.

[redacted]

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a. Prepare specifications for vehicle antennas

b. Design antennas to meet specification requirements

c. Conduct research on materials to meet special environmental conditions.

2.5.8.1.10.8 Ground Reconnaissance Data Receiving Equipment

2.5.8.1.10.8.1 General Considerations. Ground reconnaissance data receiving equipment will be provided to encompass all necessary facilities for reception, monitoring, processing, recording, storage, and retransmission on the ground of the visual information transmitted by the vehicle during readout. Operation will meet the system requirements at all vehicle ranges from the ground station. Adequate signal-to-noise ratio will be maintained to prevent appreciable degradation of the signal information content. Receiving antennas will be high-gain directive configurations which are capable of being dynamically slaved to point at the vehicle when in range of the Ground Intercept Station.

2.5.8.1.10.8.2 Visual Data Receiving Equipment

2.5.8.1.10.8.2.1 The development program of the Pioneer Visual Data Receiving Equipment will be divided into three phases:

a. A test phase during which the basic receiver will be used in conjunction with the Pioneer antenna and pedestal to prove feasibility and to assist in the preparation of firm specifications for the early operational system.

b. The design, development, and fabrication of the Early Operational (Pioneer) Visual Data Receiving Equipment.

c. The design, development, and fabrication of the Advanced Operational Visual Data Receiving Equipment.

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2.5.8.1.10.8.2.2 The receiving equipment will operate at S-band, and will be capable of frequency-modulated reception.

2.5.8.1.10.8.2.3 As a preliminary objective, the visual data link will be designed for handling signals, the video bandwidth of which is approximately six megacycles/sec at the half-power points.

2.5.8.1.10.8.2.4 A circularly-polarized parabolic antenna, having a gain of at least 50 db (for a linearly-polarized signal) may be used to determine its suitability. Initial use may be made of low-noise traveling wave tube input. Other types will be used if deemed more desirable.

2.5.8.1.10.8.2.5 The Visual Data Receiving Equipment will be achieved by the following work program:

a. A study will be made to determine the comparative merits of employing elevation-traverse or three-axis antenna pedestal mounts in the early operational and/or advanced systems.

b. A study will be made to determine the feasibility of using a receiver which will provide means for sensing a prescribed modulation (such as amplitude modulation) imposed by scanning the transmitted beam for accurately aligning the vehicle antenna by command control.

c. Design, develop, and fabricate an Experimental Model Visual Data Receiver.

d. Design, develop and fabricate or procure an antenna pedestal, antenna, and antenna feed system.

e. Assemble items of paragraph (c) and (d) above, and conduct evaluation tests.

f. Prepare specifications, design, develop, fabricate, and test Pioneer Visual Data Receiving Equipment.

g. A continuing study and development effort will be made to determine the ultimate increased bandwidth requirements for the advanced systems, using existing components wherever possible.

h. Prepare specifications, design, develop, fabricate, and test the Advanced Visual Data Receiving Equipment.

2.5.8.1.10.8.3 Ferret Ground Equipment. The design and development of this subsystem will not be affected by the Thor-boosted program. However, ground component design will be necessary for the AFMTC Atlas-boosted and the Vandenberg AFB Atlas-boosted programs. The schedule shall be compatible with the development of the airborne equipment.

2.5.8.1.10.8.4 Infrared Ground Equipment. The design and development of this subsystem will be limited to component design in critical technical areas. Fabrication will be limited to equipment necessary to test critical components within the framework of subsystem goals.

2.5.8.1.10.9 Vehicle Data Transmitting Equipment

2.5.8.1.10.9.1 Data transmitting equipment will be provided in the vehicle to accept stored reconnaissance data and transmit these data to appropriate Vehicle Intercept and Control Stations in accordance with either programmed or real time instructions received from the ground. The transmission rate or information transfer per unit time will be the maximum possible commensurate with the bandwidth available in the link which will provide the extreme long-time reliability required in this application. Reliable propagation in the most adverse weather, ionospheric and other environmental conditions, is required and will be an important factor in determination of frequency and method of modulation. High quality transmission over the link in spite of doppler effects will be required. Denial of useful information to unfriendly receivers and prevention of exploitation of transmission for any unfriendly purposes will be an objective of the design.

2.5.8.1.10.9.2 Visual Data Link. The visual data link will incorporate high-gain antennas at both the transmitting and receiving ends of the link. The transmitter and receiver will operate at S-band, and will be frequency modulated. As a preliminary objective, the visual data link will be designed for handling signals, the video bandwidth of which is

approximately six megacycles/sec at the half-power points. The following work program will be conducted:

a. Prepare specifications for visual data link.

b. Conduct program of design, development, fabrication, and test. The antenna design will be in accordance with para. 2.5.8.1.10.7.2.

2.5.8.1.10.10 Ground Telemeter Receiving Equipment

2.5.8.1.10.10.1 Equipment will be provided to encompass all ground and shipboard facilities for reception, monitoring, processing, recording and storage of vehicle instrumentation and environmental data transmitted by the vehicle during readout.

2.5.8.1.10.10.2 Operation will meet the requirements of the system at any vehicle range within radio range of the ground station.

2.5.8.1.10.10.3 Early Test and Pioneer Equipment. If ranging data is transmitted from the vehicle telemeter transmitter, a ground telemeter receiver will be capable of extracting the range information and applying it to the ranging circuitry of the tracking equipment. During early test flights, standard VHF telemetry receiving station components (modified as required) will be utilized to the maximum extent. Channel capacity and receiver bandwidth will be adequate. The receiving equipment will employ a directional antenna capable of tracking the telemetered signal emanating from the vehicle, or of being dynamically slaved to the tracking antenna. This telemeter antenna may form a part of the tracking device. The work program will consist of the following:

a. Design, develop, fabricate and test such subassemblies as required to form complete ground telemetering receiving equipment.

b. Assemble, install, calibrate, and test.

[redacted]

2.5.8.1.10.11 Vehicle Telemeter Transmitting Equipment. Vehicle telemetering equipment will be provided for transmitting range, environmental, and equipment status data. FM/FM and PAM/FM telemetering equipment will be provided for early flight tests. PAM/FM telemetering equipment will be phased to Subsystem G activity. The telemeter transmitting equipment for operational flights will be similar to the Vehicle Data Transmitting Equipment for the Infrared and Ferret Subsystems. The telemeter system will provide all necessary facilities for sensing inputs, storing during orbit, and transmitting range signals, environmental data, equipment performance data, useful scientific data, and data which will generally further the development program. The requirements of antenna design will be such that an acceptable pattern will be provided commensurate with expected vehicle space attitude with respect to the earth's surface during ascent, erection, and on orbit.

The development of telemetering equipment will be achieved in accordance with the following work program:

a. Specify the quantities to be measured, including dynamic range and accuracy required.

b. Design, develop, fabricate, and test a transmitter prototype model suitable for early flight tests and environmental chamber tests.

c. Design, develop, fabricate, or procure and install test instrumentation for flight tests.

d. The work program for the operational telemetering equipment will be parallel to that outlined above.

2.5.8.1.10.11.1 In the early Thor firings, telemetry equipment will be required for transmitting a limited amount of environmental and equipment status data. Existing vehicle-borne telemetry equipment commensurate with existing range facilities shall be used to the fullest extent practicable.

2.5.8.1.10.12 Recoverable Package Communications

[redacted]

2.5.8.1.10.12.1 All effort regarding the recoverable package is described under paragraph 2.5.11.

2.5.8.1.10.12.2

2.5.8.1.10.13 Electronic Counter-measures Vulnerability

2.5.8.1.10.13.1 The Contractor shall conduct a continuing study of each phase of the program to assess the vulnerability of the system to electronic countermeasures. Such studies shall take into account efforts to:

a. Gain control of the mission through the command link.
b. Deny control of the command link.
c. Deny reception of the telemeter link.
d. Deny reception of the data link.

2.5.8.1.10.13.2 Consideration of ECM vulnerability shall include but not be limited to:

a. Susceptibility of the several receivers to interfering signals. (Data link, Beacon, Command link, Telemetry link, etc.)
b. Accessibility of the vehicle and ground-based equipment to enemy countermeasures based on consideration of geographic location, orbit path, antenna patterns, equipment 'on' time.
c. Power levels required to successfully interfere with operation of the vehicle.

2.5.8.1.10.13.3 This study shall be phased to coincide with the important stages of development of the system. It shall be continued throughout the development period of the system to monitor changes in the equipment or system which affect vulnerability. The Contractor shall correct deficiencies which are found to seriously degrade the probability of a successful mission.

2.5.8.1.10.14 Ground Communications Equipment

[redacted]

2.5.8.1.10.14.1 Ground communications will be provided to enable communications within and between the individual ground installations of the system. The net will include:

a. General operational (administrative and logistic) and command circuits.

b. Data transmission circuits.

2.5.8.1.10.14.1.1 In the operational phase, a 50 percent overbuild shall be provided after the minimum inter- and intra-site communication circuit requirements for all functions have been determined, unless the studies referenced here indicate a greater potential.

2.5.8.1.10.14.1.2 Existing AF facilities, such as the communication circuits in "White Alice", Dew-Line, and the like, shall be used where available and applicable; commercial facilities shall be leased to complete and/or augment such AF facilities as required. The Contractor shall analyze and determine the necessary retrofit engineering required to above-referenced AF facilities to provide for their use in support of WS-117L. The Contractor shall also be responsible for providing the necessary engineering details, parameters, and equipment to permit dropout and insertion of WS-117L communication circuits in AF facilities to be used.

2.5.8.1.10.14.2 Inter-Station Communication Facilities

2.5.8.1.10.14.2.1 The inter-station operational and command communications network will link the vehicle intercept and control stations and the launch station(s) to the technical operation center. The reconnaissance communications network will link the vehicle intercept and control stations to the technical operation center. The intelligence data analysis center will be linked directly to the technical operation center for reconnaissance data receipt, and will have appropriate operational circuits to the technical operational center.

[redacted]

2.5.8.1.10.14.2.2 The general operational and command circuits will be conventional wire lines carrying voice, teletype, code and/or graphics (facsimile) messages. Backup facilities shall be included to assure reliability of communications as required. Such facilities shall include provisions for alternate routing and/or direct backup communications. These circuits will handle the trajectory data, tracking programs, and commands between the vehicle intercept and the control stations and the technical operation center and the Intelligence Data Analysis Center. Commercial circuits will be used wherever security considerations permit such use. These facilities will be included during the prelaunch, launch, ascent, and operational tracking phases.

2.5.8.1.10.14.2.3 The data transmission circuits will initially consist of narrow bandwidth links such as land lines, high-frequency radio and/or microwave relay and high-speed courier aircraft. In the initial phases of the program, consideration will be given to the use of primitive data evaluation techniques for reducing the quantity of data to be transmitted. Techniques using facsimile and slowed-down video, will be considered for transmission of a limited amount of information which may be considered vital. Later, in the ultimate system, wider bandwidth communication facilities will be used in accordance with the results of the studies indicated below, capable of transmitting the complete reconnaissance and attitude information received from the vehicle.

2.5.8.1.10.14.2.4 Studies and investigations will be conducted to determine the following information:

a. The need for special development of wide-band ground links other than those currently available, in the light of operational experience.

b. The comparative merits of application of microwave relay, coaxial, and scatter links for the transmission of wide-band reconnaissance data.

[redacted]

[redacted]

c. The minimum information rates (of the viual ferret, digital data, and facsimile circuits) and the corresponding RF bandwidth required to satisfactorily accomplish the system requirements, for both the initial test and operational phases.

d. The types of error detection and correction techniques to be employed to insure the accurate transmission of the reconnaissance, command, and orbital data between the ground base stations.

e. The number and quality of communication channels to be employed for both administrative and logistic purposes as well as for tracking programs and commands between the individual ground installations of the system.

f. The tolerable error rates (or acceptable system error rates) for each type of communication function.

g. The required traffic flow of information between the various ground based facilities.

h. The type of modulation (AM versus FM) to be used and the tolerances for envelope delay distortion and equalization in the transmission of the visual reconnaissance data over suitable microwave, coaxial, and/or scatter links.

i. The type and quantity of alternate routing to be employed for all inter-station communuications links to minimize vulnerability to accidental or enemy destruction.

j. The types of security techniques that will be employed for resisting enemy jamming or providing low detectability. Also, the types of suitable encoding techniques that will be developed with minimum bandwidth requirements.

k. The types of data storage and monitoring facilities or equipment which will be used at each ground based intercept station.

l. The type (fregency, space, and/or time) and degree (dual, triple, and/or quadruple) of possible diversity combiners to be used to minimize losses due to fading.

m. Evaluation and study shall be performed to determine the applicability, relative advantages and disadvantages of general purpose equipment to serve the various functional needs of the system prior to the initiation of special purpose equipment development. In doing this, full consideration shall be given to existing equipment and development programs within the Air Force, Army, Navy, and/or available from commerical sources.

2.5.8.1.10.14.2.5 Prepare specifications for ground-to-ground communications circuits, including data storage, based upon the results of the above studies and investigations and procure or design, fabricate, test, and install the required inter-station communication facilities.

2.5.8.1.10.14.2.6 Provide facilities for the storage of the received information on magnetic tape. The storage facility will be capable of nondestruction readout of information for preliminary evaluation before retransmission, without further processing. The storage medium will permit data extraction for storage and handling over long periods of time.

2.5.8.1.10.14.2.7 Obtain initial use of available communication circuits and/or equipments excluding wide-band links.

2.5.8.1.10.14.2.8 Obtain or develop broad band links as indicated to be necessary by operational requirements in accordance with the results of the studies indicated above.

2.5.8.1.10.14.2.9 Proper and adequate considerations will be made with respect to ground-based antenna siting as it may affect screening, refraction, or reflection from obstacles or nearby buildings, and interference with associated equipment.

2.4.8.1.10.14.2.10 The minimum standards for the operational inter- and intra-site communication equipment, installation and transmission characteristics shall be as established in RADC Exhibit 5001 "1962 Point-to-Point Communication Subsystem," and such other Air Force Engineering standards as shall be mutually agreed upon from time to time.

2.5.8.1.10.14.3 Intra-station Communication Facilities

[redacted]

2.5.8.1.10.14.3.1 Internal communications will be provided at each intercept and control station and launch site as required for efficient and reliable operation of the subsystem.

2.5.8.1.10.14.3.2 A study will be made of the man-machine relationships involving human factor analysis of the required traffic flow of information within each intercept station.

2.5.8.1.10.14.3.3 Based upon the above study and analysis, a determination will be made of the required number and types of intra-station communications facilities (for the prelaunch, launch, ascent, and orbiting phases), which will include, but not be limited to, the following:

a. Automatic dial telephone equipment
b. Sound powered phones
c. Public address and paging equipment
d. Analog and digital data transmission and display equipment
e. Remote monitoring and display devices
f. Intercom facilities
g. Maintenance phones
h. Emergency alerting and warning circuits.

2.5.8.1.10.14.3.4 Evaluation and study shall be performed to determine the applicability, relative advantages and disadvantages of general purpose equipment to serve the various functional needs of the system prior to the initiation of special purpose equipment developments. In doing this, full consideration shall be given to existing equipment and development programs within the Air Force, Army, Navy, and/or available from commercial sources.

[redacted]

[redacted]

2.5.8.1.10.14.4 Signal Density and Interference Studies. Signal density and interference stuides will be conducted to insure proper siting of ground stations to achieve reasonable performance of the communication system. The interference limits as delineated in MIL-I-6181 "Interference Limits, Test and Design Requirements" shall govern the design and construction of all equipment within the system to insure a minimum of radiated and conducted radio interference in both the operational and accelerated programs. Considerations shall also be given to the avoidance of interference (such as proper frequency selection, etc.) with other Air Force systems in existence or expected to be in the field by the operational time period.

2.5.8.1.10.15

2.5.8.1.10.16 Frequency Allocation Requirements

2.5.8.1.10.16.1 A study shall be conducted to determine frequencies required for operation of all equipment in both the test and advanced phases of the WS-117L program. These requirements shall be submitted at the earliest possible date in order to assure government allocation of these frequencies for the WS-117L program.

2.5.8.2 Item II - Hardware Program

2.5.8.2.1 Ground-Space Communications subsystems shall be produced as defined in Paragraph 2.5.8.1 to satisfy the requirements of the program as enumerated in Section 1.0 of the Work Statement.

2.5.8.2.1.1 Components of the vehicle equipment will be required for all flights. Early Thor-boosted flights will require but not be limited to a basic telemetry transmitter, a timer, a beacon-transponder and associated antennas. Thor-boosted flights containing a recoverable package will require, in addition, equipment required to permit homing during descent and location

either prior to or after impact. Early Atlas-boosted flights will contain a combination of interim and final type equipments required to transmit telemetry information and accept commands at S-Band frequencies. Pioneer Visual and Ferret flights will contain elements of the programmer, timer, and advanced telemetry and command control equipment leading to the finalization of equipment for the Advanced Reconnaissance Vehicle.

2.5.9 Ground Support Equipment

2.5.9.1 Item I - Research & Development Program. The Contractor shall conduct a program leading to the development of Ground Support Equipment to be used for the vehicle flight test program and for the operational WS-117L program. When compatible with flight test schedules and technical objectives, the flight test ground support equipment shall be prototype operational ground support equipment. The development program plans shall be in accordance with Spec MIL-D-9412C (USAF) and WDT Exhibit 57-29 (Para. IV not applicable).

2.5.9.1.1 The operational WS-117L will consist of an Atlas booster and a WS-117L vehicle plus the ground support equipment associated with each. The system must be capable of operation by military personnel under a single military commander. It is, therefore, essential that procedures, techniques, and components of the Atlas and WS-117L vehicle ground support equipment be standardized where possible to maximize the interchangeability of parts and minimize crew training. To reach this operational goal, the Contractor will incorporate Atlas designs and techniques into the WS-117L vehicle developmental ground support when they are consistent with the WS-117L technical objectives.

2.5.9.1.2 In the design of operational checkout equipment, the following characteristics are deemed desirable:

a. Blockhouse equipment and functional checkout equipment should be automatically programmed by versatile devices so that changes in programming, due to vehicle modifications, can be made without rewiring or redesign of the checker.

b. The programmer should be capable of programming system or subsystem checks as desired through a change of programming media (punched cards, punched tape, or magnetic tape) and the installation of a suitable plug board. The various equipments, driven by the programmer, should be capable of checking out the system or its subsystems to any desired degree.

c. Subsystem checkout should be performed by the functional checkout equipment, if a work load analysis shows this to be feasible.

2.5.9.2 Item II - Hardware Program. The Contractor shall provide, operate, and maintain all test ground support equipment, including spares, required to support the vehicle flight test programs; this will include all engineering aids required to design, test, and evaluate the GSE.

2.5.9.2.1 Gas and fuel line identification shall be accomplished according to the instructions contained in AFBM Exhibit 58-20, and shall be accomplished on a "not delay basis" for items in process or under the routine maintenance operations for items already fabricated and delivered for use. It shall be a specified requirement for new procurement and/or fabrication.

2.5.10 Data Control System

2.5.10.1 Item I - Research and Development

2.5.10.1.1 Scope of the Data Control System

2.5.10.1.1.1 The Data Control System will provide the scheduling of all vehicle operations that affect the reconnaissance and supporting efforts. Based upon the priority of the requests from the user of the reconnaissance data, schedules will be established and revised as necessary to fulfill the requests. These schedules will determine the appropriate vehicle capable of performing the specific mission, when it can acquire the data (based upon its flight path and previous data requests), and when and where this data can be acquired from the vehicle. To establish the schedules, it will be necessary to determine the orbit of each vehicle and refine these calculations as further information becomes available. Also to be scheduled into the vehicle

operation are such internal system requests as regular and special calibration checks and quality-control-initiated adjustments. An interstation schedule will be maintained to assure optimum utilization of each remote station and its equipment.

The Data Control Program consists of the development of an integrated data collection and processing system to prepare reconnaissance data for transmission to the user. This program will provide centralized scheduling of vehicle reconnaissance activity and insure integrated quality control, proper format, and certification of the reconnaissance data.

2.5.10.1.1.2 Operation of various data control equipment will be monitored to determine the efficiency of equipment. In the event of malfunction within any piece of equipment or system, corrective measures will be determined and action commands initiated or prepared for future initiation. Deviations from the normal level of efficiency of the various pieces of equipment or systems will be recorded and used to determine the quality of the data outputs. Records will be maintained of all equipment malfunctions or failures, and these will be reported to the responsible departments for future system improvement. In addition, all such data obtained by the various subsystems on their own equipment will be reported to the Data Control System for use in data quality control efforts.

2.5.10.1.1.3 The reconnaissance data will be certified as to quality on the basis of telemetry and calibration or ground monitoring data. Additional auxiliary data such as time of acquisition and specific calibration information may be appended, based on pre-established format. This certification will make use of the orbital calculation (2.5.10.1.1.1) and the quality control information (2.5.10.1.1.2). A real time system will be developed to correlate the actual time of acquisition of the data with the time of delivery to the users.

2.5.10.1.1.4 The Contractor shall be responsible for:

a. Ground and flight test data analysis and reduction.

b. The engineering evaluation of the overall reconnaissance system and provision of the results to the appropriate organization for use in future designs.

2.5.11 Biomedical Capsule (Subsystem L)

2.5.11.1 Item I - Research and Development

2.5.11.1.1 Biomedical Data. This data shall be obtained by the selection of suitable vertebrate specimens and environmental instrumentation, as permitted by the WS-117L payload weight limitations, with the primary objectives of demonstrating specimen survival and cosmic radiation effects.

2.5.11.1.2 The WS-117L design modification shall be accomplished as required to maintain the recovery capsule program current. The auxiliary power system shall be arranged to provide electrical power required by the capsule during the ascent and orbiting flight phases.

2.5.11.1.3 Recovery Capsule. The Contractor shall design as required by the conditions of re-entry and shall include suitable equipment for the survival of the biomedical specimen and for the recovery of cosmic radiation and biomedical environmental data. The capsule shall be equipped with beacon, dye marker, and strobe lamp equipment as considered feasible to facilitate the search and recovery operation.

2.5.11.1.3.1 The Contractor will develop and design the complete Biomedical Recovery Capsule including the necessary components, subassemblies, and retro-rocket system. Government technical agencies will provide available technical advice, biological specimen performance, environmental requirements, biological specimen tests, and shall approve the environmental provisions of the capsule assembly.

2.5.11.1.3.2 The BRC shall be designed, insofar as possible, to assure the launch, orbit, and recovery of the viable animal subjects and instrument subassemblies. Conditions shall be provided so that the animal subjects will have suffered no irreversible damage except that damage ascribable to prolonged weightlessness and cosmic radiation.

2.5.11.1.3.3 The Biomedical Recovery Capsule assembly shall consist of the following major assemblies:

a. Shell Assembly. A shell assembly shall be designed for assurance of the structural integrity under the stress conditions encountered during boost, orbit, and recovery, and shall provide the necessary design characteristics to ensure thermal heat balance during flight.

b. The capsule shall include a recovery package complete with radio beacons, strobe lights, radar chaff dispensers, dye markers, parachutes, and the auxiliary equipment necessary to ensure the maximum opportunity for location and recovery.

c. Environmental Controls. The environmental subassembly shall include the necessary nutrients, water, atmospheric conditions, temperature, and pressure to assure adequate life conditions for the selected viable specimen.

d. Capsule Internal Structure. The capsule internal structure shall be so designed that the acceleration forces of boost, re-entry, and impact will be within the tolerances of the viable specimen selected. This internal structure shall also provide for acceptable environmental temperature conditions.

e. Instrumentation. Instrumentation shall be provided to include a minimum of the following data:

1) Ascent and Orbit Interval

a) Capsule air temperature

b) Capsule air pressure

c) Oxygen pressure

d) Capsule humidity

e) Viability indication (desirable but not mandatory)

f) Camera coverage (desirable but not mandatory).

2) Re-entry Interval

a) Capsule air temperature

b) Acceleration in 3 orthogonal planes

c) Oxygen pressure

d) Capsule pressure

e) Noise level

f) Viability indication (desirable but not mandatory)

g) Camera coverage (desirable but not mandatory).

Adequate instrumentation for the recovery of data in accordance with the flight test objectives of paragraph 2.5.11.3.3 shall also be provided.

f. Retro-rocket Equipment. The capsule assembly shall include the necessary retro-rocket equipment for the initiation of re-entry.

g. Electrical Power. Adequate electrical power shall be included for the operation of internal capsule equipment.

2.5.11.1.4 Search and Recovery Operation. A program will be planned, developed, and coordinated to initiate the recovery of the re-entry capsule, with consideration being given to primary "air snatch" operations as well as water and land recovery plans. To ensure a communication system and arrange for the transmission of biomedical data by means of the telemetering system and for the initiation of the capsule re-entry and recovery phase through suitable command programmer arrangements, adequate coordination must be assured. Adequate coordination must also be assured to plan for tracking the package over a sufficient portion of the trajectory to permit recovery.

2.5.11.1.5 Environmental Performance Specifications. The purpose of this specification is to outline the environmental parameters necessary to support life in the BRC. The maximum or minimum values stated below cannot usually be regarded as optimum for homeostasis; therefore, when

possible, optimum values will be presented. The Contractor will make every reasonable effort to achieve the optimum values during any phase of flight and will not exceed maxima or minima at any time after launch. A 14.7 psi pressure schedule is acceptable prior to launch, and, if used, will consist of approximately 730 mm Hg partial pressure oxygen, 10 mm Hg partial pressure water, 10 mm Hg partial pressure inert gas, 8 mm Hg partial pressure carbon dioxide and 3 mm Hg partial pressure other gases.

a. Total Pressure. The pressure of the enclosed environment will not be less than 5.0 psi (258 mm Hg) nor more than 10.10 psi (522 mm Hg). The optimum value is 5.0 psi unless contraindicated by engineering requirements.

b. Oxygen Partial Pressure. The partial pressure of oxygen will not be less than 150 mm Hg nor more than 300 mm Hg.

c. Carbon Dioxide Partial Pressure. The partial pressure of carbon dioxide will not exceed 8 mm Hg at any time. Any value less than this is optimal.

d. Water Partial Pressure. Partial pressure of water vapor may vary between 5 mm Hg and 10 mm Hg. 10 mm Hg is optimal.

e. Biologically Inert Gas Partial Pressure. The inert gas found in the enclosed environment may be either nitrogen or helium. Partial pressure of the gas used will not be more than approximately 190 mm Hg. The optimal value is 10 mm Hg.

f. Other Gases. Other gases present such as hydrogen sulfide, indoles, skatoles, etc. will not exceed 3 mm Hg.

g. Toxins. Endogenously produced toxins (other than biological) such as battery gas, lithium hydroxide dust, etc. will be excluded or filtered from the system. Other toxins which may be produced by exogenous phenomena in orbit, e.g., ozone, need not be controlled.

h. Temperature. The air temperature of the enclosed environment will be maintained between 55° and 85° F. The optimum temperature is 70° F. Temperature peaks during re-entry will not exceed 120° F for 5 minutes nor 100° F for 30 minutes. Wall temperatures of the bio-pack may rise to values higher than this for correspondingly briefer periods of time, but should be maintained at levels unlikely to produce tissue damage on contact.

i. Time. The environment described above will be maintained for at least 84 hours for Missions A B, C, and D and at least 132 hours for Mission E.

j. Acceleration. All accelerative forces imposed on the animals will lie under a curve described by the following time-dwell versus 'g' coordinates: 70 g's for .1 sec; 35 g's for 1 sec; 18 g's for 10 sec; 9.5 g's for 100 sec; 5 g's for 1000 sec.

2.5.11.1.6 Ground Support Equipment. Ground support equipment shall be designed for the preparation, checkout, and installation of the recovery capsule system.

2.5.11.1.7 Data Reduction. Machine analysis of telemetered data will be performed.

2.5.11.1.8 Test Plan. A test plan outlining the acceleration, vibration, noise, environmental simulation, and drop recovery tests to be performed on components, subassemblies, and full assemblies, will be submitted to the Government for approval. The test plan will also indicate the use of animals and Contractor available test facilities, and the desired use of the Government test facilities needed to implement the test program.

2.5.11.1.9 Prior Approval. Rough drawings, "first approximation" data, specifications, plans, informal presentations, etc. will be submitted to the Government for approval prior to purchase, fabrication, or assembly of components, subassemblies, and full assemblies.

2.5.11.2 Item II - Hardware

2.5.11.2.1 Biomedical subsystems shall be produced as further defined in this paragraph to satisfy the requirements of the program as enumerated in Section 1.0 of the Work Statement. Biomedical Recovery Capsule assemblies shall be fabricated with the necessary spare units

and test articles to support a series of five flight experimental programs indicated in the following tabulation.

SHOT	PURPOSE	ANIMAL	INFORMATION AND INSTRUMENTATION
A	Survival and Recovery	(4) Mice (4C-57)	Temperature, total pressure, oxygen bottle pressure, acceleration, noise level, humidity, viability, cosmic radiation
B	Survival and Recovery	(4) Mice (4C-57)	Same as A
C	Survival and Recovery	(1) Rhesus Monkey	Same as A plus psycho-operant task
D	Survival and Recovery	(1) Rhesus Monkey	Same as C
E	Survival and Recovery	(1) Rhesus Monkey	Same as C

2.5.11.2.2 Ground support equipment, as described in Paragraph 2.5.11.1.6 shall be produced.

2.6 COORDINATION OF SUBSYSTEM A THROUGH H WITH SUBSYSTEM I, "DATA PROCESSING" SUBSYSTEM

In order to ensure optimum design and development of the complete WS-117L system and the proper meshing of applicable portions of Subsystems A through H with Subsystem I, the Data Processing Subsystem, LMSD and the Prime Contractor SS/I will collaborate to make arrangements for a sufficiently full and timely flow of information from each project to the other and from each set of subcontractors to the other, as their work affects the interfacial areas. They will jointly arrange orderly means to bring to light any divergencies between the two parts of the total program, to effect the best possible compromises as they are needed, and to refer to the Government Contracting Officers (LMSD to BMO and Prime Contractor SS/I to RADC) for decision on any questions that cannot be

settled by agreement. They are each responsible for maintaining constant vigilance of the interfacial areas and the timely notification and referral to BMD-WS-117L Project Office of any potential or actual problem area, or area of omission by either group which would affect the overall system capability. It is the intent of the procuring agencies (BMD-RADC) to assist in the solution of interface problems before the problems require arbitrary decision.

2.7 DIVISION OF RESPONSIBILITIES BETWEEN LMSD AND CONVAIR AT VAFB

2.7.1 Mating of the WS 117L booster to the WS 117L vehicle will be a joint effort by Lockheed Missile Systems Division and Convair, accomplished at Vandenberg Air Force Base. The time and place for composite system check-out and compatibility tests will be determined by mutual agreement at Vandenberg Air Force Base within current Flight Test Working Group Procedures. It will be accomplished by Lockheed and Convair working on their respective equipment or as mutually arranged.

2.7.2 Lockheed has over-all systems responsibility as Weapons System Contractor. Convair shall have the status of Associate Contractor within the scope of this proposed WS 117L Program.

2.7.3 Lockheed shall be responsible for the WS 117L Satellite vehicle and supporting equipment including the booster adapter.

2.7.4 Convair shall be responsible for the WS 117L booster and that portion of the ground support equipment for which it is responsible in the WS 107A-1 Program.

2.7.5 Convair shall be responsible for all modification and design changes to the WS 117L booster and ground support equipment referenced in paragraph

4 above. Modifications and/or changes to subsystem equipment furnished to the WS 107A Program by associated contractors will be the responsibility of these respective contractors. However, it will be Convair's responsibility to timely integrate all changes and MODs.

2.7.6 It will be Lockheed's responsibility to coordinate with Convair all design engineering and installation of equipment that could affect the operation of either the WS 117L booster or basic test facility at Vandenberg Air Force Base.

2.7.7 Lockheed Missile Systems Division as Weapon System Contractor will be responsible for over-all conduct of the WS 117L Project under the direction of the AFBMD-WS 117L Project Office.

2.7.8 Convair will be responsible to the AFBMD Test Controller to conduct the WS 117L booster countdown in accordance with the countdown procedures developed jointly by LMSD and Convair and approved by the VAFB Flight Test Working Group. At any time during the countdown that the Convair Test Conductor cannot meet the objectives of the test, such will be reported to the AFBMD Test Controller for resolution.

2.7.9 Lockheed will be responsible to the AFBMD Test Controller to conduct the WS 117L vehicle countdown in accordance with the countdown procedures developed jointly by LMSD and Convair and approved by the VAFB Flight Test Working Group. At any time during the countdown that the Lockheed Test Conductor cannot meet the objectives of the test, such will be reported to the AFBMD Test Controller for resolution.

2.7.10 Convair is responsible to provide the material necessary to keep the systems listed below in operable condition and accomplish any necessary

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modification to insure the technical compatibility with the WS 117L complex:

a. Power generation/distribution system, including power house.

b. Propellant loading and transfer system.

c. Air conditioning.

d. All other areas which affect the direct mission support items to include spare parts required.

Convair is also responsible for the day to day management and upkeep of the complex facilities.

2.7.11 Lockheed Missile Systems Division will be responsible for publishing the WS 117L Detailed Test Objectives, subsequent to coordination with AFBMD, and Convair on those items that concern the WS 117L booster, its support and operation.

2.7.12 Convair Astronautics shall provide Lockheed Missile Systems Division (LMSD) with QPRI on the booster portion of WS 117L. WS 117L booster QPRI shall be prepared as a supplement to the QPRI Report for WS 107A-1. This supplement shall consist of a complete manning table for the Atlas booster in the 117L environment; such information as may be necessary to enable Lockheed to prepare an integrated Maintenance-Operations Sequences Summary (Personnel Activities Sequences); and Position Definitions for all 117L booster positions whose activities differ appreciably from the corresponding WS 107A-1 positions. The Data shall be collected under AFBM Exhibit 58-7, and prepared in accordance with AFBM Exhibit 58-8.

2.7.13 Convair will be responsible for data recording and data reduction of landline instrumentation utilized at VAFB as pertains to WS 117L booster operations.

2.7.14 Convair will be responsible for the airborne telemetering and IRSS requirements of the WS 117L booster. Convair will be responsible for reduction of data obtained from telemetering carried within the WS 117L booster.

2.7.15 Lockheed will be responsible for all aspects of airborne telemetering requirements of the WS 117L vehicle.

2.7.16 Both contractors will be responsible for expeditious review and comment on any facility designs for the WS 117L launch complexes at VAFB, as well as establishing requirements for servicing, ground handling, launch phase, instrumentation, etc.

2.7.17 Convair shall be responsible for insuring aerodynamic stability, control and relative flight performance conditions, prior to satellite separation, to insure proper SM-65 booster performance for WS 117L test objectives.

2.8 DIVISION OF RESPONSIBILITIES BETWEEN LMSD AND DOUGLAS

2.8.1 Mating of the WS 117L booster to the WS 117L vehicle will be a joint effort by LMSD and Douglas and accomplished at Vandenberg AFB. The time and place for composite systems checkout and compatibility tests will be determined by mutual agreement at Vandenberg AFB within current Flight Test procedures. It will be accomplished by Lockheed and Douglas working on their respective equipment or as mutually arranged.

2.8.2 Lockheed has over-all systems responsibility as Weapons System Contractor. Douglas shall have the status of Associate Contractor within the scope of this proposed WS 117L Program.

2.8.3 Lockheed shall be responsible for the WS 117L Satellite vehicle and supporting equipment including the booster adapter.

2.8.4 Douglas shall be responsible for the WS 117L booster and that portion of the ground support equipment for which responsible in the WS 315A Program.

2.8.5 Douglas shall be responsible for all modification and design changes to the WS 117L booster and ground support equipment referenced in paragraph 4 above. Modification and/or changes to subsystem equipment furnished to the WS 315A Program by associated contractors will be the responsibility of those respective contractors. However, it will be Douglas' responsibility to timely integrate all changes and MODs.

2.8.6 It will be Lockheed's responsibility to coordinate with Douglas all design engineering and installation of equipment that could affect the operation of either the WS 117L booster or basic test facility at VAFB.

2.8.7 Lockheed, as Weapon Systems Contractor, will be responsible for over-all conduct of the WS 117L Project under the direction of the AFBMD-WS 117L Project Office.

2.8.8 Lockheed will be responsible to the AFBMD Test Controller to conduct the WS 117L vehicle countdown in accordance with the countdown procedures developed jointly by LMSD and Douglas and approved by the VAFB Flight Test Working Group. At any time during the countdown that the Lockheed Test Conductor cannot meet the objectives of the test, such will be reported to the AFBMD Test Controller for resolutions.

2.8.9 Douglas will be responsible to the AFBMD Test Controller to conduct the WS 117L booster countdown in accordance with the countdown procedures developed jointly by LMSD and Douglas and approved by the VAFB Flight Test Working Group. At any time during the countdown that the Douglas Test Conductor cannot meet the objectives of the test, such will be reported to the AFBMD Test Controller for resolution.

2.8.10 LMSD will be responsible for publishing the WS 117L Detailed Test Objectives, subsequent to coordination with AFBMD and Douglas on those items that concern the SM-75, its support and operation.

2.8.11 Douglas will be responsible for all revisions to the landline instrumentation installation at VAFB. Lockheed will coordinate the design of equipment to insure it is compatible with existing instrumentation operations.

2.8.12 Douglas will be responsible for data recording and data reduction of existing landline instrumentation utilized at VAFB.

2.8.13 Douglas will be responsible for the airborne telemetering requirements of the WS 117L booster. Douglas will be responsible for reduction of data obtained from telemetering carried within the WS 117L booster.

2.8.14 Lockheed will be responsible for all aspects of airborne telemetering requirements of the WS 117L vehicle.

2.8.15 Design and modification of the umbilical mast required to support WS 117L operations at VAFB will be accomplished by Douglas. Lockheed will supply Douglas all material required by the WS 117L vehicle.

2.8.16 Modifications required on launcher, service tower, blockhouse, landlines and related conduits and cabling presently installed at VAFB will be the responsibility of Douglas. Preliminary design of extension or modifications to such existing facility services, i.e., ground electrical power, water, telephone, etc., to be utilized by Lockheed at VAFB will be coordinated by Douglas.

2.8.17 Douglas shall be responsible for detail scheduling all WS 315A complex activities relating to the WS 117L Program that are to take place concurrently with WS 315A activities.

2.8.18 Douglas will be the launch complex manager, and in this capacity will be responsible for preparation and checkout of the launch complex during test and countdown operations.

3.0 PROGRAM SCHEDULES

Schedules for the delivery of specifications shall be in accordance with Contract Exhibits referenced in Item III of Section 1.0 of the Work Statement.

Next page is 118

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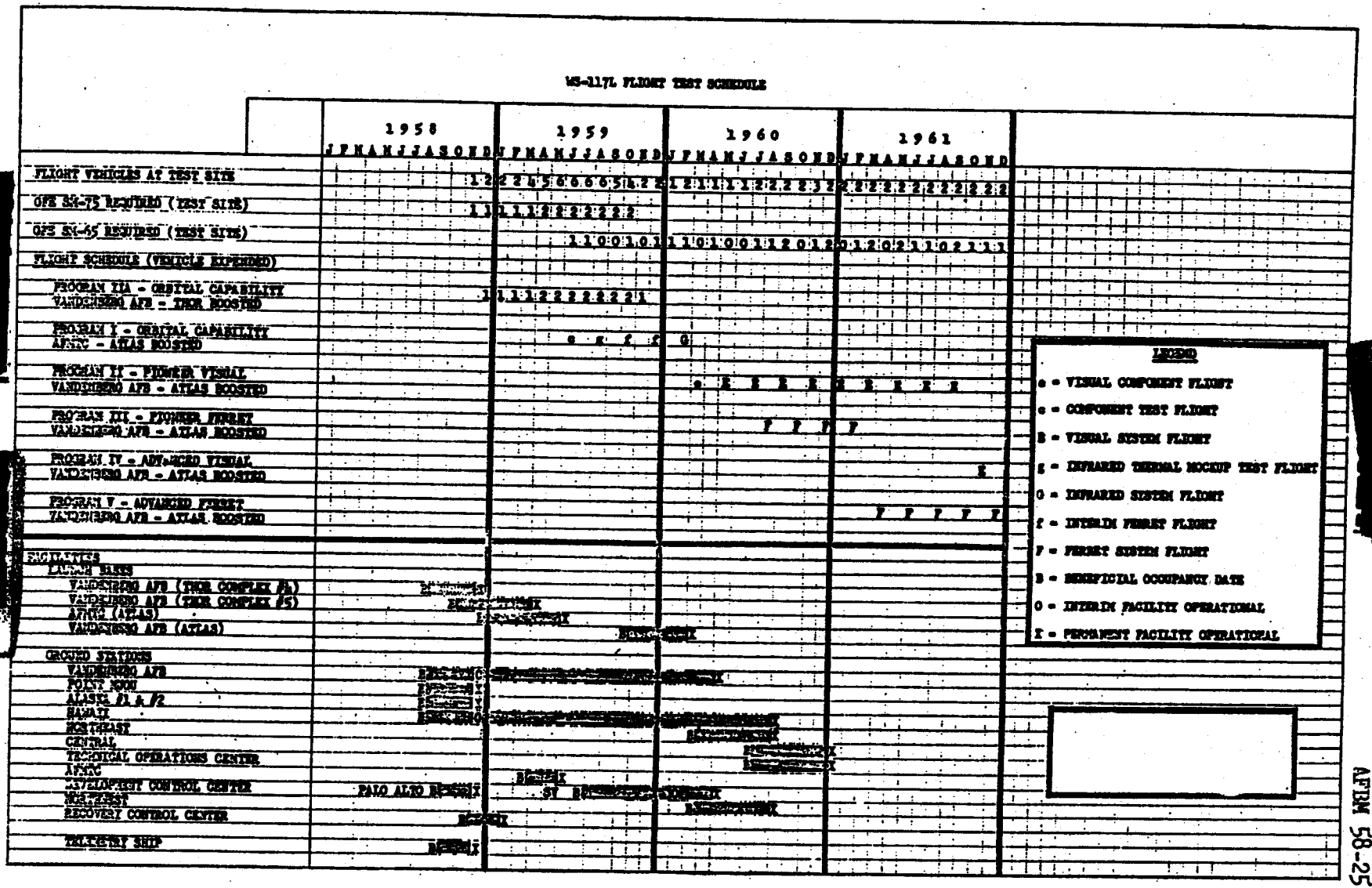
WS-117L FLIGHT TEST SCHEDULE
1958
1959
1960
1961
J F M A M J J A S O N D
FLIGHT VEHICLES AT TEST SITE
OPS SA-75 REQUIRED (TEST SITE)
OPS SA-65 REQUIRED (TEST SITE)
FLIGHT SCHEDULE (VEHICLE EXPENDED)
PROGRAM IIA - ORBITAL CAPABILITY
VANDENBERG AFB - THOR BOOSTED
PROGRAM I - ORBITAL CAPABILITY
AFMTC - ATLAS BOOSTED
PROGRAM II - PIONEER VISUAL
VANDENBERG AFB - ATLAS BOOSTED
PROGRAM III - PIONEER FIRST
VANDENBERG AFB - ATLAS BOOSTED
PROGRAM IV - ADVANCED VISUAL
VANDENBERG AFB - ATLAS BOOSTED
PROGRAM V - ADVANCED FIRST
VANDENBERG AFB - ATLAS BOOSTED
FACILITIES
LAUNCH SITES
VANDENBERG AFB (THOR COMPLEX #4)
VANDENBERG AFB (THOR COMPLEX #5)
AFMTC (ATLAS)
VANDENBERG AFB (ATLAS)
GROUND STATIONS
VANDENBERG AFB
POINT MUGU
ALASKA #1 & #2
HAWAII
NORTHEAST
CENTRAL
TECHNICAL OPERATIONS CENTER
AFMTC
DEVELOPMENT CONTROL CENTER
NORTHEAST
RECOVERY CONTROL CENTER
TELEMETRY SHIP
PALO ALTO
ST
LEGEND
e = VISUAL COMPONENT FLIGHT
c = COMPONENT TEST FLIGHT
E = VISUAL SYSTEM FLIGHT
g = INFRARED THERMAL MOCKUP TEST FLIGHT
G = INFRARED SYSTEM FLIGHT
f = INTERIM FIRST FLIGHT
F = FIRST SYSTEM FLIGHT
B = BENEFICIAL OCCUPANCY DATE
O = INTERIM FACILITY OPERATIONAL
X = PERMANENT FACILITY OPERATIONAL

3.1

WS-117L SYSTEMS DELIVERIES

	FY CY58 J	F	M	A	M	J	J	A	S	O	N	D	CY59 J	F	M	A	M	J	J	A	S	O	N	D	CY60 J	F	M	A	M	J	J	A	S	O	N	D	CY61 J	F	M	A	M	J	J	A	S	O	N	D
1 PROGRAM IIA																																																	
2 FUNCTIONAL MOCKUP																1																																		
3																																																	
4 PROPULSION TEST VEH. ASSEMBLY #1					1																																											
5																																																	
6 PROPULSION TEST VEH. ASSEMBLY #2						1																																										
7																																																	
8 PROPULSION TEST VEH. ASSEMBLY #3										1																																							
9																																																	
10 STRUCTURAL TEST VEHICLE					1																																											
11																																																	
12 FACILITY CHECKOUT VEHICLE							1																																										
13																																																	
14 FLIGHT TEST VEHICLES											1	1	1	1	2	2	2	2	2	2	2	1																												
15																																																	
16 PROGRAM I																																																	
17																																																	
18 FUNCTIONAL MOCKUP																1																																		
19																																																	
20 STRUCTURAL TEST VEHICLE														1																																			
21																																																	
22 CAPTIVE TEST VEHICLE																						1																												
23																																																	
24 FLIGHT TEST VEHICLES																	1	1	1	1	1																												
25																																																	
26 PROGRAM II																																																	
27																																																	
28 FLIGHT TEST VEHICLES													1			1	1	1	1																														
29																																																	
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31																																																	
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34																																																	
35																																																	

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DELIVERY SCHEDULE - BOOSTERS [redacted] 25

3.1

Program No.	Booster No.	Quantity	Delivery By	Delivery To	Booster Perf. Date	Booster Need Date
IIA	160	1	AF	VAFB	6/6/58	11/21/58
Thor	163	1	"	"	7/11/48	1/2/59
	170	1	"	"	8/8/58	1/30/59
	174	1	"	"	9/12/58	2/27/59
	179	1	"	"	10/10/58	3/27/59
	192	1	"	"	10/24/58	4/10/59
	200	1	"	"	11/14/58	4/24/59
	206	1	"	"	11/28/58	5/8/59
	212	1	"	"	12/12/58	5/27/59
	218	1	"	"	12/26/58	6/11/59
	Note 1	1	"	"	1/9/59	6/26/59
	"	1	"	"	1/23/59	7/10/59
	"	1	"	"	2/6/59	7/28/59
	"	1	"	"	2/20/59	8/11/59
	"	1	"	"	3/13/59	8/27/59
	"	1	"	"	3/27/59	9/11/59
	"	1	"	"	4/10/59	9/25/59
	"	1	"	"	4/24/59	10/9/59
	"	1	"	"	5/8/59	10/30/59
I	10 D	1	AF	AFMTC	12/19/58	6/2/59
Atlas	16 D	1	"	"	2/13/59	7/31/59
XSM-65D	22 D	1	"	"	4/17/59	10/1/59
	29 D	1	"	"	6/12/59	12/1/59
	33 D	1	"	"	8/14/59	1/27/60
II	38 D	1	AF	VAFB	9/18/59	3/1/60
Atlas	45 D	1	"	"	11/13/59	4/29/60
XSM-65D	50 D	1	"	"	1/15/60	7/1/60
	57 D	1	"	"	3/18/60	9/1/60
	62 D	1	"	"	5/13/60	11/1/60
	70 D	1	"	"	7/8/60	12/30/60
	76 D	1	"	"	9/16/60	3/1/61
	80 D	1	"	"	11/11/60	5/2/61
	83 D	1	"	"	1/13/61	6/30/61
	Note 2	1	"	"	3/17/61	9/1/61
III	Note 2	1	AF	VAFB	2/12/60	8/2/60
Atlas	"	1	"	"	4/8/60	9/30/60
XSM-65D	"	1	"	"	6/17/60	12/1/60
	"	1	"	"	8/19/60	2/1/61

Note 1. Serial numbers not yet assigned by Douglas Aircraft Corp.

Note 2. These Boosters changed from "E" Series to "D" Series. New serial numbers not yet assigned by Convair.

Note 3. Boosters furnished will be the serial numbers listed, or fully equivalent boosters.

Note 4. Boosters will be delivered by the Government to the launch sites for the WS-117L missions. Accountability for the boosters will not be assumed by Lockheed.

3.2 PLACE AND MANNER OF DELIVERY

3.2.1 All deliveries under this contract shall be constructive only. Satellite Vehicles, Mockups, PTVA's and Captive and Flight Test Vehicles shall be returned to the Contractor as government furnished equipment, for further testing, immediately after acceptance.

3.2.2

4.0 GOVERNMENT-FURNISHED EQUIPMENT, FACILITIES, AND SERVICES

The Government shall furnish equipment, facilities, and services in accordance with Exhibit 57-21A:

4.1 SYSTEM SUPPORT

4.1.1

4.1.2 At AFMTC

a. Engineering and office space plus necessary office furnishings and equipment.
b. Blockhouse space for checkout and firing consoles, and special instrumentation.
c. Launch pad occupancy
d. Shop and laboratory space plus necessary tools and equipment
e. Assembly area
f. Stockroom and tool crib
g. Outdoor storage area
h. Hazard storage area
i. Tracking and telemetry services.

j. Service tower modifications to accommodate WS-117L vehicle

k. Services to receive, check out, erect, and fire SM-65 boosters. (The Contractor will be responsible for servicing the orbital vehicles.)

l. SM-65 boosters as required, modified to WS-117L configuration

m. Hardstand and laboratory facilities at Antigua and, if required, at Ascension Island.

4.1.3 At Vandenberg AFB, Point Mugu, and Downrange Telemetry

a. Engineering and office space plus necessary office furnishings and equipment

b. Blockhouse space for checkout and firing consoles, and special instrumentation

c. Launch pad occupancy

d. Shop and laboratory space plus necessary tools and equipment

e. Assembly area

f. Stockroom and tool crib

g. Outdoor storage area

h. Hazard storage area

i. Tracking and telemetry services as available

j. Services to receive, check out, erect and fire SM-65 boosters. (The Contractor will be responsible for servicing the orbital vehicles.)

k. SM-65 boosters as required, modified to WS-117L configuration

l. Services to receive, check out, erect, track and fire SM-75 boosters. (The Contractor will be responsible for servicing the orbital vehicles.)

m. SM-75 boosters as required, modified to WS-117L configuration.

n. Ships, modified for use of WS-117L telemetry and crews for downrange instrumentation.

o. Housekeeping type services such as guard service, utilities, transportation.

[redacted] [redacted]

p. Use of base fire fighting equipment

q. First aid service

r. Use of recreational facilities

s. Maintenance services such as building, ground and utility.

4.1.4 At Jointly Selected Sites - Hawaii, Annette, and Kodiak Islands, NE, NW and Central States.

a. Engineering and office space plus necessary office furnishings and equipment

b. Shop and laboratory space and special tools and equipment as required

c. Required tracking and telemetry services as available

d. Interstation communications - For early flights this will include AF-leased TWX equipments and lines plus AF-leased phone lines to Palo Alto for use on a no-cost basis by LMSD for WS-117L purposes only.

e. Equipment transportation to sites.

f. Use of military base services, when available, such as mess, recreation, utilities and utility maintenance, fire protection and first aid.

g. Ships, boats, aircraft and related equipments required in support of recovery operations on biomedical capsules.

4.2 SUBSYSTEM SUPPORT

4.2.1 Vehicle

a. Atlas nose section and drill jig.

4.2.2 Propulsion

a. Equipment and material, including work-in-process, excess to Convair for Bell Rocket Engine.

b. Tooling excess to Convair for Bell Rocket Engine.

c. Rocket Engine Mockup (Hustler excess).

4.2.3 Auxiliary Power

4.2.4 Guidance and Control

a. MIT interim attitude damping system-engineering model including specs and drawings (2 sets)

b. MIT advanced attitude damping system - engineering model including specs and drawings

c. Ground checkout equipment set for MIT advanced attitude damping system

d. Specs and drawing sets for MIT gimbaled platform for All-inertial Guidance (2 sets)

e. Specs and drawing sets for MIT 2 FGB gyros and for PIG accelerometers (2 sets)

f. Development of guidance equations for Atlas flights (Ramo-Wooldridge)

g. Optimization of AC Spark Plug guidance for Thor flights (AC Spark Plug Division of GM)

h. Modification of Burroughs trays for WS-117L use.

4.2.5 Visual

4.2.6 Ferret

a. Semi-Trailer vans

b. APR-9 Radar Sets (5).

4.2.7 Infrared

a. One test aircraft

b. Maintenance for this aircraft

c. Minor shop facilities for installation of test equipment

d. Airplane crew services for flight test

e. Target aircraft flights for infrared measurements

f. Helium

g. Radar Set AN/MPS-19.

4.2.8 [redacted] [redacted]

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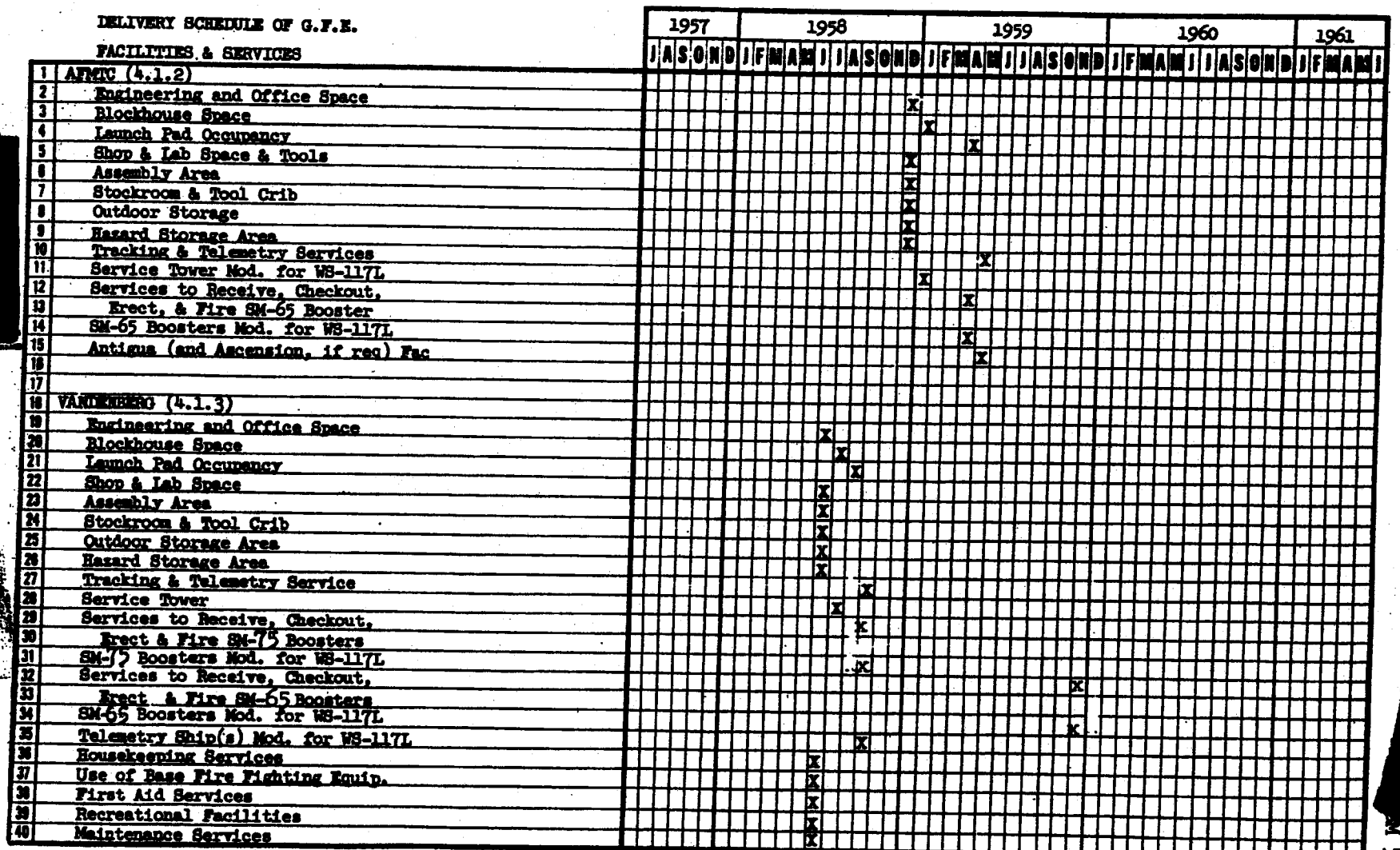
4.4

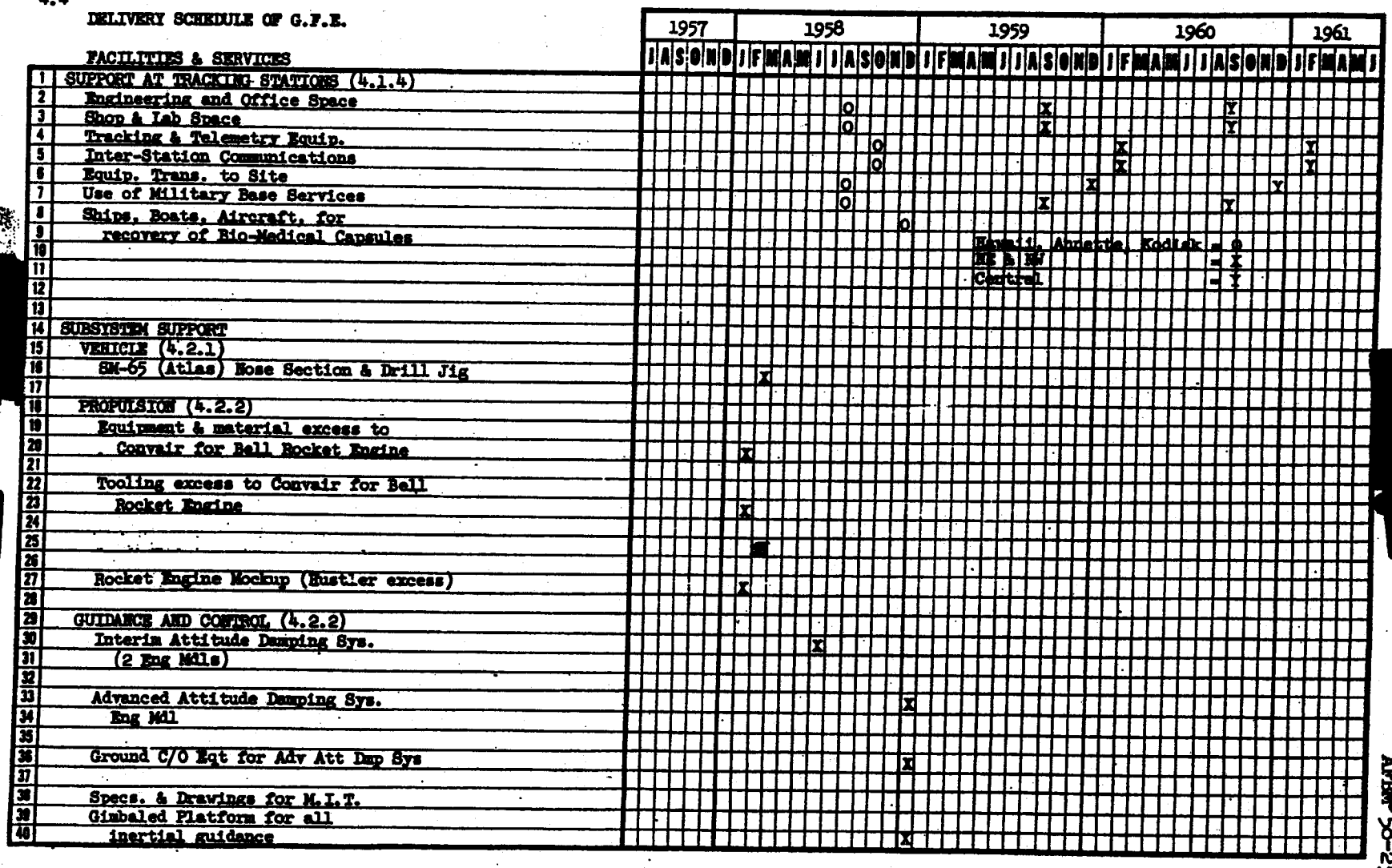
DELIVERY SCHEDULE OF G.F.E.

FACILITIES & SERVICES



4.4

DELIVERY SCHEDULE OF G.F.E.



4.4

DELIVERY SCHEDULE OF G.F.E.

FACILITIES & SERVICES

		1957						1958												1959												1960												1961				
		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	J	F	M	A	M	J
1	Specs & Drawings for MIT FGB gyros												X																																			
2																																																
3	Specs & Drawings for MIT PIG accel.																X																															
4																																																
5	Dvt of Guid Equations for Atlas Flts																	X																														
6																																																
7	Optimization of AC Spark Plug Guid.																																																
8	for Thor Flts.																X																														
9																																																
10	Mod. of Burroughs trays for WS-117L																				X																											
11																																																
12																																																
13	SUBSYSTEM SUPPORT																																																
14	FERRET (4.2.6)																																																
15	Semi-Trailers																X																															
16																																																
17	APR-9 Radar Sets									X																																						
18																																																
19	INFRARED (4.2.7)																																																
20	One Test Aircraft								X																																							
21																																																
22	Maintenance for this Aircraft								X																																							
23																																																
24	Shop Facilities for Instal. of Test Equip.								X																																							
25																																																
26	Airplane crew services for flt test								X																																							
27																																																
28	Target Aircraft Flights for Infrared Measurements								X																																							
29																																																
30	Helium									(First requirement prior to Jan. 1958)																																									
31																																																
32	Radar Set AN/mps-19									X																																						
33																																																
34																																																
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37																																																
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39																																																

5.0 PERFORMANCE OF BOOSTERS

5.1 PERFORMANCE OF THE SM-65 BOOSTER

The SM-65 booster furnished by the government when carrying a satellite vehicle of 9300 pound gross weight, shall have the minimum performance indicated below, within the tolerances indicated. Attainment of stated velocities and altitudes are contingent upon receipt of proper signals from the guidance equipment. The tolerances on sustainer and vernier shut-off times and residual pitch, yaw and roll rates include only the uncertainty introduced by the government furnished booster equipment and not those due to guidance. Since the Contractor exercises technical direction over the development of the guidance equipment, these errors are not included in the below-guaranteed performance.

REFERENCE TRAJECTORY:

Parameter	Time from Launch	Velocity Magnitude (Nonrotating) Earth	Velocity Direction from Local Vertical	Altitude	Range from Launch Point	Weight	Thrust
Units	Sec.	Ft/Sec	Degrees	N. Miles	N. Miles	Lbs	Lbs
Launch	0	0	0	0	0	271,085	362,000
Staging	143	9,680	65.2	35.6	50	58,242	428,416
Sustainer Burnout	267	18,300	71.8	124	300	18,179	79,608
Vernier Burnout	292	18,168	72.9	147	365	17,950	2,169
Apogee*	637	16,653	89.9	300	1,260	17,950	0

Earth's Radius = 2.09029×10^{7} Ft.
* Apogee of SM-65 Powered Trajectory Coasting Ellipse

Data from R-W Computer Analysis
1 April 1957 - WDTR 56-75

Residual Angular Velocities and Accelerations

	Angular Rate	Angular Acceleration
Pitch	2°/Sec	$3 \times 10^{-3}\ ^{\circ}/\text{Sec}^2$
Yaw	1°/Sec	$3 \times 10^{-3}\ ^{\circ}/\text{Sec}^2$
Roll	2°/Sec	$3 \times 10^{-3}\ ^{\circ}/\text{Sec}^2$
Vector Sum	3°/Sec	$5.2 \times 10^{-3}\ ^{\circ}/\text{Sec}^2$

5.2 SM-75 BOOSTER

The SM-75 furnished by the government when carrying a satellite vehicle of 7500 pounds gross weight, shall have the minimum performance indicated below. This minimum configuration is based on post-serial 138 missiles. A propellant utilization penalty of 1 percent is assumed. An additional allowance for 132 pounds of booster instrumentation is included:

Parameter	Time from Launch	Velocity Magnitude (Nonrotating) Earth	Velocity Direction from Local Vertical	Altitude	Range from Launch Point	Weight	Thrust
Units	Sec	Ft/Sec	Degrees	N. Miles	N.Miles	Lbs	Lbs
Launch	0	0	0	0	0	#114,000	152,000
Mainstage Burnout	157	12,550	65.5	45.5	--	17,350	177,000
Apogee*	369	11,125	0	135	447	17,300	--

Earth Radius = 2.09029×10^7 Ft.

*Apogee of SM-75 Power Trajectory Coasting Ellipse

Post Serial 138 missiles containing 50# range safety equipment and 132# booster instrumentation

Based on WS-315A Series IV Weight Information as of November 1957

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