AF-WP-L-29 MAY 53 SM

~~CONFIDENTIAL~~ [redacted]
SECURITY CLASSIFICATION

Part of Weapons System Midas G

RDB PROJECT CARD	TYPE OF REPORT: New Project		REPORTS CONTROL SYMBOL DD-RDB(A)82
1. PROJECT TITLE: (SECRET TITLE) INFRARED RECONNAISSANCE SUB-SYSTEM FOR ARS, WS-117L (UNCLASSIFIED TITLE) SUBSYSTEM G, WS-117L	2. SECURITY: ~~SECRET~~	3. PROJECT NUMBER: 1761	
	4. INDEX NUMBER: 2-117L	5. REPORT DATE: 2 April 1957	
6. BASIC FIELD OR SUBJECT: Strategic Air Warfare System 117L	7. SUBFIELD OR SUBJECT SUBGROUP: 37-Recon-Electronic Equipment	7A. TECH. OBJ.: SA-9A,9B 10,10-9	
8. COGNIZANT AGENCY: ARDC	12. CONTRACTOR AND/OR LABORATORY: Lockheed Aircraft Corp.	CONTRACT/W.O. NO.: AF 04(647)-97	
9. DIRECTING AGENCY: HQ ARDC, WDD	Sec 21 C		
OFFICE SYMBOL: WDTR	TELEPHONE NO.: Ext. 1343		
10. REQUESTING AGENCY: HQ USAF	13. RELATED PROJECTS: WS-117L	17. EST. COMPL. DATES: RES. 1959; DEV. 1961; INST. 1965; OP. EVAL.	
11. PARTICIPATION, COORDINATION, INTEREST: USAF/AMC-P, SAC-I, APGC-I, ATIC-I, ADC-I, ATC-I, USN/CNO-I, USA/C/S-I, OTHER/CIA-I	14. DATE APPROVED	18. FY / FISCAL ESTS. (M $): Prev. OM; 57 191M; 58 1000M; 59 3000M; 60 3000M; 61-65 10000M; TOTAL 17191M	
	15. PRIORITY: 1A; 16. A (Missiles)		

INFORMATION COPY

19.

This is the initial report on this project.

20. REQUIREMENT AND/OR JUSTIFICATION

The Infrared Reconnaissance Subsystem is designed to fulfill, in part, the intelligence objectives outlined in System Requirement No. 5, dated 17 October 1955. Development of an infrared sensing capability provides unique intelligence data for strategic warning purposes. Ultimately, with a system of satellites simultaneously on orbit, unfriendly territory will be placed under continuous and complete surveillance. The subsystem will automatically screen out unintelligible signals and respond only to highly emitting targets which rise out of the lower atmosphere. This fixes its response to large jet or rocket types of airborne vehicles and permits rapid interpretation of signals received.

22. RDB	SN	CN	IC & P	X.	I.	C.

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DOWNGRADED AT 12 YEAR INTERVALS; NOT AUTOMATICALLY DECLASSIFIED. DOD DIR 5200.10

[redacted]
SECURITY CLASSIFICATION

WD-57-01332

INFRARED RECONNAISSANCE SUBSYSTEM FOR ARS, WS-117L Project: # 1761 2 April 1957

21 a. Brief and Military Characteristics: As visualized, the Infrared Subsystem in a satellite vehicle at 1000 miles altitude will detect and locate ICBM launchings to a range of approximately 2600 miles. The information is relayed directly to a ground receiving station within 2400 miles range. With one such station located at high latitude, and fifteen satellites in operation simultaneously, the entire region above latitude 55° North can be kept under continuous surveillance. When a data link is developed which will permit information to be relayed between satellites for transmission to the ground, greater coverage with half as many vehicles can be achieved. From a 300 mile orbit, the Infrared Subsystem will locate large jet aircraft and missiles to slant ranges of approximately 420 miles. Since immediate transmission is not essential when air breathing vehicles are detected, the data may be stored and read out later during the 90 minute orbital cycle.

21 b. Approach:

Target detection ranges and background effects will be studied to establish the performance to be expected of an infrared system. An optimized subsystem will be evolved, progressing from component and system breadboard studies to experimental and prototype models, with orbital flight tests of the prototype system. Suitable detector elements and scanning and cooling methods are critical features of the design. When the utility of infrared reconnaissance by a single satellite has been successfully demonstrated, multiple satellites and higher orbital altitudes will be attempted. Concurrently, development of an intersatellite data link and accurate tracking angle reference systems will be pursued at an appropriate pace.

21 c. Subsystem Tasks

(1) Task 39832: Background Effects

(a) Contractors:

Prime Contractor: Lockheed Aircraft Corporation, AF 04(647)-97

Subcontractors: Baird Associates
General Mills, Inc.

Technical Advisor: Mr. L. H. Meuser
WCLR, WADC

(b) Objective: Determine the extent to which background radiation imposes limitations on the infrared detection system and determine the choice of system parameters which will minimize it. This will contribute to early evaluation of the target detection capabilities of a satellite-borne infrared-sensing system.

(c) Approach: Balloon flight tests will be conducted using elements of the system as initially conceived, with suitable spectral sensitivity, filtering, field of view, scan speed, chopping rate, etc., and provisions for variations thereto. A limited number of day and night balloon flights will be conducted at maximum attainable altitude, in the vicinity of 100,000 feet, under representative and extreme terrain and cloud conditions. Measurements of background radiation will be correlated with significant features of observed areas.

(2) Task 39833: Target Characteristics Viewed from High Altitude

(a) Contractors:

Prime Contractor: Lockheed Aircraft Corporation, AF 04(647)-97

Subcontractors: Eastman Kodak Company (Proposed)

Technical Advisor: Mr. L. H. Meuser
WCLR, WADC

(b) Objective: Measure infrared radiation intensity emanating from appropriate types of missiles and aircraft as a function of their altitude. Make these measurements from as high an altitude as possible to minimize the very great effect of the lower atmosphere. Together with background effects investigated under Task 39832, these measurements are essential to evaluating operational performance expectations.

(c) Approach: An instrumented aircraft will be flown at 45,000 feet or higher. Equipment will have in-flight calibration features to measure intensity in important spectral regions, placing particular emphasis on the 2-3 and 4-5 micron regions. Measurements will be performed on two-target types as follows:

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

2. Burning rocket engines of the ICBM type. Radiation intensity will be measured during ascent from sea level to burnout, and beyond if possible.

Pursuit of this task is contingent upon obtaining a suitable USAF aircraft with crew and such operational support as is necessary. A request for test aircraft and support from AFFTC, Edwards Air Force Base, has been initiated and resources annexes are in preparation.

(3) Task 39834: Prototype Infrared Subsystem

(a) Contractors:

Prime Contractor: Lockheed Aircraft Corporation AF 04(647)-97

Subcontractors: Aerojet-General Corporation
Eastman Kodak Company

Technical Advisor: Mr. L. H. Meuser
WCLR, WADC

(b) Objective: Develop a prototype Infrared Subsystem with detection capabilities as outlined in the General Design Specification.

The prototype will have no tracking capability nor will it be equipped for intersatellite communication.

(c) Approach: The feasibility of various technical approaches will be studied. Scanning methods for locating small targets in a large field of view will be investigated. These include techniques such as rotating a fan of pencil beams in conjunction with an electronically scanned linear array of detecting elements, utilizing a solid angle of pencil beams emanating from an electronically scanned stationary mosaic of detectors, or utilizing a single element with an optical scanning device. Promising detector elements such as lead sulphide, lead telluride, lead sellenide, indium antimonide, gold doped germanium, etc. will be evaluated. Relative suitability of such detectors will be determined in terms of spectral response, sensitivity, time constant, cooling requirements, physical properties, nuclear radiation damage, and environmental compatibility. Airborne data processing equipment similar to that under development for the Electronic Reconnaissance Subsystem will be utilized, with and without, data storage features.

Breadboard component studies will be conducted and an experimental model built. The experimental model will be tested exhaustively on the ground and in aircraft. Test results will lead to prototype design specifications. Power requirements, heat generation, weight, and size of the prototype will be reduced to an absolute minimum by miniaturization and transisturization wherever possible. A very substantial effort will be exerted to achieve an extreme degree of reliability for the entire system. Redundant as well as improved components will be considered. After extensive ground and aircraft tests, the prototype will be given orbital flight tests.

(4) Task 39835: Feasibility of Advanced Applications

(a) Contractors:

Prime Contractor: Lockheed Aircraft Corporation, AF 04(647)-97

Subcontractor: Undetermined

(b) Objective: Study the feasibility of more difficult and advanced applications of satellite-borne infrared-sensing equipment.

(c) Approach: Practicable operational concepts and equipments will be studied to extend the performance of the Infrared Subsystem beyond that of the prototype system. Coverage of enemy territory as a function of orbital plane, orbital altitude, number of vehicles on orbit, and data transmission methods will be investigated. The operational utility of a satellite system in an AICBM role will be considered, including the feasibility of tracking the ICBM over its burning path for trajectory prediction. Characteristics and requirements of a reliable intersatellite communication link to enlarge the area under prompt surveillance will be established. Methods for obtaining an accurate angle reference system will be studied, including line-of-sight between satellites and celestial references.

21 d. Other Information:

The satellite platform furnishes a unique vantage point for viewing infrared targets in that it provides a very large horizon distance and minimum intervening atmosphere. Technical problems involved in the subsystem development are also unique, considering the environment and the long duration of unattended operation. Duplication of other efforts is therefore not believed to exist. Equipment and techniques are under development which have similar operational applications, but which have more limited coverage. In particular, development work undertaken by AFOIN-4 is closely related to this effort and coordination between the two programs will be effected.

21 e. Background History

During early design study of the WS-117L, the Missile Systems Division, Lockheed Aircraft Corporation, recognized the possibility of accomplishing useful reconnaissance with satellite-borne infrared-sensing equipment. A proposal to this effect was included in MSD-1726, 30 June 1956, "Pied Piper First Annual Report" on Contract AF 33(616)-3105. Feasibility was further pursued by Lockheed, results being given in periodic reports and being summarized in MSD 1929, 6 September 1956, "Preliminary Study of WS-117L Warning System Against ICBM Attack." Lockheed was also engaged in a separate AICBM study on Contract AF 33(616)-3284, reporting potential AICBM applications of a satellite infrared system in MSD 1844, 31 August 1956, "Third Quarterly Report - AICBM Study Program." A related program initiated by AFOIN-4 contributed to the feasibility and desirability of this approach.

21 f. Future Plans:

During the next reporting period feasibility studies will be extended. Measurements of background effects on an elementary system and of target characteristics as viewed from high altitude will establish range and performance capabilities. Preliminary design of the subsystem will be conducted leading to specifications for an experimental model.

21 g. References

(1) General Operational Requirements (80) SA-2C, 11 March 1955

(2) System Requirement 5, 17 October 1955

(3) MSD 1726, 30 June 1956, "Pied Piper First Annual Report"

(4) MSD 1844, 31 August 1956, "Third Quarterly Report-AICBM Study Program"

(5) MSD 1929, 6 September 1956, "Preliminary Study of WS-117L Warning System Against ICBM Attack"

(6) Contract AF 33(616)-3105

(7) Contract AF 33(616)-3284

INFRARED RECONNAISSANCE SUBSYSTEM FOR ARS, WS-117L Project: # 1761 2 April 1957

(8) Contract AF 04(647)-97

21 h. Coordination and Signature Block

George E. Austin

GEORGE E. AUSTIN
Major, USAF
Project Engineer

FREDERIC C. E. ODER
Colonel, USAF
Assistant for WS-117L

GENERAL DESIGN SPECIFICATION

I. General

a. Statement of the Problem: The Infrared Subsystem will partially fulfill the objectives outlined in System Requirement No. 5, 17 October 1955, by providing the following capabilities for the WS 117L:

(1) Detection of ICBM launchings whenever and wherever they occur, giving immediate and unambiguous warning of ICBM attack.

(2) Detection of large jet aircraft and missiles for early warning of attack by such vehicles, and for surveillance of air traffic patterns as an indicator of the imminence of hostilities.

(3) Tracking of ballistic missiles during their burning stages with sufficient accuracy for trajectory and impact prediction in AICBM applications. This represents a very advanced capability.

b. Approach: The Infrared Subsystem will passively receive infrared signals in selected portions of the 1-12 micron region, process these signals, and feed them to the Ground Space Communication Subsystem for transmission to the ground in suitable form for immediately locating the emitting sources. Hopefully, these sources will be limited to large rocket or jet engines at altitude, with ground targets blanked out by the lower atmosphere.

Since warning of ICBM attack requires instantaneous reporting of targets detected by the Infrared Subsystem, data storage and subsequent readout during passage over a ground receiving station cannot be considered for this capability. Using multiple satellites simultaneously on orbit, but with no intersatellite data link, direct transmission from each satellite to ground must be utilized. The geographical area under surveillance at any time is then limited by the readout range as well as by the detection range. Each of these ranges is expected to be approximately 2500 miles for an orbital altitude of 1000 miles.

Preliminary analysis indicates that with one high latitude ground receiving station and fifteen satellites equally spaced on an 83 degree, 1000 mile orbit, all launching sites within the USSR for missiles with a 5500 nautical mile range can be kept under constant surveillance. The coverage of total Soviet territory will be no less than 50% at any time and will average approximately 80%. With intersatellite communication, greater coverage can be obtained with half as many satellites.

For operation against manned aircraft and other airbreathing vehicles, storage and later transmission of detection data is feasible. Whereas, the ICBM detection range is line-of-sight limited and can be increased by increasing orbital altitude, the less intense emissions from airbreathing targets are not likely to be detected from a 1000 mile orbit. A 300 mile orbital altitude must therefore be utilized for this application. A single satellite will provide useful surveillance of USSR aircraft patterns and activity. Cutting approximately a 600 mile swath with each passage, the

the satellite brings a very large percentage of Soviet territory under observation at some time during each day. The type of intelligence data so obtained is an activity indicator, providing an alert whenever significant deviations from normal patterns occur.

c. Solution:

The infrared Subsystem must detect and locate emitters of minute size in a large field of view. A conceptual but non-optimized design to accomplish this employs a line array of approximately 150 cooled lead telluride detecting elements. These are placed in the focal plane of a 56 inch diameter corrected reflector system, creating a fan-shaped field of view comprised of 150 digitalized, 0.25 degree pencil beams. As the fan beam is rotated around a vertical axis, 150 concentric annular rings are swept out. Simultaneously with the mechanical rotation, each of the detecting elements in the line array is scanned electronically. Target location is determined from the azimuthal orientation of the optical system together with the identity of the detecting element in the line array.

Target radiation falling upon a detecting element changes its conductivity and produces a voltage signal which is amplified by an individual pre-amplifier mounted on the rotating scanner. A commutator system receives the signal from the preamplifier and passes it to another amplifier. An azimuthal potentiometer produces a voltage indicative of the scanner's position. The electronic scanning voltage, which is used to scan the elements, is fed to an electronic scan coder circuit which associates and correlates all target signals out of the target amplifier with the appropriate scan voltage. These target position data, together with a timing code signal are passed through a data processing circuit to put the signals into appropriate form to be relayed to ground by the satellite-to-ground transmitter.

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1.

R & D SCHEDULE

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

3. DATE 2 April 1957

4. TITLE
(SECRET TITLE) INFRA-RED RECONNAISSANCE SUBSYSTEM FOR ARS, WS 117L
(UNCLASSIFIED TITLE) SUBSYSTEM G, WS 117L

5. INITIAL ☒ CHANGE

6. NUMBER 1761

SCHEDULE

CALENDAR YEARS

TITLE	PROJECT OR TASK NR	1957 J A S O N D	1958 J F M A M J J A S O N D	1959 J F M A M J J A S O N D	1960 1 2 3 4	1961 1 2 3 4	1962 1 2 3 4	TO COMPL 1 2 3 4
Subsystem G	1761							63 [illegible]465
Background Effects	39832		R	B	C D	P		E J K
Target Characteristics	39833		R					
IR Equipment Components	39834			B	C D	P		E J K
Feasibility of Adv. App.	39835		R					

Key - A - Contract Awarded (October 1956)
B - Fabrication of Development Model Started (Prototype Flight Article)
C - Development Model Fabrication Completed (Prototype Flight Article)
D - End of Contactor Compliance Testing of Development Model (Acceptance Test)
E - Completion of Functional Testing of Development Model to Demonstrate Capability
J - Preparation of Procurement Data (End)
K - Production - Engineering (End)
Q - Ground Test Starts
P - Integration with First Flight (Completion of Ground Test)
R - Completion of Study

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1.

R & D TEST ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE OF PAGES

3. DATE: 2 April 1957

4. TITLE: (SECRET TITLE) INFRA-RED RECONNAISSANCE SUBSYSTEM FOR ARS, WS 117L
(UNCLASSIFIED TITLE) SUBSYSTEM G, WS 117L

5. INITIAL ☒ CHANGE

6. NUMBER: 1761

7. RESP CENTER	8. PROJECT OFFICER	9. SUPPORTS (Sys or Proj)	10. CONTRACTOR	11. CONTR NR	12. PRIORITY AND PREC	13. SECURITY
WDD (WDTR)	Major G. E. Austin	WS 117L	Lockheed Acft.Corp	AF 04 (647)-97	1A, 1-6	SECRET

14. ITEM NUMBER	15. TEST ITEM	16. TEST DESCRIPTION	17. TEST AGENCY AND SITE	18. TEST ITEM AVAILABLE	19. RQD TEST COMPL DATE
1.	Infrared radiation characteristics from appropriate targets as seen from high altitude.	One A/C with IR sensing equipment will measure the radiation intensity in selected spectral regions from burning ICBM rockets and jet aircraft with high horsepower engines. High altitude capability in excess of 40,000 feet is necessary for the instrumented A/C in order to subordinate effects of the lower atmosphere. Variations in target radiation with altitude and aspect will be determined. Data obtained will be used to evaluate performance of an IR detection system mounted on a very high altitude platform.	(1) Agency to be determined. AFFTC or AFAC under consideration. (2) Site - Some flights necessary in vicinity of Patrick AFB. Site of other flights optional.	(1) IR instrumentation avail 30 Aug 57 (2) A/C to be instrumented desired 30 Aug 57 (3) ICBM targets available as scheduled in WS 107A and WS 315A test Programs. (4) A/C targets for fly-by to be arranged.	31 Mar 58

TEST CENTER APPROVAL

20. NAME	ORGANIZATION	DATE
21. NAME	ORGANIZATION	DATE

RESPONSIBLE CENTER APPROVAL

22. NAME	ORGANIZATION	DATE

ARDC FORM 1 JUL 55 105 PREVIOUS EDITIONS OF THIS FORM ARE OBS[illegible]

CONFIDENTIAL [redacted]

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1.

R & D TEST AND TEST SUPPORT AIRCRAFT ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE OF PAGES

3. DATE: 2 April 1957

4. TITLE: (SECRET TITLE) INFRARED RECONNAISSANCE SUBSYSTEM FOR ARS, WS 117L
(UNCLASSIFIED TITLE) SUBSYSTEM G. WS 117L

5. INITIAL ☒ CHANGE ☐

6. NUMBER: 1761

7. ITEM NUMBER	8. AIRCRAFT REQUIRED QTY	TYPE, MODEL AND SERIES	SERIAL NUMBER	9. ASG CODE	10. MODE CODE	11. DATE REQD AND LOCATION	12. ESTIMATED RELEASE DATE	13. RECOMMENDED DISPOSITION	14. HRS EST	15. EST COST
1.	1	B-47 (or equivalent)			L	30 Aug 57	31 Mar 58		**	**
2.	1	B-47 (or equivalent)			A	*	*		110	110M
3.	1	F-100 (or equivalent)			A	*	*		12	12M
4.	1	C-130 (or equivalent)			A	*	*		4	3M
5.	1	B-52 (or equivalent)			A	*	*		15	12M
								TOTAL	12	24M
										161M

* Location and Dates to be determined by Center. Center is expected to be either AFAC or AFFTC. 60 flight hours involving Item 1 must be conducted within 200 miles of Patrick AFB at times determined by Missile Launchings. The additional 50 hours and all hours indicated for Items 2 through 5 are to be flown at times and places of convenience during the period 30 Aug 57 to 31 March 58. Estimated hours are considered minimal.

** Hours and costs are totalled for period 30 Aug 57 through 31 Mar 58.

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WD-57-01352

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1.

R & D MANPOWER ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE OF PAGES

3. DATE: 2 April 1957

4. UNCLASSIFIED TITLE: Subsystem G, WS-117L

5. INITIAL ☒ CHANGE ☐

6. NUMBER: 1761

7. ORG COMP CODE	8. ORGANIZATION TITLE	9. TYPE ORG	10. ACTUAL MAN-QTRS LAST QTR	11. PROJECTED DIRECT MAN-YEARS						
				FY 19 57		FY 19 58		FY 19 59	FY 19 60	TO COMPL
				AVAL	RQRD	AVAL	RQRD	RQRD	RQRD	RQRD
..JTR	WS-117L Project Office, WDD	R	1.0	0.5	1.0	0.5	1.0	2.0	2.0	*
WCLR	Aerial Reconnaissance Lab., WADC	R	0.5	0.5	0.5	0.5	0.5	0.5	0.5	*
	TOTALS:		1.5	1.0	1.5	1.0	1.5	2.5	2.5	*
	TOTAL MANPOWER DOLLARS:		2,730	7,280	10,920	7,280	10,920	18,200	18,200	91,000

* Continuing Requirements

ARDC FORM 1 JUL 56 109 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

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1.

R & D CONTRACT FUNDS ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE OF PAGES

3. DATE 2 April 1957

4. TITLE
(SECRET TITLE) INFRARED RECONNAISSANCE FOR ARS, WS-117L
(UNCLASSIFIED TITLE) SUBSYSTEM G, WS-117L

5. INITIAL ☒ CHANGE ☐

6. NUMBER 1761

7. ITEM	8. PROJ OR TASK NR	9. END ITEM CAT	10. CONTRACT NUMBER	11. BPSN	12. PREV YRS 000	12. PREV YRS OTHER	13. FY 57 000	13. FY 57 OTHER	14. FY 58 000	14. FY 58 OTHER	15. FY 59 000	15. FY 59 OTHER	16. FY 60 000	16. FY 60 OTHER	17. TO COMP 65 000	17. TO COMP 65 OTHER
SUBSYSTEM G, WS-117L	1761	E	04(647)-97	2-117			191M		1000M		3000M		3000M		10000M	
			P-100 Funds:													
			P-200 Funds:					150M		500M		550M		500M		2000M 2000M
		Sub Totals:														
			P-600				191M		1000M		3000M		3000M		10000M	
			P-100					150M		500M		550M		500M		2000M
			P-200													2000M
TOTAL							191M	150M	1000M	500M	3000M	550M	3000M	500M	10000M	4000M

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R & D COST ESTIMATE RECAPITULATION

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE OF PAGES

3. DATE: 2 April 1957

4. UNCLASSIFIED TITLE: SUBSYSTEM G, WS 117L

5. INITIAL ☐ CHANGE ☒

6. NUMBER: 1761

ITEM		A. PREVIOUS YEARS		B. FISCAL YEAR 57		C. FISCAL YEAR 58		D. FISCAL YEAR 59		E. TO COMPLETE	
		000	OTHER	000	OTHER	000	OTHER	000	OTHER	000	OTHER
7. CONTRACT	A. TOTAL			191M	150M	1000M	500M	3000M	550M	13000M	4000M
	B. AVAILABLE			191M							
	C. NEW REQ				150M	1000M	500M	3000M	550M	13000M	4000M
8. MATERIEL	A. TOTAL										
	B. AVAILABLE										
	C. NEW REQ										
9. FACILITIES											
10. MANPOWER		2.7M		10.9M		10.9M		18.2M		109.2M	
11. TRAINING											
12. TEST ITEMS											
13. TEST SUPPORT AIRCRAFT						161M					
14. SUBTOTAL				191M	150M	1000M	500M	3000M	550M	13000M	4000M
15. TOTAL		2.7M		351.9M		1671.9M		3568.2M		17109.2M	

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RDB PROJECT CARD	TYPE OF REPORT: New Project		REPORTS CONTROL SYMBOL DD-RDB(A)48
1. PROJECT TITLE: (UNCLASSIFIED TITLE) Ground-Space Communications Subsystem for ARS, WS 117L	2. SECURITY: SECRET		3. PROJECT NUMBER: 1762
	4. INDEX NUMBER:		5. REPORT DATE: 2 April 1957
6. BASIC FIELD OR SUBJECT: Strategic Air Warfare System 117L	7. SUBFIELD OR SUBJECT SUBGROUP: 46-Communications		7A. TECH. OBJ.: SA-9A, 9B 10, IO-9
8. COGNIZANT AGENCY: Air Research and Development Command	12. CONTRACTOR AND/OR LABORATORY: Lockheed Aircraft Corporation		CONTRACT/W.O. NO.: AF 04(647)-97
9. DIRECTING AGENCY: HQ, ARDC, WDD			
OFFICE SYMBOL: WDTR	TELEPHONE NO.: X-1343		
10. REQUESTING AGENCY: HQ USAF	13. RELATED PROJECTS: WS 117L		17. EST. COMPL. DATE: RES. 1959; DEV. 1962; TEST 1965; OP. EVAL.
11. PARTICIPATION, COORDINATION, INTEREST: USAF/AMC-P, USN/CND/I, SAC-I, USA/C/S-I, ADC-I, Other/CIA-I, ATC-I, APGC-I	14. DATE APPROVED:		18. FY / FISCAL ESTS. (M $): Prev. 535M; 57 1472M; 58 5000M; 59 5000M; 60 6000M; 61-65 20000M; Total 37472M
	15. PRIORITY: 1A	16. A (Missiles)	
19. This is the initial report on this project			

INFORMATION COPY

20. REQUIREMENT AND/OR JUSTIFICATION

The objectives of this project are to assure the satisfactory development of equipment to perform all of the functions concerned with air to ground data transmission and receipt, establishment and maintenance of contact with the vehicle (including acquisition tracking, and ground control), orbital computations, and command communications.

Reference ARDC System Requirement No. 5 dated 17 October 1955.

21a Brief and Military Characteristics:

The "Ground-Space Communications" ground equipment will provide for acquisition and tracking, reception of data, and transmission of specific commands to a satellite vehicle moving on an orbit at approximately 300 miles altitude. This capability will be provided for a maximum radio range from the ground stations. In addition, the ground equipment will provide for inter-station ground communications, including transmission of reconnaissance data; computation necessary for acquisition, programming and for geographic

22. RDB	SN	CN		X.	I.	C.
RD-613						

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SECURITY CLASSIFICATION

DOWNGRADED AT 12 YEAR INTERVALS; NOT AUTOMATICALLY DECLASSIFIED. DOD DIR 5200.10

WP-57-01143

registration of the vehicle position, telemetry reception and recording, and a synchronized timing system.

The electronics to be contained in the vehicle and which are to be developed under this project will provide the means for transmission of the reconnaissance data to the ground receivers, control and programming of the vehicle payload functions, telemeter encoding and transmitting, vehicle timing and, as an important function of the command facility, a destruct command channel.

b. Approach

A system of ground stations will be strategically located to provide efficient tracking, command control, and intercept of the vehicle. When the vehicle is within radio range of a station, an acquisition and tracking system will determine the position of the vehicle and transmit the position data to the orbit computer. Discrete program commands will be based upon a determination of the position of the vehicle in its orbit. The high-gain telemetry and reconnaissance data receiving antennas will be slaved to the tracking system. The video output from the data link receivers will be available for monitoring and will be conveyed to the Intelligence Center for decoding and data storage. The directional data link antenna on the vehicle will be scanned so that the ground receiver can detect errors in its direction. Antenna orientation in the vehicle will be corrected over the command link.

The station locations are to be determined to provide maximum coverage while still preserving security. Inter-station communication systems are to be used; these will rely on wire and radio nets.

The major problems to be overcome are (1) high reliability of vehicle electronic equipment due to long unattended operation in a foreign environment, (2) development of a steerable airbrone data link tracking scheme, and (3) availability of a suitable data transmitting tube.

"See Tasks"

c. Subsystem Tasks

The Ground-Space Communication Subsystem is divided into the following tasks:

1a. Task No. 39840 (Uncl Title) Acquisition and Tracking Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

(UNCLASSIFIED TITLE) Ground-Space Communications Subsystem for ARS, WS 117L
Project 1762 -2 April 1957

Task Advisor: Mr. J. Fallik, RADC - RCEMBL - X71217
Mr. G. H. Parker, RADC

c. Objective: The objective of this task is to design, develop, fabricate and test acquisition and tracking equipment for the WS 117L Flight Test and Operational Phases.

Acquisition equipment will insure the acquisition of a vehicle at a maximum line-of-sight range for a 5° elevation angle from the ground station, under all situations following periods in which the vehicle has not been under ground surveillance. One such equipment will be provided at each Vehicle Tracking and Intercept Station.

Each Intercept Station will contain ground tracking equipment whose primary purposes will be to obtain vehicle position and velocity data for orbit computations, and to dynamically orient ground data receiving antennas at the vehicle in order to receive reconnaissance data.

d. Early test flights will utilize modified pulse radar equipments for tracking. During later flights, nulling interferometers or radars will perform the tracking function. Independent acquisition equipment will be provided at all times.

The approach will be to utilize existing techniques and equipments insofar as possible.

2a. Task No. 39841 (Uncl Title) Vehicle Transponder Beacon Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

Task Advisor: Mr. A. J. Falkowski - WADC - WCLNO-2 - X21239

c. Objective: The objective of this task is to design, develop, fabricate and test the vehicle beacon equipment utilized to supply a tracking signal for the ground acquisition and tracking equipments. During a good portion of the flight test program, a pulse beacon transponder compatible with the ground pulse radar will be provided. In the later test phases the tracking signal furnished to the ground nulling interferometers, if used, will be supplied by either the vehicle telemeter or data transmitter.

d. A beacon having all the required features is not available in inventory or in the process of R&D. However, related items are being developed by Evans Signal Laboratory of the Army, NRL, and the Air Force Missile Test Center.

e. A program is necessary to develop beacon equipment compatible with the vehicle and associated ground equipments.

(UNCLASSIFIED TITLE) Ground-Space Communications Subsystem for ARS, WS 117L
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3a. Task No. 39842 (Uncl Title) Orbit Computing and Ground Programming Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

Task Advisor:

c. Objective: The objective of this task is to design, develop, fabricate and test the ground orbit computing and programming equipment. A computer will be provided at each Vehicle Intercept and Control Station to compute the vehicle's orbit for indexing reconnaissance data, reacquisition, and vehicle programming. A master computer at the Master Intercept Station, will have an additional capability relative to determining the operating mode of each Intercept Station.

d. The orbit computer will be selected and requisitioned from several which are now under development and which meet requirements. Required input-output devices will be developed.

4a. Task No. 39843 (Uncl Title) Ground Timing and Synchronization Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

Task Advisor: Mr. G. H. Parker, RADC, RCEMBL
Mr. J. Fallik - RADC - RCEMBL - X71217

c. Objective: The objective of this task is to design, develop, fabricate and test the ground timing equipment required to provide a time base for the weapon system. Timing equipment will be provided at each Intercept Station suitably synchronized with the over-all timing system and possessing sufficient accuracy to permit geodetic indexing of vehicle position.

d. The approach will be to select and procure the necessary equipment such as crystal oscillator secondary standards, and standard radio receiver and time delay equipments. Auxiliary equipment will be designed and developed as required.

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5a. Task No. 39844 (Uncl Title) Vehicle Programming and Timing Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

Task Advisor: Mr. A. J. Falkowski - WADC - WCLNO-2 - X21239

c. Objective: The objective of this task is to design, develop, fabricate and test of vehicle programming and timing equipment. The vehicle programmer will accept and store commands received over the command link and release them for execution at the correct time. Vehicle timing equipment will be provided since the sequence of programmed actions is dependent upon time. Timing is also necessary in the vehicle to provide a means for geodetically indexing the reconnaissance data.

d. Although the items of hardware to accomplish these task functions are within the state-of-the-art, specific items are not available in the inventory. A development program is therefore necessary.

6a. Task No. 39845 Ground Command Control Equipment (Uncl Title)

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

Task Advisor: Sidney Rosenberg, RADC, RCVO - X-3117

c. Objective: The object of this task is to design, develop, fabricate and test the Ground Command Control Equipment for the WS 117L System.

(1) The purpose of the ground command control equipment is to transmit operational program commands and time signals to the vehicle in proper form, sequence and quantity for both real time and programmed vehicular, time-sequenced execution. It will also be capable of initiating "lost bird" operation. The equipment will be capable of transmitting reliable commands (via a high gain directional antenna) to the vehicle at radio range up to 2000 n. miles for elevation angles greater than 5°.

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(2) 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. Means will be provided to automatically indicate correct reception and decoding of the commands at the vehicle.

d. Proposed Approach

(1) When a pulsed radar-transponder combination is used for primary tracking, consideration will be given to the possible use of a common transmitter and/or antenna for primary tracking and command control purposes.

(2) For the early Pioneer Test Program, the following engineering approach will be taken:

(a) Procure and modify, if necessary, a suitable high power FM command transmitter. The choice of frequency will be determined by the results of interference and jamming studies.

(b) Procure and modify a suitable standard parabolic antenna and pedestal for item (a) above.

(c) Develop and fabricate an antenna feed system for a circular polarized antenna.

(d) Assemble, and conduct compliance and field tests on above equipment.

(3) For the Advanced Ground Command Control Equipment, the following engineering approach will be undertaken:

(a) Investigate methods of improving transmission reliability and decreasing sensitivity to interference and jamming.

(b) Design, develop, fabricate and test an Advanced Command Control Transmitter and Modulator.

7a. Task No. 39846 (Uncl Title) Vehicle Command Receiving Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

Task Advisor: Mr. A. J. Falkowski - WADC - WCLNO-2 -X21239

(UNCLASSIFIED TITLE) Ground-Space Communications Subsystem for ARS, WS 117L Project 1762 - 2 April 1957

c. Objective: The objective of this task is to design, develop, fabricate and test the command receiving equipment in the vehicle. This equipment will receive commands from the ground command transmitting equipment either for real time or programmed actions. It must, therefore, be compatible with the ground command equipment, and must also be compatible with associated vehicular equipment.

d. The approach to this task will be to utilize known techniques and develop hardware compatible with expected vehicle life and environment.

8a. Task No. 39847 (Uncl Title) Ground Reconnaissance Data Receiving Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

Task Advisor: Mr. Sidney Rosenberg - RADC - RCVO - X3117

c. Objective:

(1) The purpose of the Ground Reconnaissance Data Receiving Equipment will be to provide all the necessary facilities for reception, processing, recording, storage and monitoring of the visual, ferret and infrared information transmitted by the vehicle during readout.

(2) The equipment will meet the system requirements at all vehicle ranges within radio range of the ground station. The receiving equipment will consist of high-gain, steerable antennas of large receiving aperture, feeding highly sensitive microwave receivers which will demodulate the signal to yield video data to the recorders.

(3) In the case of the ferret reconnaissance, the information bandwidth requirements are considerably less than those necessary for visual reconnaissance. Thus, the bandwidth of the ferret receiver will be less than that in the visual data receiver. The ferret data receiving equipment will be capable of receiving telemetry-type signals from the vehicle transmissions.

(4) The infrared data receiving equipment will be capable of handling a number of telemeter channels for infrared reconnaissance data.

d. Approach

(1) Visual Receiving Equipment

(a) The development program of the Visual Data Receiving Equipment will be divided into three (3) phases as follows:

1. A. test phase during which a basic receiver will be designed, fabricated and be used in conjunction with an Engineering Prototype (test) antenna, pedestal, and feed system to prove feasibility and assist in the preparation of firm specifications for the Early Operational (Pioneer) system.

2. The design, development and fabrication of the Pioneer Visual Data Receiving Equipment. The comparative merits of employing elevation azimuth, elevation-traverse or 3-axis antenna pedestal mounts will be determined. A determination will be made of 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.

3. The design, development and fabrication of the Advanced and Surveillance Visual Data Receiving Equipment.

(b) The receiving equipment will operate in the C-band or S-band and will be frequency modulated. As a preliminary step, the receiving equipment will be designed for handling 6 megacycles video bandwidth signals. Utlimately, the video bandwidth may approach 20 megacycles, depending upon the ultimate vehicle transmitted visual data requirements. A circularly-polarized parabolic antenna having a gain of at least 50 db (for linearly-polarized signals) will be initially used to determine its suitability. Initial use will be made of low noise, travelling-wave tube input. Other types may be used if deemed more desirable.

(c) For the recording, storage and playback of the Advanced visual reconnaissance data, suitable magnetic tape recorders, with increased bandwidth capabilities, will be developed, fabricated and tested. Recorders employing several rotating heads will be investigated.

(2) Ferret Data Receiving Equipment:

The development of the ferret data receiving equipment will be divided into three phases, as follows, to provide progressively greater frequency coverage as more powerful vehicular power supply systems become available: Pioneer Ferret, Advanced Ferret and Ferret Surveillance. Data receivers, parabolic antennas, R-F feed systems, and 3-axis pedestals will be developed, fabricated and tested for the three types of ferret receiving equipments.

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(3) Infrared Data Receiving Equipment

Experimental and prototype receiving equipments will be designed, fabricated and tested using telemetry-type techniques.

9a. Task No. 39848 (Uncl Title) Vehicle Data Transmitting Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF04(647)-97

Task Advisor: Mr. A. J. Falkowski - WADC - WCLNO-2 - X21239

c. Objective: The objective of this task is to design, develop, fabricate and test equipment which will be capable of transmitting reconnaissance data from the vehicle to the Vehicle Intercept and Control Stations. The transmission rate or information transfer per unit time will be the maximum possible commensurate with system requirements.

The visual data link will incorporate high-gain directional antennas at both the transmitting and receiving ends of the link. As a preliminary objective, the visual data link will be designed for handling signals, the video bandwidth of which is approximately 6 megacycles/sec at the half power points. The ultimate bandwidth capabilities for the advanced systems will be in the order of 20 megacycles/sec.

For ferret reconnaissance data, the information bandwidth requirements will be considerably less than those necessary for visual reconnaissance. Accordingly, the data link will be modified by narrowing the bandwidth of the ground receiver and, if possible, employing a shaped-beam antenna in the vehicle. Consideration will be given to employing the same type of transmitter for the ferret system as that employed in the visual system.

The information bandwidth requirements of the infrared reconnaissance data transmitters are sufficiently small to allow transmission on a number of telemeter channels.

d. The approach to this task will be to utilize known techniques and develop hardware compatible with expected vehicle life and environment.

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10a. Task No. 39849 - Ground Telemeter Receiving Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)97

Task Advisor: Mr. Sidney Rosenberg - RADC - RCUO - X3117

c. Objective: The purpose of the Ground Telemeter Receiving Equipment is to provide all necessary facilities for the reliable reception, processing, recording and storage of vehicle instrumentation and environmental data transmitted by the vehicle during readout within radio range of the ground station. The receiving equipment will be capable of extracting the range information and applying it to the ranging circuitry of the tracker equipment when the ranging data is transmitted from the vehicle telemeter transmitter.

d. Proposed Approach:

(1) In the Engineering Prototype, non-orbiting test program available AFMTC telemeter receiving equipment (modified as required) will be used to the maximum extent at each of the contemplated AFMTC down-range Vehicle Tracking, Control and Telemetry stations. During the low latitude, orbital test program, standard VHF telemeter receiving station components (modified as required) will be used to form a complete telemetering receiving facility. A directional antenna will be employed which will be capable of tracking the telemetered signal emanating from the vehicle or being dynamically slaved to the tracking antenna.

(2) Concurrent with the above work, a program will be undertaken to progressively develop early test and advanced equipment operating at C-band or S-band frequencies to provide additional channel capacity and receiver bandwidth for high-latitude operational orbits. Data telemetering during these orbits will be primarily concerned with monitoring the status of the equipment in the vehicle.

11a. Task No. 39850 (Uncl Title) Vehicle Telemeter Transmitting Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

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Contract No. AF 04(647)-97

Task Advisor: Mr. F. C. Karabaich - WADC - WCLCE-5 -X30253

c. Objective: The objective of this task is to design, develop, fabricate and test the vehicle telemetering equipment and associated instrumentation utilized in conjunction with the WS 117L flight test. This equipment will be provided for obtaining range, environmental, and equipment status data. FM/FM and possibly PWM/FM telemetering equipment will be provided for early flight tests. The telemeter transmitting equipment will be identical to vehicle data transmitting equipment where telemeter bandwidth is adequate.

d. During low latitude test flights at AFMTC, the vehicle telemeter equipment will be compatible with AFMTC instrumentation. Concurrently development of advanced equipment will proceed utilizing knowntechniques.

12a. Task No. 39851 - Ground Communications Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

Task Advisor: Mr. Sidney Rosenberg - RADC - RCUO - X3117

d. Objective:

(1) The purpose of the ground communications equipment is to provide communications facilities within and between the individual ground installations of the system. The interstation communication net will include:

(a) General Operational (administrative and logistic) and command circuits (including vehicle antenna tracking programs and trajectory data).

(b) Reconnaissance (visual, ferret and infrared) data transmission circuits.

(2) The interstation operational and command net will link the vehicle Intercept, Control, Telemetry and Data Acquisition Stations together and each station to the Intelligence Center. The data channels will connect each station with the Intelligence Center.

(3) The interstation data transmission circuits will handle information of sufficient bandwidth to be eventually capable of transmitting

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the complete reconnaissance information received from the vehicle in the Surveillance System. Facilities for storage of the received information on magnetic tape or other storage media will be provided. The storage facility will be capable of non-destructive readout of information for preliminary evaluation or for re-transmission without further processing. The storage medium will be of a permanent nature to permit storage for long periods of time.

(4) Wherever possible within the constraint considerations of security, practicality and time, the interstation communication facilities will be integrated with the AF Communication Support System, S-456L (SR-132, GOR-129).

(5) Error detection and correction techniques will be employed to insure the accurate transmission of the reconnaissance, command and orbital tracking data between the ground-based stations. Suitable security and encoding techniques will be developed to resist enemy jamming, provide secrecy and low detectibility.

(6) Internal communications will be provided at each Launching Site and Intercept and Control Stations, as required, for efficient and reliable operation of the subsystem. These facilities will provide for all phases of the operation, i.e., pre-launch, launch, ascent guidance, non-orbiting and orbiting phases.

d. Proposed Approach

(1) Interstation Communication Facilities

(a) The general operational and command circuits will make maximum use of conventional wire lines carrying voice, teletype, code and/or graphics (facsimile) messages with radio nets as back-up. Commercial circuits will be used wherever security considerations permit such use.

(b) 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 aircraft. Techniques using facsimile, slowed-down video, etc. will be considered for transmission of a limited amount of information which may be deemed vital. Later in the Surveillance System, wider bandwidth communication facilities (microwave relay and/or scatter links) will be used, capable of handling the complete reconnaissance information received from the vehicle.

(c) Alternate routing will be employed for all interstation communication links to minimize vulnerability to accidental or enemy destruction.

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(d) Frequency, space and/or time diversity combiners will be used to minimize losses due to fading.

(e) If environmental conditions permit, equipment specifications will be in accord with JAN specifications.

(f) The following work program will be followed in the engineering approach to the communication requirements:

1. Initially, the AFMTC downrange communications facilities will be used to the maximum extent to tie-in the three ground based stations. Leased land-lines will also be used linking the test sites (initial non-orbiting and orbiting) and the prototype operational station (South Central U.S.A.)

2. Leased land-lines and narrow band radio nets will then be installed linking the operational stations.

3. Interim and Advanced wide-band communication links will be developed, procured or rented. The specifications for these links will be based upon operational experience and requirements to be established.

(2) Intrastation Communication Facilities:

(a) 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.

(b) Intra-communication facilities will include, but not be limited to, the following: automatic dial equipment, sound-powered phones, public address and pagin equipment, analog and digital data transmission and display equipment, remote monitoring and display devices, intercom facilities, maintenance phones, and emergency alerting and warning facilities.

13a. Task No. 39852 (Uncl Title) Ground Support Equipment

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

c. Objective: The objective of this task is to design, develop, fabricate and test the ground support equipment necessary to maintain, test and

calibrate all the operating equipments of this subsystem. The ground support equipment will include pre-launch support equipment for check-out of the vehicular equipments which form portions of this subsystem.

d. The approach will be to establish requirements and, subsequently, procure or develop the required ground support equipment.

14a. Task No. 39853 (Uncl Title) Propagation Research

b. Contractor: Lockheed Aircraft Corporation
Missile Systems Division
P. O. Box 504
Sunnyvale, California

Contract No. AF 04(647)-97

Task Advisor: Mr. L. Colin - RADC - RCEMB - X71217

c. Objective: The objective of this task is to provide information and data relative to propagation anomalies as they affect the operation of WS 117L. The following are typical data which may be required in order to fulfill the requirements of this weapon system:

(1) Entire time spectrum of the index of refraction of the troposphere and ionosphere at a particular geographic location.

(2) Mean (e.g. monthly or yearly) time delay through the troposphere and ionosphere as a function of elevation angle frequency and geographical location.

(3) Root Mean Square of the fluctuations in time delay through the troposphere and ionosphere as a function of elevation angle, radar frequency and geographical location.

The operational Vehicle Intercept and Control Stations will be complemented with the requisite equipment for obtaining the basic radar correction data, due to propagation anomalies, in accordance with the results of this task.

d. The approach will be to:

(1) Monitor work in the field of radio propagation research.

(2) Monitor and provide consulting services relative to contractor's radio propagation experiments with a satellite vehicle as a source of electromagnetic radiation.

(3) Develop a method of predicting the ionospheric and tropospheric bending effects from measurements, based on the results of d-(1) and d(2) above.

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21d. Other Information

(1) General: This subsystem is one of several under WS 117L. The cognizant agency for the system is the Western Development Division of Headquarters ARDC. The responsibility for advising on technical matters in the subsystem tasks has been assigned to Rome and Wright Air Development Centers. Appropriate references are listed in Paragraph 21g of this document.

A related effort, also being undertaken by the Department of Defense, is the Navy Vanguard Program, which is concerned with tracking a satellite vehicle, computing the satellites' orbit, and telemetering data from the vehicle to ground stations.

(2) Survey of Similar Existing Standardized Equipment or Techniques:

The only existing standard equipments which may be used in this subsystem are ground telemetering receiving equipment and ground communications equipment. Otherwise, every attempt will be made to utilize known techniques in the development of hardware. Some of these techniques are:

(a) Interferometer measurement techniques

(b) Frequency standard and timing techniques

(c) FM transmission techniques

(d) Radio propagation measurement techniques

(3) Survey of Similar Equipment or Techniques in Process of R and D. Some of these are:

(a) 60 foot automatic positioning telemeter antenna being developed by Radiation Inc., Melbourne, Florida

(b) COTAR position measuring equipment being developed by Cubic Corp., San Diego, California

(c) Three axis tracking mount being developed by Reeves Instrument Corporation, Long Island, New York

(d) Ground transmitters (1KW) modified for FM data link use by Collins Radio Co., Cedar Rapids, Iowa.

In order to meet the requirements of this subsystem, maximum utilization will be made of existing technique and equipment developments. Duplication of effort will be avoided.

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(4) Replacement Recommendations: The equipments developed for this subsystem will have possible utility at instrumented test ranges, in navigation systems, in tactical control systems, etc. The nulling interferometer, for instance, will provide a replacement capability for pulse radar trackers. Data transmission and reception equipment may offer replacement capabilities for similar equipments used in other systems.

(5) Statement of Effects: This portion of System 117L will not impose a severe operational burden on maintenance, organization, and logistics in general. This statement does not apply to the development and test phases inasmuch as these phases will involve large undertakings and considerable effects are implied on logistics, maintenance, organization, etc. It is anticipated that judicious use will be made of contractor personnel and facilities.

21e. Background History: The concept of the Advanced Reconnaissance System is a result of studies conducted at the Rand Corporation. A study completed in 1947 together with similar investigations by other contractors concluded that a satellite vehicle was feasible as a reconnaissance vehicle but not as a weapon carrier. In 1950 the Research and Development Board vested satellite custody in the Air Force, and Rand was directed to explore its possible military utility. Recommendations for an expanded study of reconnaissance applications were made to the Air Staff in late 1950 and a formal report (Rand 217) followed in April 1951. Feasibility studies for critical subsystems initiated at that time were television (RCA), attitude control (North American Aviation), nuclear auxiliary power units (Bendix Aviation, Frederick Flader, Allis Chalmers and Vitro Corporation).

Recommendations for the ARS development were made by Rand in November 1953, and these were followed by the final report (Rand-262) in February 1954. The Air Force Requirement was written in August 1954 and issued on 29 November 1954. This requirement, SR-5, directed system design studies in order to determine the technical and economical magnitude of a full scale development effort. Rome Air Development Center was listed as a participating center for specific technical design study area in ground-air communications, including acquisition tracking and command of the flight vehicle.

In early 1955, RCA, Lockheed Aircraft Corp., Glenn L. Martin Company and Bell Telephone Labs were solicited to bid for a contractual design study effort of one year's duration. Proposals received from RCA, Lockheed and Martin were evaluated by USAF personnel on the acquisition, tracking, ground-air communications and command portion of the Advanced Reconnaissance System. Bell Telephone Labs did not bid. In May 1955 an evaluation conference was held at WADC attended by representatives of all the participating centers, at which time the decision was made to award a design study contract to each of the three bidders on the basis of different approaches. These contracts were awarded during [redacted] at a cost of $500,000 each.

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Other historical events of importance are listed as follows:

a. Creation of Headquarters ARDC Directorate of Systems Management at Wright-Patterson AFB the latter half of 1954. The Advanced Reconnaissance System along with other systems, became the responsibility of this new directorate.

b. Creation of an ARS Technical Advisory Group.

c. Issuance of New System Requirement No. 5, dated 17 October 1955 directing the submission, upon request, to Headquarters ARDC (Western Development Division) of information necessary for the preparation of a System Development Plan by the participating centers. The target date for submission of this plan to Headquarters USAF was April 1956.

d. Official transfer of Advanced Reconnaissance System responsibility to the Western Development Division of Headquarters ARDC in December 1955.

e. Submission by the design study contractors (RCA, Lockheed and Martin) of System Development Plans on 1 March 1956.

f. Evaluation of contractor technical competence by participating centers.

g. Preparation of an abbreviated System Development Plan by the participating centers for submission to higher headquarters.

h. Official approval of WS 117L System Development Plan dated 2 April 1956.

i. Selection of Lockheed Aircraft Corporation as the weapon system contractor in May, 1956.

j. Preparation of contractual work statement and revised System Development Plan documentation in January 1957.

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21f. Future Plans

Plans relative to development growth and required resources are specified in the applicable annexes. It should be noted that the extent of the envisaged development program is of considerable magnitude and difficulty. Therefore, periodic amendments relative to plans and resources are to be expected.

8. References:

1. System Requirement No. 5, dated 29 November 1954.
2. Task Plan for Task 15002, dated 25 April 1955.
3. System Requirement No. 5, dated 17 October 1955.
4. Letter from Commander, WDD to Commander, RADC, dated 23 December 1955, Subject: (U) Support of Advanced Reconnaissance System.
5. Rand Corporation Report R-262, "(Unclassified Title) Project FEED BACK Summary Report, Volume I", (Secret Report), dated 1 March 1954.
6. WDD WS 117L Development Plan, dated 2 April 1956.

21h. Coordination and Signature Block:

William O. Troetschel
WILLIAM O. TROETSCHEL
Captain, USAF
Project Engineer

Frederic C. E. Oder
FREDERIC C. E. ODER
Colonel, USAF
Assistant for WS 117L

[redacted]

1. R & D SCHEDULE

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

3. DATE: 2 April 1957

4. TITLE: (Unclassified Title) GROUND-SPACE COMMUNICATIONS FOR ARS, WS 117L

5. INITIAL ☒ CHANGE

6. NUMBER: 1762

SCHEDULE TITLE	PROJECT OR TASK NR	CALENDAR YEARS 1956 J A S O N D	1957 J F M A M J J A S O N D	1958 J F M A M J J A	1959 1 2 3 4	1960 1 2 3 4	1961 1 2 3 4	TO COMPL 1 2 3 4
Ground Space Communications	1762	A	R	Q B	C D	P T		E J K
Acquisition & Tracking Equip. Radar	39840	A	Q B R	C D O P				E J K
Interferometer			Q R B		C O D	P		E J K
Vehicle Transponder/Beacon Transponder	39841	A	Q B R	C D O P				E J K
Beacon			Q R B		C O D	P		E J K
Orbit Computing & Ground Programming Equip.	39842							E J K
Orbit Computer			Q B R		Q E D C			E J K
Ground Programmer					Q E D C			E J K
Ground Timing & Syn. Equip.	39843		Q R B		Q E D C			E J K

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1. R & D SCHEDULE

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

3. DATE 2 April 1957

4. TITLE (UNCLASSIFIED TITLE) GROUND-SPACE COMMUNICATIONS FOR ARS, WS 117L

5. INITIAL ☒ CHANGE

6. NUMBER 1762

SCHEDULE TITLE	PROJECT OR TASK NR	CALENDAR YEARS 1956 1957 1958 1959 1960 1961 TO COMP
Ground Space Communications	1762	
Vehicle Programming & Timing Equip.	39844	
Ground Command Control Equip.	39845	
Vehicle Command Receiving Equip.	39846	
Ground Recon Data Rec Equip.	39847	
Vehicle Data Transmit Equip	39848	
Ground Telemeter Rec Equip Limited:	39849	
Advanced:		
Vehicle Telemeter Trans Equip. Limited:	39850	

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WW-57-01143

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1.

R & D SCHEDULE

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL*

3. DATE 2 April 1957

4. TITLE (UNCLASSIFIED TITLE) GROUND-SPACE COMMUNICATIONS FOR ARS, WS 117L

5. INITIAL ☒ CHANGE

6. NUMBER 1762

SCHEDULE

CALENDAR YEARS: 1956 | 1957 | 1958 | 1959 | 1960 | 1961 | TO COMPL

TITLE	PROJECT OR TASK NR
Ground Space Communications	1762
Vehicle Telemetar Trans Equip Advanced:	39850
Ground Communication Equip.	39851
Intra-Station:	
Inter-Station:	
Limited:	
Advanced:	
Ground Support Equip.	39852
Propagation Research	39853

Continuing

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[redacted]

- KEY -

A. Contract awarded

B. Fabrication of development model started (Prototype flight article)

C. Development model fabrication completed (Prototype flight article)

D. End of contractor compliance testing of development model (Acceptance test)

O. Ground Test starts

P_A Integration with first flight (Completion of ground test)

E. Completion of functional testing of development model to demonstrate capability (After flight test approval)

J. Preparation of procurement data (End)

K. Production Engineering (End)

Q. Design studies completed

R. Engineering Analysis Report

T. Technical Reports

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1. R & D MATERIEL ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE OF PAGES

3. DATE 2 April 1957

4. TITLE (UNCLASSIFIED TITLE) GROUND-SPACE COMMUNICATIONS SUBSYSTEM FOR ARS, WS 117L

5. INITIAL ☒ CHANGE

6. NUMBER 1762

7. Cost Estimates: Gross: 12,040,000 Net: 12,040,000

SUPPLY	MAINTENANCE	TRANSPORTATION	COMMUNICATIONS	TOTAL
		Delayed	Delayed	12,040,000 12,040,000

8. SUPPLY & EQUIPMENT

Nomenclature Including S/N	Estimated Unit Cost	Total Requirements				Time Phased Net $ Requirements			
		Grs Qty	Gross Cost	Net Qty	Net Cost	FY 56	FY 57	FY 58	FY 59
Class 16-A									
Command Receiver and Decoder Improved ARW 59(R-786)	20,000	10	200,000	10	200,000		40,000	60,000	100,000
High Speed Digital Computers	1,250,000	4	5,000,000	4	5,000,000			2,500,000	2,500,000
Class 16-B, Van Mounted AN/MPS-19 Radar Sets (Part of AN/MSQ-1A Radar)	600,000	4	2,400,000	4	2,400,000		600,000	1,200,000	600,000
Automatic Positioning Telemeter Antenna & VHF Acquisition Sys.	300,000	1	300,000	1	300,000			300,000	
Telemetry Receiving Station	300,000	4	1,200,000	4	1,200,000		300,000	600,000	300,000
Command Link Transmitters	100,000	10	1,000,000	10	1,200,000		300,000	200,000	500,000
Command Encoder Type KY-172	100,000	2	200,000	2	200,000		100,000	100,000	
D. S. Kennedy 28 foot parabolic Reflector and Antenna Pedestal and Drive	75,000	4	300,000	4	300,000		75,000	150,000	75,000

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R & D MATERIEL ANNEX CONTINUATION SHEET

8. SUPPLY & EQUIPMENT Nomenclature Including S/N	Estimated Unit Cost	Total Requirements				Time Phased Net $ Requirements			
		Grs Qty	Gross Cost	Net Qty	Net Cost	FY 56	FY 57	FY 58	FY 59
Class 17C Timing & Synchronization Equip. Including Crystal Controlled Frequency Standard Count-Down Frequency Divider & Synchronometer. GR 1100 AP	140,000	5	700,000	5	700,000		140,000	280,000	280,000
Miscellaneous Test & Calibration Equip.			280,000		280,000		70,000	140,000	70,000
Class 19F 30 KVA Power Units Type SF 30G & Trailer	5,000	8	40,000	8	40,000		10,000	20,000	10,000
Class 50H Truck Units for MPS-19 Radar, Type M-45, 2½ Ton 6 x 6 Cargo Vehicle	20,000	4	80,000	4	80,000		20,000	40,000	20,000
Boresight Tower for MPS-19 (Class Unknown)	5,000	4	20,000	4	20,000		5,000	10,000	5,000
60 foot automatic positioning telemeter (Class Unknown)	300,000	1	300,000	1	300,000			300,000	
					TOTALS:		1,665,000	5,910,000	4,465,000

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1.

R & D MANPOWER ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE OF PAGES

3. DATE 2 April 1957

4. UNCLASSIFIED TITLE

GROUND-SPACE COMMUNICATIONS SUBSYSTEM FOR ARS, WS 117L

5. INITIAL ☒ CHANGE ☐

6. NUMBER 1762

7. ORG COMP CODE	8. ORGANIZATION TITLE	9. TYPE ORG	10. ACTUAL MAN-QTRS LAST QTR	11. PROJECTED DIRECT MAN-YEARS						
				FY 19 57		FY 19 58		FY 19 59	FY 19 60	TO COMPL
				AVAL	RQRD	AVAL	RQRD	RQRD	RQRD	RQRD
WDTR	WS 117L Project Office, WDD	R	0.5	0.5	1.0	0.5	2.0	2.0	2.0	*
RCU	Directorate of Communications, RADC	R	1.3	0.6	1.8	1.2	4.0	4.0	4.0	*
RCEM	Missile Support Laboratory RADC	R	4.5	4.5	5.5	4.5	6.5	7.0	7.0	*
WCLN	Communications and Navigation Laboratory, WADC	R	0	0.4	1.0	0.4	2.0	2.0	2.0	*
RCS	Directorate of Technical Services, RADC	S	0	0.5	0.5	1.0	1.0	1.0	1.0	*
WCLC	Flight Control Laboratory WADC	R	0	0.5	0.5	0.5	0.5	0.5	0.5	*
	Total Manpower		6.3	7.0	10.3	8.1	16.0	16.5	16.5	*
	Total Manpower Dollars:		11,466	50,960	74,984	58,968	116,480	120,120	120,120	600,600

*Continuing Requirement

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1.

R & D CONTRACT FUNDS ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE OF PAGES

3. DATE: 2 April 1957

4. TITLE (UNCLASSIFIED TITLE)
GROUND-SPACE COMMUNICATIONS SUBSYSTEM FOR ARS, WS 117L

5. INITIAL ☐ CHANGE ☐

6. NUMBER: 1762

7. ITEM	8. PROJ OR TASK NR	9. END ITEM CAT	10. CONTRACT NUMBER	11. BPSN	12. PREV YRS 600	12. PREV YRS OTHER	13. FY 57 600	13. FY 57 OTHER	14. FY 58 600	14. FY 58 OTHER	15. FY 59 600	15. FY 59 OTHER	16. FY 60 600	16. FY 60 OTHER	17. TO COMPL 600	17. TO COMPL OTHER
Ground Space Communi-cations Subsystem	1762	E	AF04(647) 97	2-117	535M		1472M		5000M		5000M		6000M		20,000M	
				P-100 Funds				420M		2000M		3000M		2500M		12500M
				P-200 Funds				135M		90M		2285M		5600M		14500M
				Sub Totals:												
				P-600	535M		1472M		5000M		5000M		6000M		20,000M	
				P-100				420M		2000M		3000M		2500M		12500M
				P-200				135M		90M		2285M		5600M		14500M
TOTAL					535 M		1472 M	555 M	5000 M	2090 M	5000 M	5285 M	6000 M	8100 M	20000 M	27000 M

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R & D COST ESTIMATE RECAPITULATION

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

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3. DATE: 2 April 1957

4. UNCLASSIFIED TITLE: Ground-Space Communications Subsystem for ARS, WS 117L

5. INITIAL ☐ CHANGE ☐

6. NUMBER: 1762

ITEM		A. PREVIOUS YEARS		B. FISCAL YEAR 57		C. FISCAL YEAR 58		D. FISCAL YEAR 59		E. TO COMPLETE 65	
		000	OTHER	000	OTHER	000	OTHER	000	OTHER	000	OTHER
7. CONTRACT	a. TOTAL	535M		1472M	555M	5000M	2090M	5000M	5285	26000M	35,100M
	b. AVAILABLE	535M		1472M							
	c. NEW REQ				555M	5000M	2090M	5000M	5285	26000M	35,100M
8. MATERIEL	a. TOTAL				1665M		5910M		4465		
	b. AVAILABLE										
	c. NEW REQ				1665M		5910M		4465		
9. FACILITIES											
10. MANPOWER		11.5M		75.0M		116.5M		120.1M		720.7M	
11. TRAINING		N/A									
12. TEST ITEMS		N/A									
13. TEST SUPPORT-AIRCRAFT		N/A									
14. SUBTOTAL		535M		1472M	2220M	5000M	8000M	5000M	9750M	26000M	35,100M
15. TOTAL		546.5M		3767.0M		13116.5M		14870.1M		61820.7M	

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Ground-Space Communications Subsystem for ARS, WS 117L

General Design Specification

A. Statement of the Problem

The Ground Space Communications Subsystem includes provision for:

1. Acquisition and tracking of the orbiting vehicle
2. Command of the vehicle from a ground station
3. Transmission and reception of data from the vehicle to the ground station
4. The necessary inter-station and intra-station communications
5. Computing the orbit and geographic indexing of vehicle position

B. Approach

The test stations located at Cape Cannaveral, Antiqua, Ascension, and Hawaii will provide the required acquisition and tracking information of the orbiting vehicle, data necessary for design of the orbit computer and determination of read-out time for acquired reconnaissance data. The South Central United States Station will serve as both R&D prototype and an operational Vehicle Intercept and Control Station. Operational studies to date (to be extended by immediate future study) indicate that the test sites will be distributed approximately as follows:

Test Stations:

1. Hawaiian Island Station
2. AFMTC (Planned use of existing facilities only).
3. Antiqua or St. Lucia Island
4. Ascension Island (Planned use of existing facilities only).
5. Camp Cooke, California
6. Northwest Station, i.e., Annette Island, Alaska
7. Northeast Station, i.e., Presque Isle, Maine
8. Southwest Station, i.e., Amarillo, Texas

Coordination will be accomplished so that, if at all possible, the South Central (U.S.) station will be located at the same site as the WS 117L Intelligence Center.

The primary tracking system will consist of radar direction finding and/or nulling interferometer and C.W. ranging equipment. The ranging system components include the command transmitter, command receiver, telemeter transmitter, telemeter receiver, and ranging phasemeter. Acquisition will be accomplished with the assistance of a correlation receiver. The primary direction finder will incorporate a pencil beam tracking antenna. In the early test program, tracking will be achieved by pulse radar-transponder equipments.

Stations numbered 1,6,7 and 8 above, will contain acquisition and tracking equipment, an orbit computer, a command transmitter, a reconnaissance data receiving and recording system, a telemeter receiving system, programming and timing equipment, and connections to the ground communications net.

Stations numbered 2,3,4 and 5 above, will include most, but not all, of the above equipment.

The command link will transmit functional program commands and time signals to the vehicle. Should a directional antenna be utilized by the satellite as part of the ground space communications link, signals for antenna orientation on subsequent passes will be transmitted over the radio-transponder link (when used) for increased redundancy and communications security. The primary command link will be capable of turning on the telemeter transmitter or transponder-beacon for lost-bird operation.

A ruggedized mechanical escapement type programmer will be utilized for the earlier vehicles. An improved programmer, using punched tape or some other storage technique, will be used for the more complex vehicles and, where possible, the programmer will be coupled to the vehicle's timing system. A matrix (magnetic core storage) system shows promise for the more complex operational vehicles and will be investigated.

The timing for the early orbiting vehicles will be provided by the programmer. However, as reconnaissance data becomes available, the timing system must be of such accuracy that there will be no degradation of the data. If investigation indicates that undue complexity will not result, a timer more suitable for the final operational system will be designed and used throughout the test and operational type flights. All the intercept stations, WS 117L Intelligence Center, and the vehicle will be time-synchronized so that orbital and acquired data can be correlated.

The orbital computers at the intercept stations will use tracking data and past orbital history to provide future orbital data and a time-synchronized recording of positional information will be available for future orbital and programming computations and for read-out with the time-synchronized reconnaissance data recordings. The computers at the intercept stations will not require the sophistication of the computer at the Master Vehicle Intercept and Control Station, but each will be capable of growth from the initial use for early flight tests to a final system.

The space-to-ground transmission of the reconnaissance data will be accomplished to furnish the maximum data commensurate with system requirements.

For the visual systems, simultaneous investigations will be made relative to simplicity, early availability and utility of a satellite fixed data transmitting antenna scheme as well as the more complex steerable antenna arrangement. The transmitter tube will be chosen to meet ARS reliability. The data link receiving antenna will be a large parabolic antenna slaved to either the direction finder or to the tracking radar.

The ferret data link system will either be identical to the visual data transmission scheme or utilize standard telemetering techniques.

Suitable time-synchronized recording of the reconnaissance data will be performed at each intercept station, and then transmitted to the Intelligence Center.

The infrared data will be multiplexed on the telemetering data link.

Ground communication facilities will be established in order to permit the rapid transmission of time-synchronized reconnaissance and orbital data from each intercept station to the Intelligence Center, the transmission programming orders from the Intelligence Center to each intercept station, and the transmission of routine information. Initially, narrow bandwidth wire and radio nets will be furnished. Wide bandwidth communications between the intercept stations and the intelligence center will be provided early enough so that at no time will the ground communication capability cause constraint in rapid data transmission.

The launch station, each intercept station, and the Intelligence Center will contain the necessary intra-station communications required for efficient operation.

C. Solutions and Recommendations

It will be necessary in the early programs to provide space-to-ground telemetering as the major means of conveying vehicle instrumentation data to the ground. It will play a major role in the development cycle, and, therefore, every attempt will be made for a high order of reliability. Standard FM/FM or PWM/FM telemetering techniques will be used in the early program. More refined vehicles will contain space-to-ground telemetering equipment as part of the operational equipment. This will be necessary in order to maintain continuous contact with vehicular equipment so that adjustment and switching of critical circuits may be accomplished by ground command. Consideration will be given to a redundant telemeter transmitter and/or use of the transponder as a telemetering instrument.

Early low latitude orbital flights will provide significant utility by virtue of the fact that existing ground tracking radars at AFMTC and Ascension and WS 117L ground tracking radars at Antiqua and Hawaii will track a transponder in the vehicle, orbital computation methods will be tested, telemetering equipment will be utilized and possible direct space-to-ground data transmission will be attempted.

During all phases of the program, continuing attention will be given towards developing techniques for decreasing the vulnerability of the

communication links to interference and jamming. This will be accomplished by conducting operational studies or development programs as required.

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RDB PROJECT CARD	TYPE OF REPORT: NEW PROJECT		REPORTS CONTROL SYMBOL DD-RDB(A)48
1. PROJECT TITLE: (UNCLASSIFIED TITLE) DATA PROCESSING SUBSYSTEM FOR ARS WS-117L	2. SECURITY: SECRET	3. PROJECT NUMBER: 1763	
	4. INDEX NUMBER: 2-117L	5. REPORT DATE: 2 April 1957	
6. BASIC FIELD OR SUBJECT: Strategic Air Warfare System 117L	7. SUBFIELD OR SUBJECT SUBGROUP: 39. Recon Interpretation and Computation.	7A. TECH. OBJ.: SA-9A, 9B 10 IO-9	
8. COGNIZANT AGENCY: Air Research & Development Command	12. CONTRACTOR AND/OR LABORATORY: SEC. 21. C	CONTRACT/W.O. NO.: NONE	
9. DIRECTING AGENCY: HQ ARDC WESTERN DEVELOPMENT DIVISION (WDD)			
OFFICE SYMBOL: WDTR	TELEPHONE NO.: Or2-0171 X1326		
10. REQUESTING AGENCY: HEADQUARTERS USAF	13. RELATED PROJECTS: WS-117L WS-138A	17. EST. COMPL. DATES: RES. 1961; DEV. 1963; TEST 1965; OP. EVAL. [illegible]	
11. PARTICIPATION, COORDINATION, INTEREST: USAF/AMC-P AFOIN,HQ,USAF-I; APGC-I AFSS-I USA/C/S-I ACIC-I; SAC-I TAC-I Other: CIA-I; ADC-I USN/CNO-I	14. DATE APPROVED	18. FY FISCAL REQTS. (M $): REV. 513M; 57 [illegible]69M; 58 [illegible]000M; 59 [illegible]200M; 60 [illegible]0000M; 61-65 [illegible]3000M; Total 28632M	
19. This is the initial Report on this Project.	15. PRIORITY: 1A	16. A(MISSILES)	

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20. REQUIREMENT AND/OR JUSTIFICATION

GOR No. 80 (SM-2C) dated 16 March 1955 and SR No. 5 dated 17 October 1955 establishes the requirement for an Air Force Intelligence Data Handling System capable of accepting and processing visual, ferret and infrared data from Satellite reconnaissance vehicles. Reconnaissance Satellites are expected to provide a much greater number of "pieces" ofintelligence than is being collected, evaluated and analyzed today, or which is anticipated to be collected by other systems in the near future. This great increase in quantity of collected data will overtax the present intelligence data handling system at a time when timeliness of information is of mounting importance. A data handling system must therefore be especially designed and developed around the characteristics of this collection system to minimize the time needed to produce meaningful intelligence from the collected raw data. The requirement can ultimately be best satisfied through the planned exploitation of automation, mechanization, electronics miniturization and modern production type techniques.

Development Directive No. 85, dated 3 August 1956, and System Development Directive No. 117L, dated 17 August 1956, direct the development of an Intelligence Data Processing Subsystem which is:

22. RDB	SN	CN	IC & P	X.	I.	C.

a. Tailored to the collection characteristics and capabilities of the reconnaissance satellite,

b. Designed to centrally provide for rapid and efficient processing and dissemination of all satellite collected data in a manner which best satisfies user requirements.

21. Brief and Military Characteristics

This project covers the design and development of a completely integrated Intelligence Data Processing Subsystem including the equipment, techniques and procedures to transform recorded, raw, photographic, ferret and infrared data into useful intelligence. This data processing subsystem will incorporate timely intelligence feedback from other intelligence collection systems and agencies to insure:

a. Best operational employment of the satellite collection capabilities.

b. Optimum extraction of information from the raw data collected.

Data will be acquired from the satellite through radio transmission channels and reception at ground receiving stations. The ground receiving stations will identify, record, and retransmit this information to a central point, for simplicity termed the ARSIC (Advance Reconnaissance System Intelligence Center). The Intelligence Data Processing Subsystem located primarily within the ARSIC will be capable of all functions necessary to transform the recorded raw data into useful intelligence. The functional areas which must be investigated and considered to insure the efficient production and availability of intelligence in the forms, frequencies and quantities desired by various users are: processing, screening, interpretation, collation, evaluation, indexing, storage and retrieval, analysis, display, dissemination and presentation.

Development of this subsystem must make maximum use of the Intelligence Data Processing Subsystem design concept, equipment, techniques, and procedures recommended and/or under development in support of System 438L, "USAF Intelligence Data Handling System". It appears that some of these techniques and equipments will meet some of the needs of this subsystem.

21b Approach

The WS-117L is being developed on a development schedule phased over a period of years and including a variety of configurations, capabilities, and useful vehicle life spans. It is planned to develop the Data Processing Subsystem on an orderly growth basis which is phased to the collection capabilities and operational ability of the system.

To be realistic, the design and development of the subsystem must be founded upon:

(UNCLASSIFIED TITLE) Data Processing Subsystem for ARS WS-117L

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(1) A definition and/or simulation of the raw data (end product) of the collection subsystems,

(2) An analysis of the uses of these defined end products; i.e., who wants what information, for what use, how often, and in what form.

Each separate use of the data must be studied to determine the processing steps involved from the initial receipt of the raw data through the production of a finished output which best satisfies that use. Once the end products of the collection subsystems are defined, a design for efficiently processing the information can be sensibly conceived. Simultaneously, research effort must be initiated to attack technical problems that threaten the development of vitally needed equipments. Large scale equipment development efforts will normally follow the completion and be guided by the system design framework and the results of the Equipment Application and Techniques Exploration Task. Following the equipment development and testing, the components will be combined, installed, and tested as a system to point out the final modifications and debugging required before it is operationally ready.

In order to meet the changing capabilities of the collection systems it will be necessary to conduct a continuing research and technical development effort on techniques and procedures for application to the more advanced facilities. The concept of the initial data handling center is one of relative simplicity. Limited amounts of mechanization and automation will be adequate to handle efficiently the early data yields of the ARS. This will provide the capacity for the orderly evaluation and development of more complex components to meet more stringent requirements as the system grows.

c. Tasks

The areas which will require development effort have been divided into general functional areas as listed below. As work progresses these tasks will require expansion to reflect various intelligence functional areas and/or to relate the development work required to the particular sensing technique employed. Operational characteristics, to the degree possible at this time, are included in the general design specification of the development plan.

(1) Task No. 39856 - Simulation of ARS Data Input

Contractor: Not Yet Determined

Technical Advisor: Mr. F. Kelly, RCWIO, Intelligence Laboratory
RADC, Rome, New York

The objective of this task is to realistically simulate all types of predicted end products of the successive collection versions of this system. These simulated end products should include the range of resolution, cover repetition and quantity values anticipated or possible. This data is

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fundamental in determining the usefulness of the raw data to the variety of potential users, and, consequently, the requirements for the processing involved. Results of this phase of the work will be the basis for the final design of the data-handling system and will determine the procedures and characteristics of the equipment needed to best satisfy the data processing requirements for each subsequent version of the reconnaissance vehicles.

(2) Task No. 39857 - Intelligence Data Processing System Design

Contractor: Not Yet Determined

Technical Advisor: Mr. R. Libby, RCWI, Intelligence Laboratory, Rome, New York

This task embraces the study work required to produce a design of a Subsystem (including procedures, equipment and technique) to efficiently transform the collected raw data into useable intelligence. Basic input data to this design study effort will be supplied in part by the simulation task. Possible uses of the collected product against the intelligence needs of major elements of the intelligence community as well as such factors as operational desirability, technical feasibility, and logistic supportability will be considered in arriving at the preferred system design.

(3) Task No. 39858 - Equipment Application and Technique Experimentation

Contractor: Not Yet Determined

Technical Advisor: 1st/Lt. A. Buckland, RCWIO, RADC, Rome, New York.

The objective of this task is to provide a source of technical know-how for individual application to the variety of functions and processes included within this subsystem and to single out apparent choke points in the data handling system against which investigative effort should be concentrated. It will provide input to the systems design group concerning the feasibility of techniques and equipments which exist or can be developed and made available for systems integration. The output of this task will be reports and technical data to form the basis for:

(a) Selection and modification of existing commerical and in-development equipment.

(b) the performance characteristics and specifications of the development items required, including the optimum technical approach.

(4) Task No. 39859 - Equipment Development

Contractor: Not Yet Determined

Technical Advisor: Mr. F. Kelly, RCWIO, Intelligence Laboratory, RADC, Rome, New York

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The objective of this task is to actively develop those hardware items which are not commercially available or in development, but required by this sub-system. Included will be modifications to existing equipment when appropriate to insure their maximum applicability. Guidance on the items to be developed and their functional specifications will stem from the Systems Design Task and the Equipment Application and Technique Experimentation task.

(5) Task No.39860 - Intelligence Data Processing Subsystem Integration and Test

Contractor: Not Yet Determined

Technical Advisor: Mr. R. Libby, RCWI, Intelligence Laboratory, RADC, Rome, New York

The objective of this task is the accomplishment of the overall contractor systems management functions to insure its operational availability, prescribed performance, and its working integration with the other parts of the intelligence system. It will include but not be limited to: the systems engineering, complete installation and equipping of the ARSIC, and the combined test of all individual items which comprise this subsystem under simulated and operational uses. Command Post Exercises (CPX) using products of the simulation program as well as test run data from the functional test of the visual, ferret, and infrared subsystems for input data will be accomplished to checkout and modify the individual component and overall subsystem procedures, operation, and performance.

(6) Task No. 39855 - Intelligence Parameters and Data Processing Subsystem Criteria Studies

Contractors: Planning Research Corporation
10966 LaConte Avenue
Los Angeles, California

Aero Services Corporation
210 East Courtland Street
Philadelphia, Pennsylvania

Physical Research Laboratory, Boston University
707 Commonwealth Avenue
Boston, Massachusetts

Ohio State University
Columbus, Ohio

Battelle Memorial Institute
505 King Avenue
Columbus, Ohio

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Broadview Research and Development
1127 Chula Vista Avenue
Burlingame, California

Task Engineer:

Mr. Frank Kelly, RCWIO
Intelligence Laboratory
RADC, Rome, New York

Task Technical Advisors:

Major W. E. Callanan, RCWIR
1/Lt. L. R. Buckland, RCWOO
1/Lt. R. E. Moss, RCWIO
Mr. A. L. Downing, RCWIP

Intelligence Laboratory
RADC, Rome, New York

Objective:

This task will provide analytical data as an input to the WS-117L Planning function to determine intelligence requirements and design criteria. It is aimed at determining the optimum detail, volume, and accuracy of the "sightings" to be made by the reconnaissance sensing equipments, by spelling out the information requirements of the users and translating these into meaningful quantitative terms and specifications. Effort will also be devoted to those areas relating the human behavioral characteristics to the intelligence processing and analysis functions. This study will include the exploration of possible applications of machine techniques for the automation of the "non-judgment" work areas within these functions.

(7) Task No. 39861 - Personnel, Training and Human Engineering Support

Contractor: Initially an In-House Effort. Eventaul contractor not yet determined.

Task Engineer: Dr. P. Bersh, RCSH, Human Factors Laboratory, RADC, Rome, New York

The objective of this task is to provide all necessary human engineering support for the Data Processing Subsystem. This task will develop criteria and specifications for training techniques, equipment, and simulators. It will also include the production of Qualitative Personnel Requirements Information (QPRI) covering all analysis, interpretation, operator and maintenance jobs required for the operational employment of this subsystem. The Data Processing Subsystem is extremely complex and, hence, the design of equipment and the integration of components into larger units must be accomplished in a manner which takes full cognizance of human capabilities and limitations. The gains to be achieved by appropriate human engineering will include:

(a) increased oper[redacted]nance efficiency.

DD Form 613 (cont.)

(b) reduction in the required time and complexity of training

(c) more timely and efficient processing of information throughout the entire subsystem.

d. (1) There will be no development duplication between this subsystem and systems 438L, 456, and 461L, but rather considerable effort will be made to take advantage and exploit the similarities of the programs for maximum trade off of the attained equipments and techniques. This subsystem will be made completely compatible with system 438L, and when operational, these systems will be mutually supporting and complimentary in nature.

(2) The operational employment of this system will require that the number of photographic interpreters and intelligence specialist trainees be increased, and the new techniques resulting from this development may require modification and expansion of the existing training programs.

e. Background History

The concept for using a satellite vehicle as a platform for reconnaissance equipment can be considered as the natural outgrowth of the requirement for obtaining intelligence information of a potential enemy whose area and security preclude its effective collection by ordinary aerial reconnaissance or other means. The need for timely and continuous intelligence information to assess a potential enemy's capabilities and probable intent has become more critical as the advancement of technology has given them offensive weapons with intercontinental range and greater destructive powers. The impetus which motivated the military establishment to foster work on new methods for collection of intelligence information came from the realization that current reliable pre-hostilities intelligence is required to insure proper direction of National Planning in development of effective counter-force weapons and counter-force strategy. The results of the numerous studies conducted since 1946 at the direction of the Department of Defense concluded that a Satellite Intelligence System was feasible and would satisfy to a great extent the requirement for intelligence information to aid the national planners in making decisions pertaining to counter-force strategy and development of effective measures against possible attack.

The concept of the Advanced Reconnaissance System is a result of studies conducted at the RAND Corporation. A study completed in 1947 together with similar investigations by other contractors concluded that a satellite vehicle was feasible as a reconnaissance vehicle but not as a weapon carrier. In 1950, the Research and Development Board vested satellite custody in the Air Force, and RAND was directed to explore its possible military utility.

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(UNCLASSIFIED TITLE) Data Processing Subsystem for ARS WS-117L 2 April 1957
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Recommendations for an expanded study of reconnaissance applications were made to the Air Staff in late 1950 and a formal report (RAND-217) followed in April 1951. Feasibility studies for critical subsystem initiated at that time were television (RCA), attitude control (North American Aviation), nuclear auxiliar power units (Bendix Aviation, Frederick Flader, Allis Chalmers, and Vitro Corporation).

Recommendations for the ARS development were made by RAND in November 1953, and these were followed by the final report (Rand-262) in February 1954. The Air Force requirement was written August 1954. Requests for proposal for systems studies were made March 1955, and the studies leading to this development plan began in June 1955 and were completed in June 1956.

The present concept of operation of the Satellite Intelligence Center was evolved as a combined effort of the Intelligence Laboratory, RADC, and the various Air Force commands. As the development of the system progresses, the concept of operations may be re-evaluated in light of changing requirements with modifications anticipated.

f. Future Plans

The extent of future plans is outlined in Tab 1, General Design Specifications. Revisions to the basic plan will be accomplished throughout the development cycle to insure timely and valid decisions.

g. References

1. RAND Corporation Report R-217, April 1951.

2. RAND Corporation Report R-262, February 1954.

3. Systems Requirement No. 5 dated 27 November 1954, revised 17 October 1955.

4. GOR No. 80 (SA-2C) dated 16 March 1955.

5. DD Form 613, entitled "Advance Reconnaissance System: Project No. 1115", dated 19 April 1955, RCS: DD-R&D/A/119.

6. Project 1115, Task 15000 (Uncl) "Intelligence Parameters Study for Advanced Reconnaissance System".

7. Project 1115, Task 15001 (Uncl) "Study of Intelligence Processing Methods for Advanced Reconnaissance System."

8. RADC Document entitled (Uncl) "Intelligence Requirements as Developed for the 1960-65 Time Period," dated 1 June 1955, Control Nr NI-2443.

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(UNCLASSIFIED TITLE) Data Processing Subsystem for ARS WS-117L 2 April 1957
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9. ATIC Document entitled (Uncl) "Technical Intelligence Considerations for Advanced Reconnaissance System 1115," dated 11 October 1955, Control Nr. T55-18539.

10. ACIC Document entitled (Uncl) "Study of Position Information Needs," dated 1 April 1955, control Nr. D5-6800-1.

11. Document entitled (Uncl) "United States Air Force Indications Plan" (Short title - USAFIP), dated 16 November 1955, prepared by the Directorate of Intelligence, HQ. USAF, Washington, D. C., Control Nr. NR. NI-5986. (Collection Plan covering strategic Warning Indicators).

12. System Requirement No. 13 dated 14 January 1955; amendment No. 1 dated 10 August 1956.

13. System 438L, Project 4586 and all associated tech and project reports.

Tasks:

45888 - Operational Intelligence Data Processing Equipment
45823 - Weather Data Automatic Reader
45828 - Reconnaissance Systems Integration
45830 - Automatic IBDA Processor
45831 - Automatic Target Analyzer

14. System 438L, Project 4588 and all associated task and project reports.

Tasks:

45889 - Intelligence Data Handling System Design Task
45890 - Machine Fact Correlation for Intelligence Analysis
45893 - Indexing Intelligence Documents for Automatic Machine Retrieval

15. System 438L, Project 4591 and all associated task and project reports.

Tasks

45910 - Basic Minicard Equipment
45911 - Minicard Conversion Equipment
45912 - Lens Components
45913 - Minicard Camera & Enlarger for Aerial Photographs
45914 - Remote Televiewer for Minicard Display
45916 - Viewer Processor MX-1993-G

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DD Form 613 (cont.)

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16. Project 4597 and all associated task and project reports

Task

45331 - Communication Intercept System Design

17. Project 4594 and all associated task and project reports

Tasks

45940 - Intelligence Classification and Indexing Techniques
45941 - Intelligence Coding Techniques
45820 - Intelligence Data Presentation Techniques
45822 - Intelligence Data Retention and Retrieval Techniques

18. Project 4599 and all associated task and project reports

Task

45861 - Photo Interpretation Mechanization

19. Project 5500 and all associated task and project reports

Tasks

45910 - Radar Target Data Processor
45902 - Infrared Target Characteristics and Utilization
45903 - Infrared Data Analysis

20. System 438L, Project 5532 and all associated task and project reports.

Tasks

45925 - Major Elint Processing Central
45926 - RADINT Data Processing

21. System 438L, Project 5533 and all associated task and project reports.

Tasks

45960 - Rapid Intelligence Data Handling System Design
45961 - Military Tel autograph Development

(UNCLASSIFIED TITLE) Data Processing Subsystem for ARS WS-117L

2 April 1957
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Tasks (cont.)

45962 - Magnetic Tape Duplicator/Transmitter Development
45963 - Geographic Indexing, Searching and Plotting

h. Coordination and Signature Block

HAROLD F. WIENBERG
Major, USAF
Project Engineer

FREDERIC C. E. ODER
Colonel, USAF
Asst. for WS 117L

DATA PROCESSING SUBSYSTEM FOR ARS, WS117L

General Design Specification

1. General

a. Statement of the Problem

(1) The primary problem involves the establishment and implementation of a realistic program to insure the timely design and development of an efficient Intelligence Data Processing Subsystem. This subsystem must possess the capability of transforming the variety and steadily increasing volume of raw data collected by the WS-117L, as programmed in the combined operational and development schedule, into meaningful intelligence which satisfies user requirements. The fundamental objective and requirement expressed by GOR No. 80(SM-2C) dated 16 March 1955 and SR No. 5 dated 17 October 1955 is to develop the WS-117L to be of maximum value to the U.S. Intelligence Community and key decision making agencies and individuals. The WS-117L will be an addition to the operating USAF Intelligence Collection System. It will have the unique capability of providing a substantially continuous "look" at those areas and things which are of primary and critical importance to the Department of Defense and other key government agencies, such as the Department of State. It is anticipated that the constant high rate, high volume collection capability of the WS-117L will greatly exceed the standard data handling capabilities of the intelligence organization. The planned USAF intelligence organization and structure will therefore require systemitized augmentation with equipment, techniques, procedures, and people to effectively utilize this newly collected product. The timing and development of this subsystem must mate with the ARS development and operation and must be compatible with, support, and receive feedback from the other elements of the intelligence system.

(2) The fact that the WS-117L will provide the capability of obtaining intelligence information of areas heretofore inaccessible to other collection methods makes it mandatory to obtain maximum operational utility of the system during the development phase. Hence, there is a requirement for essentially three versions of the Intelligence Data Processing Subsystem phased timewise to match the developmental growth and capability of the collection system. The problem is to insure sufficient capacity within the Data Processing Subsystem during its development to efficiently utilize the increasing volume of data collected by the various development versions of the satellite vehicle.

b. Approach

(1) The approach as set forth in the subsystem plan is based on an evolutionary concept to:

(a) Secure useable information at the earliest possible time.

Data Processing Subsystem for ARS, WS-117L (cont.)

(b) Encourage a pattern of normal development growth toward improved versions based on the relationship of operational experience and firm knowledge of the product defining needs.

(c) state of the art development, defining possible improvements in information yield (quantity and quality) and efficiency of handling (timeliness and reliability).

(2) It is intended that this subsystem development be phased to match the realistic operational demands and requirements for the WS-117L product, and to be compatible with the volume and type of system collection capabilities for each subsequent version of the reconnaissance vehicle. It will therefore be required to serially:

(a) Engage in studies and work leading to a data handling system design and simultaneously conduct technique research oriented towards the requirements for the initial and interim operating systems.

(b) Initiate the required equipment development programs and perform required engineering to install and test the system while concurrently conducting research on techniques and procedures for applications to the more advanced facilities.

c. Solution

(1) The philosophy underlying the development of the Data Processing Subsystem is based on conclusions arrived at through studies accomplished since 1946 by the United States Air Force and various scientific organizations. These conclusions are summarized as follows:

(a) Intelligence information of vital importance to the nation can be obtained by a Satellite Intelligence System.

(b) A Satellite Intelligence System is technically feasible and is practical for development at this time.

(2) The success of the overall program is dependent upon the following factors which apply specifically to the Data Processing Subsystem:

(a) Continual cooperation and coordination between the United States Air Force and industry throughout the development of the WS-117L Weapon System.

(b) The timely occurrence of decisions throughout the system development to insure scheduling of effort to meet the operational dates established for the WS-117L Weapon System.

Data Processing Subsystem for ARS, WS117L (cont.)

(c) The integration of personnel, techniques, procedures and equipment through a growth program concept where the system is transformed from the more simple to the complex. The growth will be in the direction of increasing the capacity of the Data Processing Subsystem to handle higher quality and greater quantity of more diverse data, i.e., visual, ferret and infrared, accurately and rapidly.

(3) The WS-117L unique feature which offers a continuous surveillance capability while enjoying high relative physical invulnerability over presently inaccessible areas must be exploited. It should be initially viewed as a revolutionary extension of aerial reconnaissance, with its collected products immediately processed, evaluated and supplemented by pertinent collected data from all appropriated sources.

(4) In order to design a Data Processing Subsystem to support a collection system as unique as the ARS, all of the eventual uses of the data must be known. Each separate use of the ARS data must be studied in order to discover all of the processing steps involved from the receipt of the input ARS information to the production of a finished output which satisfies that use. Once the uses of ARS data are determined, a subsystem design framework can be worked out. Simultaneously research effort can be started to attack technical problems that threaten the successful development of required equipment. With the subsystem design framework completed, equipment developments can be started aided by the results of the foregoing research. Individual equipment testing will precede the installation and final integration to test and operate the subsystem.

The Data Processing Sub-System design has been divided into a series of tasks. The division is based on time phasing rather than function, and as it is planned, the overall systems development will progress from the first to the last. The general tasks areas are as follows:

(a) Intelligence Parameters and Data Handling Criteria Studies

(b) Simulation of ARS Data Input

(c) Subsystem Design.

(d) Equipment Application and Technique Exploration

(e) Equipment Development.

(f) Data Processing System Integration and Test

(g) Personnel Training and Human Engineering Support.

Data Processing Subsystem for ARS, WS117L (cont.)

(5) Simulation of ARS collected product. In order to specify the uses of the ARS data, a simulation program must be carried out. Photographic output at simulated ARS resolution and quantity taken at ARS repetition frequencies must be obtained and analyzed. Ferret and Infrared collection outputs will also be accurately simulated. Working groups consisting of prospective intelligence users and the subsystem designers will collectively determine the usefulness of the data, and outline the requirements for the processing involved. These results will be used in a subystem design phase which will determine the procedures and characteristics of the equipment needed to satisfy the processing requirement.

(a) Photographic cover will be produced of the following types of targets at accurately simulated ARS scale VS resolution, commensurate with the various planned ARS configurations. This requirement will involve high altitude flights with short focal length cameras of known areas, which have both seasonal and non-seasonal changes, and slow change versus anticipated rapid change in construction, movement, etc.

(1) Missile Test Centers

(2) Urban Areas

(3) Airfields

(4) Industrial Areas

(5) AEC Sites

(b) Repetitive photgraphic cover of the above selected target areas will be produced at normal small serial reconnaissance scales, approximately 1/10,000, so that the photo interpretation can be made on a week-to-week basis, unencumbered by exceedingly small scales.* This effort will provide basic photo cover upon which P.I. studies should be made to determine the full effect such repetitive cover has on operating procedures, information extraction techniques and to uncover the data processing problems involved in handling this information.

*This photo cover should be flown on a schedule 2-3 times/week daytime basis (random time selection) and following a supply build up of new data should be expanded to include repetitive night cover of the same areas for comparison.

Data Processing Subsystem for ARS, WS117L (cont.)

(c) Laboratory methods will be developed to degrade conventional aerial photgraphs so that they are respresentative of the ARS scales, resolution and contrast. These photographs should be the best representation of ARS photography that can be obtained without making high altitude flight tests. The purpose of developing such degrading methods is to provide simulation data as soon as possible to minimize the delay involved in obtaining ARS type flight test data.

(d) Close work with members of the intelligence community and other agencies noted below will be required to determine the possible users of the simulated photography obtained in (a) and (b). The results of this investigation will provide fundamental data paramount to the efficient design of the Data Processing Subsystem:

(1) ACIC

(2) D/I Hq USAF

(3) Weapon System Offices (Weapon Guidance Input)

(4) 438L

(5) Hq SAC

(6) Hq TAC

Estimates will be made of the quality of ground received data required to satisfy requirements of the users (with the aid of further simulation) to provide meaningful goals and objectives to the collection subsystem developments as well as providing criteria concerning volume, flow pattern, analysis techniques, dissemination nets, etc., for the data handling subsystem designs. Simulation of the data input produces by the ferret and infrared configurations of the ARS must also be made. For any given ferret sensor and ground environment, the quantity and form of the data will be calculated and simulated. In conjunction with appropriate intelligence organizations this simulated ferret data will be examined to determine its possible utility. Electronic intelligence and communications intelligence data, quality and volume estimates needed to satisfy user requirements will be made to provide guidance to sensor developments and criteria for design of the improved Data Processing Subsystem.

(6) Subsystem Design. The Data Processing Subsystem will be designed to provide for the efficient handling of the data collected by the various configurations of the ARS vehicles. The data obtained from the simulation program will be a basic input to this subsystem design and will provide the means of realistically determining user needs. Equipment developments will be undertaken for all of the components of the subsystem

Data Processing Subsystem for [redacted] WS117L (cont.)

as specified by this design. The subsystem design phase will be a continuous effort, and using simulated data of improved versions of the ARS, future requirements and growth of the Data Processing Subsystem will be studies. In this way, the early subsystem can be designed with general awareness of future system requirements, and hence, should provide a framework for improvements. The problem of centralized vs decentralized data processing cost, the technological and operational implications of ground to ground transmission of data between ground intercept stations as a function of realistic delay time, as well as user requirements must be examined and incorporated in the initial subsystem design studies. A continual investigation of existing, anticipated, and new ARS requirements, together with ARDC technical developments and applicable commercial developments will be programmed during the major portion of the cycle.

(7) The Equipment Application and Technique Experimentation Task, and the Equipment Development Task will be accomplished as outlined in the project plan. There are no specific items noted at this time since it is intended to base hardware developments on a firm knowledge of the potential input to the photo interpretation group (and hence utility) and on a well designed system basis.

(8) Data Processing Subsystem Integration and Test. This work will be done in two phases:

(a) research investigation leading to the preparation of detail design specifications for fabrication purposes for the installation and equipping of the ARSIC for purposes of research and development test of the subsystem under simulated and operational use;

(b) complete installation of subsystem equipment necessary to efficiently handle the pioneer-type visual reconnaissance data is desired by 1 March 1960.

During the intervening 6 months period, between that date and the 1st high latitude scheduled launch, CPX-type operations using products of the simulation program for input data will be accomplished to check out and modify the individual component and overall system procedures and performance. This installation will consist of equipment conforming to the best commercial engineering practices and where practicable equipment conforming to applicable JAN specifications.

(a) This work will include but not be limited to:

1. Procurement specifications data for all equipment items necessary for operation of the ARSIC (excluding items in the AF inventory).

2. Equipment quantity and organizational location lists for implementation of the ARS data handling subsystem.

Data Processing Subsystem for ARS Activity (cont.)

3. Qualitative personnel requirements information for operation of the ARS data handling subsystem.

4. Facility requirement estimates and plans necessary for implementations of the ARS data handling subsystem on a research and development operational test basis. These will include, but not be limited to, the following (this excludes facility cost, but includes equipment lay out restrictions):

(a) Space

(b) Accessory equipment

(c) Air conditioning equipment

(d) Power

(e) Communications channel

(f) Security (physical and communication requirements)

5. Nomenclature description data for each component equipment and major equipment group of the subsystem. These descriptions will contain a functional description of the item and will be submitted as soon as the essential mechanical and electrical characteristics for descriptive purposes are determined.

6. Proposed operational procedures for effective operation of the subsystem and integration of its output with the elements of the 438L System. These will include definitive data flow charts, file-up grading procedures, and special computer programs, in such detail that personnel trained in operation of the equipment per se and capable of performing existing photo interpretation processes could implement the subsystem on a trial basis. Operational procedures evolved while optimizing the efficiency of this subsystem will correspond to existing organizations and procedures insofar as possible.

7. Estimates (cost and manpower) for contractual technical services for the subsystem (facilities provided) in order to operate it on a one year research and development operational test basis. This will include services for error and reliability check outs.

8. Estimates of consumable material required for operation of the subsystem on a one year research and development operational test basis (tape, ribbons, films, processing materials, etc.).

9. Completion of a detailed ARS data processing testing program to be accomplished in the 6 month CPX test phase, which program is designed to check out system performance, reliability, saturation points, saturation behavior, etc.

Data Processing Subsystem for ARS WS117L (Cont.)

d. Time Sequence of Development:

(1) As previously stated, the Data Processing Subsystem must provide for the orderly transformation of the raw data collected by the reconnaissance satellites into meaningful intelligence. The requirement for rapid processing of intelligence information is acute, and the problems of speed are of higher priority than ever before. Storage and recall components which encompass large storage capacity in small space must provide intelligence information in a very short search time basis for all users.

(2) The development of the subsystem will be from the simple requirements of handling the gross pioneer product to the more complex requirements of handling the larger detailed visual product as well as products of the ferret and infrared collection media. The general scheduling of the systems and their brief description follows:

(a) Initial Subsystem - October 1960 - The basic subsystem configuration must be chosen to achieve the minimum modification to existing Air Force data handling systems now in R&D. This subsystem must be of unitized design, so that later developments in component processing equipment (based on the improved collection techniques by later versions of the satellite) may be incorporated without altering the "basic" subsystem concept. This in fact may be composed of many persons with easily developed assists to the information extraction process rather than automatic equipment. This system must have the capability of meeting the moderate functional requirements necessary to support the initial reconnaissance capabilities during this period and be compatible with other elements of the Operating Intelligence Data Handling System.

(b) Interim Subsystem - October 1961 - The subsystem configuration must be firmed up during FY-60. Packaging of components, including necessary modifications to commerical and/or military components developed under the initial subsystem must be completed during the latter part of FY60, and complete subsystem tests must be accomplished in time to insure a data reduction facility capable of handling the advanced photographic and ferret versions of the satellite. Again, the processed output must be compatible with the Operating Intelligence Data Handling System. The volume of ARS collected data will be approximately three (3) times that of the initial system.

(c) Final Subsystem - July 1963 - This subsystem will consist of operational versions of data processing equipment, techniques and procedures not now recognized, but resulting from the logical development of the previous two subsystems. Much of the final equipment will come about as a result of solutions to subsystem operational problems encountered in the initial and interim subsystems. The primary output of the system will be all source evaluated ARS semi-finished and/or finished intelligence which will be

Data Processing Subsystem for ARS WS117L (cont.)

fed into the Operating Intelligence Data Handling System existing in this period and disseminated to other special elements of the intelligence system. The volume of ARS collected data will be approximately three (3) times that of the interim system and ten (10) times that of the initial system.

(3) The technical responsibility for the task areas listed below must be combined into one contract in order to most efficiently accomplish the objective of this subsystem:

(a) Subsystem Design

(b) Equipment Application & Technique Exploration

(c) Equipment Development

(d) Data Processing Subsystem Integration and Test.

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1.

R & D SCHEDULE

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

3. DATE: 2 April 1957

4. TITLE: (UNCLASSIFIED TITLE)
DATA PROCESSING SUBSYSTEM FOR ARS, WS 117L

5. INITIAL ☒ CHANGE ☐

6. NUMBER: 1763

SCHEDULE

CALENDAR YEARS: 1957 | 1958 | 1959 | 1960 | 1961 | 1962 | 1963 TO COMPL

TITLE	PROJECT OR TASK NR
Data Processing Subsystem	P-1763
- Tasks -	
Intelligence Parameters & Data Processing Criteria Studies	39855
Simulation of ARS Data Input	39856
Intelligence Data Processing System Design	39857
Initial System	
Interim System	
Surveillance System	
Equipment Application & Technique Exploration	39858
Initial System	
Surveillance System	
Equipment Development	39859
Initial System	
Interim System	
Surveillance System	

Contract will be Awarded Task No. 39855 by 21 May 1957
Contract will be Awarded Task No. 39856, 39857, 39858, 39859, 39860, by 30 June 1957

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1.

R & D SCHEDULE

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

4. TITLE
(UNCLASSIFIED TITLE)
DATA PROCESSING SUBSYSTEM FOR ARS, WS-117L (cont'd)

3. DATE
2 April 1957

5. INITIAL ☒
CHANGE

6. NUMBER
1763

SCHEDULE

TITLE	PROJECT OR TASK NR	CALENDAR YEARS: 1957 (J A S O N D) · 1958 (J F M A M J J A S O N D) · 1959 (J F M A M J J A S O N D) · 1960 (1 2 3 4) · 1961 (1 2 3 4) · 1962 (1 2 3 4) · TO COMPL (1 2 3 4)
Tasks (cont'd)		
Engineering for Data Processing Subsystem Implementation		
Installation and Test	39860	
Initial System		B C O P E
Interim System		B C O P E
Surveillance System		B C O P E
Personnel Training and Human Engineering Support	39861	
Initial System		A Q C O P E J
Interim System		A Q C O P E K
Surveillance System		A Q Q
Contract will be Awarded Task Nos. 39856, 39857, 39858, 39859, 39860, by 30 June 1957.		

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KEY

A. Contract Awarded

B. Fabrication of development model started (Prototype flight article)

C. Development model fabrication completed (Prototype flight article)

D. End of contractor compliance testing of development model (Acceptance test)

O. Ground Test starts

P. Integration with first flight (Completion of ground test)

E. Completion of functional testing of development model to demonstrate capability (After flight test approval)

J. Preparation of procurement data (End)

K. Production engineering (End)

Q. Design studies completed

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1.

R & D MATERIEL ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

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4. TITLE
(UNCLASSIFIED TITLE) DATA PROCESSING SUBSYSTEM FOR ARS, WS 117L

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2 April 1957

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1763

7.

Cost Estimates:	SUPPLY	MAINTENANCE	TRANSPORTATION	COMMUNICATIONS	TOTAL
Gross:	1,500,000				
Net:	1,500,000				

8. SUPPLY & EQUIPMENT

Nomenclature Including S/N	Estimated Unit Cost	Total Requirements				Time Phased Net $ Requirements			
		Grs Qty	Gross Cost	Net Qty	Net Cost	FY 56	FY 57	FY 58	FY 59
Minicard System, AN/GSQ-11 Complete	1,500,000	1	1,500,000	1	1,500,000				1,500,000

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1.

R & D MANPOWER ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

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3. DATE: 2 April 1957

4. UNCLASSIFIED TITLE: DATA PROCESSING SUBSYSTEM FOR ARS, WS117L

5. INITIAL ☒ CHANGE ☐

6. NUMBER: 1763

7. ORG COMP CODE	8. ORGANIZATION TITLE	9. TYPE ORG	10. ACTUAL MAN-QTRS LAST QTR	11. PROJECTED DIRECT MAN-YEARS						
				FY 19 58		FY 19 59		FY 19 60	FY 19 61	TO COMPL
				AVAL	RQRD	AVAL	RQRD	RQRD	RQRD	RQRD
WDTR	WS117L Project Office WDD	R	1	1	1	1	1	2	2	*
RCWIO	Intelligence Lab, RADC	R	5	4	4	4.8	7.5	12.5	14.0	*
RDSH	Human Factors Lab, RADC	R	0	0	0	1.0	2.0	2.0	2.0	*
	TOTAL:		6	5	5	6.8	10.5	16.5	18.0	*
	Total Manpower Dollars:		10,320	36,400	36,400	49,500	74,400	120,100	131,000	655,000

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1\.

R & D CONTRACT FUNDS ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2\. REPORTS CONTROL SYMBOL

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3\. DATE 2 April 1957

4\. TITLE
(UNCLASSIFIED TITLE)
DATA PROCESSING SUBSYSTEM FOR ARS, WS 117L

5\. INITIAL ☒ CHANGE

6\. NUMBER 1763

7. ITEM	8. PROJ OR TASK NR	9. END ITEM CAT	10. CONTRACT NUMBER	11. BPSN	12. PREV YRS 600	PREV YRS OTHER	13. FY 57 600	FY 57 OTHER	14. FY58 600	FY58 OTHER	15. FY 59 600	FY 59 OTHER	16. FY60 600	FY60 OTHER	17. TO COMPL 600	TO COMPL OTHER
Data Processing Subsystem	1763	E		2-117	513M		969M		2000M		6000M		6000M		27000M	
				P-200 Funds:				880M		3500M		4230M		5000M		13000M
TOTAL					513 M		969 M	880 M	2000 M	3500 M	6200 M	4230 M	6000 M	5000 M	27000 M	13000 M

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R & D COST ESTIMATE ~~REGISTRATION~~ ~~CONFIDENTIAL~~

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

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3. DATE 2 April 1957

4. UNCLASSIFIED TITLE: Data Processing Subsystem for ARS, WS 117L

5. INITIAL ☒ CHANGE

6. NUMBER 1763

ITEM		A. PREVIOUS YEARS		B. FISCAL YEAR 57		C. FISCAL YEAR 58		D. FISCAL YEAR 59		E. TO COMPLETE	
		600	OTHER	600	OTHER	600	OTHER	600	OTHER	600	OTHER
7.	A. TOTAL	513M		969M	880M	2000M	3500M	6200M	4230M	19000M	32000M
CONTRACT	B. AVAILABLE			969M							
	C. NEW REQ				880M	2000M	3500M	6200M	4230M	19000M	32000M
8.	A. TOTAL								1500M		
MATERIEL	B. AVAILABLE										
	C. NEW REQ								1500M		
9. FACILITIES											
10. MANPOWER		10.3M		36.4M		74.4M			120.1M		768.0M
11. TRAINING			N/A								
12. TEST ITEMS			N/A								
13. TEST SUPPORT AIRCRAFT			N/A								
14. SUBTOTAL		513M		969M	880M	2000M	3500M	6200M	5730M	19000M	32000M
15. TOTAL		523.3M		1885.4M		5574.4M		12050.1M		51786.0M	

AFDC FORM 1 JUL 55 116 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

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~~SECRET~~

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AFB-51-61101

R&D PROJECT CARD	TYPE OF REPORT: Rewritten Project	REPORT CONTROL SYMBOL: DD-R&D/A/119

1. PROJECT TITLE (UNCLASSIFIED Title) a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L POSS)

2. SECURITY OF PROJECT: SECRET

3. PROJECT NO.: 8728

4. INDEX NUMBER: 2-117

5. REPORT DATE: 2 April 1957

6. BASIC FIELD OR SUBJECT: Strategic Air Warfare System (117L)

7. SUB FIELD OR SUBJECT SUB GROUP: Personnel Utilization, 65

7A. TECH. OBJ.:

8. COGNIZANT AGENCY: Air Research and Development Command Western Dev.Div.

9. DIRECTING AGENCY: AFPTRC

10. REQUESTING AGENCY: Hq USAF

11. PARTICIPATION AND/OR COORDINATION
AMC (I) ACIC-I
APGS (I) USN/CND-I
ATC (I) USA/C/S-I
SAC (I) Other AFC-P
ADC (I)
CIA (I)

12. CONTRACTOR AND/OR LABORATORY
Lockheed Aircraft Corp
Office for QPRI
Maintenance Laboratory
Operator Laboratory
Personnel Laboratory

CONTRACT/W. O. NO.: AF04(647)-97

13. RELATED PROJECTS: WS-117L

17. EST. COMPLETION DATES
RES.
DEV. Dec 1960
TEST
OP. EVAL.

18. FY	FISCAL ESTIMATES
56	[illegible]M
57	22[illegible].8M
58	156.0M
59	164.0M
60	124.0M
Total	467.0M

14. DATE APPROVED

15. PRIORITY: 1A

16. MAJOR CATEGORY: A(Missiles)

19. REPLACED PROJECT CARD AND PROJECT STATUS
This rewritten report supersedes New Project Report on this project dated 28 February 1956

20. REQUIREMENT AND/OR JUSTIFICATION

Requirement for this project was established by ARDC System Requirement No. 5, dated 17 October 1955, which directed this Center to support the preparation of a System Development Plan. Responsibility for technical support in the execution of the WS 117L Development Plan was assigned under the provisions of ARDC System Development Directive No. 117L, dated 17 August 1956. Specific approval for inclusion of project for development of Qualitative Personnel Requirements information (QPRI) was contained in Amendment No. 2 to SDD No. 117L, dated 1 October 1956. ARDC Project Development Directive No. 8728, October 1956, directed implementation of this Center's plan for development of QPRI (Project Development Plan No. 8728, dated 28 February 1956) for WS 117L. Requirement for re-writing the original plan for development of QPRI for WS 117L was established as a result of two separate actions First: the Weapon System Project Office (WDD) directed each Center concerned with the development of WS117L to rewrite project development plans to align objectives in consonance with the Statement of Work which was prepared recently for contractual negotiations, reference 21i(7). Second: the application of existing research techniques in the areas of job analysis and description, training programming, training equipment requirements and evaluation will provide valuable support to the development of the personnel sub-system of WS117L. This project is designed to yield optimum information needed by planning agencies concerned with the personnel and training aspects of weapon system 117L.

22. OASD (R&D)	SN.	CN.	C.	X.	I.	C.

DD FORM 1 APR 58 613
REPLACES DD FORM 613, 1 JAN 58, WHICH MAY BE USED.

UNCLASSIFIED

GPO 899936

(UNCLASSIFIED Title) a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L POSS)

21a. Brief of Project and Objective:

The development of this project will utilize the technical and operational capabilities of the Air Force Personnel and Training Research Center in the production of systematic information relevant to the personnel and training requirements of the total weapon system 117L development plan.

21b. Approach:

This project will require both contract and inservice efforts to facilitate correlation between personnel subsystem development and equipment development. Initially, great reliance will be placed upon the prime contractor to develop and systematically integrate information derived from conceived equipment design. Information will be prepared by the contractor with consultative and technical monitoring effort on the part of the AFPTRC project officer. Contract work in support of task efforts and in-service efforts are indicated below.

21c. Tasks of the Project:

(1) Task 87151-IMPLICATIONS OF DESIGN.

(a) Contractor: Work under this task will be accomplished primarily by the prime contractor, with consultative and technical guidance furnished by Project Officer, this Headquarters.

(b) Objective: To provide the preliminary data needed to prepare an early report, or reports, which will forecast the general personnel subsystem requirements and the personnel and training problems that adoption of the system may generate.

(c) Approach: Since this weapon system does not readily lend itself to the concept of control by a major air command or primary interest by a single agency of the Air Force, consideration will be given to the thorough exploration of the personnel implications under various operating-controlling conditions. Basically, the report(s) will attempt to define problems which will be generated by both operational plans and equipment design In so doing, consideration will be given to the relationship of WS-117L to WS-107A-1 and possibly WS-107A-2 and the findings of previous research in support of these latter systems.

(UNCLASSIFIED Title) a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L POSS)

(2) Task 87300-QUALITATIVE PERSONNEL REQUIREMENTSJINFORMATION.

(a) Contractor: Data will be collected and assembled by the prime contractor for the production of reports which will be phased with equipment design and development.

(b) Objective: To provide manning document information, position descriptions, and personnel selection information regarding the total personnel subsystem of WS117L.

(c) Approach: Effort in this area will be directed toward the development of information which can be used to describe technical jobs associated with the operation and maintenance of the system. From these descriptions, forecasts of required skills and knowledges will be made. Early identification of skills and knowledges and subsequent classification, if possible, within the Air Force personnel system will permit forecast of training requirements. Information derived in the development of the foregoing area will be used for manning information when operational and maintenance concepts are stabilized

The QPRI report will comprise four sections: General Information, Manning Document Information, Training Equipment Requirements Information, and Information on Special Problem Areas. The format of the report will be patterned after AFPTRC QPRI reports which have been published for ballistic missile systems.

Section one, General Information, will describe the general purpose and function of the system, as well as stated or assumed concepts of operation and maintenance.

Section two, Manning Document Information, will: identify all equipment-associated operator and maintenance positions; indicate tasks performed within each job-position; indicate skill levels required for those positions requiring new personnel skills; and reference Air Force specialties which most nearly identify the job-positions.

Section three, Training Equipment Requirements Information, will identify in general terms the special training devices which will be needed to impart new skills required for the operation and maintenance of the weapon system. Further action in this area is defined in a subsequent task.

Section four, Special Problem Areas, will include an expansion of the problem areas (identified in the "Implications of Design" report) which can be isolated under a specific set of conditions. This portion of the report will identify personnel problems of an organizational and/or command nature.

(UNCLASSIFIED Title) a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L POSS)

(3) Task 87152-TRAINING PROGRAMS AND PROCEDURES.

(a) Contractor: None.

(b) Objective: To make recommendations for the training program and training procedures to be used to obtain skills required by operator and maintenance personnel of the system.

(c) Approach: Recommendations for specific training procedures will be made in consonance investigative findings from prior tasks. Emphasis will be given to those areas in which the training of skills may prove particularly significant and difficult.

(4) Task 87153-TRAINING EQUIPMENT CHARACTERISTICS.

(a) Contractor: Preparation of a report on the training characteristics of required trainers will be an in-service effort. Previous contractual efforts will be used, if applicable.

(b) Objective: To identify the special training devices required for the WS-117L training program and define the characteristics of the individual trainers.

(c) Approach: Consideration will be given to the adaptation and/or modification of research instruments into prototype training devices. Also, attention will be given to the possible use and/or adapting of special training devices, developed for the ballistic missile training program, which possess characteristics identified by this task effort, e.g., Radar Tracking and Guidance Computer Trainer.

(UNCLASSIFIED Title) a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L POSS)

(5) Task 87154-PROFICIENCY TEST DEVELOPMENT.

(a) Contractor: To be determined. Partial in-service effort by Personnel and Maintenance Laboratories monitored by this Headquarters.

(b) Objective: To provide valid tests of the job knowledge, skill, and achievement varity for measuring the progress and/or proficiency of operating and maintenance personnel.

(c) Approach: This activity will consist essentially of establishing, monitoring and evaluating the test materials to be produced on a contract basis.

(6) Task 87155-HANDBOOKS AND JOB AIDS

Further detail on this task will be provided as the system progresses.

(7) Task 87156-TRAINING EQUIPMENT TESTING

Further detail on this task will be provided on this task as system development progresses.

21d. Other Information.

(1) General. The information basic to the preparation of reports required by Task 87151 and Task 87300 efforts will be obtained through contractual effort. Publication of these reports on a contractual basis may be accomplished with this Headquarters acting in a consultative and monitoring capacity. It is anticipated that contract funds in the amount indicated in ARDC Form 110 will be programmed through funding action to be taken by the Weapon System Project Office for WS 117L.

Tasks 87152, 87153, 87154, 87155, and 87156 have been included under the assumption that Tasks 87151 and 87300 will produce information which indicates further effort should be expended to meet an Air Force requirement for information in the areas covered by these tasks. However, further development effort will not be expended in those task areas in which the associated final activities are purchased by the Air Force as a contract-service, e g. Task for development of handbooks and job aids will not be undertaken if it is determined manning on a contractual basis is required or desired.

(2) Survey of Existing Standardize Equipment or Techniques.

None except as discussed in Task 87152 and Task 87153.

(UNCLASSIFIED Title) a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L POSS)

(3) Survey of Similar Equipment in Progress of R&D.

Survey will be made to determine possible adaptation of research instruments into special training devices. Similar exploration will be made in the area of trainers being developed for ballistic missile systems.

(4) Replacement Recommendations. None.

(5) Statement of Effects.

This project will yield information useful to the agencies responsible for programming the personnel and training programs required to properly man WS 117A.

21e. Background History and/or Progress.

Since the writing of the initial project card, several visitis have been made to WSPO to determine funding status and to obtain general information on status of system development. As previously mentioned, representatives from this Center participated in preparation of statement of work for contractual negotiations. WSPO clearance was obtained to make initial contacts at contractor facility to discuss development plan relevant to the personnel subsystem. System contractor personnel were familiarized with the QPRI program and the nature of tasks involved in the development plan for personnel and training problems. Visit to contractor revealed that competent staffing has been accomplished to perform the caliber of work desired. Arrangements have been made to furnish contractor with format guides for reports to be published under this development project.

21f. Future Plans. Tentative arrangements were discussed with prime contractor for publication of Task 87151 report during June 1957. Also discussed were plans for publication of initial QPRI report (Task 87300) during December 1957 or early January 1958.

The project officer will maintain close contact with WSPO to establish proper phase relationships of project effort with equipment development status which is, in turn, largely dictated by funding action.

21g. References.

(1) ARDC System Requirement No. 5, dated 17 October 1955.

(2) Project Development Plan No. 8728 (DD Form 613), 28 February 1956.

(3) WS 117L Development Plan (WDD), 2 April 1956.

(UNCLASSIFIED Title) a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L POSS)

(4) ARDC System Development Directive No. 117L, 17 August 1956.

(5) Amendment No. 2 to ARDC SDD No. 117L, 1 October 1956.

(6) Project Development Directive No. 8728, October 1956.

(7) Letter WDTR, Hq ARDC, 18 December 1956, subject, "Meeting of Technical Advisors to WS 117L".

21h. Coordination and Signature Block.

Responsible Center, AFFTRC.

~~Fred~~ Roberts Lt Col

For STANLEY VALCIK
Major USAF
QPRI Project Officer

THOMAS WILDES
Col USAF
DCS/Operations

~~Frederic K. Oder~~
FREDERIC C. E. ODER
Colonel, USAF
Assistant for WS 117L
Technical Operations (WDD)

1.

R & D SCHEDULE

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

3. DATE: 2 April 1957

4. TITLE (UNCLASSIFIED Title) a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L POSS)

5. INITIAL ☐ CHANGE #1

6. NUMBER: 8728

SCHEDULE

TITLE	PROJECT OR TASK NR	CALENDAR YEARS: 1957 J A S O N D	1958 J F M A M J J A S O N D	1959 J F M A M J S O	1960 1 2 3 4	19 1 2 3 4	19 1 2 3 4	TO COMPL 1 2 3 4
System 117L QPRI	8728				2			
Implications of Design	87151	2						
QPRI	87300							
Training Programs & Proc	87152			2				
Training Equipment Char	87153	1			2			
Proficiency Test Devel	87154	1			2			
Handbooks & Job Aids	87155		1	1	2			
Training Equip Testing	87156				2			
			1		2			

1-Contract Awarded
2-Technical Documentary Report Received.

ARDC FORM 1 JUL 56 103 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

1.

R & D MANPOWER ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE 1 OF 1 PAGES

4. UNCLASSIFIED TITLE a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L POSS

5. INITIAL ☐ CHANGE #2

3. DATE 2 April 1957

6. NUMBER 8728

7. ORG COMP CODE	8. ORGANIZATION TITLE	9. TYPE ORG	10. ACTUAL MAN-QTRS LAST QTR	11. PROJECTED DIRECT MAN-YEARS FY 19 57 AVAL	FY 19 57 RQRD	FY 19 58 AVAL	FY 19 58 RQRD	FY 19 59 RQRD	FY 19 RQRD	TO COMPL RQRD
PTQ	Office for QPRI	R	.3	.9	2.2	.2	.4	3.5		
PTF	Operator Laboratory	R	#	.2	.3	.2	.4	1.6		
PTR	Maintenance Laboratory	R	#	1.5	1.5	3.8	3.8	4.8		
PTS	Office for Social Science Programs	R	#				.5			
	Total Manpower		.3	2.6	4.0	4.2	5.1	9.9		
	Total Estimated Manpwr Dollars		1M	21M	34M	36M	43M	84M		

ARDC FORM 1 JUL 56 109 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE

UNCLASSIFIED

1.

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

CONTRACT FUNDS ANNEX

2. REPORTS CONTROL SYMBOL

PAGE 1 OF 1 PAGES

3. DATE 2 April 57

4. TITLE (UNCLASSIFIED Title) a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEMS (SYSTEM 117L) b. (SYSTEM 117L QPRI)

5. INITIAL ☐ CHANGE #1

6. NUMBER 8728

7. ABBREVIATED TITLE	8. SYSTEM PROJECT OR TASK NUMBER	9. BUDGET PROJECT SERIES	10. PRIOR YEARS (In thousands)	11. FY 57 (In thousands)	12. FY 58 (In thousands)	13. FY 59 (In thousands)	14. FY 60 (In thousands)	15. TO COMPLETION (In thousands)
System 117L QPRI	8728			12.8M	156.0M	144.0M	81.0M	
16. TOTAL				12.8M	156.0M	144.0M	81.0M	

NOTE: Enter on the final sheet of this form subtotals by Budget Project [illegible] columns 9 thru 15 immediately above box 16.

ARDC FORM 1 SEPT 56 110 PREVIOUS EDITIONS OF THIS FORM MAY BE USED

1.

R & D COST ESTIMATE RECAPITULATION

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE 1 OF 1 PAGES

3. DATE 2 April 1957

4. UNCLASSIFIED TITLE a. PERSONNEL OPERATIONS SUBSYSTEM FOR THE ADVANCED RECONNAISSANCE SYSTEM (SYSTEM 117L) b. (SYSTEM 117L QPRI POSS)

5. INITIAL ☐ CHANGE #1

6. NUMBER 8728

ITEM		A. PREVIOUS YEARS		B. FISCAL YEAR 57		C. FISCAL YEAR 58		D. FISCAL YEAR 59		E. TO COMPLETE	
		$000	OTHER	$000	OTHER	$000	OTHER	$000	OTHER	$000	OTHER
7. CONTRACT	A. TOTAL			12.8M		156.0M		144.0M		81.0M	
	B. AVAILABLE										
	C. NEW REQ			12.8M		156.0M		144.0M		81.0M	
8. MATERIEL	A. TOTAL										
	B. AVAILABLE										
	C. NEW REQ										
9. FACILITIES											
10. MANPOWER				10M	11M	14M	20M	20M	23M	40M	44M
11. TRAINING											
12. TEST ITEMS											
13. TEST SUPPORT AIRCRAFT											
14. SUBTOTAL				12.8M		156.0M		144.0M		81.0M	
15. TOTAL				22.8M	11M	170M	20M	164M	23M	124M	44M

ARDC FORM 1 JUL 55 116 PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

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AF-WP-L-29 MAY 53 5M

[redacted]

RDB PROJECT CARD	TYPE OF REPORT: New Project		REPORTS CONTROL SYMBOL DD-RDB(A)48
1. PROJECT TITLE (UNCLASSIFIED TITLE): Geophysical Environment Data for ARS, WS117L Short Title: ARS Environment	2. SECURITY: SECRET	3. PROJECT NUMBER: 1764	
	4. INDEX NUMBER: 2-117L	5. REPORT DATE: 2 April 1957	
6. BASIC FIELD OR SUBJECT: Strategic Air Warfare System 117L	7. SUBFIELD OR SUBJECT SUBGROUP: Atmospheric Physics - 7B Physics	7A. TECH. OBJ.: SA-9A, 9B, 10 IO-9	
8. COGNIZANT AGENCY: ARDC	12. CONTRACTOR AND/OR LABORATORY: Geophysics Research Directorate	CONTRACT/W.O. NO.	
9. DIRECTING AGENCY: GRD, AFCRC			
OFFICE SYMBOL: CRZA	TELEPHONE NO.: Ext 2-7730 X-9	See 21c	See 21c
10. REQUESTING AGENCY: HQ, USAF	13. RELATED PROJECTS: WS 117L	17. EST. COMPL. DATES: RES. 1957; DEV. 1958; TEST 1959; OP. EVAL.	
11. PARTICIPATION, COORDINATION, INTEREST: USAF: AMC-P ATIC-I, SAC-I, ADC-I, APGC-I, ATC-I; USN: CNO-I; USA: C/S-I; Other: CIA-I	14. DATE APPROVED	18. FY	SCALE RTS. (M $) FROM
	15. PRIORITY: 1A	16. A(Missiles)	FY57 422M FY58 1000M FY59 1410M FY60 425M Total 3417M
19. This is the initial report on this project			

20. REQUIREMENT AND/OR JUSTIFICATION

System Requirement No. 5 dated 17 October 1955 and subsequent letter directive from WDD dated 23 December 1955 assigned to AFCRC the responsibility for providing environmental data which affect the design and testing of ARS vehicles. Based on independent studies by the Geophysic Research Directorate the three design study contractors and conferences with personnel of the WSPO, it was concluded that in four areas of geophysical environment insufficient data were available for successful design and test of the Advanced Reconnaissance System Vehicles. The four so considered are (a) Meteor Physics (b) Density at Orbital Altitudes, (c) Solar Radiation in the U.V. and X-ray Region and (d) Thermal Radiation. Specific discussions of requirements for additional design data in each of these areas are included under each task.

21 a. Brief and Military Characteristics

The objective of this project is to provide environmental data considered essential to insure and simplify the design of a successful Advanced Reconnaissance System.

22. RDB	IC & P	X.	I.	C.

DD FORM 1 JAN 52 613

[redacted]

PAGE 1 OF PAGES

240-57-01140

~~CONFIDENTIAL~~

(UNCLASSIFIED TITLE) Geophysical Environment Data for ARS, WS 117L 2 April 1957
Short Title: ARS Environment Proj 1764

21 b. Approach

See individual Tasks. (21c)

21 c. Tasks

1. (a) T-39791 - Solar Radiation Program in Ultraviolet and X-ray Region for ARS

(b) This task will be accomplished through a combination of "in-house" and contractual effort. Currently the contractual effort is by Comstock and Weatcott, Inc., under Contract AF 19(604)-1889. Other contractors contemplated at the moment are: University of Chicago, Chicago, Ill. and Radio Corporation of America, New York, N. Y.

(c) Task objective is to determine the intensity of Solar U.V. and Soft X-ray radiation as it would strike the satellite and the extent of damage due to collisions of molecules, atoms and ions with the satellite surface.

Requirement and/or Justification

Vehicle design will be affected by radiation in the solar ultraviolet and X-ray region. It has been shown by GRD that the quantum yield of photoelectric effect on metals exposed to short wavelength ultraviolet is about 250 times as great as that of the conventional photoelectric effect in the visible and near UV. Thus, since a vehicle traveling at 500 km is essentially receiving unfiltered solar radiation of low wavelength, one must consider a possible "charging up" of the metal due to the loss of photoelectrons from the surface. This charge can theoretically rise to a high voltage, depending on the wavelength and intensity distribution of the incident radiation. Such a charging-up could influence the telemetering or other electronic functions of the equipment in the vehicle. Also, it is known that short wavelength ultraviolet causes deterioration of a plastic surface. This could fog plexiglass and damage rubber-like materials. Present data are inadequate to evaluate this effect simply because we do not know within several factors of ten the solar intensity above the atmosphere at wavelengths below 1500 Angstrom Units and we believe that design purposes can therefore not be satisfied.

The effect of atmospheric composition at 500 km is difficult to assess. There might be heating of the vehicle to contend with, due to recombination of atoms on the surface as well as impacts with other atoms and molecules. Such a heating effect would be super-imposed on that due to solar radiation and would act even at night when the vehicle is shielded from the sun by the earth. Since solar ultraviolet and X-ray radiation is part of the total picture of the integrated interaction of the sun and the earth's atmosphere and data of this kind are extremely scarce the measurements of these variables at vehicle altitude would be unique. These measurements would give us information as to the physical mechanisms operating in the ionosphere and delimit in an essential fashion the ionospheric functioning by giving us a better understanding of the nature of atmospheric ionization. This would assist in the forecasting of ionospheric propagation and could contribute toward the solution of the satellite communications prob[redacted]

(UNCLASSIFIED TITLE) Geophysical Environment Data for ARS, WS117L 2 April 1957
Short Title: ARS Environment Proj 1764

(d) Approach

At the present time, there are two main areas of research:

(1) A laboratory investigation of the effect of collisions of particles, atoms, molecules and ions on solid surfaces (sputtering) conjoined with the effect of recombination of atomic species on solid surfaces.

This laboratory study will be carried on mainly in-house, but with modest contract let for auxiliary studies.

Primary in this research will be the problem of developing ultra high vacuum mass spectrometer tubes for study of the effect of ion bombardment of surfaces. Such a tube would require suitable component parts, valve sealants, tubing and pumps to obtain this vacuum. This is necessary to duplicate in the laboratory pressures at satellite altitudes. The feasibility of this development has already been established by in-house work. About half of this is finished, leaving principally design engineering.

Different techniques, among them molecular beams, will be used for the acceleration of the non-charged particles on receiving test plates the nature of which will be determined by vehicle design. In particular, the effect on metals will be examined. The plates will be tested by a variety techniques, microscopes, etc., for possible damage due to momentum transport (sputtering).

(2) Solar ultraviolet and X-ray study -- The goal set in this research is the measurement of absolute intensities of the solar spectrum from 1500 Angstroms down to a few Angstroms. This program is divided into three phases, laboratory investigations, measurements of solar intensities in rockets and finally, construction of the satellite instrumentation by miniaturization of rocket instrumentation.

This region of the spectrum is relatively unexplored; hence, a whole new system of monochromators, sources and detectors must be constructed. First, there must be the calibration against a primary detector, thermocouple not calorimetric. These secondary detectors must be reliable and reproducible. In type, they may be dependent upon the interaction of radiation with a filling gas or on the effect of radiation upon a cathode. Therefore, laboratory work will be needed to select adequate detectors.

The monochromators to be constructed are unique in design and rather elaborate in the equipment necessary to perform the desired calibration. They have already been designed and are presently under construction. To put them into actual operation will take an extensive period of working-out of the manifold details and problems involved.

The construction of detectors will be to a large extent under contract.

Because the interaction of matter with radiation in this region is as yet little understood, the objectives can only be reached by an extensive deepening of our insights into the nature of these processes. For example, a predicted phenomena is that of photoconductivity effect. This, when more fully investigated, may yield a possible secondary type of detector.

The process of building suitable detectors can only go on simulateneously with this type of exploratory research. After the laboratory phase, the instruments will be flown in Aerobee-Hi rockets to measure the radiation intensity above the earth's atmosphere. The number of flights necessary will be at least six, possibly increasing to eight or nine depending on results.

2. (a) T-39792 Interplanetary Matter and Meteor Physics in Relation to ARS

(b) This task will be accomplished through a combination of "in-house" and contractual effort. Currently the following contracts are in effect:

(1) - AF 19(604)-1894 - Temple University
(2) - AF 19(604)-1908 - Oklahoma A and M
(3) - AF 19(604)-1901 - Smithsonian Observatory
(4) - AF 19(604)-1892 - Stanford Research Inst.

No other contracts are contemplated at the moment.

(c) The objective of this task is to determine the possible hazard from meteoric bombardments to a vehicle above the earth's atmosphere and to provide data as to the spatial distribution, size, composition, and velocity of micrometeoric matter.

Requirement and/or Justification

The hazard from meteoric collision with a body essentially in interplanetary space, unprotected by the earth's atmosphere is not very well known. The probability of collisions intense enough to destroy the vehicle or affect its operation is very important in the design of a protective "meteor bumper" to insure proper operation of the vehicle. These meteoric collisions may result in dangerous surface erosions affecting heat exchange properties and optical windows. Stability, temperature control, reliability may all be influenced by meteoric bombardment.

Information regarding the influx of meteoric material into the earth's atmosphere has been collected by the following methods: visual observations, photography, radio reflections from meteor trails, and telescopic observations. From such studies and measurements, the diurnal and seasonal variations in the influx of sporadic meteors, velocities and radiants of shower meteors, velocity distribution of sporadic meteors, mass distribution of meteors, and spatial density of meteors have been determined. These measurements give a value for the rate of influx of interplanetary material into the earth's

atmosphere of 5×10^6 gm per day. However, these ground-based methods are limited and a grave anomaly, of importance to the ARS, exists. Since the visual and photographic methods are only sensitive to meteors of visual magnitude +5 (10^{-2} grams mass, 10^{11} ergs energy) and the radio and telescope methods to visual magnitude of the order of +8 (mass x 10^{-4} gm, energy 6×10^9 ergs), information derived from these methods regarding meteoric particles with mass less than 10^{-4} gm is seriously lacking. These smaller particles are far more numerous and therefore have a high probability of encountering a vehicle above the earth's atmosphere.

The anomaly on the influx of interplanetary matter arises from various indirect measurements of the fine interplanetary matter. These measurements include determination of the density of matter in the zodiacal cloud, or the interplanetary dust cloud, by S. C. Van de Hulst and C. W. Allen; measurements of the nickel content in deep sea ocean sediments by H. Pettersson and H. Rotsch; and initial rocket soundings from V-2 and Aerobee rockets. These measurements indicate a rate of accretion of interplanetary matter by the earth as high as 5×10^{10} gm per day, up to a factor of 10^4 times higher than predicted from regular methods of observation. It seems, also, that this high rate of influx may be necessary to explain the presence of the E region ionization during the night. This higher rate leads to a probably encounter for visual magnitude 15 (energy 10^{10} Bev) of one hit per square meter per second. Such impact rates are significant for a vehicle with a required lifetime of about a year. These impact rates may possibly be further increased by a factor as great as 10^4 to 10^6 if geomagnetic focusing of cosmic dust particles, suggested also by S. F. Singer, was detected experimentally.

From the standpoint of ARS, the hazard to space vehicles in an interplanetary environment seems closely dependent upon the effects of interplanetary matter, as well as such other factors as cosmic radiation, atmospheric drag, and energetic solar radiation. On the one hand, relatively large impacts may result in penetration of the vehicle surface and subsequent destruction of important equipment, affecting the usefulness of the vehicle, while smaller impacts would result in an abrasion affecting the usefulness of lenses and photosensitive surface areas, etc.

It is therefore necessary to determine the probability of collisions with interplanetary particles as a function to time, and the effect of the individual collisions on the vehicle in order to determine design criteria for ARS. These requirements may be fulfilled by a measurement program involving high altitude rockets and satellite type vehicles, and direct laboratory studies of high speed impact interactions. Related studies that would support direct probing methods are also of interest in order to afford a higher degree of validity to the experimental results.

(d) Approach

The areas of investigation in this task may be broadly divided into rocket and satellite experiments and laboratory studies.

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(1) Determination of the influx of meteoric material by rocket experiments

This includes the design and construction of equipment and launching of rockets containing this equipment for the detection of meteoric material. The equipment for detecting meteoric material will operate on the principle of detecting the vibrational energy generated upon impact. This apparatus includes piezoelectric accelerometer, an amplifier, and a telemetering system with its associated ground-based receiver-recorder. Aerobee and/or Nike-Cajun rockets will be used to carry out the program. It is important that a statistically valid sample of meteoric material be obtained for final design of the ARS.

The program of research for direct rocket probing of interplanetary matter involves first the design and development of a basic piezoelectric accelerometer capable of measuring the spatial distribution and mass of interplanetary particles. Such equipment has been used by Prof. Bohn in 1949 and was used again during 1955. Hence, only minor development and calibration methods are required prior to construction of the basic unit. Such equipment is sensitive enough to detect particles of visual magnitude 25. Approximately ten to twenty detection units will be built on a semi-mass production basis. Approximately five to ten successful experimental firings from Holloman Air Force Base using Aerobee rockets are required prior to establishing a weighted statistical figure for the intensity and probability of a particle impact with a vehicle. About five successful firings at a high latitude would be required to establish the extent of a latitude dependence particularly by small meteoric particles.

(2) Design and development of equipment for detection of meteoric material for inclusion in the ARS.

It is expected that development work in the rocket phase of detection of meteoric material will aid greatly in the development of equipment of a similar nature to be included in the early oribiting and non-orbiting ARS test vehicles. It is important that the apparatus be designed with a high degree of reliability, yet be lightweight, and have a low power requirement.

(3) Theoretical and laboratory studies and high speed impact phenomena

Essential to the measurement of interplanetary matter is a knowledge of the relation of the intensity and frequency distribution of the acoustical energy generated by high speed meteoric impacts to the mass, the mass density, and the velocity of collision with the meteoric particle. Thereby, the surface erosion and the distribution function of meteoric material in space may be determined from the ARS measurements. Polished plate experiments on rockets that may be recovered will yield some information, but high speed impact measurements in the laboratory for the study of collisions of solids with gases and surfaces are required to support this subtask. In addition, optical and radio measurements of meteor influx and atmospheric interactions will also assist in the direct experimental studies.

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High speed impact studies of particles with surfaces are possible at this time only by a method using shaped charges, since only by this means have particle velocities comparable with meteor velocities been generated in a laboratory basis. The physics of high speed interactions is not well understood, and experimental measurements at velocities up to 50 km/sec are highly desirable. Even then, it is difficult to predict the degree of success of this technique, but this approach is presently available at relatively low cost. Because the energy density of the impacting reactions may be as much as a hundred times greater than previously observed, considerably different effects than theoretically predicted are to be expected.

(4) Theoretical studies

This subtask is concerned with the correlation and application of various data applicable to the problem of determining the hazard from interplanetary matter upon ARS. Where possible, information from shock tube studies, radio and optical meteoric studies, investigations of meteoric craters, deep see ocean sediments, microchemical analysis of rare gas constituents, etc., that contribute to the overall problem of the determination of the hazard from interplanetary matter will be considered. In this manner, the reliability of the information derived from the direct experimental program may be further evaluated.

The primary emphasis of the approach of the 4 subtasks, therefore, is the determination of the spatial distribution of interplanetary matter, the size distribution, and the mass density of this material, and thus with suitable laboratory studies to be able to predict the probability that meteoric material may penetrate a given thickness of satellite skin per unit time, and the rate of erosion per unit area for a surface exposed above the earth's atmosphere. An improved understanding of the physics of hypersonic interactions in the velocity range equivalent to an energy of 50 to 1000 electron volts is also of importance.

The rocket program for detection of meteoric particles would require approximately ten successful rocket flights up to altitudes as high as 150 km before sufficient data to make a satisfactory estimate of the rate of influx of interplanetary matter. It should be stressed that ten successful flights corresponds to a total measuring time of about a quarter of an hour above altitudes of 50 km. (Measurements below this altitude would be contaminated by terrestrial material). From considerations of the normal difficulties experienced in past experimental programs using high altitude rockets, probably instrumentation for fifteen rockets will be necessary. The estimated cost of development and construction of this instrument is 60M to 100M based on cost of 5M per instrumentation. The cost of rockets for this work based on 30M for a single Aerobee rocket would be 450M for 15 Aerobees. However, since the meteoric detection equipment may be used on a Nike-Cajun rocket system, also, the overall rocket cost is expected to be much lower than the

estimate using Aerobee because the Nike-Cajun system when it becomes available would cost less than half as much as an Aerobee. The fund requirements however, are based upon rocket requirements using Aerobees.

Upon availability of an ARS vehicle as a platform for the measurement of meteoric particles, a relatively large sampling time for making measurements of interplanetary matter will be available. It is therefore of importance that meteoric detection equipment be mounted on such an early test vehicle. Such equipment must be very reliable and capable of operation over a long period of time, while its weight should be kept to a minimum. The development of equipment for the ARS is estimated to cost 50M over a two-year period, while flight and rocket testing would involve an additional 40M.

The program on research on high speed impact phenomena will be based on studies using shaped charges, and also investigations of dynamic interactions of meteoroids in the atmosphere. The estimated cost of the initial phase of this work is 80M over a two-year period.

3. (a) T-39793 - Atmospheric Density Determination at Altitudes of Artifical Earth Satellites.

(b) This task will be accomplished through a combination of "in-house" and contractual effort. Current contracts in effect are as follows:

(1) AF 19(604)-1871 - University of Michigan
(2) AF 19(604)-1890 - University of Michigan

(c) The objective of this task is to obtain reliable values of atmospheric density, pressure and kinetic temperature between the altitudes of 200 to 400 miles.

Requirement and/or Justification

The primary objective of this task is to obtain reliable values of atmospheric density, pressure and kinetic temperature in the vicinity of 200 to 400 miles altitude, the altitude of a proposed satellite system. These data are needed in solving various problems on the design of the ARS vehicle. Some of these problems are:

1. What altitude must be maintained by a satellite vehicle of specified size and shape in order that the atmospheric drag be sufficiently small to permit a minimum specified life time of the satellite.

2. How does temperature rise on the skin of the satellite vehicle due to aerodynamic heating (friction between itself and the molecules of the atmosphere) vary with altitude below 400 miles altitude.

3. What is the minimum value of mass to cross-section area ratio of a satellite which will permit the required lifetime to be achieved at specific

orbiting altitudes. The present estimates of the magnitudes of these properties are quite uncertain. Pressure and desnity may be in error by factor of 100 or- 1000 at 350 miles altitude because they are based on extrapolation of values at 100 miles and on unconfirmed theories. Extension of measurements to 200 miles or 250 miles altitude would greatly improve the reliability of extrapolation to 300 miles, while measurements at 300 miles would be even better.

The task involves the study and implementation of two basically different methods for obtaining the necessary data. The first method involves the direct measurement of the drag force on a sphere falling from great altitudes after its ejection from a rocket. This method is of special interest since it is the drag force on the satellite which ultimately determines its life. Results of this measurement are free from effects of contamination from the rocket. The limitation of this method lies in the fact that the sphere must fall from an altitude of 10 to 20 percent higher than that for which the drag data are desired.

The second method for obtaining these data involves a selective ionization gauge for measuring number density of particular constituents as well as total number density. This method in principle may be used to the peak of rocket trajectory but is adversely affected by contamination from the mother rocket. Various outgassing and ejection techniques under study will minimize this limiation.

A secondary objective of this task is to develop the necessary techniques and devices for measuring pressure, temperature and density from ARS test vehicles. This phase depends in part upon the success of the primary objectives, although the conditions for outgassing are sufficiently different to materially simplify the accomplishment of this objective.

(d) Approach

At this writing, the task appears to involve eight steps.

(1) Feasibility study of two proposed methods for measuring the required parameters.

The feasibility of two methods for the measurement of atmospheric density, pressure and temperature are being explored. These methods are (1) an extension of the falling sphere experiment and (2) the ionization gauge experiment currently being employed up to altitudes of 75 to 100 miles.

The present falling sphere experiment involves the ejection of a sphere from a rocket at high altitudes, and the measurement of the drag force of the atmosphere on the sphere as it moves though space. (It may be ejected anytime after the end of rocket powered flight and hence will rise to a peak slightly lower than that of the rocket.

The sphere contains an accelerometer which measures drag acceleration as a function of time to 1% accuracy, independent of orientation. The sphere also contains a radio transmitter which relays the accelerometer signal to a ground recorder. The double integration of the total acceleration yields sphere altitude as a function of time to a reasonable accuracy for high angle flights. An independent complicated analytical reiteration method yields sphere velocity and altitude versus time independently. The determination of atmospheric density depends upon a knowledge of drag coefficient at the mach numbers and Reynold's numbers experienced by the sphere. These values of drag coefficient have been measured in ballistic ranges and hypersonic wind tunnels.

The present ionization gauge experiment involves the measurement of ion current from ionized air molecules on one or more chambers on the surface of a rocket. The knowledge of air pressures around conical surfaces with known orientation to the air stream leads to a value of ambient pressure and to temperature if the relative velocity of cone to air is known. This sytem requires some kind of tracking for high accuracy although integration of pressure and temperature values results in approximate altitudes.

Extending the sphere experiment to higher altitudes involves increasing the area to mass ration of the sphere, shifting the range of the accelerometer to very low values (this essentially eliminates its use at higher accelerations, corresponding to lower altitudes). The system does not work at or near zenith since the velocity is too low (approaching zero for a verital flight) for drag to be measurable.

The extension of the ionization gauge method involves three main steps: (a) Adapting to rocket use existing ionization gauges designed for ver low pressures (Alpert type); (b) eliminating the effect of contamination of the measurement from rocket outgassing by housing the gauges in a separate thoroughly outgassed body which will be spring ejected from an evacuated cavity at high altitude; (c) Eliminating the uncertainty of molecular dissociation by making the gauge sensitive to only one or two specific molecular species through simple mass spectrometer techniques.

The feasibility study of the use of these methods at high altitudes is currently under way and involves a study of (a) the theoretical limitation (b) inherent sources and estimates of errors (c) engineering difficulties (d) space and weight requirements (e) estimated cost per flight. An analysis of these studies will determine which method has the better chance of success, but at present it appears that both should be tried. Perhaps both may be flown simultaneously in each rocket vehicle.

(2) Design and construction of preliminary models of equipment for one or both methods

This step of the task involves the design and construction of the equipment which is expected to be flown in the initial series of rocket [redacted]

flights. This step may include wind tunnel tests or rocket flight tests of specific portions of the total instrumentation for the method, as well as the final packaging of at least two sets of the equipment for the rocket flights of each of the two methods.

(3) Initial rocket flights of the equipment for one or both methods

This step includes the field operation involved in preparing the equipment for actual rocket flight together with the necessary operation of the rocket flights for each method. The preparation for two flights is insurance against rocket or other failure during the first flight.

(4) Evaluation of flight performance and necessary redesign of equipment

This step involves the detailed study of the telemeter record of the flight to determine the performance of the various parts of the measuring equipment, as well as the transcription of recorded data to usable form for computation of the required atmospheric parameters. Deficiencies in the performance of the equipment detacted by the record are then to be removed by suitable redesign. Because of the urgency of the program, major portions of the equipment should already have been constructed at this point for the series of data-gathering flights and it will be necessary to take the chance of having to modify some of the components at this stage of the task.

(5) Major series of data gathering rocket flights

This step of the task involves the flying of three to ten sets of instrumentation for density and or pressure measurements in special 300 mile altitude rockets presently being designed for AFCRC or in non-orbiting ARS Weapons System test vehicles or both. Contact will be made with the ARS Weapon System office to obtain space in these test vehicles. If the first three flights indicate sufficient self-consistency the balance of the data gathering flights can be cancelled.

The special 300 mile altitude rocket is a multi-stage system made up of existing rocket components, i.e., Cajun rockets and Nike boosters. An engineering study presently contracted for will result in engineering drawings for the necessary fins and coupling devices and nose cone necessary to combine the propulsion system into an atmospheric data gathering rocket system capable of carrying 40 lbs. of instrumentation to 200 - 300 miles. Upon completion of this engineering study, engineering drawings will be available from which the necessary parts and propulsion units may be built and purchased at an estimated cost of $20,000 per rocket system.

(6) Analysis of data and preparation of revised atmospheric model

This step of the task involves the reading of telemeter records, the computation of the values of the atmospheric parameters, and

the compilation of these data into consistent atmospheric models. This step is not necessarily limited to follow step (5) chronologically, but will follow each rocket flight from which usable data results.

(7) Repackaging of equipment for test satellite vehicles

This step involves the electrical mechanical redesign of the equipment used in the rocket firings of step (5) or planned in steps (1) and (2) to make that equipment suitable for gathering desired atmospheric data from ARS test vehicle.

(8) Installation and flight of density and pressure measuring equipment in satellite vehicle

This phase involves the field operation of a program for measuring atmospheric density and pressure at orbital altitudes of satellite test vehicles, and would be followed by a reapplication of step (6).

4. (a) T-39794 - Thermal Radiation Program for ARS

(b) This task will be accomplished through a combination of "in-house" and contractual effort. Present contractor is the University of Colorado under Contract AF 19(604)-1899. Additional contracts are contemplated.

(c) The objective of this task is to measure the intensity of irradiant heat sources above the atmosphere.

The radiation environment is one of the external conditions which may grievously affect the period during which information can be obtained from an oribiting satellite.

To be operational, the design of the satellite must be engineered so as to maintain within pre-determined limits the temperatures of vital communication components, such as electronic units, batteries, etc. If and when nuclear sources are used for power, then the excess energy must be radiated away from an external heat exchanger; its design requires a knowledge of the radiation exchange environment.

The temperature of a satellite in orbit at given times and places can be calculated. Required for these calculations are a knowledgeof the interstellar heat sink into which it is radiating energy -- thus cooling it -- and a knowledge of the intensities of the thermal fluxes which tend to warm it. Estimates of the equilibrium temperature of the satellite can be verified only by measurements within the orbiting satellite. Under the worst condition the

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temperature within the communication equipment may cause it to fail before any information is received. A slightly more favorable but undesirable condition would be a premature failure of communcation, (Thus, should the absorptivity--equal to emissivity--of the skin of the satellite change while in orbit, the equilibrium temperature of the satellite might differ drastically from that calculated on the basis of design specifications.)

The objective of this task is, then, the development and testing of devices adequate for the measurement of the three irradiant sources--direct solar energy, solar energy reflected jointly from earth and atmosphere (I.E., albedo) and earth emissivity (in the infrared)--and the flux from a satellite into interstellar space.

It is proposed that flux measuring devices should be installed on the earliest test vehicles so that flux measurements can be obtained so long as communication with the satellite is continued. Should communications then cease, and should the thermal, flux measurements seriously disagree with the values in the design calculations, at least one source of possible trouble should be identified.

During the development and testing of the devices for measuring the three sorts of radiation, balloon and rockets equipped with these devices will be flown. As scientific by-products of the testing program, some confirmation of current estimates of the intensities of the three sources will be obtained. Our present information on the radiation environment is next summarized.

Reliability of Present Estimates of the Solar Constant and the Albedo and Infrared Emission of Earth Plus Atmosphere

a) The solar constant is believed to lie between 1.946 and 2.05 gram calories centimeter $^{-2}$ minute $^{-1}$, a deviation of 3% from the mean of 2.0 gm cal cm^{-2} min^{-1} (1,396 watts meter $^{-2}$).

b) For this discussion, the term albedo applies to the solar radiation reflected directly from the earth's surface and scattered and reflected from the atmosphere with its content of clouds. From point to point in the orbit of a satellite with orbital distances as now stated the albedo will be highly variable. Deviations may be expected of at least plus or minus 20 - 30 per cent from the mean value of the albedo which may be taken as lying between 36-56 per cent (I.E. approximately 36-56 per cent of the solar constant is diffusely reflected or scattered back from the earth).

c) The infrared emission of the earth may be estimated by theory. Current estimates for the various zones of latitude obtained by deduction may well be in error by 20 to 50 per cent; on the average energy to about 32 per cent of the solar constant is diffusely emitted as infrared radiation from the unit consisting of earth and atmosphere.

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(d) Approach

I. Introduction

The following subtasks are foreseen:

(1) The design, development, testing and calibration of devices for the measurement of radiation of the following kinds.

(a) Total radiation from 0.27 to 2.7 microns (By "total" is a single detector which integrates the energy in the specific spectral region non-selectively -- i.e., recording to heating value, not by number of photons.)

(b) Total radiation from 4 to 20 microns.

(2) The design, development, testing and calibration of temperature sensors.

(3) Considered, but at present neither planned, funded nor contracted, would be the study of the temperature of a model of the satellite in a simulated radiation environment in a test chamber in the laboratory, or balloon-borne to an altitude where the air pressure approximates ten millibars (about 100,000 feet).

(4) A subtask within scope of this task, but deserving separate discussion will result in new techniques, design experience, and data important to ARS as vehicles for reconnaissance. This subtask is amplified specifically in Section II, Activities in "(4) Activities -Infrared Background Studies".

II. Activities

(1) Activities - General

The statement of the task may be amplified by noting that the satellite in its orbit will be warmed by energy from sun and from earth and cooled by radiating energy outward. Its native temperature will vary between upper and lower limits determined by intrinsic qualities (skin absorptivity and emissivity for various parts of the spectrum from ultraviolet through far ultraviolet and the heat capacity), and the trajectory (portion of period of orbit when irradiated by sun plus earth, or in the eclipse shadow of earth when irradiated by earth emission only; and the distances from earth at apogee and perigee, and whether these occur in sunlight or in shadow.

Further, it is probably that various other sources of heat may be added as the development of the satellite proceeds from the preliminary phases of design, construction, and test to the more sophisticated, complex designs. For example, possibly a fission reactor may serve as source of power for attitude control and for electronic equipment. The introduction of such a heat source will complicate the engineering considerations because the efficiency of the removal of the excess heat will depend on the thermal environment of the heat exchangers.

(2) Activities --- Model Study

A possible activity which, as noted above, has not passed beyond the discussion stage, is that of the Model Study for obtaining approximate values of the equilibrium temperatures under working conditions a simulated satellite might be studied. By appropriate choice of the model, which would incorporate such devices as quartz windows inserted into the sphere, probably supplemented by isolated heat - detecting receivers, it is probably that significant information could be obtained. Such a model could be tested in a "Stratospheric Chamber" equipped with appropriate radiant heat sources. Or, the model satellite could be carried by balloon to high altitudes ---about 100,000 feet where pressures approximating 8 mm Hg. would minimize convective cooling.

In such studies numerous experimental details would have to be carefully watched. For the receivers consideration would have to be given to the absorption of radiation by the receiving surfaces ("blackness" to different spectral regions to the "color temperature" of the radiant flux), also to the conditions for the conductive removal of heat, and to the necessary precautions against convective cooling, since in the satellite at orbital altittudes there would be no convective cooling.

Departures from anticipated temperature by the satellite in its early history would be reason to look for unique influence -- heating by collision with meteoric matter, shortwave radiation with more than the expected intensity of gamma radiation.

Such a model might lend itself to experimental work in the design of a satellite to be powered by a fission device.

(3) Activities -- Design and development of the temperature and radiation sensing equipment

It is recognized that measuring the temperature of the skin and of the important points within the satellite in order to confirm the adequacy of the design is primarily the concern of the contractors. However, the themal flux sensors and the temperature sensors both will most likely be built around thermistors, hence, for reasons of design efficiency they would be parts of a common system. All thermal flux devices have high temperature coefficients, and the design will require a reference standard for absolute temperature determination.

It has been noted the type of thermal flux detector used should be "total" and "non-selective." As distinguished from photo-conductive detectors, the preferred type would be the "temperature" detector, i.e., the absorbed energy is measured by temperature change using a thermocouple or a thermister or equivalent.

Hence, the development and testing (including calibration) of the radiation sensors involves the use of the same accessory electronic equipment for imparting information to the telemetering system as would be used when thermistors are employed for obtaining temperature data within the satellite. A minor activity from the viewpoint of both man-hours and dollar costs, is therefore involved adding the responsibility for development, testing and calibration of the temperature sensing devices to the identical responsibilities for the devices for measuring thermal flux.

Timely and detailed reports of progress on this task will be provided so that designs of the temperature sensors and accessory electronic equipment will be available to the prime contractor for his use in instrumenting early test vehicles.

Approximately six months have passed since Contract AF 19(604)-1899 for $40,000 was awarded to the University of Colorado for work on this task. Relatively good progress has been made in the design of compact lightweight transistorized thermal flux detectors available soon for testing in high altitude balloon flights. However, for quantitative thermal flux measurements one accepted technique is alternately to expose the radiation sensor to the thermal flux to be measured and then to view a reference standard or flux (a black-body) determined by its absolute temperature. It is the development and testing of these assemblies of components which will demand the major effort.

(4) Activities -- Infrared Background Studies

In reconnaissance "vision" is involved. With the eye as the detector, the significant bandwidths used in vision are 0.4 to 0.7 microns. "Vision" in the ultraviolet involves a detector in the range 0.2 - 0.4 microns. In the infrared, "vision" comprises wavelengths from 0.7 to 25 microns. It is obvious that "vision" is the discrimination of an object viewed with a given bandwidth against a "background" also "seen" by the detector. Further, radiation scattered toward the detector by material between the object and the detector obscures vision (cf. visibility through fog).

Reconnaissance by use of far infrared introduces another factor not unlike the scattering effect in visibility through fog. That is, the radiation from the object and its background will be veiled by the energy emitted by the strata of atmosphere between object and detector. In the region from

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4 to 24 microns knowledge of temperatures, spectral emissivities (equal absorptions) of the specific gases of the atmosphere are required. Much is known about the pressure dependence of the absorption but easy calculation is not yet possible.

Both experimental and theoretical phases under this infrared background study are planned:

Experimental:

(1) The design and construction of a far-infrared spectrometer to be borne aloft by balloon capable of measuring the terrestrial thermal flux, spectrally resolved from 4 to 24 microns, etc. The work to be contracted.

(2) Design and construction of balloon borne equipment to measure attenuation of the infrared solar flux in the region of 0.8 to 9 microns at various altitudes from 5,000 to 100,000 feet, with sun at low altitudes to increase the path length through the atmosphere. The work to be contracted.

Theoretical:

(3) The thermal emission from model atmosphere corresponding as closely as possible to the terrestrial atmosphere will be calculated using the latest available and suitable modified laboratory transmission functions. The emission will be computed for various heights to be later specified in the atmosphere. The work to be contracted.

Possible contractors, and the possible Principal Investigators are:

Johns Hopkins University, Prof. John F. Strong
University of Utah, Prof. J. V. Hales (with Prof. W. Elsasser, Consultant, Scripps Institute of Oceanography)
Aerotronics, Glendale, Calif., Dr. Gilbert N. Plass
University of Colorado, Prof. W. S. Rense
University of Denver, Mr. David Murcray
Ball Bros. Research Institute, Dr. David Stacey

(5) Activities - By-Products Directly Applicable to ARS

The main groups of by-products of the program of work on the Thermal Radiation program may be anticipated for ARS. One group is the reduction in the uncertainty in the three sorts of radiation intensities

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noted as important -- the solar constant, the albedo associated with various physiographic features of the earth (both the earth surfaces itself and cloud cover meteorologically and physiographically determined), and the infrared emission. During the testing of the thermal radiation sensors during ballon and rocket flights data will necessarily accumulate which may reduce the error in present estimates of the intensity of these radiations.

The studies undertaken during the assessment of the radiation environment of the satellite will produce new knowledge about the energetics of the planet earth and its atmosphere. The new knowledge, as well as the sensors and accessory equipment from the task on thermal environment, will be of advantage to the contemplated Weather Reconnaissance Project in the event that is undertaken. Hard and fast lines cannot be drawn separating the work on thermal flux sensors from the work on the sensors which could be used on the Weather Reconnaissance Project. To the extent that work on this task (T-39794) advances the work on the Weather Reconnaissance Project, this later progress may be considered a by-product. However, under the Weather Reconnaissance Project would be required the production of sensors specifically adapted for installation in aircraft, and following the flights, reduction and study of the data. Such work is not contemplated in the budget proposed for this task.

5. (a) Task 39795 - Rocket and Instrumentation Support

(b) This task will be accomplished through a combination of "in-house and contractual effort. The type of effort required by this task is being carried on by AFCRC under GRD P-7659. In P-7659 several contractors have been used and have attained a competence in their respective areas (See Approach) In view of this competence, many of the same contractors will be used to accomplish the objectives of this task. Contemplated contractors include:

1.) Aerojet - General Corporation
2.) Wentworth Institute
3.) Oklahoma A and M
4.) New Mexico A and M

(c) The task objective is to instrument and launch research rockets in support of the objectives of the other tasks in this project.

Requirement and/or Justification

The requirement for this task is delineated in the approach of each of the other tasks of the project.

(d) Approach

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The instrumentation and launching of research rockets requires:

(1) The provision of vehicles and launch facilities suitable to each experiment.

(2) The instrumentation of the nose cone. This effort may vary from simple attachment to the rocket to adaption of the experimental equipment to the vehicle and its support instrumentation.

(3) Collateral instrumentation for tracking, telemetering, range safety, data recording, parachute recovery, special sequencing and command of experiments, orientation of sensing devices (biaxial pointing control) and others.

(4) The provision of suitable ground data recording equipment.

Techniques and procedures have been established under GRD P-7659 to accomplish the desired results in the above areas of effort. In order to meet the requirements of the other tasks of this project, the same techniques and procedures will be followed under this task. In particular, the same contractors and facilities will be used, where applicable, and coordination with necessary test facilities will be carried out in the same manner as under P-7659.

In order to efficiently and effectively make use of system test vehicles close coordination will be established with the prime contractor. Such liaison is necessary to adapt the experiment to system test vehicles from the standpoint of size, weight, available telemeter, power, etc.

d. Other Information

Not applicable

e. Background History

System Requirement No. 5 dated 17 October 1955 subsequent letter directive from WDD placed on AFCRC the responsibility of providing environmental data effecting the design and test of ARS vehicles. Studies by the Geophysics Research Directorate, AFCRC, the design study contractors and the ARS Weapons System office determined that in certain areas the state of the art was such that additional data would be required to satisfy the design requirements of ARS. In December 1955 and January 1956 Tasks 76971, 76972, 76973 and 76974 under Project 1115 were prepared by Geophysics Research Directorate, Air Force Cambridge Research Center. These tasks were, with certain exception approved by WDD 3 July 1956. This project constitutes a rewrite of these tasks under Project 1764 in support of WS 117-L.

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f. Future Plans

This project is for the specific purpose of providing environmental design data for the Advanced Reconnaissance System, therefore, the various task and subtasks will be terminated, with concurrence from the WS 117L WSPO, when it is apparent that sufficient data has been obtained in a particular field to satisfy design requirements or to determine a no hazard condition to the ARS vehicle and operational subsystems.

Conversely close coordination will be maintained with the WSPO and prime contractor so that new tasks can be timely instituted to meet requirements generated by the introduction of new design conception.

g. References

ARDC System Requirement No. 5 dated 17 October 1955
Secret Letter WDD to AFCRC sub: Support of Advanced Reconnaissance System (U) dated 23 December 1955.
WS 117L Advanced Reconnaissance System Development Plan dated 2 April 1956.
ARDC System Development Directive Advanced Reconnaissance System dated 17 August 1956.

SIGNED

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Project Scientist
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SIGNED

MILTON GREENBERG
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1. Special Annex for Mission Support Funds

2. Reports Control Symbol

Page of page

3. DATE: 2 April 1957

4. TITLE

5. Initial

6. NUMBER - 1764

(UNCLASSIFIED TITLE) Geophysical Environment for ARS, WS 117L

SHORT TITLE: ARS Environment

1a. $4255. of P-690-02 funds will be required in the performance of task 39721 in FY 57.

(1)	6 trips to Los Angeles and Palo Alto, Calif. at $400.	$2400.
(2)	3 trips to Chicago, Ill. at $125.	375.
(3)	12 trips to New York, N.Y. at $40.	480.
(4)	Miscellaneous travel	1000.
		$4255.

b. This travel will be essentially to monitor contracts and coordinate with other Centers. The requirements for FY 57 will continue through FY 58 and FY 59.

c. In FY 58 six (6) additional trips to HADC at $400. each will be required to arrange rocket tests.

d. In FY 59 twelve (12) additional trips to HADC or Patrick AFB at $400. each will be required for rocket tests on apparatus.

e. Therefore, for FY 58 P-690-02 $6655.

FY 59 $9055.

2a. $8000. of P-690-02 funds will be required in the performance of T-39792 during FY 57. Specifically it is contemplated.

(1)	12 trips to Holloman Air Development Center, N.M. at $450. each	$5400.
(2)	4 trips to San Francisco, Los Angeles area, Calif. at $400. each	1600.
(3)	3 trips to Philadelphia, Pa. at $50. each	150.
(4)	Miscellaneous travel; $850	850.
	TOTAL	$8000.

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DD Form 613 (cont.)

3A-57-01140

Special Annex for Mission Support Funds (cont.)

2 April 1957
Project 1764

b. Travel to Holloman Air Development Center will be performed in carrying out high altitude rocket experiments. Each rocket experiments. Each rocket firing requires at least two (2) personnel for a period of a week to ten (10) days.

c. It is contemplated that some of the shaped-charge experiments may be performed by the Poulter Laboratories in the San Francisco area. Research on High Speed Impact Phenomena will be coordinated with Rand Corporation in Santa Monica. Temple University in Philadelphia has developed acoustical apparatus for the detection of meteoric impacts.

d. The travel requirements for this task thru FY 59 will probably remain at about $8000. per year.

3a. $5970. of P-690-02 funds will be required in the performance of Task T-39793 in FY 57.

(1)	2 trips to Los Angeles, Calif. at $400. each	$800.
(2)	4 trips to Ann Arbor, Mich. at $125. each	500.
(3)	8 trips to HADC, N.M. at $400. each	3200.
(4)	2 trips to Chicago, Ill. at $125. each	250.
(5)	8 trips to New York area at $40. each	320.
(6)	Miscellaneous travel	1000.
	Total	$6000.00

b. This travel will be essentially to monitor contracts and coordinate with other Centers. The requirement for FY 57 will continue through FY 58 and FY 59.

c. In FY 58, 7 additional trips to HADC at $400. and 2 additional trips to Los Angeles at $400. will be required to participate in rocket data gathering flights and monitoring contracts.

d. In FY 59, 4 additional trips to HADC at $400. will be required to participate in rocket data gathering launchings.

3. In FY 60 travel will be required as follows:

(1)	2 trips to Los Angeles at $400. each	$800.
(2)	2 trips to Chicago at $125. each	250.
(3)	3 trips to New York at $40. each	120.
(4)	Miscellaneous travel	300.
	Total	$1470.

Therefore,

	P690-02
FY 58	9570
FY 59	7570
FY 60	1470

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Special Annex for Mission Support Funds (cont.)

2 April 1957
Project 1764

4. $3,225.00 of P-690-02 funds will be required in the performance of task T-39794 during FY 57. Specifically we contemplate:

(1)	3 trips to Los Angeles, California at $400. each	$1200.
(2)	4 trips to Baltimore, Maryland at $60. each	240.
(3)	3 trips to Chicago, Illinois at $125. each	375.
(4)	2 trips to Holloman ADC, N.M. at $400. each	800.
(5)	2 trips to WADC, Dayton, Ohio at $100. each	200.
(6)	2 trips to RADC, Rome, N.Y. at $55. each	110.
(7)	Miscellaneous travel: $300.	300.
		$3225.

a and b Travel to the Los Angeles area and to the Baltimore area is predicted on the assumption that the contractors, at least for the vehicles for scientific measurements, will be in either or both areas. Also, at least one visit to WDD is contemplated.

c. Travel to the Chicago area is included on the assumption that contractor for the temperature and radiative transfer sensors might quite probably be in Chicago or equally distant from Boston, Mass.

d. Travel to Holloman ADC looks forward to preliminary testing of instrumentation in the upper atmosphere by balloons or rockets, or both.

e. Travel to WADC and to RADC will be required to coordinate the various Center efforts. It is possible that the number listed is a minimum and that more will be required.

f. Miscellaneous travel to discuss specific problems with experts at various Universities will be required.

g. After FY 57 we anticipate that because of the increased activity the travel requirement will be increased to an average $4,500. per year.

h. An annual average of $1000. of P-690-03 funds will be required to transportation of instrumentation units during FY 58 and FY 59.

5a. $14,000 of P690-02 funds will be required in the performance of task T-39795 during FY 58.

(1)	12 trips to HADC at $500. each	$6000.
(2)	4 trips to Los Angeles, Calif. at $400.	1600.
(3)	8 trips to Palo Alto, Calif. at $450. each	3600.
(4)	4 trips to Patrick AFB, Fla. at $200. each	800.
(5)	Miscellaneous	2000.
	Total	$14,000.

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DD Form 613 (cont.)

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AFB-57-01140

Special Annex for Mission Support Funds (cont.)

2 April 1957
Project 1764

b. Travel to HADC will be performed to participate in launching of high altitude rockets.

c. Travel to Los Angeles will be performed for coordination of program with WSPO.

d. Travel to Palo Alto will be performed for liaison in obtaining technical information on use of system test vehicles.

e. Travel to Patrick AFB will be performed for coordination and participation in launching of system test vehicles.

f. The travel requirements in this task are expected to remain essentially the same for FY 59 and FY 60.

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1. R & D SCHEDULE

☐ SYSTEM ☐ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

3. TITLE

(UNCLASSIFIED TITLE) Geophysical Environment Data for ARS; WS 117L

Short Title: ARS Environment

4. INITIAL ☒ CHANGE ☐

5. DATE

2 April 1957

6. NUMBER

1764

SCHEDULE

CALENDAR YEARS

TITLE	PROJECT OR TASK NR	1955	1956	1957	1958	1959	1960	TO COMPL
ARS Environment	1764							
Solar U.V. and X-Ray	39791							
- Intensity Measurements								
- Sputtering								
(Interp) Ionic Matter & Rad.	39792							
- Rocket-Borne Trace Studies								
- ARS Meteor Detection Studies								
- High Speed Impact Phenomena								
- Theoretical Studies								
Satellite Altitude Density	39793							
- In-House Studies								
- Evaluation of Two Methods								
- Instrumentation & Rocket Test								
- ARS Test Vehicle Program								
Therm RAD for ARS	39794							
- Temperature Sensors								
- Radiation Sensors								
- Background Studies								
- Theoretical								
- Experimental								
Rocket Support	39795							

Schedule Key:

1 - Let Study Contract
2 - Termination and Tech Rept (Study Contract)
3 - Begin In-house Studies
4 - Development Contract Awarded
5 - Technical Report
6 - Apparatus Tested in Lab
7 - Test & Data Gathering Flights
8 - Satellite Instrumentation Complete
9 - Measurement on ARS Flight
10 - Analysis of Data
11 - Final Report

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318-57-01140

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1.

R & D MANPOWER ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE 26 OF PAGES

3. DATE: 2 April 1957

4. UNCLASSIFIED TITLE
Geophysical Environment Data for ARS, WS 117L
Short Title: ARS Environment

5. INITIAL ☒ CHANGE ☐

6. NUMBER: 1764

7. ORG COMP CODE	8. ORGANIZATION TITLE	9. TYPE ORG	10. ACTUAL MAN-QTRS LAST QTR	11. PROJECTED DIRECT MAN-YEARS FY 1957 AVAL	FY 1957 RQRD	FY 1958 AVAL	FY 1958 RQRD	FY 19 59 RQRD	FY 19 60 RQRD	TO COMPL RQRD
CRD	Geophysics Research Directorate AFCRC	R	4.5	5.0	24.5	5.0	29.0	32.0	26.0	
	TOTAL		4.5	5.0	24.5	5.0	29.0	32.0	26.0	
	Total Manpower Dollars		7,938	36,400	178,360	36,400	211,120	232,960	189,280	

Manpower Justification Attached:

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AD-57-01140

~~CONFIDENTIAL~~ [redacted]

1.

R & D MANPOWER ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE OF PAGES

3. DATE 2 April 1957

4. UNCLASSIFIED TITLE
Geophysical Environment Data for ARS, WS 117L
Short Title: ARS Environment

5. INITIAL ☒ CHANGE

6. NUMBER 1764

7. ORG COMP CODE	8. ORGANIZATION TITLE	9. TYPE ORG	10. ACTUAL MAN-QTRS LAST QTR	11. PROJECTED DIRECT MAN-YEARS						
				FY 19 57		FY 1958		FY 1959	FY 1960	TO COMPL
				AVAL	RQRD	AVAL	RQRD	RQRD	RQRD	RQRD

1. Task 39791 will require the services of a total of eight physicists (civilian or military) of qualifications equaling those of GS-12 or higher. Two of these are now available, both GS-13, and therefore six additional physicistswill be required, beginning immediately and extending through the duration of the project.

2. The manpower requirements on Task 39792 for measuring the influx of interplanetary matter is estimated on the basis that three physicists and one electronic engineer (GS-11 to GS-13) will be required during the initial phase of the program during the remainder of FY 57. As test firing increases in FY 58 and FY 59 an additional mathematician (GS-11) will be required in the analysis of this data. This research team will be reduced to three (3) through the completion of the task.
This group will be responsible for the overall planning of the program and the experimental rocket and satellite program. The application of significant experimental laboratory data, and the establishment of significant experimental laboratory data, and the establishment of theoretical design criteria will be made up by this group also. The preparation and prosecution of general scientific plans, coordination, monitoring of contractual research and development, the preparation of summary and technical reports will be handled by this team. It is believed that the scope of the problem involving acoustics, electronics collision theory, meteor physics and other basic studies should be handled by a team; with a minimum size of at least five (5) people. At this time, the magnitude of this program may not be determined until the first phase of the research has been completed.

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AMD-57-61140

(UNCLASSIFIED TITLE) Geophysical Environment Data for ARS,WS117L 2 April 1957
Short Title: ARS Environment Proj 1764
R&D Manpower Annex (Cont.)

3. Manpower to perform research on Task 39793 will be divided into the following listed three (3) experimental teams:

a. Falling-Sphere Density Experiment Team

This team will consist of one task scientist (GS-12), one physicist (GS-11), and one engineer (GS-9)

b. Pressure Gauge Density Experiment Team

This team will consist of one deputy task scientist (GS-12), one physicist (GS-11), and one engineer (GS-9).

c. Data Reduction Team

This team will consist of one secretary (GS-3), and one computer (GS-9).

4. Responsibility of the 3 experimental teams will be as follows:

a. Falling-Sphere Density Team

(1) The responsibility of the Falling-Sphere Density Team will be to modify the existing Falling-Sphere Density Measuring Technique and scientifically develop, test and launch a modified instrumentation for density measurement at altitudes up to 500 Km.

(2) The responsibility of the task scientist is to plan and direct the over-all task program. In addition, he will directly administer the program of the Falling-Sphere team. He will consult with and advise the physicist and engineer in the theoretical study, design, development, laboratory testing, and contractual procurement of the flight model instrumentation; and will serve as Field Director at experimental test grounds.

(3) The physicist will be responsible for carrying out the team program of theoretical work on the applied and background research pertaining to the Falling-Sphere Density Experiment. He will be concerned with the evaluation of the theoretical aspects of the experiment, and all experimental progress in related fields of research. He will consult with, advise and assist the engineer in the laboratory experimental phases of the team program, and the electronic and mechanical design of instrumentation. He will be responsible for the preparation of scientific reports and papers as required in the experimental program.

(4) The engineer will be responsible for the team laboratory experimental program, the electronic and mechanical design and construction of instrumentation. He will initiate procurement of instrumentation. He will

initiate procurement of and will monitor a contractor construction contract to build the final instrumentation for rocket installation. He will serve as field engineer during proving ground experimental tests.

5. Pressure Gauge Density Experiment Team

a. The responsibility of the Pressure Gauge Density Team will, in consideration of present methods limited to altitudes of about 130 km, scientifically plan, develop, test, and launch a rocket borne pressure gauge instrumentation for density measurement at altitudes up to 500 km.

b. The responsibility of the deputy task scientist will be to plan, direct and administer the program of the team. He will consult with and advise the physicist and engineer in theoretical study, design, development, laboratory testing, contractual procurement of the flight model instrumentation and will serve as Field Director at experimental test grounds.

c. The Physicist will be responsible for carrying out the team program of theoretical work on applied and background research pertaining to the Pressure Gauge Density Experiment. He will be concerned with the evaluation of the theoretical aspects of the experiment, and all experimental progress in related fields of research. He will consult with advise and assist the engineer in the laboratory experimental phases of the team program and in the electronic and mechanical design of the instrumentation. He will be responsible for the preparation of scientific reports and papers, as required in the experimental program.

d. The Engineer will be responsible for the ream laboratory experimental program, the electronic and mechanical design and construction of instrumentation. He will initiate procurement of, and will monitor a contractor construction contract to build the final instrumentation for rocket installation. He will serve as field engineer during proving ground experimental tests.

6. Data Reduction Team - The responsibility of the Data Reduction Team will be to reduce telemetered, photographic, and other transmitted data that may be supplied from airborne density instrumentation; and to present this data in useful form for geophysical interpretation.

7. The Task 39794 Planning and Supervision will be under the direction of a Task Scientist. Throughout the period of the task, he will be responsible for the preparation and prosecution of the general scientific plans and for the coordination of work of the contributing agencies of the entire program. He will be responsible for all the phases of the program, including selection of contractor, approval of proposals, supervision of both contractual

(UNCLASSIFIED TITLE) Geophysical Environment Data For ARS, WS117L
Short Title: ARS Environment
R&D Manpower Annex (cont.)

2 April 1957
Proj 1764

and in-house efforts contributing to design, fabrication, test, calibration and data reduction and interpretation -- in short, the integration of the results of the contract program and the in-house programs. The Task Scientist is currently available.

8. a. The manpower requirements for T-39795 for Rocket and Instrumentation Support are estimated on the basis that four Research Engineers, (GS-11 to GS-13) will be required during FY 57 to accomplish instrumentation for the required program. During FY 58 an additional two Research Engineers will be required to absorb the load of frequent field trips to rocket launch sites and to maintain the heavy schedule of rocket preparation and firings. In FY 59 two additional Research Engineers will be required to conduct liaison on instrumentation of orbiting and non-orbiting test vehicles.

b. This group will be responsible for the instrumentation of all rocket experiments in the program for coordination with launch sites, for collection and recording of data from rocket fligha and for liaison and planning with prime contractor in use of system test vehicles.

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R & D CONTRACT FUNDS ANNEX

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE 31 OF 32 PAGES

3. DATE: 2 April 1957

4. TITLE: (UNCLASSIFIED TITLE) Geophysical Environment Data for ARS, WS 117L
(Short Title) ARS Environment

5. INITIAL ☒ CHANGE ☐

6. NUMBER: 1764

7. ITEM	8. PROJ OR TASK NR	9. END ITEM CAT	10. CONTRACT NUMBER	11. BPSN	12. PREV YRS		13. FY 57		14. FY 58		15. FY 59		16. FY 60		17. TO COMPL	
					000	OTHER	000	OTHER	000	OTHER	000	OTHER	000	OTHER	000	OTHER
ARS Environment	1764	R&E	Various	2-117	160M		422M		1000M		1410M		425M			
P-100 Funds:						6M				950M		470M				
P-200 Funds:												50M				
Sub-Totals:			P-600		160M		422M		1000M		1410M		425M			
			P-100			6M				950M		470M				
			P-200									50M				
TOTAL					160M	6M	422M	0M	1000M	950M	1410M	520M	425M			

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R & D COST ESTIMATE RECAPITULATION

☐ SYSTEM ☒ PROJECT ☐ TASK ☐ OTHER

2. REPORTS CONTROL SYMBOL

PAGE 32 OF 32 PAGES

4. UNCLASSIFIED TITLE
Geophysical Environment Data for ARS, WS 117L
Short Title: ARS Environment

5. INITIAL ☐ CHANGE ☐

3. DATE
2 April 1957

6. NUMBER
1764

ITEM		A. PREVIOUS YEARS		B. FISCAL YEAR 57		C. FISCAL YEAR 58		D. FISCAL YEAR 59		E. TO COMPLETE	
		GOVT	OTHER	GOVT	OTHER	GOVT	OTHER	GOVT	OTHER	GOVT	OTHER
7. CONTRACT	A. TOTAL	160M	6M	422M		1000M	950M	1410M	520M	425M	0
	B. AVAILABLE	160M	6M	422M							
	C. NEW REQ					1000M	950M	1410M	520M	425M	0
8. MATERIEL	A. TOTAL										
	B. AVAILABLE			-							
	C. NEW REQ										
9. FACILITIES											
10. MANPOWER		7.9M		36.4M		178.4M		36.4M		422.2M	
11. TRAINING		N/A									
12. TEST ITEMS		N/A									
13. TEST SUPPORT AIRCRAFT		N/A									
14. SUBTOTAL		160M	6M	422M		1000M	950M	1410M	520M	425M	0
15. TOTAL		173.9M		458.4M		2128.4M		1966.4M		847.2M	

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