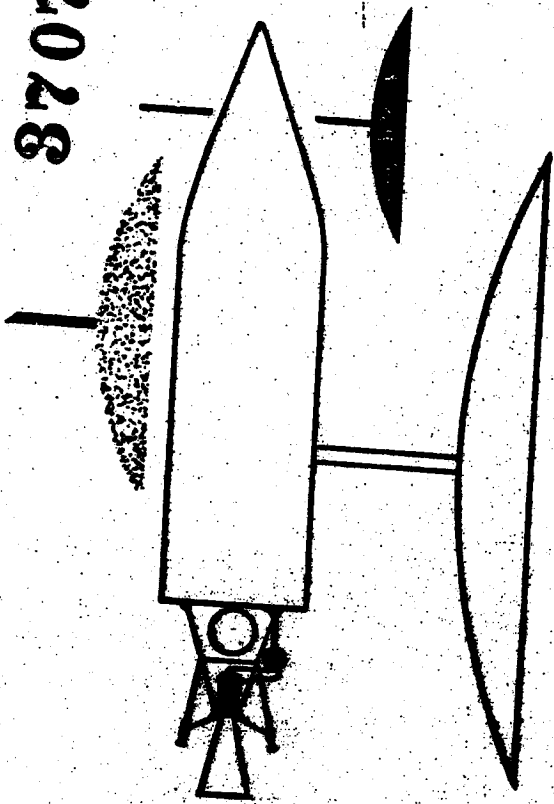


LMSD  
1536  
VOL. II  
PART J  
(C.3-D.4E-42)

**CONFIDENTIAL**

MSD 1536

922028



*Pied  
Piper*  
**DEVELOPMENT  
PLAN**

**VOL. II SUB-SYSTEM PLAN**  
**J. Vehicle Intercept and  
Control, Ground Station**

LMSC LIBRARY INVENTORY - PALO ALTO  
Return to LMSC Library. Do not destroy  
or transmit to another person or office.

RECEIVED  
TISIA E

**LOCKHEED AIRCRAFT CORPORATION**  
**MISSILE SYSTEMS DIVISION**  
**VAN NUYS, CALIFORNIA**

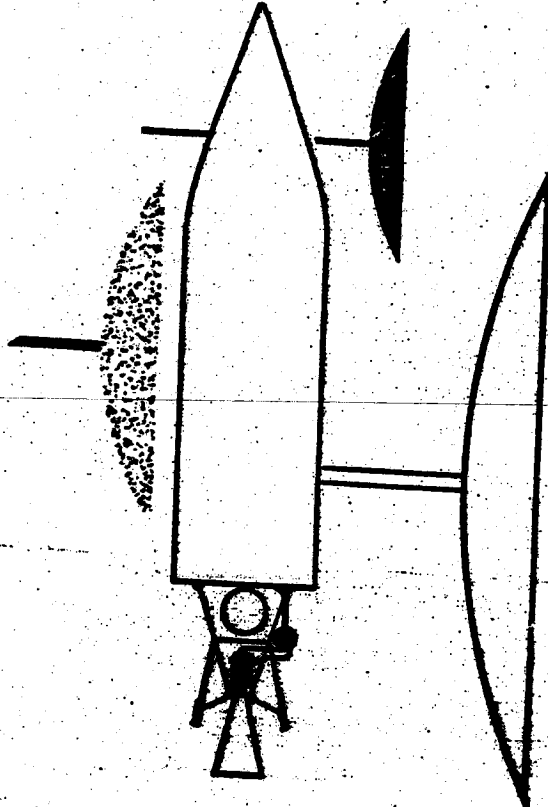
DEC 3 9 1963  
**CONFIDENTIAL**  
NO. 6121E

LMSC LIBRARY INVENTORY - PALO ALTO  
Return to LMSC Library. Do not destroy  
this item or give it to another person or office.

**CONFIDENTIAL**

MSD 1536  
1 MARCH 1956

*E-42*  
COPY NO. 56  
SHEETS



*Pied  
Piper*  
**DEVELOPMENT  
PLAN**

**VOL. II SUB-SYSTEM PLAN**

**J. Vehicle Intercept and  
Control, Ground Station**

DOWNGRADED AT 12 YEAR INTERVALS.  
NOT AUTOMATICALLY DECLASSIFIED  
DDG DMR 5200.10

~~In addition to security requirements, which must  
be met, the following restrictions apply to the  
distribution of this information to foreign governments  
or foreign nationals: it may be made only with the  
approval of AEGIS Com 555.~~

**LOCKHEED AIRCRAFT CORPORATION**  
**MISSILE SYSTEMS DIVISION**  
**VAN NUYS, CALIFORNIA**

**CONFIDENTIAL**

~~CONFIDENTIAL~~

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS WITHIN THE MEANING OF THE FBI & FIA. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

~~CONFIDENTIAL~~

~~SECRET~~

MSD 1536

FOREWORD

The Advanced Reconnaissance System (ARS) consists of a satellite vehicle containing equipment to perform visual, ferret, and infrared reconnaissance, together with the necessary system of ground stations and data processing centers.

This Development Plan for the accomplishment of the ARS was prepared by the Missile Systems Division, Lockheed Aircraft Corporation and its subcontractors, CBS Laboratories and Eastman Kodak Company. The specifications for the system were determined in the course of a one-year study now being conducted for the United States Air Force under contract AF 33(616)-3105. The plan is presented in two parts; Volume I, System Plan, and Volume II, Subsystem Plan. The subsystems are described in separate books, Volume II-A through II-I.

~~SECRET~~

~~SECRET~~

MSD 1536

PIED PIPER DEVELOPMENT PLAN

VOLUME I. SYSTEM PLAN

VOLUME II. SUBSYSTEM PLAN

- A. Airframe
- B. Propulsion
- C. Auxiliary Power
- D. Guidance and Control
- E. Visual Reconnaissance
- F. Electronic Reconnaissance
- G. Infrared Reconnaissance
- H. Vehicle Electronics
- I. Airborne Test Systems
- J. Vehicle Intercept and Control Ground Station
- K. Ground Data Processing
- L. Vehicle Ground Support

ROCKWELL SYSTEMS CORPORATION

~~SECRET~~

ROCKWELL SYSTEMS CORPORATION

~~SECRET~~

## CONTENTS

## Subsystem J Vehicle Intercept and Control Ground Station

## RDB PROJECT CARD (Form DD 613)

Tab 1 General Design Specifications

Tab 2 Subsystem Summaries

Milestones

Hardware Delivery

Test Schedules

R and D Schedules

Tab 3 R and D Tests (Form ARDC 105)

Tab 4 R and D Test Aircraft (Form ARDC 106)

Tab 5 R and D Materiel (Form ARDC 107)

Tab 6 Required Facilities

Tab 7 R and D Contract Funds

Tab 8 Estimate of Manpower Requirements

## APPENDIX

1. General
2. Ground Data Link
3. Ground Radar Equipment
4. Propagation
5. Orbit Computer
6. Command Link
7. Telemetry
8. Ground Communication

References

~~SECRET~~

~~SECRET~~

MSD 1536

RDS PROJECT CARD

TYPE OF REPORT

REPORTS CONTROL SYMBOL  
DS-RDR(A)48

1. PROJECT TITLE  
VEHICLE INTERCEPT AND GROUND CONTROL STATION  
SUBSYSTEM  
(UNCLASSIFIED)  
(PIED PIPER)

3. SECURITY  
Secret

2. PROJECT NUMBER  
1115

4. INDEX NUMBER

5. REPORT DATE  
1 March 1956

6. BASIC FIELD OR SUBJECT

7. SUBJECT OR SUBJECT SUBGROUP

7A. TECH. CGL.

8. COMNAME AGENCY

12. CONTRACTOR AND/OR LABORATORY

CONTRACT/W.O. NO.

9. DIRECTING AGENCY

Lockheed Missile  
System Division

AF 33(616)-3105

OFFICE SYMBOL

TELEPHONE NO.

10. REQUESTING AGENCY

13. RELATED PROJECTS

17. EST. COMPL. DATE

11. PARTICIPATION, COORDINATION, INTEREST

14. DATE APPROVED

REQ.

REV.

TEST

CP. EVAL.

18. FY | FISCAL EST. (M \$)

15. PRIORITY  
Maximum

16.

19.

20. REQUIREMENT AND/OR DISCUSSION

- a. The reconnaissance data obtained by the Satellite Vehicle will be transmitted to suitable ground base stations in quantity and variety previously not available, over a high performance data link. In order to maintain contact with the vehicle, a ground acquisition and tracking radar with associated orbit computer, and command control link must be developed. In addition, data link receiving equipment, and inter-station communications networks are required to accomplish these objectives.
- b. The reconnaissance information obtainable will be of great value to SAC, TAC, and Air Defense.
- c. A satellite has not been used previously in a reconnaissance mission. It will provide a major increase in the coverage available, resulting in a greatly increased Air Defense capability.

21. RDR

22

23

ICSP

X L C

DD FORM 613

MISSILE SYSTEMS DIVISION

~~SECRET~~

J, P 1

SECRET AND/OR CONFIDENTIAL

SECRET AND/OR CONFIDENTIAL

~~SECRET~~

MSD 1536

1. PROJECT TITLE <b>VEHICLE INTERCEPT AND GROUND CONTROL STATION SUBSYSTEM (Unclassified) (PIED PIPER)</b>	2. SECURITY OF PROJECT <b>Secret</b>	3. PROJECT NUMBER <b>1115</b>
	4.	5. REPORT DATE <b>1 March 1956</b>

**21 a. Brief and Operational Characteristics**

The vehicle intercept and control ground station equipment will permit vehicle interception, tracking, and the transmission of specific commands over line-of-sight distances to the vehicle. This command capability will permit the proper orientation of Data Link and Telemetry antennas, insuring efficient read-out of reconnaissance information by the data link receivers in addition to the specific command capability required. A digital orbit computer will receive inputs from the microwave tracking radar in order to determine the future trajectory of the vehicle. The ground station sites and intercommunication techniques will be selected for optimum over-all performance.

**21 b. Approach**

A system of ground stations will be strategically located to provide efficient control and intercept of the vehicle. When the vehicle is in line-of-sight range from a station, a microwave radar system will acquire and track it and feed data to the orbit computer. Orbit computations will provide the basis for discrete program commands fed into the FM command transmitter. The high gain telemetry and data link receiving antennas will be coupled to the tracking radar system. The video output from the data link receiver will be available for decoding and data storage devices. The vehicle-borne data link antenna will be scanned so that the ground receiver can detect errors in its direction. These will be corrected over the FM 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, relying on a combination of wire lines and VHF scatter techniques as required.

**21 c. Tasks of the Subsystem**

The Vehicle and Control Ground Station development is divided into the following tasks:

- 1. a. Acquisition and Tracking Radar
  - b. Contractor: Lockheed Aircraft Corporation, Missile Systems Division.
  - c. A Microwave radar capable of acquiring and tracking the ABE vehicle at ranges out to 1500 miles line-of-sight, with high tracking accuracy.



D. PROJECT TITLE <b>VEHICLE INTERCEPT AND GROUND CONTROL STATION SUBSYSTEM</b> (Unclassified) (PIED PIPER)	2. SECURITY OF PROJECT <b>Secret</b>	3. PROJECT NUMBER <b>1115</b>
	4.	5. REPORT DATE <b>1 March 1956</b>

2.a. Orbit Computer

b. Contractor: Lockheed Aircraft Corporation, Missile Systems Division.

c. A digital computer to permit the computation of orbit parameters with sufficient accuracy and speed to predict the future trajectory of the vehicle to prevent loss of the vehicle and to permit interpretation of the reconnaissance data.

3.a. Command Transmitter

b. Contractor: CBS Laboratories

c. A high-powered FM command transmitter operating independent of the radar as the primary command technique.

4.a. Command Controller

b. Contractor: Lockheed Aircraft Corporation, Missile Systems Division.

c. A command unit associated with the tracking radar to permit the transmission of discrete commands over the radar link as directed by the orbit computer, by field requirements and by system operation. This is a backup command unit but is a capability inherent to the tracking radar.

5.a. Telemetry Receiving System

b. Contractor: Lockheed Aircraft Corporation, Missile Systems Division.

c. This equipment is required for the test phases of the program to receive and record pertinent data including pressures, temperatures, etc. for the development of the vehicle.

6.a. Data Link Ground Station

b. Contractor: CBS Laboratories

c. For Visual Reconnaissance a special high-performance receiver with associated high gain antennas capable of following the vehicle while within line-of-sight will be used. It will be under the control of the closely associated tracking radar and command link.

~~SECRET~~

MSD 1536

1. PROJECT TITLE <b>VEHICLE INTERCEPT AND GROUND CONTROL STATION SUBSYSTEM (Unclassified) (PIED PIPER)</b>	2. SECURITY OF PROJECT <b>Secret</b>	3. PROJECT NUMBER <b>1115</b>
	4.	5. REPORT DATE <b>1 March 1956</b>

This equipment must have interference rejection characteristics exceeding the generally accepted standards employed in television links at present.

The data link receiver will include a means to demodulate vehicle antenna scanning signals and to generate antenna tracking error commands for transmission to the vehicle.

A visual data recorder photographs the kinescope output of the data receiver and, using synchronizing pulses in the data link transmission, reconstructs the photograph as it was originally seen at the data link transmitter.

Electronic Reconnaissance data are transmitted over a PPM/TM telemeter link to the intercept and control station receiver. The ground station will be equipped to reconstruct the received data into digital form and to record it on magnetic tape.

7.a. Inter-Station Communications

b. Contractor: Lockheed Aircraft Corporation, Missile Systems Division.

c. A means whereby trajectory data and general communications can be exchanged between ground stations, either by land line or VHF scatter techniques, is required. It will be developed, or adapted from existing military or civilian installations as needed.

~~SECRET~~

J. P. K.

~~SECRET~~

*Pied  
Piper*

MSD 1536

**LOCKHEED AIRCRAFT CORPORATION  
MISSILE SYSTEMS DIVISION**

**TABS**

~~SECRET~~

~~SECRET~~

MSD 1536

Subsystem J - VEHICLE INTERCEPT AND CONTROL GROUND STATION

Tab 1 - General Design Specifications

I. GENERAL

A. Statement of the Problem

~~The Vehicle Intercept and Control Ground Station provides means for keeping track of the ARS vehicle; for receiving and collecting reconnaissance data; for controlling specific functions in the payload elements by discrete commands; and the intercommunication required between other ground stations, command headquarters, and intelligence evaluation locations.~~

B. Approach

A group of Vehicle Intercept and Control Ground Stations will be established. They will be located in a manner providing satisfactory coverage for the ARS vehicle both in the early test phases and in the later operational phases of this program.

Each station will employ a microwave radar for vehicle acquisition and tracking. Orbit parameters will be determined with the aid of a Digital Orbit Computer at each station location. The accuracy required is within the present state-of-the-art. The computed trajectory will permit prediction of the future trajectory of the ARS vehicle in order to assist in tracking acquisition and to provide geographical location tie-in of data as a function of the time of collection.

A Command Radio Link will be employed using high-power FM techniques to transmit up to 100 different commands to the vehicle. In this unit broad beam antennas on the ground will be used to "flood the sky" and permit very reliable command contact with the vehicle even in the event radar tracking is interrupted.

A Command Control unit designed into the tracking radar, and modifying the repetition rate or pulse spacing, will be used as a secondary command unit to transmit up to 10 discrete commands to the vehicle.

J-Tab 1, p 1

~~SECRET~~

~~SECRET~~

MSD 1536

The Data Link receiving station for visual reconnaissance information includes steerable directional antennas as part of the ground station equipment. These antennas will be controlled in position by the associated tracking radar equipment. The receiver will derive vehicle antenna position error signals as the vehicle antenna is conically scanned. These error signals are then fed into the radio command link, and to the vehicle on-board data link transmitting antenna servos, which positions the vehicle data link antenna in a manner which aligns it with the ground data link receiving antenna. Data modulation is then transmitted over this link.

The ferret reconnaissance information is transmitted over a narrower bandwidth link making use of familiar FM/FM telemetry techniques, and in fact, employing commercially available receiving equipment for this purpose. The receiving antenna will be directive and have in the order of 20-30 db gain as required. The received data will be reconstructed into digital form and recorded on magnetic tape.

In early phases of the ARS test program, Telemetry receiving equipment will be included in the complement of ground station equipment. The directive antenna arrays used with this equipment will be slaved to the tracking radar equipment.

Each ground station will operate as a complete unit but an inter-station Communications Network will be used. Wire facilities are contemplated where station location permits. In other cases, HF communications and VHF scatter Techniques will be employed. This equipment is planned at present to be GFE until a more exacting indication of the requirements can be evolved.

A simplified block diagram of the ground station is shown in Fig. 1. It will be noted that the various sections of the ground station can be geographically separated but from the standpoint of logistical support of the operation, these equipments should be close together, and indeed, adjacent to ARS vehicle launching sites if possible.

Site selection is complicated by a number of factors including the desirability of achieving maximum tracking coverage on a variety of orbits; operational and domestic security; logistical support considerations including operator efficiency as affected by climate and working conditions; and finally, technical problems of transmission bandwidth, propagation factors, communication range between stations, etc. The map in Fig. 2 shows the recommended station arrangement. This three station arrangement with stations located in the vicinity of Portland, Maine, Honolulu, T.H., and San Francisco, California, gives adequate coverage while still providing good security and logistics support.

i-Tab I, p 2

~~SECRET~~

ROCKWELL AIRCRAFT CORPORATION

~~SECRET~~

KCD 1536

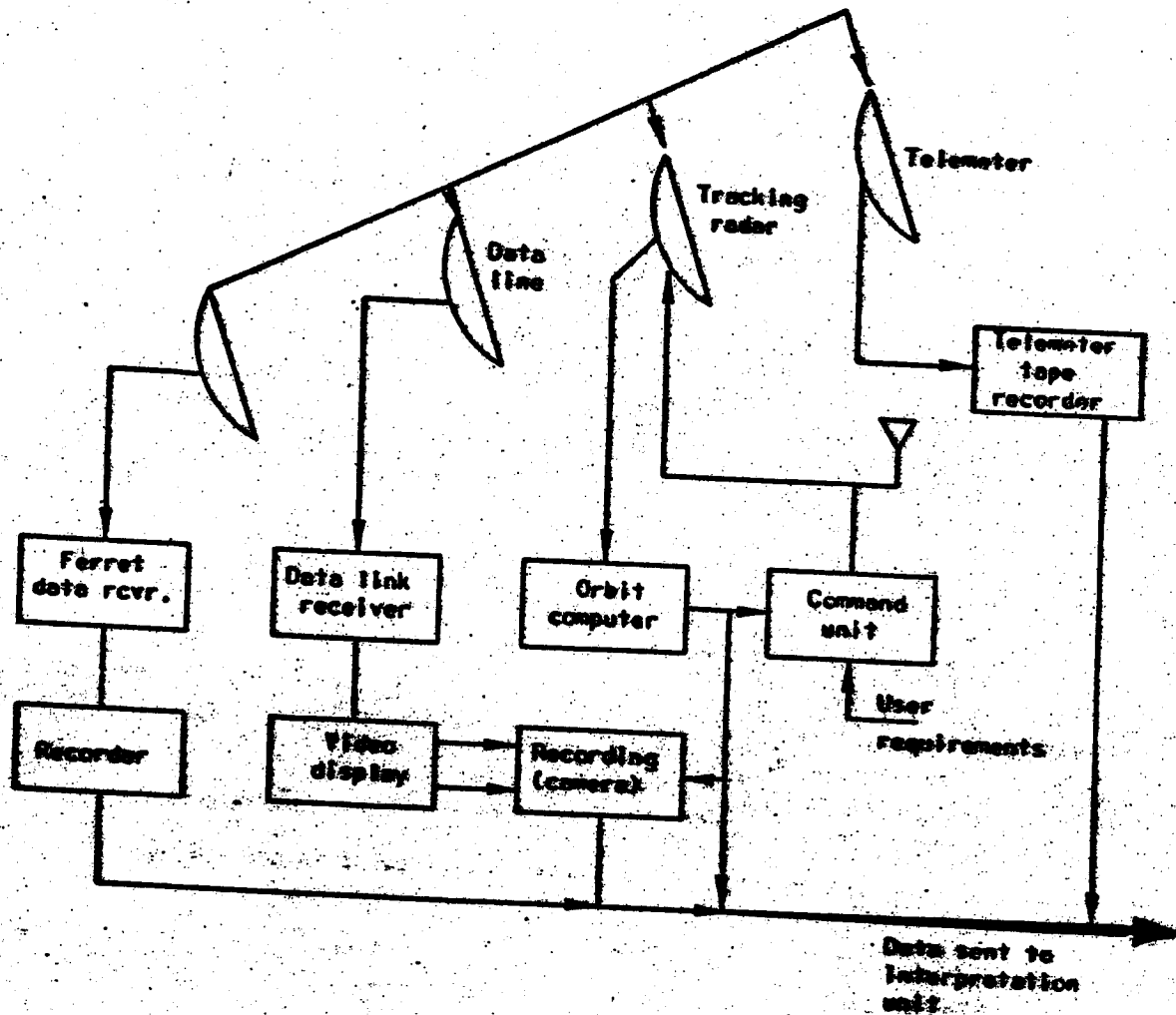


Fig. 1 Ground Station Simplified Block Diagram

SECRET

GROUP SECRET CONTROL