CONFIDENTIAL

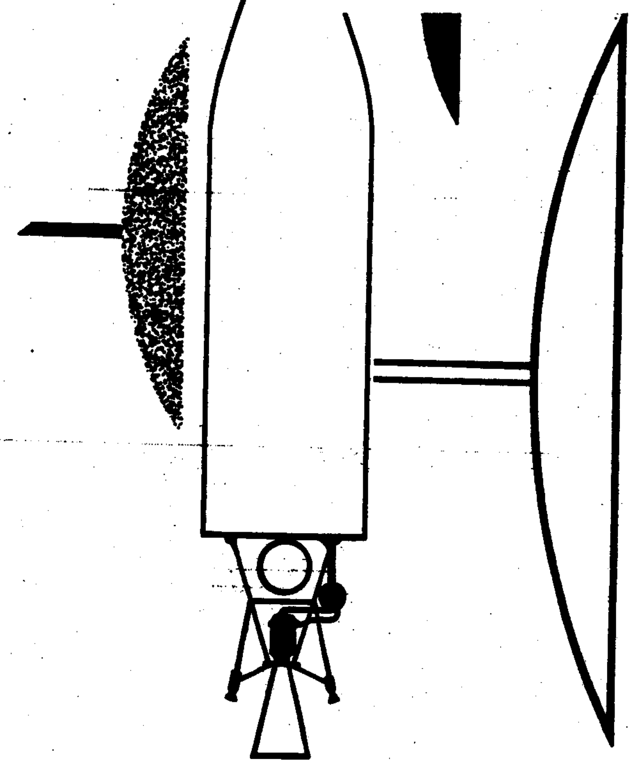
[redacted]

MSD 1536

K243.8636-36
V. 2, PT. 1
1 MAR 1959

27 OCT 1989

EXEMPTED FROM 25 MAR 1996
DECLASSIFICATION IAW EO 12958
REVIEW DATE_______ REVIEWER (6)
REFER TO ______________
EXEMPTION (S): 1 2 3 (4) 5 6 7 8 9



Pied Piper DEVELOPMENT PLAN

VOL. II SUB-SYSTEM PLAN

A. Airframe

Excluded from General Declassification Schedule

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

3-68062
00920355

CONFIDENTIAL

[redacted]

LOCKHEED AIRCRAFT CORPORATION
MISSILE SYSTEMS DIVISION
VAN NUYS, CALIFORNIA

56RDZ 6524

THIS DOCUMENT CONTAINS INFORMATION AFFECTING THE NATIONAL DEFENSE OF THE UNITED STATES WITHIN THE MEANING OF THE ESPIONAGE LAWS, TITLE 18 U.S.C., SECTIONS 793 & 794. ITS TRANSMISSION OR THE REVELATION OF ITS CONTENTS IN ANY MANNER TO AN UNAUTHORIZED PERSON IS PROHIBITED BY LAW.

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-L.

PIED PIPER DEVELOPMENT PLAN

CONTENTS

Subsystem A Airframe

~~CONFIDENTIAL~~

[redacted]

SECURITY CLASSIFICATION

MSD 1536

RDB PROJECT CARD

TYPE OF REPORT: New System - Delelopment Plan

REPORTS CONTROL SYMBOL DD-RDB(A)48

1. PROJECT TITLE
AIRFRAME SUBSYSTEM
FOR ADVANCED RECONNAISSANCE SYSTEM
(UNCLASSIFIED)

(PIED PIPER)

2. SECURITY: ~~S~~

3. PROJECT NUMBER: 1115

4. INDEX NUMBER:

5. REPORT DATE: 1 March 1956

6. BASIC FIELD OR SUBJECT:

7. SUBFIELD OR SUBJECT SUBGROUP:

7A. TECH. OBJ.:

8. COGNIZANT AGENCY:

9. DIRECTING AGENCY:

OFFICE SYMBOL:

TELEPHONE NO.:

10. REQUESTING AGENCY:

11. PARTICIPATION, COORDINATION, INTEREST:

12. CONTRACTOR AND/OR LABORATORY: Missiles System Division
Lockheed Aircraft Corp.

CONTRACT/W.O. NO.: AF33(616)-3105

13. RELATED PROJECTS:

14. DATE APPROVED:

15. PRIORITY:

16.

17. EST. COMPL. DATES

RES.	
DEV.	
TEST	
OP. EVAL.	

18. FY	FISCAL ESTS. (M $)

19.

20. REQUIREMENT AND/OR JUSTIFICATION

20. This subsystem, the airframe of the satellite vehicle which is to be an additional stage to the WS-107 vehicle, must be capable of establishing the reconnaissance equipment in orbit and be compatible with the operation of the orbiting components of the reconnaissance systems. The operational environment is sufficiently different from that of any other system that no equivalent vehicle is available or under development.

~~CONFIDENTIAL~~

22. RDB	SN	CN	[redacted] P	X.	I.	C.

DD FORM 1 JAN 613 MISSILE SYSTEMS DIVISION 2. [redacted] A.p 1

LOCKHEED AIRCRAFT CORPORATION

1. PROJECT TITLE	2. SECURITY OF PROJECT	3. PROJECT NUMBER
SUBSYSTEM DEVELOPMENT PLAN - AIRFRAME FOR ADVANCED RECONNAISSANCE SYSTEM (UNCLASSIFIED)	Secret	1115
(PIED PIPER)	4.	5. REPORT DATE 1 March 1956

21 a. Brief Characteristics

The airframe is the backbone of a final stage for the WS-107 vehicle, it has structural integrity for the boost phase, and carries the equipment required to establish itself in orbit, as well as furnish a framework for the components of the reconnaissance subsystems.

21 b. Approach

Booster vehicles will be derived from the WS-107 (Atlas program). The Pioneer vehicle airframe is designed to be compatible with the Atlas as well as the ground handling and launching equipment of the Atlas system. The Advanced vehicle airframe will be designed for use with a modified booster and launching system. Both airframes must satisfy the structural requirements of the boost phase, and contain components which make them consonant with the orbital environment. They must be capable of being stabilized in the orbit and also furnish an adequate framework during boost.

The tasks of the airframe subsystem, which are each described in par. 21c below, are:

1. Pioneer airframe structure
2. Pioneer adapter and separations
3. Pioneer pressurization system
4. Pioneer environment control
5. Advanced airframe structure and mechanisms
6. Booster modification for the advanced system
7. Advanced pressure system
8. Advanced environment control
9. Bola and other special configurations

21 c. Tasks of the Subsystem

1. Pioneer Airframe Structure

The airframe of the Pioneer vehicle is designed to be compatible with an unmodified Atlas System (WS-107). It is to house the Pioneer propulsion system and reconnaissance equipment. The airframe is approximately 61 inches in diameter and 18 feet in overall length. It is designed to tolerate about 8g longitudinal acceleration and 1.2g lateral acceleration. Vibration modes will be made compatible with those of the Atlas. The airframe structure

1. PROJECT TITLE	2. SECURITY OF PROJECT	3. PROJECT NUMBER
SUBSYSTEM DEVELOPMENT PLAN - AIRFRAME FOR ADVANCED RECONNAISSANCE SYSTEM (UNCLASSIFIED) (PIED PIPER)	~~Secret~~ 4.	1115 5. REPORT DATE 1 March 1956

carries a destruct system which will not permit the vehicle to re-enter dense atmosphere. The configuration and structure of the Pioneer Vehicle is discussed in the appendix.

2. <u>Pioneer Adapter and Separation System Task</u>

No modifications of the Atlas are required for the Pioneer vehicle. Attachments to the present mounting ring will carry the adapter skirt which will include the separation system.

3. <u>Pioneer Pressurization System</u>

The Pioneer pressure system is a simple helium system providing pressure to the main propellant tanks and to any components that require a pressurized atmosphere. The principal reason for pressurizing the propellant tanks is to drive the propellant constituents into the combustion chamber at a pressure sufficiently high to make turbo pumps unnecessary. Furthermore, the internal tank pressures provide gas to any payload component that may require a pressurized environment. The pressurization task is common to the propulsion subsystem where it is discussed in greater detail.

4. <u>Pioneer Environment Control</u>

This task is that of furnishing a satisfactory environment to each of the reconnaissance components. The firm requirements on the electronic equipment will be furnished by the results of the environmental simulation tests and verified in the STV tests. The required pressurization can be furnished by the pressure system and the operating temperature range can be maintained at whatever is required at or slightly above room temperature. The techniques of temperature control are based on the work reported in the appendix.

5. <u>Advanced Airframe Structure and Mechanisms</u>

The airframe of the Advanced system will accommodate a larger propulsion system and establish a larger payload on orbit. This design must be based on the actual performance achieved with the Atlas. The vehicle design will not change basically from that reported in Ref. a, the principal changes being in propellant tank size, and possible system for mechanically positioning the reconnaissance system components, such as cameras and antennae, and unfolding those antennae whose sizes have required folding during the boost phase. Such configurations as that of the Bola, (Ref. b) will require further analysis and must await the results of tests which may be done during the early orbit achievement.

1. PROJECT TITLE	2. SECURITY OF PROJECT	3. PROJECT NUMBER
SUBSYSTEM DEVELOPMENT PLAN - AIRFRAME FOR ADVANCED RECONNAISSANCE SYSTEM (UNCLASSIFIED) (PIED PIPER)	~~Secret~~	1115
	4.	5. REPORT DATE 1 March 1956

6. Advanced Booster Modification and Separation System

For the Advanced system the payload capability of the booster must be increased. At present it appears that the optimum gross weight of the orbiting vehicle will be about 14,000 pounds. This will require strengthening the front end of the booster. This modification will include the separation system.

7. Advanced Pressure System

Although designs have not been worked out specifically for the Advanced vehicle, it is anticipated that the pressurization system would be essentially as indicated for the Pioneer system including the capability of pressure stabilizing the tanks. It may be noted that a reduction of over 60% in pressurization system weight could be achieved if liquid oxygen is available in the missile for refrigerating the helium.

8. Advanced Environment Control

This task will become firm only after observations are made of the operation of the Pioneer system. The temperature control will be based on extensions of the work reported in the appendix.

9. Bola and Other Special Configurations

This task will be defined when the various nuclear and solar power units are specified. These special configurations must furnish some method of reducing the nuclear radiation field in which the reconnaissance equipment operates. The Bola configuration, (Ref. b) which separates the radiation source from the reconnaissance gear, will be examined in greater detail. The design configurations capable of incorporating a solar power unit must await the collecting of further information concerning the orbital environment. The configuration incorporating the infrared warning system will be made after the development of the detection and communication equipment, and a determination of the best altitude of the orbit.

21 d. Not Applicable

21 e. Not Applicable

21 f. Not Applicable

[redacted]

R&D PROJECT CARD
CONTINUATION SHEET

MSD 1536

1. PROJECT TITLE	2. SECURITY OF PROJECT	3. PROJECT NUMBER
SUBSYSTEM DEVELOPMENT PLAN - AIRFRAME FOR ADVANCED RECONNAISSANCE SYSTEM (UNCLASSIFIED) (PIED PIPER)	~~Secret~~	1115
	4.	5. REPORT DATE: 1 March 1956

21 g. <u>References</u>

a) First Quarterly Progress Report, Pied Piper, Vol. IV, MSD 1363, 1 November 1955 (S)

b) Bola Configuration, Task 16, Pied Piper Progress Report for November 1955, MSD 1440 (S)

21 h. Not Applicable

CONFIDENTIAL

[redacted]

Pied Piper

MSD 1536

LOCKHEED AIRCRAFT CORPORATION
MISSILE SYSTEMS DIVISION

TABS

CONFIDENTIAL

[redacted]

Subsystem A - AIRFRAME

Tab I - General Design Specifications

I. GENERAL

A. Statement of the Problem

An airframe must be designed which will:

1. Permit achievement of maximum reconnaissance capability
2. Be compatible with the WS 107 system
3. Permit achievement of orbit capability by the end of 1958

B. Approach

A vehicle will be designed which will meet the requirements of (2) and (3) above, fulfilling insofar as possible the maximum reconnaissance capability. The constraints imposed by (2) and (3) establish the size and weight and dictate the choice of certain components. This will be the "Pioneer Vehicle."

To more adequately comply with the requirements of (1), an improved reconnaissance vehicle will be designed (called "Advanced Vehicle") which will utilize the performance capabilities of the Atlas booster but will assume relaxation of the physical and temporal limitations. The advanced vehicle will provide a possible orbiting capability, but at reduced payload, using boosters of lower performance than Atlas such as IRBM or large, solid rockets.

C. Solution and Recommendation

1. Airframe Configuration

The configurations of the Pioneer and Advanced vehicles are basically the same - a cylindrical body with a conical nose. The diameter of the cylinder of the Pioneer is determined by the available diameter of the Atlas booster, 61 inches. The length of the Pioneer vehicle is 18 feet, which is the maximum allowed by the height of the present launching stand. The dimensions of the Advanced vehicle will be made compatible with the modified Atlas booster and the requirements of the propulsion and other basic subsystems as well as with the larger payloads. Our examinations have shown that the shape of the Pioneer vehicle has very little effect on the performance of the Atlas booster. The shape will be determined therefore, by considerations of aerodynamic heating in the early boost phase and by equipment packaging requirements. Investigation has shown that for the given shape the skin thicknesses shown in the appendix were necessary. The skin of the Pioneer vehicle furnishes protection for the components during the boost phase and temperature control for the various reconnaissance components during the orbit phase. In this connection it should be noted that the skin and structure aft of the tank section is in reality an adapter section which remains with the booster upon separation of the orbital unit.

Drawings of the configuration and the inboard profile are included in the appendix.

2. Inboard Profile

The principal components in the center section of the airframe are the propellant and pressurization gas tanks. These are basically spherical in shape and are nested so that each tank is partially submerged in the next larger tank. The high pressures required of a gas-fed system dictated the shape of the tank and for these shapes the nested configuration of the tanks was chosen from consideration of the resulting strength and rigidity.

The configuration chosen for the Pioneer vehicle is easily produced. The engine is mounted from the bottom of the most rearward tank and is the largest component in the aft section of the vehicle. In addition to the two control engines mounted on opposite sides of the main engine nozzle, several antennas and payload components can be mounted in the annulus surrounding the engine. These components are exposed upon separation of the satellite vehicle from the sustainer, because the entire adapter section remains with the Atlas sustainer. The components can be opened out and reoriented as necessary during orbiting.

The conical nose compartment contains the auxiliary power source, the guidance and control unit, and other small payload components as required. It should be noted that an ogival nose shape can be accommodated which will allow more space for payload components, if needed.

Communication and power transmission between the forward and after compartments can be accomplished through the space between the tanks and the outer skin. This space also contains the pressurization system lines and valves, and provides room for the mounting of slot antennas in the outer skin.

The profile of the Advanced vehicle has not been chosen. However, the requirement for larger quantities of propellant will permit a tank structure which is integral with the skin which will give a completely pressure-stabilized system, achieving some saving in weight.

3. Structure

The tank assembly of the Pioneer vehicle is the structural backbone of the vehicle. Thrust loads from the booster are transmitted through the structure of the adapter section to the conical support for the propellant tanks. The adapter section is in effect a circular column consisting of a magnesium skin stiffened by several equally spaced longerons and circumferential rings. The boost loads are transmitted as tensile stresses in the tank walls to the engine mount. Conversely, when the engine is thrusting, its loads are transmitted through the engine mount to the tank bottoms and thence, like the booster loads, they are transmitted via the pressurized gas to the tank head which supports the auxiliary power source, guidance and control package, and other payload units. Thrust is transmitted to the airframe through another conical structural unit from the forward tank to the base of the nose cone. The nose cone is itself only an aerodynamic shield for the forward part of the missile. The region of external skin between the two thrust cones is entirely non-structural and is used for mounting slot antennas.

4. Compatibility with Atlas

The achievement of compatibility with the present Atlas system has determined the design of the Pioneer vehicle. This vehicle will be carried by the booster using an adapter section which will fit the attachment rings for the present nose. The adapter section will remain with the booster on separation. The length of the vehicle is determined by the clearance between the Atlas booster and the gantry crane of the present launcher. The weight of the early versions of the Pioneer vehicle will be that of the present Atlas booster payload; this will be increased to the maximum safe booster loading as the program develops. The only changes in the present Atlas system will be in the trajectory.

The Advanced vehicle will require modification of the Atlas system to utilize the complete capability of the Atlas booster, which will involve redesign of the launcher and the front of the booster.

5. Aerodynamics

Investigation of the aerodynamics of the Atlas vehicle indicates that about 2.5 per cent of the total impulse of the propulsion system is dissipated in the drag effect. Further, it is indicated that redesigning the Pioneer vehicle can only change this between the limits of 2.4 to 2.6 per cent, which indicates that some other requirement will dictate the size and shape. For example, the aerodynamic heating during the early stages of the boost is more important. The Pioneer vehicle is designed so that its temperature rise will not degrade its structural integrity.

6. Performance

The performance of the Atlas was investigated for the present payload of 3,500 pounds and for the present maximum payload capability of 7,000 pounds. The Pioneer vehicle was designed to use this performance and to give the additional performance required to achieve orbital capability with payloads adequate to accomplish visual reconnaissance. The Advanced vehicle is designed to achieve the maximum payload on orbit for the performance of the Atlas booster. The complete picture of the performance is shown in the appendix.

7. Environmental Control

The airframe will furnish temperature control for the payload components. Present studies indicate that using the power dissipated together with properly designed insulation and radiation shields the correct operating temperatures for the components can be maintained. The design will be made after tests in the environmental chamber have been completed. No other type of environmental control will be performed by the airframe.

8. G.F.E.

The overall environmental requirements indicate that no part of this subsystem will be G.F.E.

9. Destruct System

A destruct system will be incorporated in the orbiting vehicle. This system will destroy the capability of the vehicle to reenter the atmosphere successfully. It does not seem necessary to employ a destruct system which will operate during the boost phase since the Atlas has such a system.

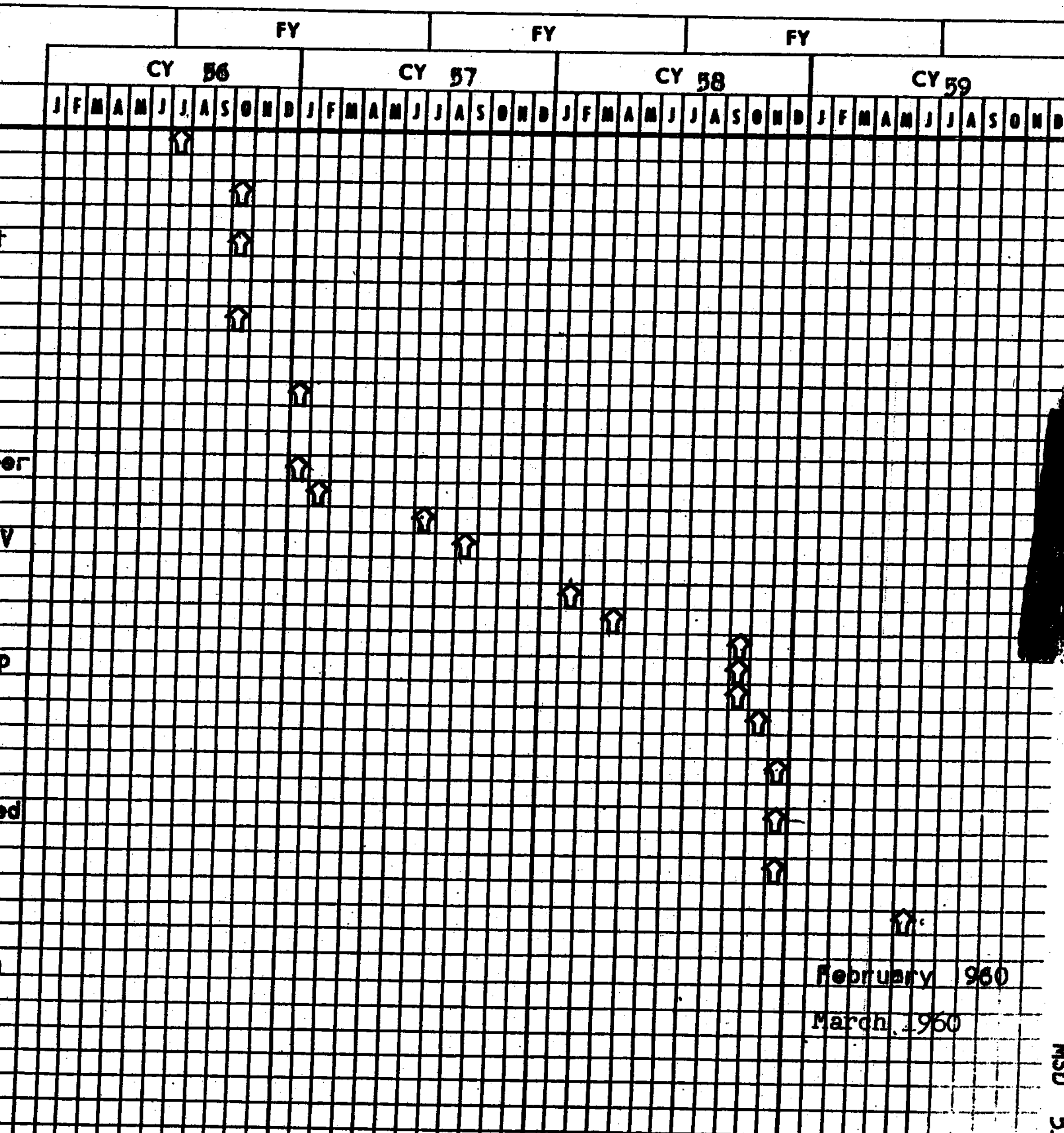
CONFIDENTIAL

[redacted]

Subsystem A - Airframe

Tab 2 Summary - Subsystem Milestones

1 System Study and Design Begins
2
3 Pioneer Vehicle Mockup
4
5 Release of Drawings for Development
6 Pioneer Vehicle
7
8 Fabrication of Development Pioneer
9 Vehicle
10
11 Testing of Development Pioneer
12 Vehicle
[redacted]
Engineering Design Freeze for Pioneer
Release Eng. Dwgs. to Shop
16 Pioneer Production Vehicle
17 Ground Firing of First Tied down OTV
18 Testing of First Production Vehicle
19 at STF
20 Flight of First NOTV
21 Flight of First OTV
22 Advanced Booster Modification Mockup
23 Advanced Vehicle Mockup
24 Release of Drawings for Development
25 Advanced Vehicle
26 Testing of Development Advanced
27 Vehicle
28 Engineering Design Freeze of Advanced
29 Vehicle
30 Release Eng. Dwgs. for Advanced
31 Production Vehicle
32 Ground Firing of First Advanced
33 Production Vehicle
34 Testing of First Advanced Production
35 Vehicle at STF
36 Flight of First Advanced Production
37 Vehicle at STF
38
39
40



CONFIDENTIAL

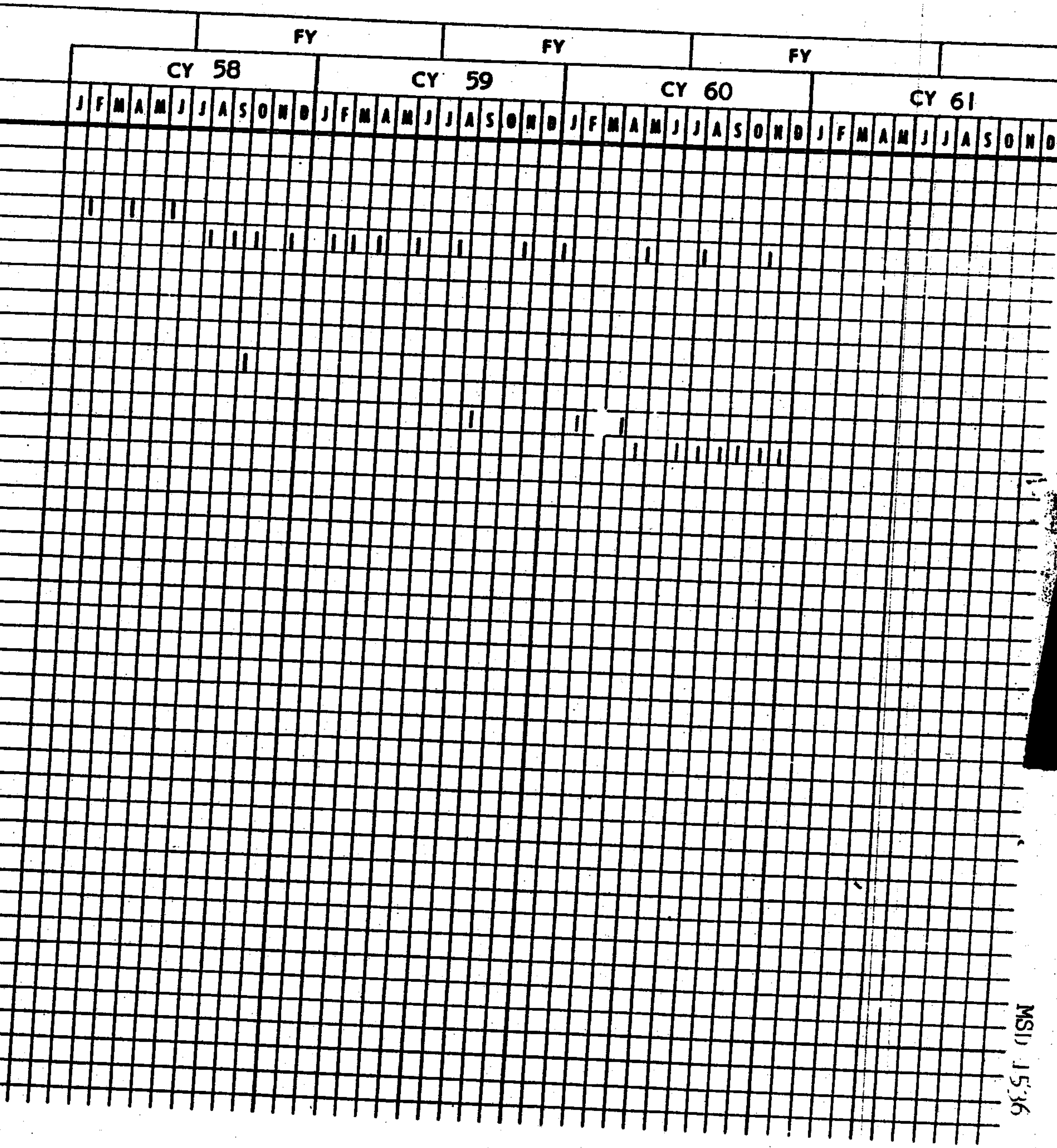
Revised Form 103

[redacted]

Subsystem A - Airframe

Tab 2 Summary - Hardware Delivery

1 Pioneer Airframe
2 Mockup (Oct/56)
3
4 Development Vehicle
5 Production Vehicle
6
7
8
9 Advanced Airframe
10 Mockup
11
12 Development Vehicle
13 Production Vehicle
14



25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

Revised Form 103

MSD 1536

[redacted]