[redacted]

~~CONFIDENTIAL~~

NOT LOGGED

LMSD-414889

JANUARY 1959

• DISCOVERER
• SENTRY
• MIDAS

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

SATELLITE DEVELOPMENT PROGRAMS

CONTRACT AF 04 (647)-97

EXCLUDED FROM
DECLASSIFICATION IAW E.O. 12958
REFER
TO: Lockheed

a syllabus prepared by

LOCKHEED AIRCRAFT CORPORATION
MISSILES AND SPACE DIVISION
SUNNYVALE, CALIFORNIA

WDSOT 59-1089

[redacted]

~~CONFIDENTIAL~~

This syllabus summarizes the basic concepts and the current state-of-development of the DISCOVERER, SENTRY, and MIDAS programs as presented in a joint Air Force - Lockheed briefing to the National Aeronautics and Space Administration on 20 January 1959.

The Lockheed Missiles and Space Division is responsible for the management of these related -- but distinctly separate -- satellite development programs in its roll as the Systems Contractor.

LOCKHEED AIRCRAFT CORPORATION
Missiles and Space Division
Sunnyvale, California

January 1959

SECTION I - INTRODUCTION

SYSTEMS EVOLUTION

Initiation of the development phase of the programs presented herein represented the culmination of a series of intensive Air Force-sponsored studies and analyses dating from the immediate post-World War II period.

A General Operational Requirement (GOR 80; SA-2C) for a satellite-based reconnaissance system was established by Air Force Headquarters in March 1955, followed in August 1956 by the publishing of a related Development Plan and a Development Directive. Overall responsibility for the development program was assigned to the Western Development Division (subsequently redesignated as the Ballistic Missiles Division) of Headquarters, Air Research and Development Command, and, in October 1956, the principal development contract was awarded to Lockheed's Missiles and Space Division.

Following the creation, in February 1958, of the Advanced Research Projects Agency in the Office of the Secretary of Defense, direction of the development program - and its funding - became an ARPA responsibility.

Prior to January 1958, it was planned that all satellites would be boosted to orbital altitude by the use of Atlas (SM-65) missiles. However, a series of measures, as follows, was taken during that month to both accelerate and augment the development program:

- A DX priority was assigned.
- The initial flight test date for Atlas-boosted reconnaissance satellites was moved forward by approximately one year, and additional flight tests were scheduled. This portion of the program was assigned the popular name, "Sentry".
- A number of Thor (SM-75) IRBM missiles were allocated for booster purposes. This Thor-boosted series of satellites was subsequently assigned the popular name, "Discoverer".

That portion of the Sentry program which had been concerned with the development of satellite-borne infrared detection systems has been assigned the distinctive designation, "MIDAS" (Missile Defense Alarm System).

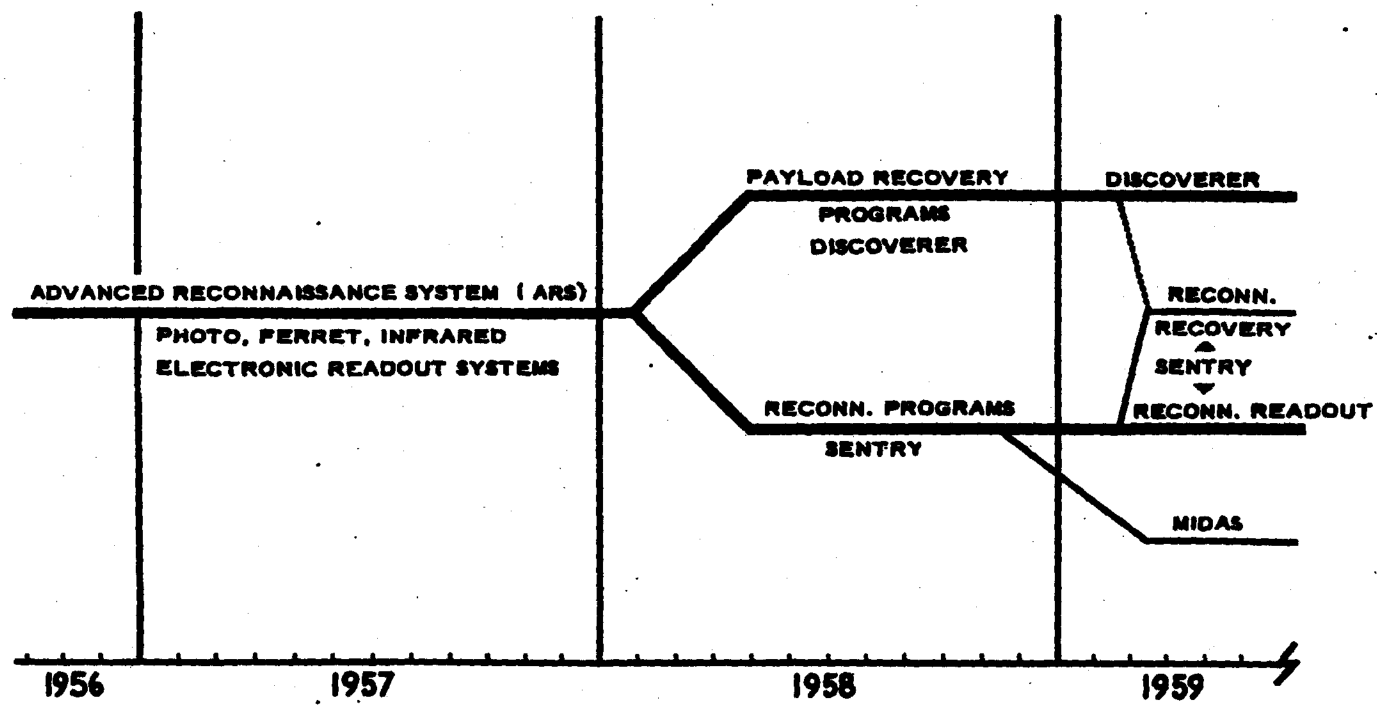
~~CONFIDENTIAL~~

The chart opposite indicates the evolution of development concepts from the original relatively straightforward Advanced Reconnaissance program, involving electronic data-readout systems, to the most recent Development Plan which provides for three essentially separate and distinct programs:

- DISCOVERER
- SENTRY
  - (1) An electronic data-readout reconnaissance system
  - (2) A system for physical recovery of reconnaissance data
- MIDAS

The characteristics of each of these programs are presented in sections which follow.

~~CONFIDENTIAL~~ [redacted]


PAYLOAD RECOVERY
PROGRAMS
DISCOVERER
DISCOVERER
ADVANCED RECONNAISSANCE SYSTEM (ARS)
PHOTO, FERRET, INFRARED
ELECTRONIC READOUT SYSTEMS
RECONN.
RECOVERY
SENTRY
RECONN. READOUT
RECONN. PROGRAMS
SENTRY
MIDAS
1956
1957
1958
1959

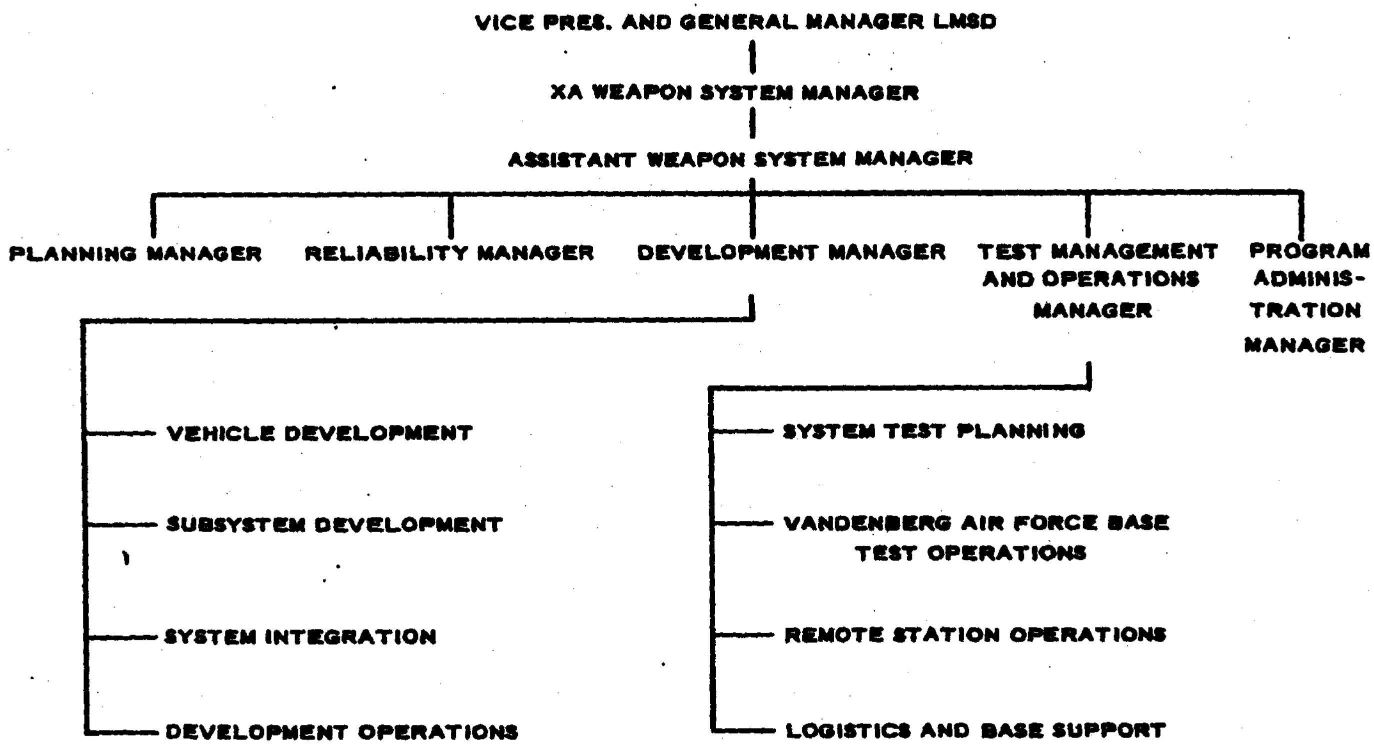
LMSD PROJECT MANAGEMENT STRUCTURE

Under the direction of the Corporate Vice President and General Manager of the Missiles and Space Division, Lockheed has established an integrated weapon system-type organization for program management purposes. This organization is designated as the "XA Weapon System."

There are five Management divisions, as follows, within the XA Weapon System organization:

1. Planning - responsible for establishing major development milestones and plans for the overall development program;
2. Development - responsible for the design and development of subsystems and associated hardware, as well as for their integration into a functioning weapon system;
3. Reliability - responsible for assuring the high functional quality of the weapon system;
4. Test and Operations - responsible for the in-plant and field tests of the system, as well as for the provision of facilities and the QPRI documentation; and
5. Program Administration - responsible for detailed budgeting and scheduling.

All functional organizations of LMSD, as well as those of the entire Lockheed corporation, support the XA Weapon System organization as required for the furtherance of the development program. Prominent among these support groups are extensive research laboratories, manufacturing and testing organizations and facilities, and quality control.



PRINCIPAL SUBCONTRACTORS

The principal subcontractors selected by Lockheed are listed on the accompanying chart. Dollarwise, this subcontracted effort accounts for roughly 55 percent of total contract costs. Chief among these subcontractors are:

- Bell Aircraft Corporation
- Eastman Kodak Company (and its subcontractor, CBS Laboratories)
- Airborne Instruments Laboratory, Inc.
- Aerojet-General Corporation
- Philco Corporation
- General Electric Company

Associate contractors having a significant role in the development program are also listed.

PRINCIPAL SUBCONTRACTORS

PROPULSION
- BELL AIRCRAFT CORP.
- AEROJET-GENERAL CORP.

AUXILIARY POWER
- SONOTONE CORP
- EAGLE-PICHER CO
- ENGINEERED MAGNETICS
- HOFFMAN ELECTRONICS CORP.
- BEECHCRAFT R & D INC.

GUIDANCE AND CONTROL
- DETROIT CONTROLS CORP.
- REEVES INSTRUMENT CORP
- MINNEAPOLIS-HONEYWELL REGULATOR CO.
- BENDIX AVIATION CORP.

VISUAL
- EASTMAN KODAK CO.
  - COLUMBIA BROADCASTING SYS
  - SPICA INC.
- AMPEX CORP.

FERRET
- AIRBORNE INSTRUMENTS LAB,INC.
- HALLER, RAYMOND & BROWN INC.

MIDAS
- EASTMAN KODAK CO.
- BAIRD-ATOMIC, INC.
- AEROJET-GENERAL CORP.
- GENERAL MILLS INC.

GROUND-SPACE COMMUNICATIONS
- PHILCO CORP.
  - REEVES INSTRUMENT CORP.
  - RADIATION INC
- LOCKHEED AIRCRAFT SERVICES,INC
- HUGHES AIRCRAFT CO.
- TEXAS INSTRUMENT CORP.

TEST MANAGEMENT & OPERATIONS
- AEROJET-GENERAL CORP.
- RALPH M. PARSONS CO.

GROUND SUPPORT EQUIPMENT
- OTIS ELEVATOR CO.
- CONSOLIDATED AVIONICS CORP.
- BEMCO INC.
- STANDARD MFG. CO., INC
- HUFFORD CORP.

BIOMEDICAL CAPSULE
- GENERAL ELECTRIC CO.
- ALL-AMERICAN ENGINEERING CO.

ASSOCIATE CONTRACTORS

BOOSTERS
- DOUGLAS AIRCRAFT CORP.(SM-75)
- CONVAIR ASTRONAUTICS (SM-65)

GUIDANCE AND CONTROL
- INSTRUMENTATION LAB, MIT
- GENERAL ELECTRIC CO.

AUXILIARY POWER
- THE MARTIN CO.
- ATOMICS INTERNATIONAL

DATA PROCESSING
- RAMO-WOOLDRIDGE CORP.

3/0

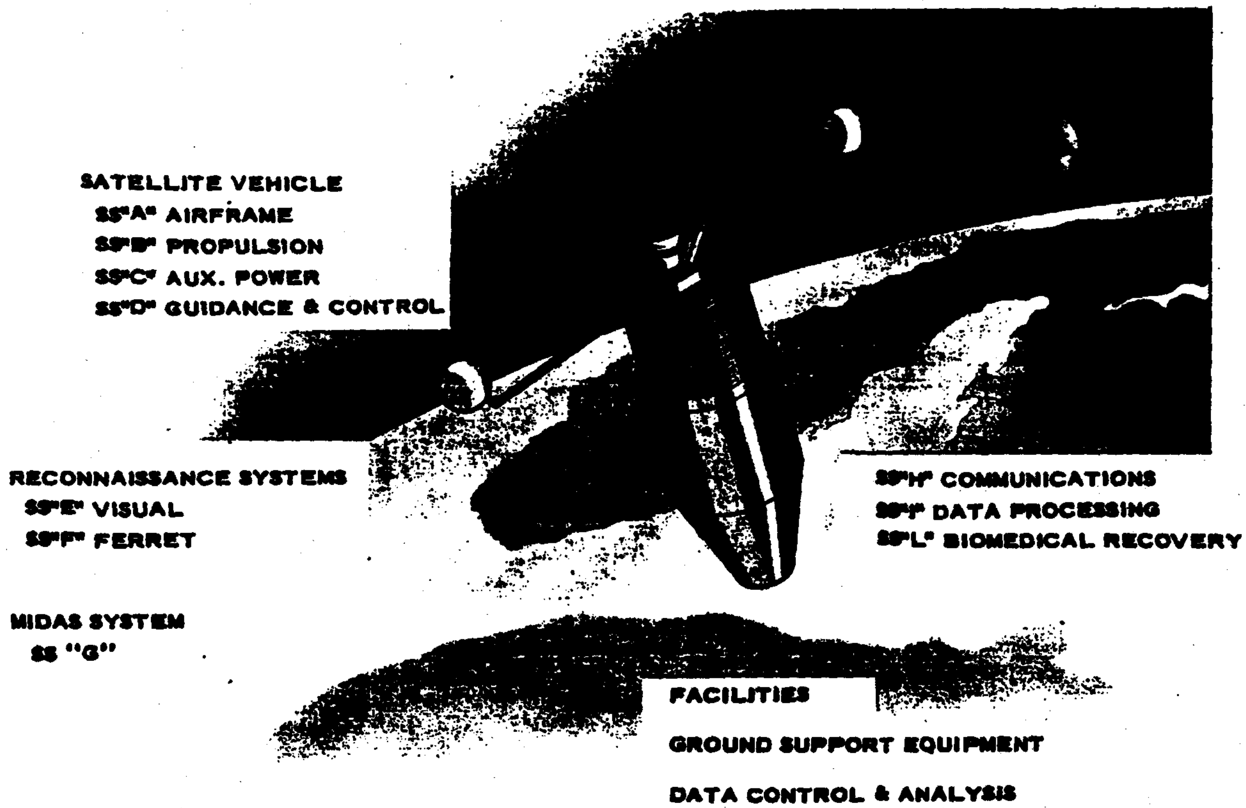
SUBSYSTEM STRUCTURE

For management control and development planning purposes, the Sentry system has been factored into the ten major subsystem areas as indicated on the chart opposite.

Lockheed is responsible for all research, design, development, and tests in connection with Subsystems "A" through "H," plus Subsystem "L." Lockheed is also responsible for:

- The development and procurement of all ground support equipment, including checkout equipment;
- The establishment of design criteria and site selection criteria for all launching, tracking, and communication facilities;
- The installation and checkout of equipment and the manning of the above facilities during the R&D phase of the program;
- The establishment of Qualified Personnel Requirements Information (QPRI).

Rome Air Development Center has overall cognizance of intelligence data processing, identified as Subsystem "I."

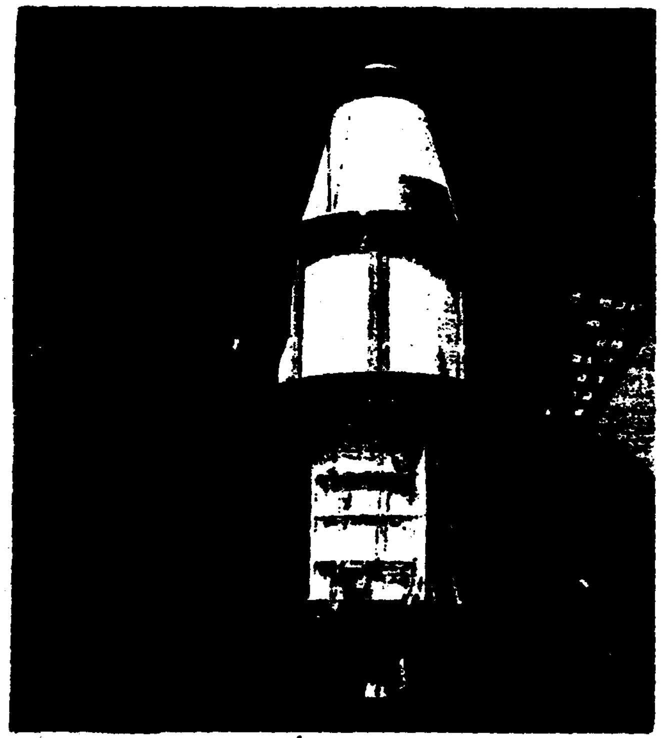

SATELLITE VEHICLE
SS"A" AIRFRAME
SS"B" PROPULSION
SS"C" AUX. POWER
SS"D" GUIDANCE & CONTROL
RECONNAISSANCE SYSTEMS
SS"E" VISUAL
SS"F" FERRET
MIDAS SYSTEM
SS "G"
SS"H" COMMUNICATIONS
SS"I" DATA PROCESSING
SS"L" BIOMEDICAL RECOVERY
FACILITIES
GROUND SUPPORT EQUIPMENT
DATA CONTROL & ANALYSIS

SECTION II – SATELLITE CHARACTERISTICS

GENERAL CHARACTERISTICS

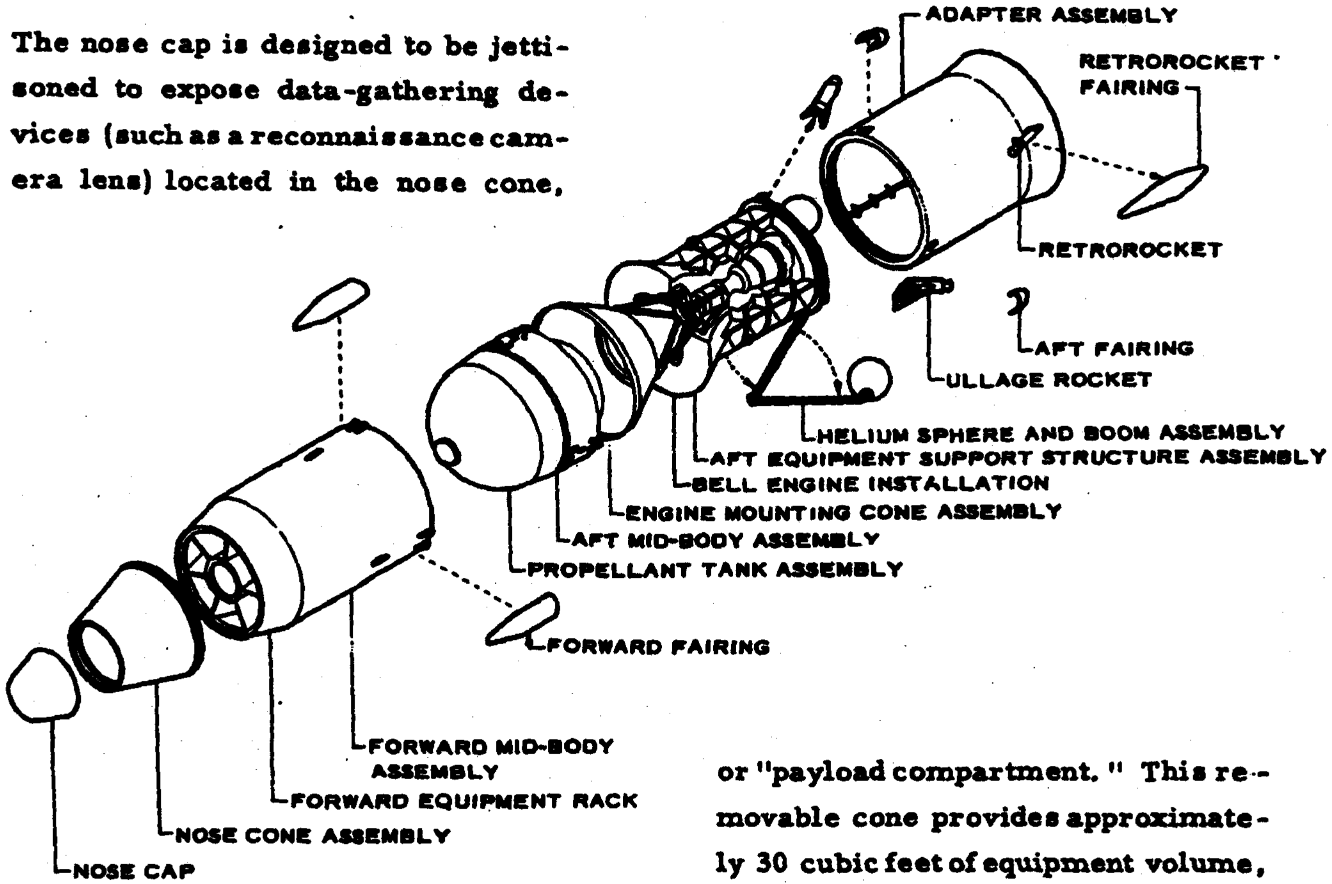
By definition, the satellite vehicle comprises:

- The airframe
- The propulsion system
- The auxiliary power system
- The guidance and control system



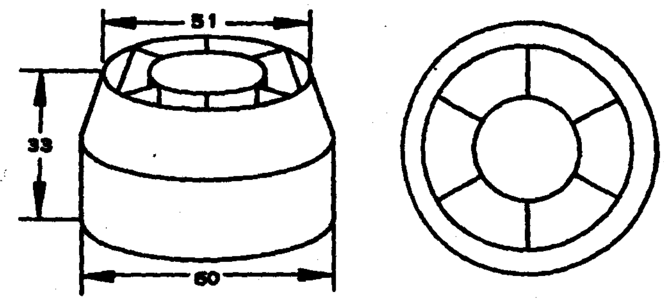
The basic satellite presently under development is 19 feet long and 5 feet in diameter, and is designed to be launched by either the Thor IRBM or the Atlas ICBM. Essentially all principal components, with the exception of the booster adapter assembly, are standard and independent of the booster selected for launch purposes. An exploded view of the satellite and its adapter assembly is illustrated on the facing page.

The nose cap is designed to be jettisoned to expose data-gathering devices (such as a reconnaissance camera lens) located in the nose cone,



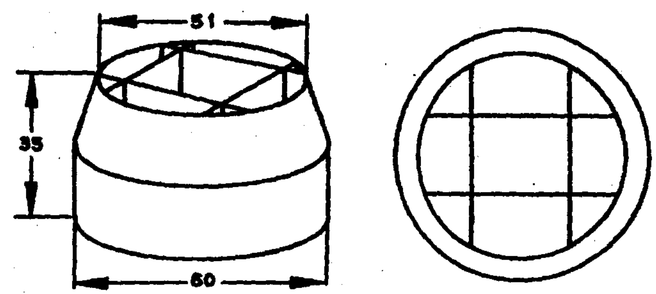
or "payload compartment." This removable cone provides approximately 30 cubic feet of equipment volume, or roughly 35 percent of the total useful space which is available for payload purposes.

Electronic equipment racks are located immediately aft of the nose cone section. Hinged panels provide ready access to this area after the nose cone has been secured in place.



RADIAL TYPE RACK (35 CUBIC FEET CAPACITY)

Radial-design equipment racks, as shown in the upper illustration to the right, will be replaced early in the program by an "egg-crate" type design, providing both more economical use of space and easier packaging of the electronic components.

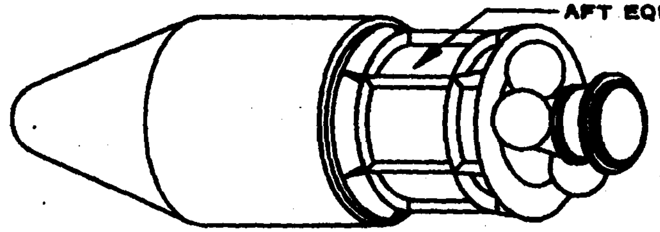


"EGGCRATE" TYPE RACK (41 CUBIC FEET CAPACITY)

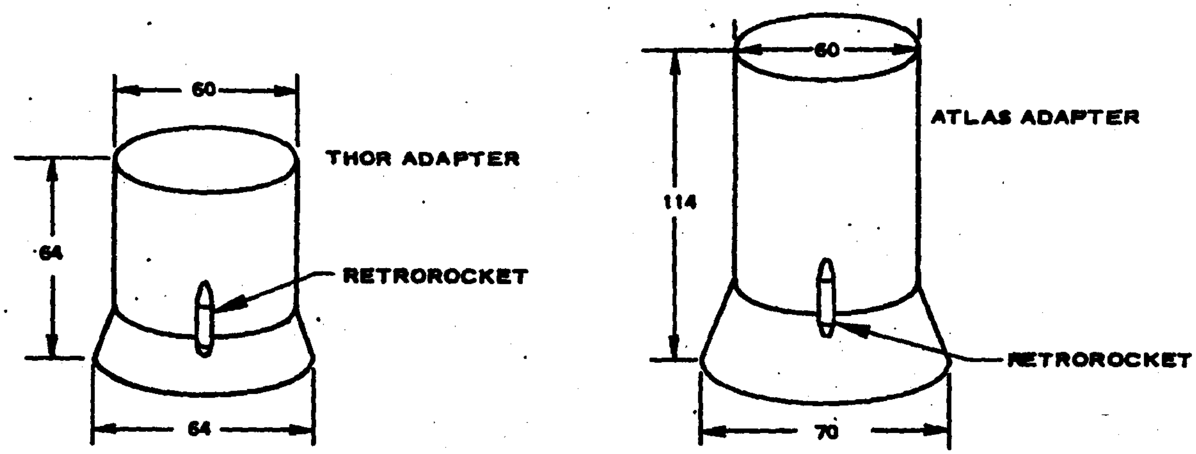
The midbody section contains nested lightweight spherical propellant tanks designed to hold not less than 37.8 cubic feet of fuel (UDMH) and 49.0 cubic feet of oxidizer (IRFNA) at 63 psi. Fairings are provided for routing of wiring and plumbing.

Aft equipment beams, surrounding the rocket engines, provide support for batteries, antenna, pressure vessels, control gas jets, geophysical research instrumentation, and the propulsion system. Eighteen batteries (8 x 12 x 14 inches) can be carried here.

Totaling the volume provided by the nose cone, the electronic equipment racks, and aft equipment storage --- the overall space available for payload purposes is approximately 85 cubic feet.



Attachment of the satellite to its booster is accomplished by use of an adapter section which remains affixed to the booster after in-flight separation of booster and satellite.



Separation is initiated by explosive bolts. Retrorockets cause the booster to slow down in relation to the satellite, resulting in separation of the two stages.

PROPULSION SYSTEM

The satellite propulsion system is comprised of the XLR-81 pump-fed, liquid propellant rocket engine; fuel and oxidizer tanks; pressurization and vent systems; helium spheres; and ullage control rockets. Discoverer Flight Test Vehicles 1 and 2 will use JP-4 as the propulsion system fuel; subsequent vehicles will use UDMH (unsymmetrical dimethyl hydrazine). The oxidizer in both instances is IRFNA (inhibited red fuming nitric acid).

In operation, the propellant tanks are pressurized by helium, regulated from 3000 psi in the pressure spheres to 63 psi in the propellant tanks.

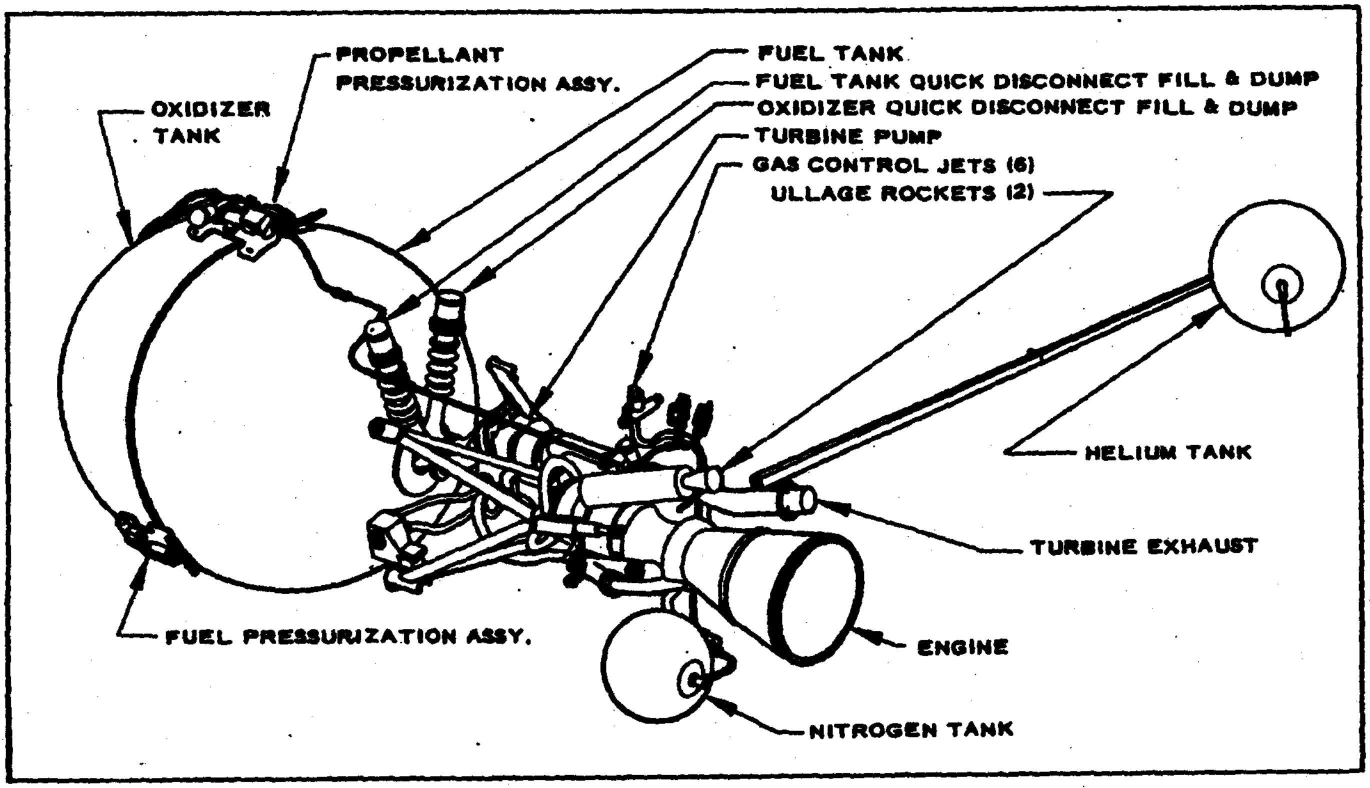
Small, solid propellant rockets (the ullage control rockets mentioned above) are fired immediately prior to engine ignition in order to orient the propellants in the tanks and to assure that liquids are at the pump inlets.

The XLR-81 engine, manufactured by Bell Aircraft Corporation, is gimbal-mounted for thrust direction control.

XLR-81 ENGINE

Significant nominal performance characteristics of the UDMH-fueled system are:

Thrust	**15,000 pounds**
I_{sp} (minimum)	**277**
Burning Time	**120 seconds**



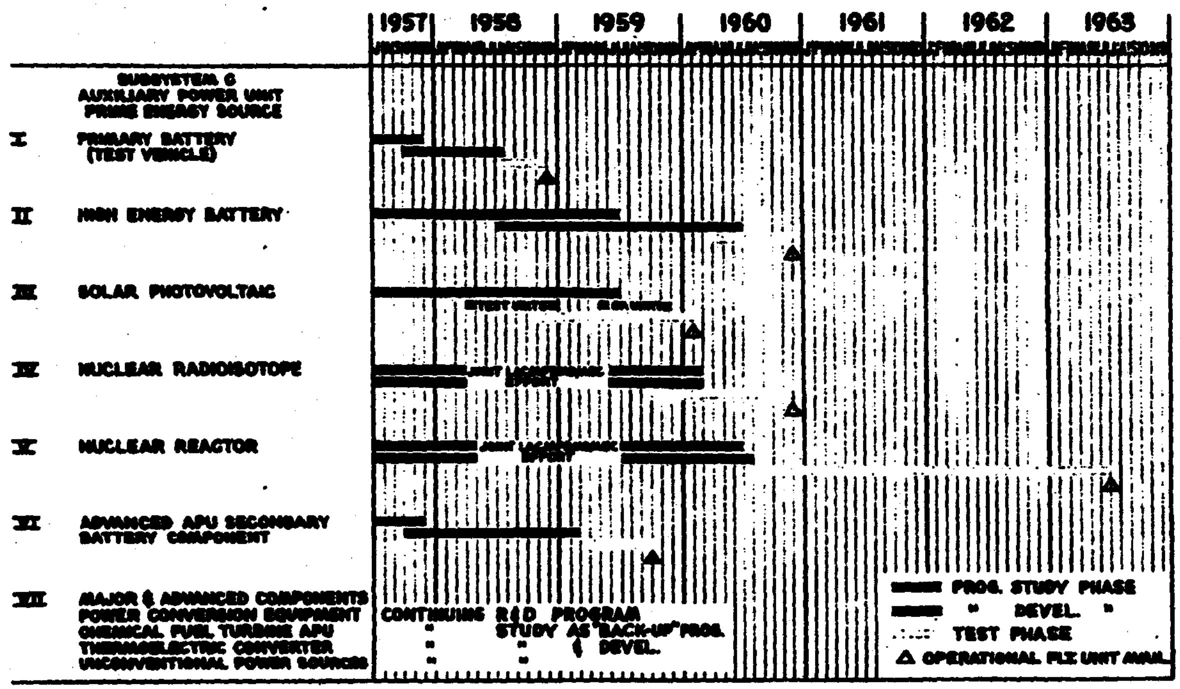
SATELLITE PROPULSION SYSTEM

AUXILIARY POWER SUPPLY SYSTEMS

The auxiliary power systems include all items required for furnishing electrical power to satellite-borne equipment. Design criteria include provision for:

- Power outputs from 100 watts to 10 KW
- Minimum interference with other components
- Reliable, long-duration operation
- Maximum simplicity with minimum weight

Prime energy sources currently under development, and their anticipated availability dates, are shown below.



TYPICAL SATELLITE WEIGHT DATA

Shown below are weight data for typical models of the Thor-boosted and Atlas-boosted satellites.

	(1) THOR BOOSTED	(2) ATLAS BOOSTED
PAYLOAD GROUP (PRIMARY PAYLOAD; AUX POWER SYSTEM; TELEMETRY; COMMUNICATIONS)	690	3,535
STRUCTURE GROUP (AIRFRAME; EQUIPMENT RACKS)	450	700
PROPULSION GROUP (ENGINE; PROPELLANT TANKS; PRESSURIZATION SYSTEM; ULLAGE ROCKETS)	570	615
GUIDANCE AND CONTROLS GROUP (ASCENT AND ORBITAL CONTROLS)	250	280
WEIGHT EMPTY	1,960	5,130
PROPELLANTS	6,640	6,470
LAUNCH WEIGHT	8,600	11,600
BURNOUT WEIGHT	1,840	4,660

(1) LAUNCH AZIMUTH: 182.5°

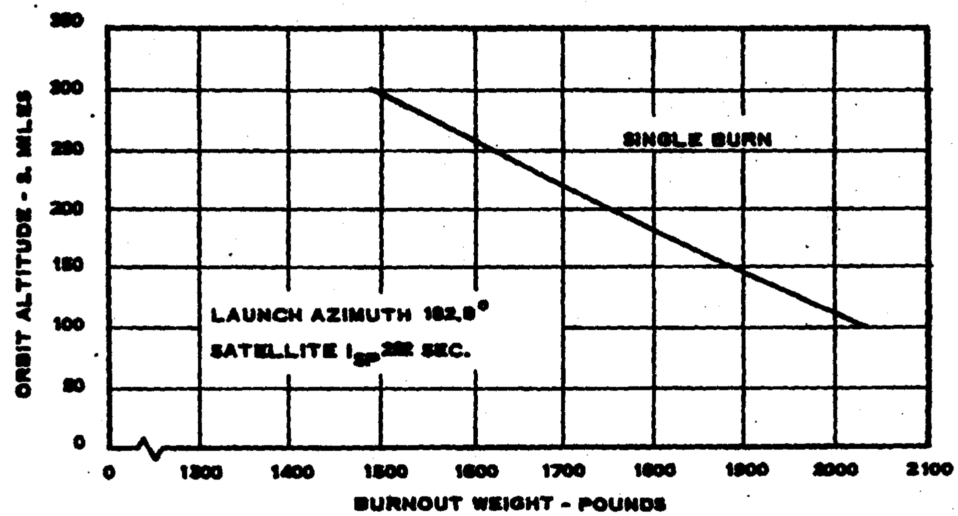
(2) LAUNCH AZIMUTH: 191°

SATELLITE PERFORMANCE CHARACTERISTICS

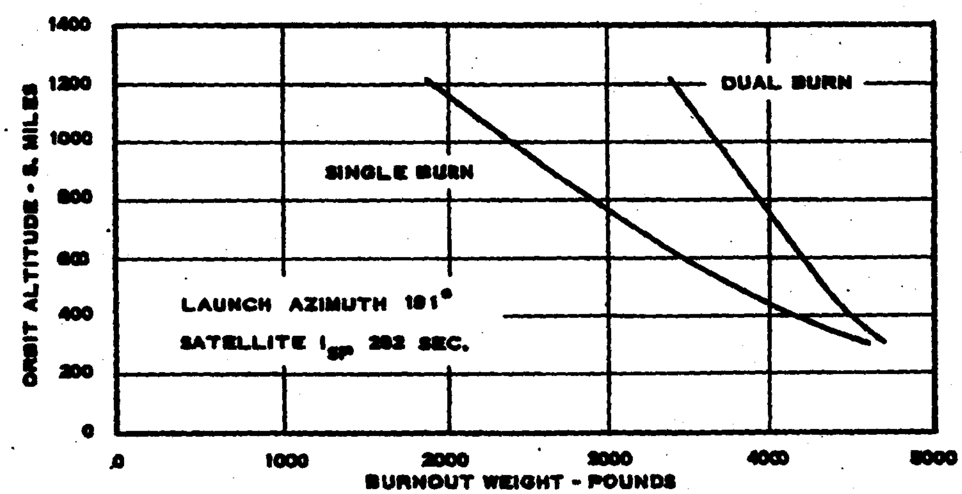
Shown opposite are curves depicting burnout weight vs. altitude for both Thor-boosted and Atlas-boosted satellite vehicles.

The term "single burn" refers to a launch procedure whereby the satellite, after separation from its booster, coasts to a point near its programmed orbital altitude. Its rocket engine is then ignited to provide the required boost to orbital velocity.

"Dual burn" refers to a proposed procedure which would enable the achievement of either higher orbital altitudes or heavier payloads, or a combination of both. In this instance, the satellite's rocket engine would be programmed to burn twice: once immediately after booster separation, and again, briefly, for a vernier adjustment of the orbital velocity.



THOR-BOOSTED VEHICLES



ATLAS-BOOSTED VEHICLES

SECTION III – COMMUNICATIONS

Details pertaining to the communication equipments and facilities required for each major development program are presented in subsequent sections directly concerned with those programs.

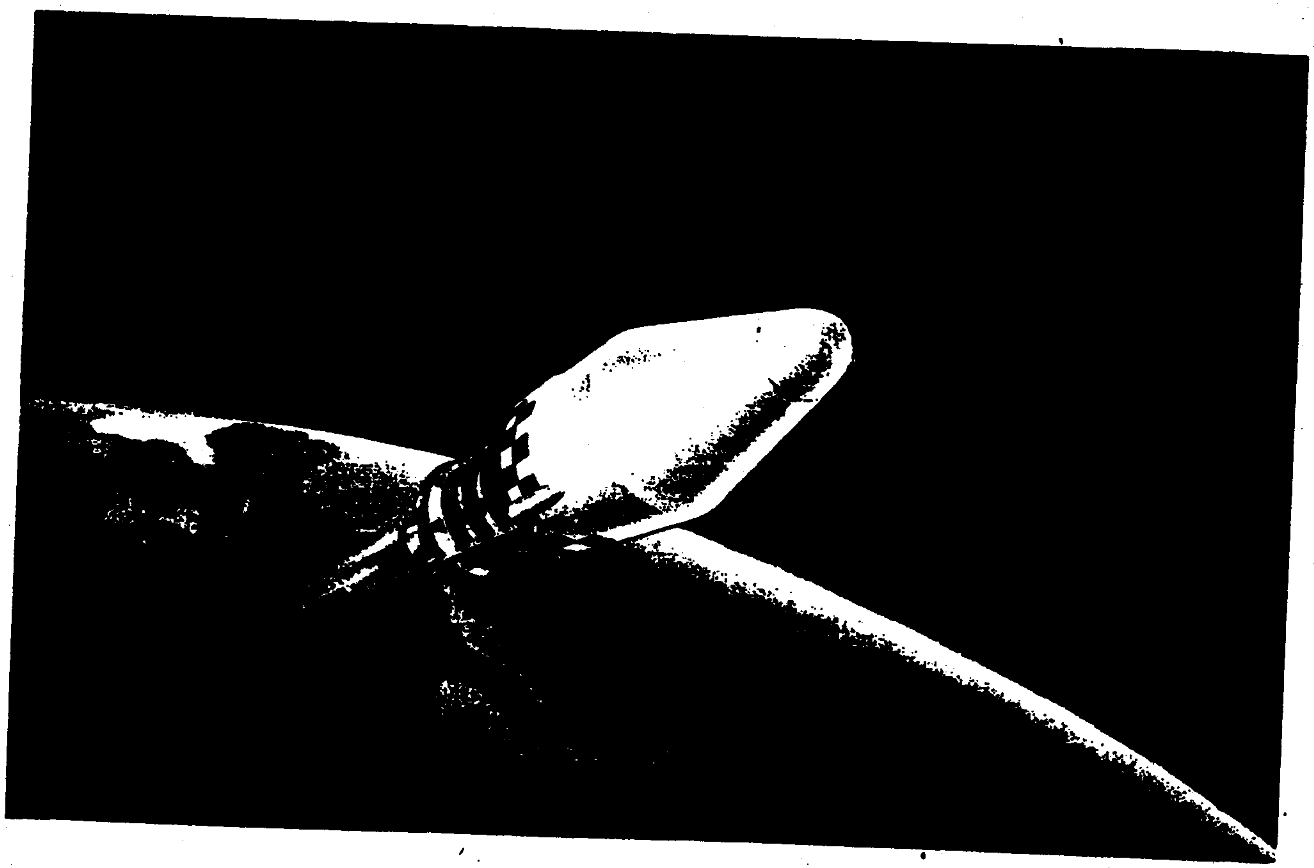
In general, Subsystem "H" (Ground-Space Communications) is responsible for the development, installation, and operation of all equipments required for communication to and from the satellites, as well as from ground station-to-ground station. Its principal functions comprise:

- Orbit Determination - satellite acquisition, tracking, and orbit computation
- Commands to Satellites - both programmed and in real time
- Telemetering
- Data Transmission - satellite-to-ground
- Ground Communications - transmission of tracking data, payload data, and administrative traffic.

The Philco Corporation serves as the principal subcontractor to Lockheed for the development of this subsystem.

Control of research and development flight test operations is directed from the Development Control Center (DCC) located in Lockheed's Palo Alto facilities. Direct lines for both TWX and voice circuits connect the DCC and its computing center with all launching and tracking stations. It is presently planned that a government facility for R&D flight test control purposes will be constructed adjacent to the main Lockheed facility at Sunnyvale.

SECTION IV - DISCOVERER PROGRAM



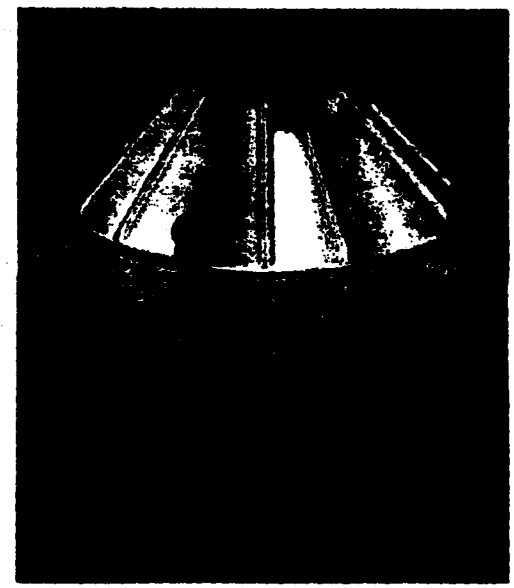
~~CONFIDENTIAL~~

Starting in early 1959, a series of Thor-boosted Discoverer satellites will be used to develop and test the ability to recover payloads from orbit. Recovery capsules (Subsystem "L") for these purposes are being developed under subcontract by the General Electric Co., Missile and Ordnance Systems Department, Philadelphia.

Other organizations prominently involved in the program include the Air Force School of Aviation Medicine; the Air Force Bioastronautics Directorate; Wright Air Development Center; Holloman Air Development Center; Hickam AFB; the Los Alamos Scientific Laboratories; and the U. S. Navy.

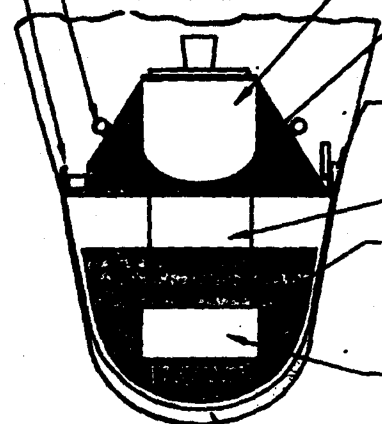
Capsule details are shown on the chart opposite. The Mark I capsule illustrated will be installed in the first two recovery flights, with Mark II capsules used thereafter for biomedical research purposes. The Mark I capsule experiments will involve mice; the Mark II capsules will carry rhesus monkeys, one 6-pound primate being carried on each flight.

MARK I BIOMEDICAL RECOVERY CAPSULE

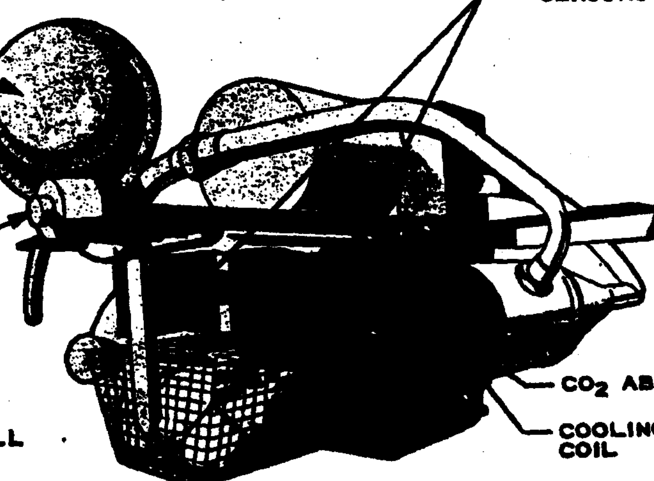


[redacted]

~~CONFIDENTIAL~~



	MK-I	MK-II
RECOVERY SHELL	77 LBS	88 LBS
PROPULSION EJECTION	58	75
RECOVERY SYSTEM	45	65
BIO PAC	15	57
TOTAL	195 LBS	279 LBS

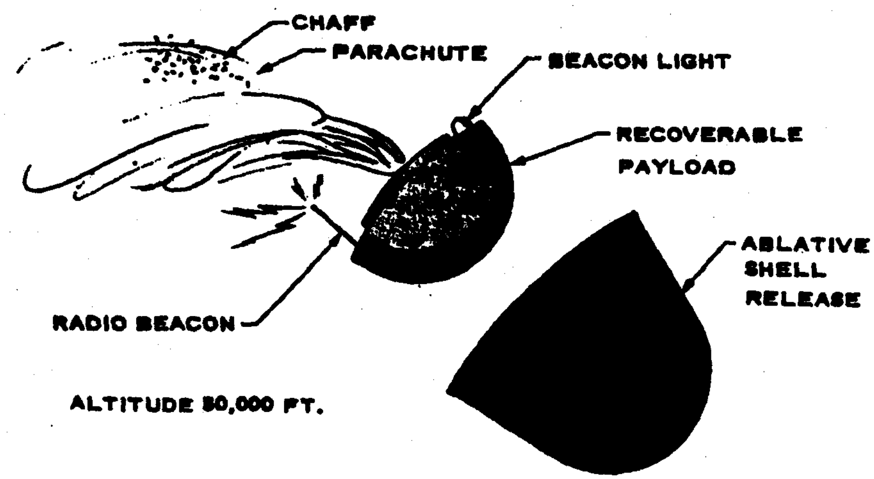


MARK I LIFE CELL

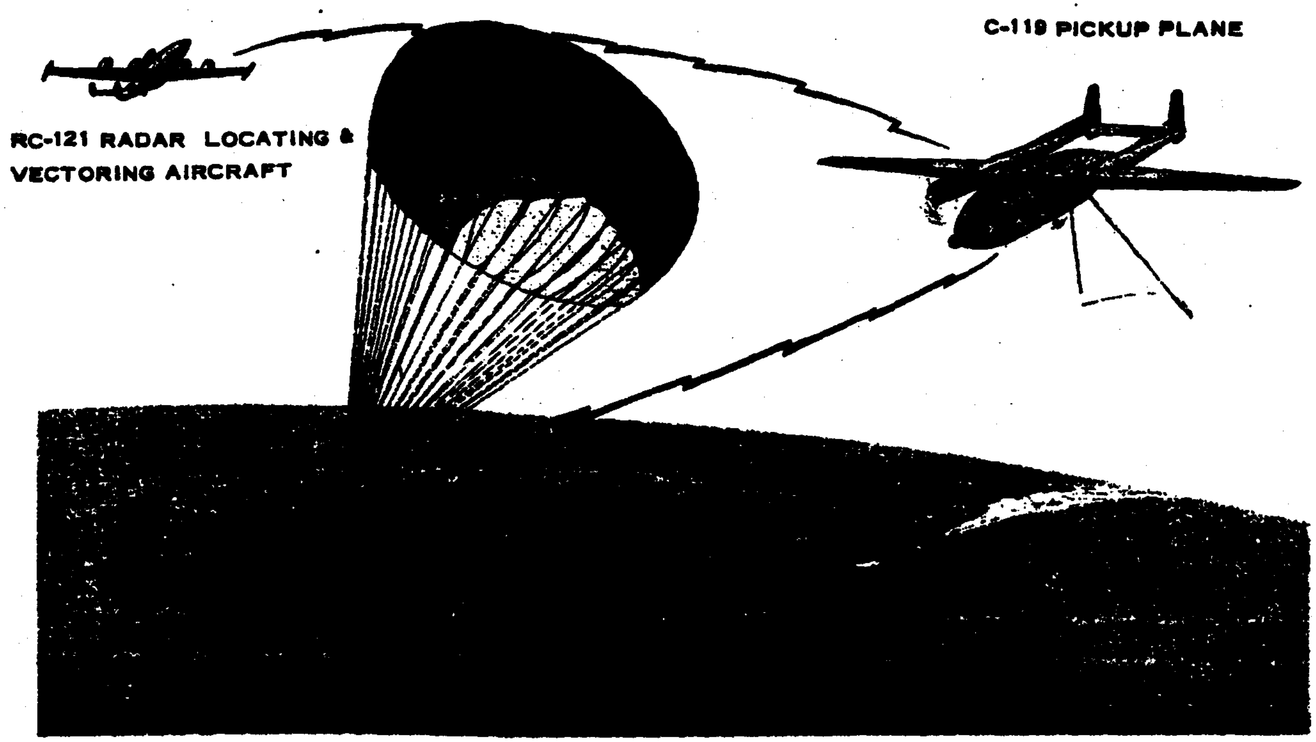
CAPSULE RECOVERY PLAN

As a Discoverer satellite passes over the Chiniak, Alaska, range during its 16th orbit, command signals from the ground station will initiate a sequence of events leading to capsule ejection on the 17th orbit, some 97 minutes later. The capsule will be moved clear of the satellite by the action of compressed springs. Spin-stabilized, it will be propelled earthward by means of a retrorocket. The spent rocket, spin devices, and their programmer are then jettisoned. The main parachute is programmed to open at an altitude of 50,000 feet, at which time the remaining, unburned portion of the protective ablative shell is released, a radio beacon is activated, and chaff is ejected.

RC-121 radar picket aircraft will vector C-119 pick-up aircraft toward the descending capsule, and pick-up attempts will be made down to a minimum altitude of 1000 feet. In the event of failure to recover a capsule in the air, recovery at sea will be effected by USN Destroyers on station in the recovery area for this purpose.

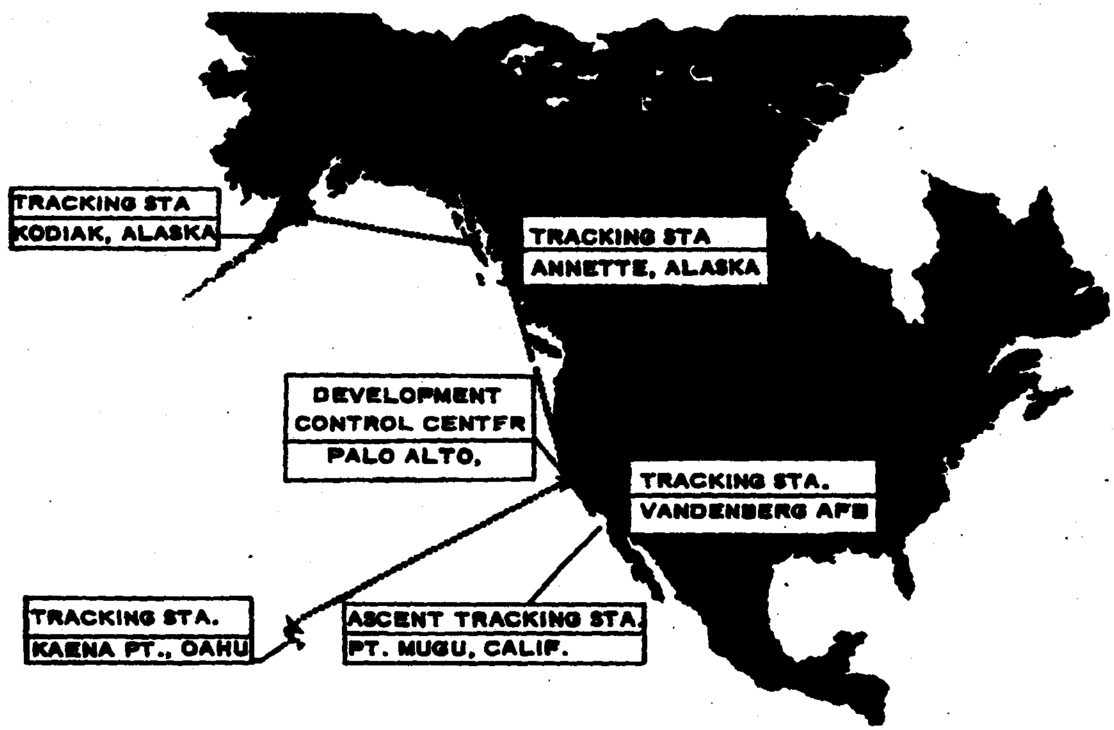


A sea marker, a flashing beacon light, and the radio beacon will aid the surface vessels in locating the capsule. Skin divers and small boats will be employed as necessary.

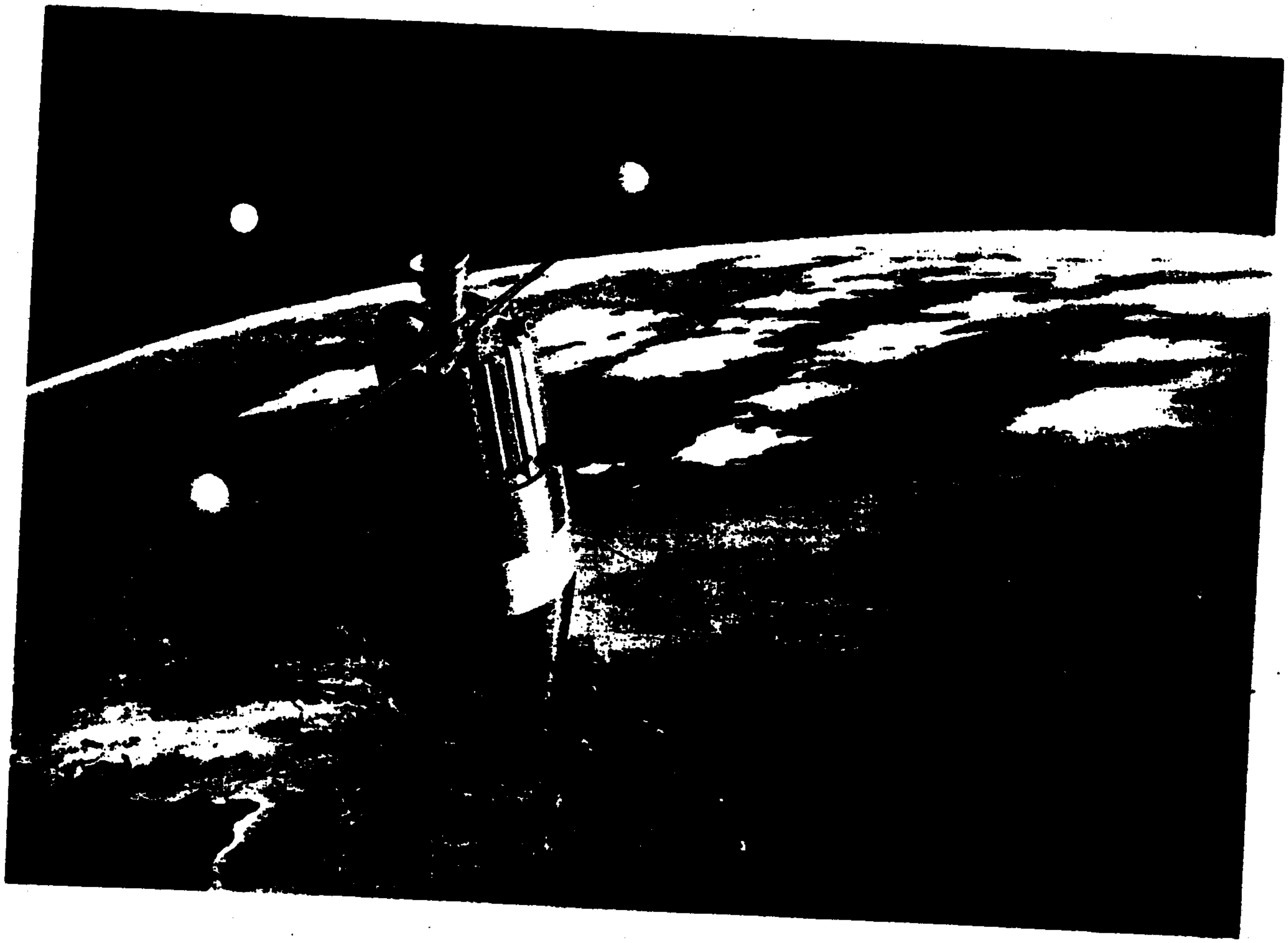


TRACKING STATIONS

Locations of the satellite tracking stations for the Discoverer program are shown on the chart below; all stations are fully equipped, manned, and ready for flight test operations.



SECTION V – SENTRY PROGRAM



PROGRAM OBJECTIVES

The primary objective of the Sentry program is the attainment of a reconnaissance system which uses satellite vehicles as the data-gathering medium. The development goals are:

- To sense and locate with a high degree of resolution all electromagnetic radiations emitted by or reflected from the territory, installations, and equipment of potential enemies;
- To transmit this information back to our own forces; and
- To record and produce these data in a form of maximum utility to intelligence agencies.

Two types of reconnaissance systems are being developed under the Sentry program:

(1) A visual - or photographic - system

(2) A Ferret - or electronic - system

All Sentry satellites are Atlas-boosted and will orbit nose-down at an altitude of approximately 300 statute miles.

VISUAL RECONNAISSANCE SYSTEMS

In a broad sense, the Sentry visual reconnaissance system (Subsystem "E") involves the design and development of equipment capable, on command, of obtaining reconnaissance photographs of any part of the world. Its operational objectives are to obtain:

- Mapping of territories of interest
- Strategic intelligence information regarding
  - Weapons and bases in being
  - Military logistics
  - Industrial war capabilities
- Bomb damage observations
- Weather observations

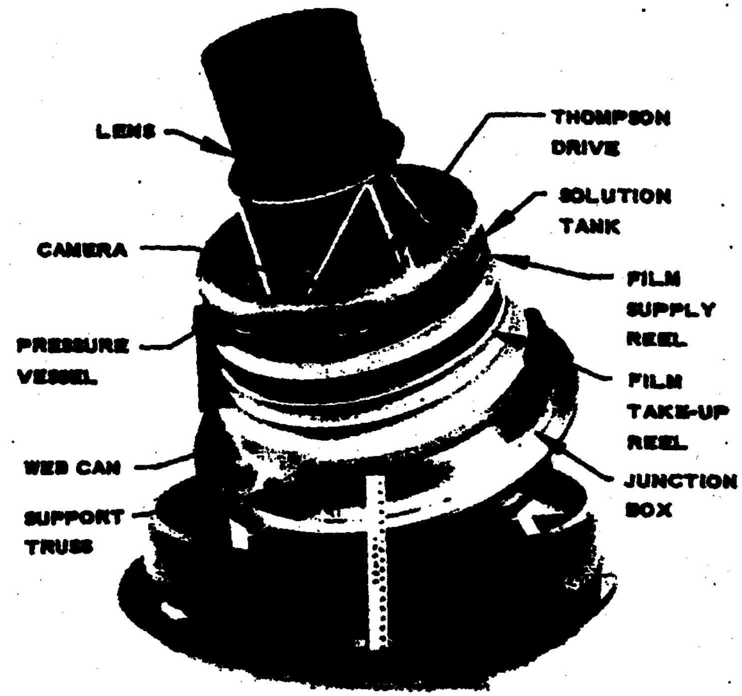
To date, development effort for the visual system has been concentrated on a film process involving electronic readout of the negative images. In the meantime, magnetic tape systems are being thoroughly investigated as a possible alternative to film. It is also presently planned that a development program will be initiated to effect physical recovery of the raw reconnaissance data (film or tape) in addition to electronic readout systems.

The initial visual system will incorporate a 36-inch focal-length camera. The possibility of developing a system with focal lengths on the order of 90 inches is also under intensive investigation.

VISUAL RECONNAISSANCE - SATELLITE EQUIPMENT OPERATION

The 36-inch focal-length system uses a 70 mm camera and can be programmed to photograph areas of particular interest, rather than continuous-strip photography. Ground resolution is 20 feet. The system incorporates steerable mounts to permit aiming the camera for taking oblique photographs.

Runs of newly exposed film are stored in a series of tension-controlled, expandable loopers from which the film is drawn continuously into a processor. The film is processed by contact with a web presoaked with chemicals.

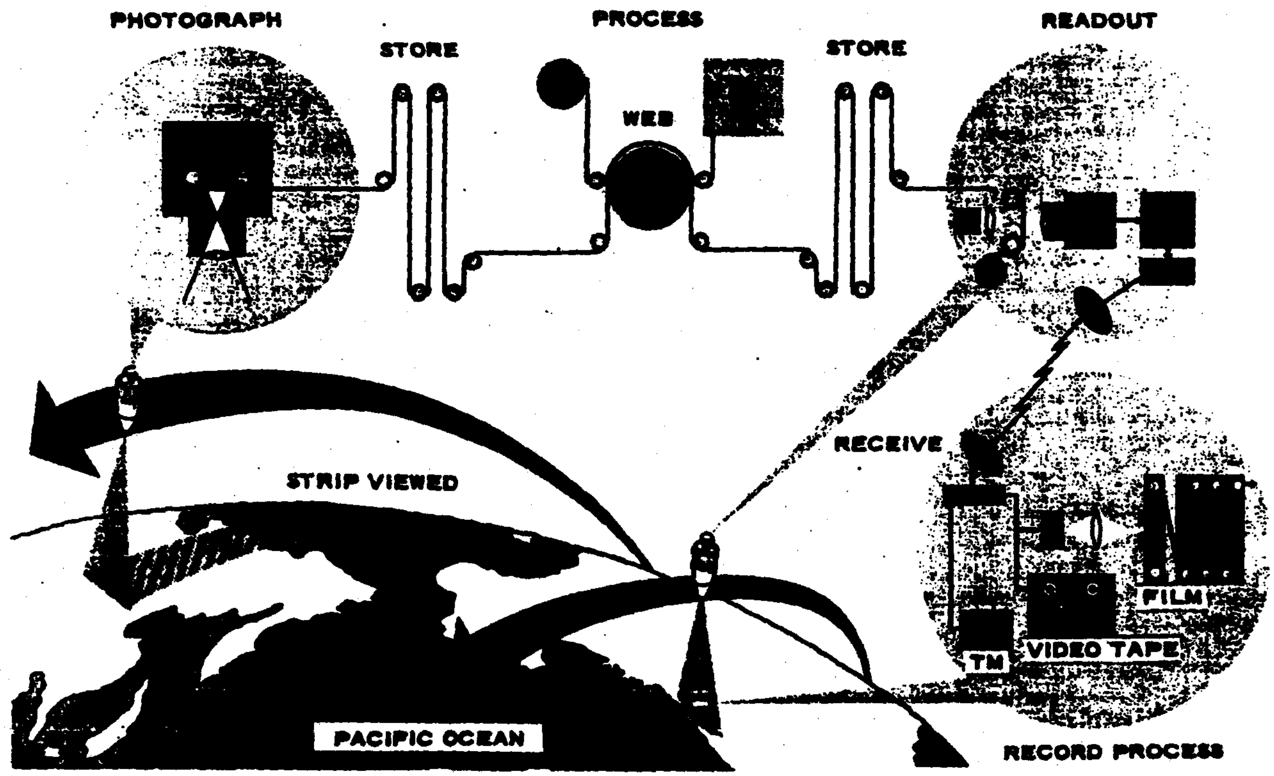


FULL-SCALE MOCKUP OF 36-INCH SYSTEM

The processed film is fed into a second series of loopers, gradually building in volume until a batch is removed by readout contact with a ground station.

Readout is accomplished by scanning the film and converting the negative image to a video signal for transmission to a ground station by means of a wideband data link.

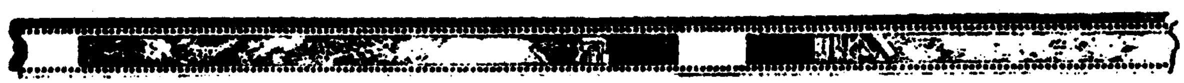
The operating sequence for the visual reconnaissance system is depicted on the accompanying chart.



VISUAL RECONNAISSANCE - GROUND RECONSTRUCTION PROCESSES

After transmission to a ground station by the wideband space-ground video data link, the signals are recorded on magnetic tape. Simultaneously, reconverted photo images are displayed as a light-modulated line on a kinescope.

The kinescope lines are photographed by a 35mm continuous-strip camera which records the photographic images as a series of positive frames called the "Primary Record." The Primary Record is then developed by a high-speed processor. Aside from photographic images, the Primary Record also contains auxiliary information channels which provide such data as the satellite attitude and the time of photography. These data are fed into a high-speed computer in which orbit and programming information had previously been stored.



PRIMARY RECORD FILM ON GROUND
(35MM POSITIVE)

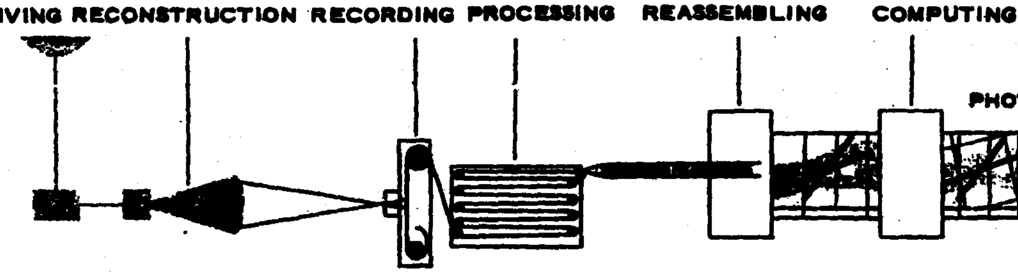
The tape output of the computer and the Primary Record film are then processed through a Reassembly Printer which produces a replica of the original 70 mm film enlarged to a width of 9.5 inches. This enlarged replica is called the "Reassembled Record."

Alphanumeric digits presented at the end of each frame of the Reassembled Record present approximately twenty different items of information about the photograph, such as attitude, time, location, scale, orientation, etc.

REASSEMBLY FILM (9.5-INCH NEGATIVE)

Equipment has been designed to grid the Reassembled Record with a one-degree terrestial, or other type grid, photographically superimposed.

Duplicate prints of the Primary Record are made available to Subsystem "I" (Intelligence Data Processing) for Air Force Intelligence and other uses.



GROUND RECONSTRUCTION PROCESS

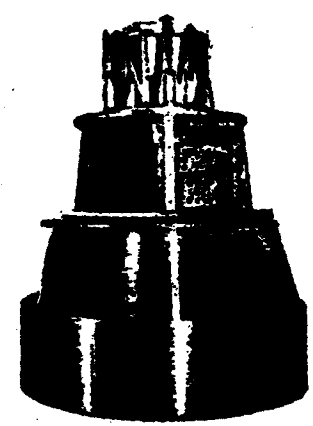
SENTRY FERRET RECONNAISSANCE SYSTEMS

Electronic reconnaissance (Subsystem "F") is employed to incercept electronic emissions originated by actual or potential enemies, and to make these data available in a useful form to intelligence agencies. Information thus obtained will assist in meeting the National Intelligence Objectives for ferret systems, which are to have reliable information on:

- The imminence of hostilities
- Enemy offensive systems
- Enemy defensive systems, and
- Technological capabilities of an enemy

The Sentry ferret system is being developed to provide continuous electronic surveillance of all territories of interest. Two principal subcontractors, Airborne Instruments Laboratory, a division of Cutler Hammer, Inc., and Haller, Raymond and Brown, Inc. are supporting Lockheed in this development program.

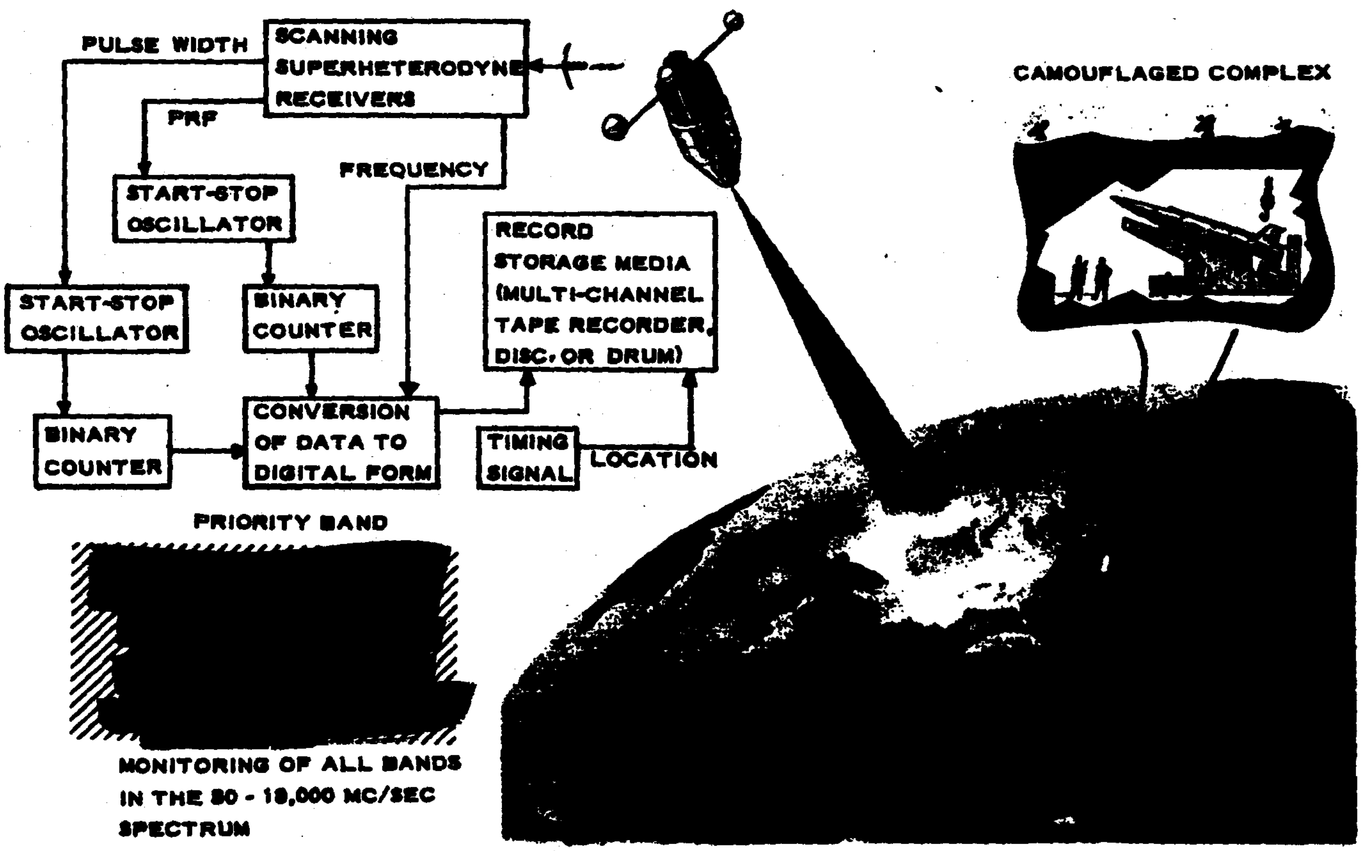
Satellite-borne equipment will intercept the electronic emissions, measure and store the signal parameters, and transmit these data to ground receiving stations. A schematic representation of satellite equipment functions - together with a listing of the priority bands for the initial system - is presented on the chart opposite.



PROTOTYPE OF SENTRY FERRET I SYSTEM

This first series of ferret satellites will observe the following:

- **Significant changes in signal parameters**
- **Significant redeployment of emitters**
- **Intensified electronic signal activity**
- **Unusual absence of signals, and**
- **Jamming activity or changes in the "normal" jamming level.**



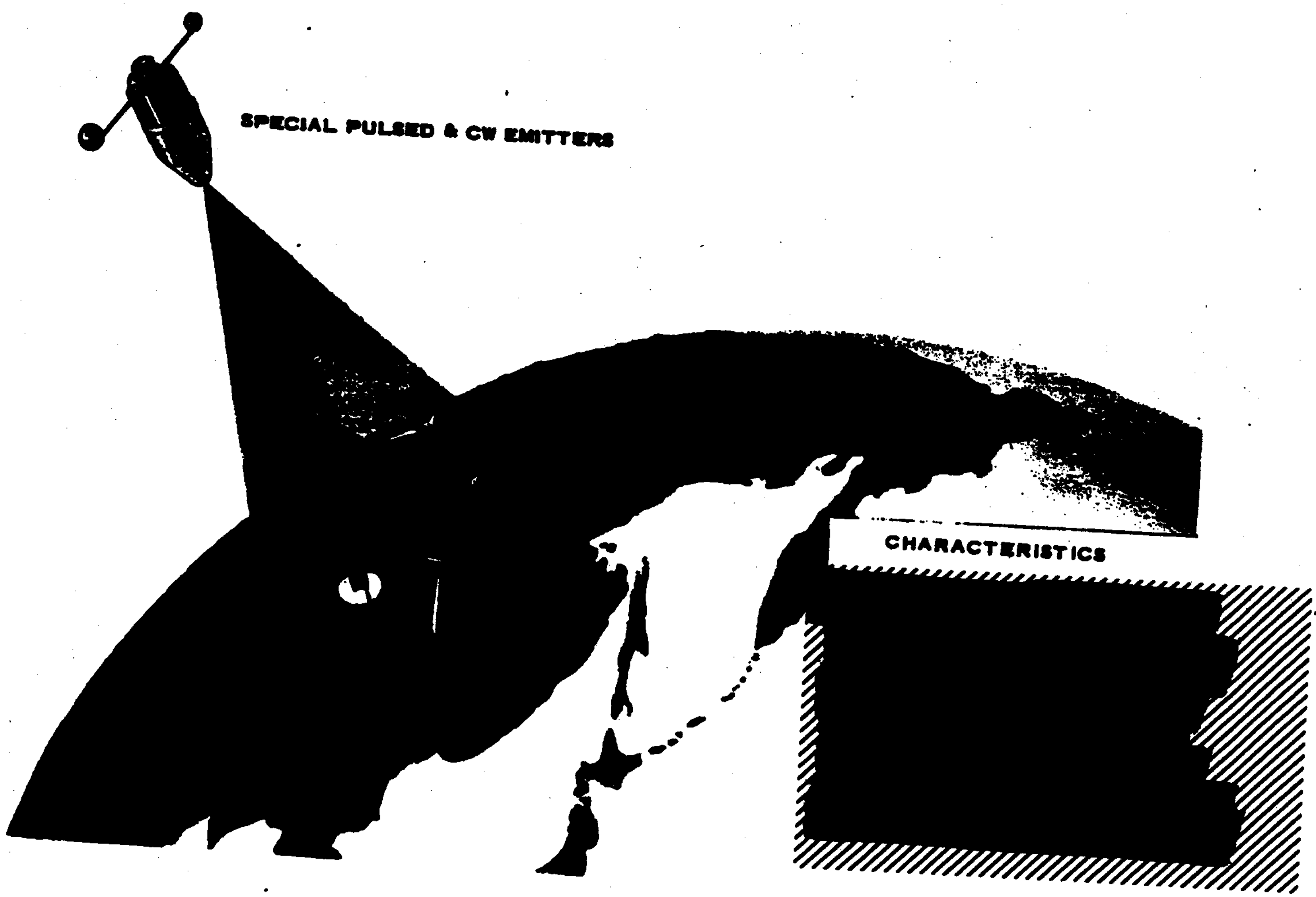
FERRET RECONNAISSANCE - ADVANCED SYSTEMS

Advanced Sentry ferret developments will provide a more sophisticated system for the collection and analysis of a wide range of electronic emissions, and will be of particular value to the intelligence agencies in their preparation of estimates of both Enemy Order of Battle and Technical Intelligence. Emitters subject to ferret intercept will include:

[redacted]

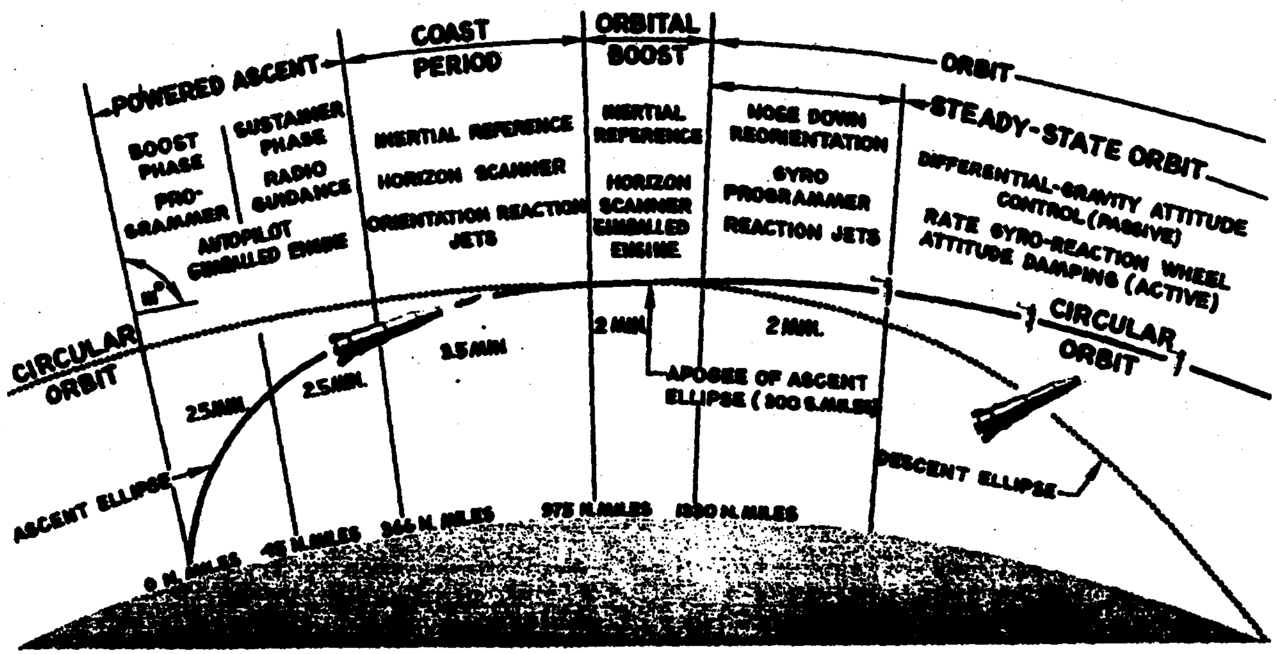
Some of the characteristics of an advanced system are shown on the accompanying chart.

As a part of the advanced system program, a "Ferret Alarm" technique is under investigation. Such an alarm system would be designed to provide instantaneous transmission to ground stations of intercepted signals of a critical intelligence nature, such as those associated with an ICBM launching complex.


SPECIAL PULSED & CW EMITTERS
CHARACTERISTICS

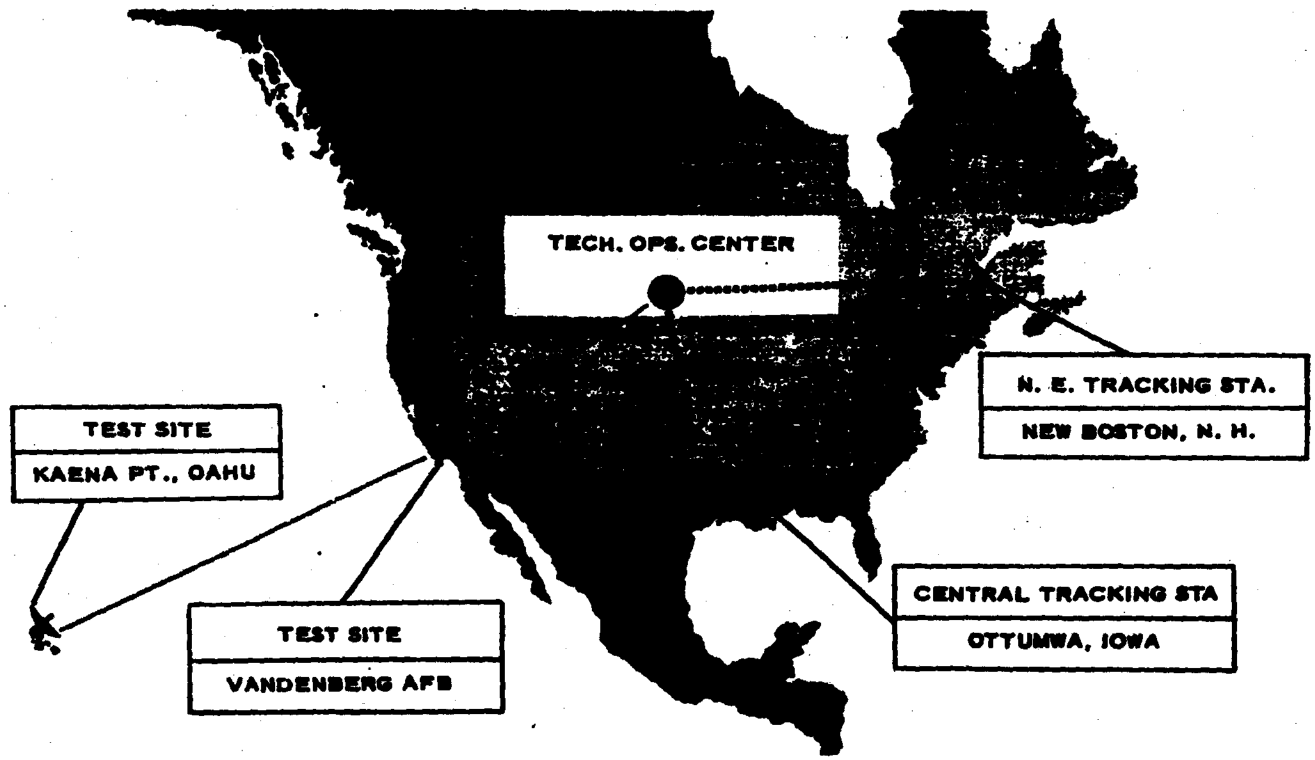
SENTRY SATELLITE ASCENT GUIDANCE AND CONTROL

The sequence of events for a typical Atlas-boosted Sentry satellite during ascent and orbit orientation is shown below.



SENTRY SYSTEM COMMUNICATION FACILITIES AND READOUT LINKS

This chart shows the locations of the tracking and data-readout stations planned for the Sentry system.



SENTRY SYSTEM COMMUNICATION LINKS

Three radio links are required for the operation of the Sentry readout reconnaissance systems:

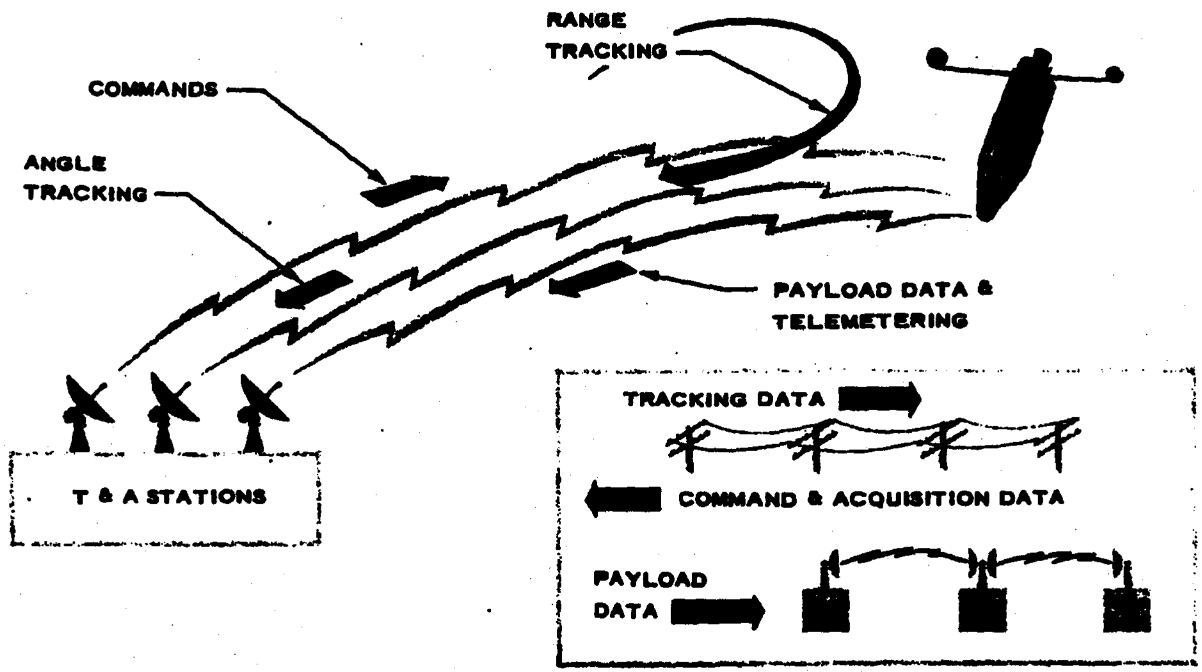
- Telemetry
- Command
- Payload data link

The space-to-ground telemetry link serves to transmit test data to the ground, to transmit operational telemetry data for reporting the status of the payload equipment, and as a signal source for an angle tracking radar on the ground.

The ground-to-space command link provides a channel to transmit the real-time commands which are used to make adjustments and calibrations of the payload equipment. This link is also used to transmit programmed commands which will be stored in the vehicle for execution when the vehicle is out of contact with the readout stations.

The combination of the command and telemetry links is used as a round-trip circuit for the transmission of ranging tones to determine satellite range. These data, together with the angular coordinates obtained from the angular tracker, are sent to the computer for orbital calculations.

A space-to-ground link transmits the actual reconnaissance data from the payload equipment to the ground where they are received, processed, recorded, and prepared for re-transmission to the Technical Operations Center. Tracking data obtained during a readout pass are sent by teletype circuits to the TOC for orbital calculations, and command and acquisition data are returned on the same circuit. Payload data are sent to the TOC by special wideband ground communications circuits.

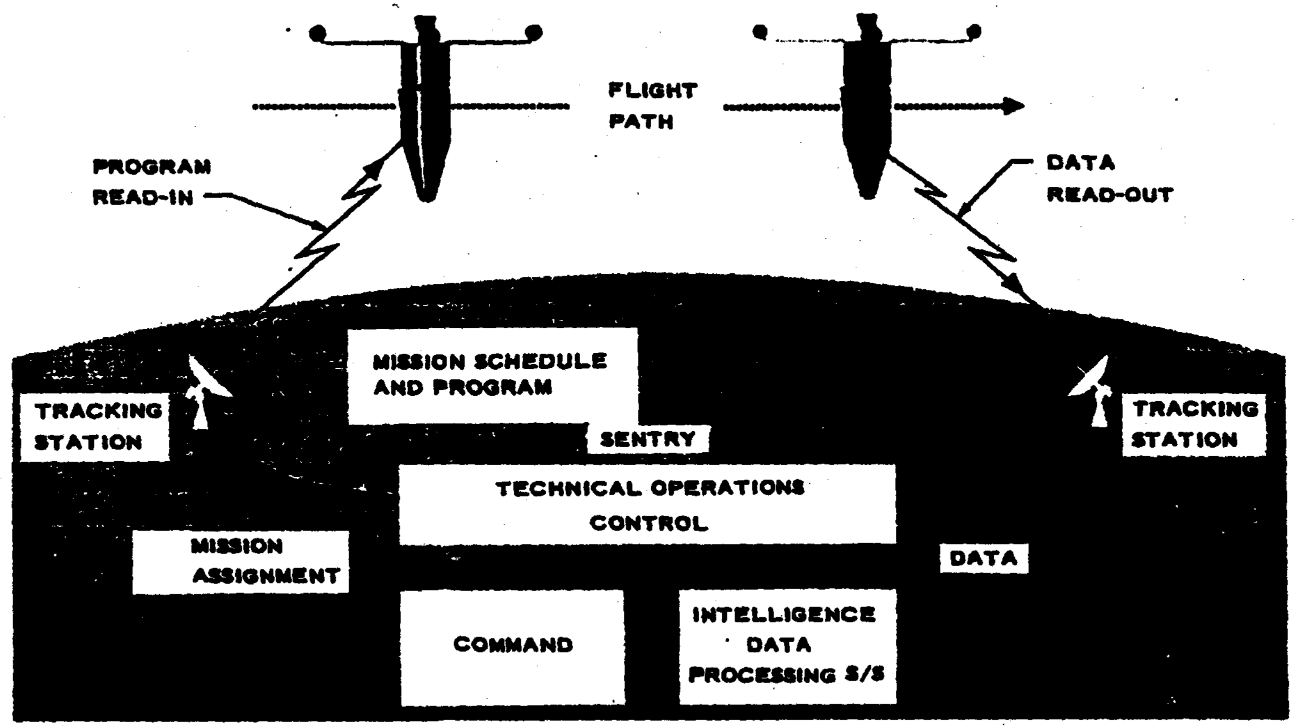


SENTRY SYSTEM MISSION CONTROL

The principal objective of the Sentry intelligence data processing system (Subsystem "I") is to continuously determine, display, and report critical intelligence data that might indicate the imminence of hostilities. The intelligence agencies will be provided with both initial analysis reports and reproductions of photographs and ferret tape recordings.

As depicted on the accompanying chart, control of the Sentry reconnaissance missions comprises three distinct functions as follows:

- Command - which establishes policy and assigns reconnaissance missions
- Technical Operations Control - which executes mission assignments generated by Command, and is responsible for tracking, orbit computations, scheduling, quality control, intelligence data indexing, and transmission of intelligence data to---
- Intelligence Data Processing - where the intelligence data are processed for interpretation and evaluation.

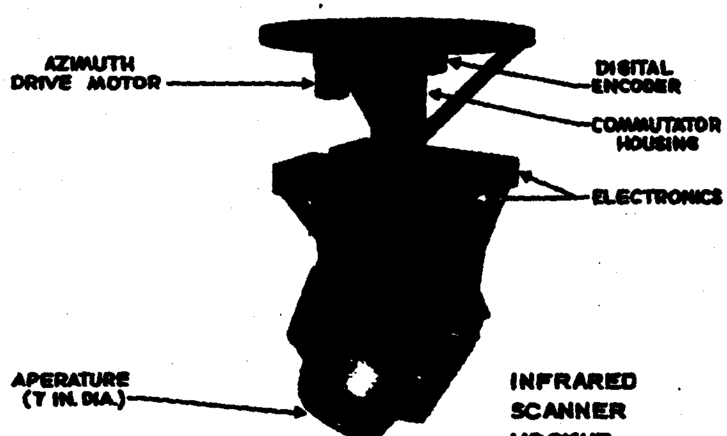

FLIGHT PATH
PROGRAM READ-IN
DATA READ-OUT
TRACKING STATION
MISSION SCHEDULE AND PROGRAM
SENTRY
TRACKING STATION
TECHNICAL OPERATIONS CONTROL
MISSION ASSIGNMENT
DATA
COMMAND
INTELLIGENCE DATA PROCESSING S/S

SECTION VI-MIDAS PROGRAM

Infrared sensing techniques (Subsystem "G") are being applied to four development objectives:

- A Missile Defense Alarm System
- An ICBM Precision Tracking and Prediction System
- An Air-breathing Vehicle Tracking and Prediction System, and
- A Ground Surveillance System.

The Aerojet-General Corporation, Avionics Division, is the principal subcontractor to Lockheed for this program, having the responsibility for the design and development of satellite-borne detection equipment. A contract for a back-up development program, using an alternative approach, has recently been awarded to Baird-Atomic, Inc.



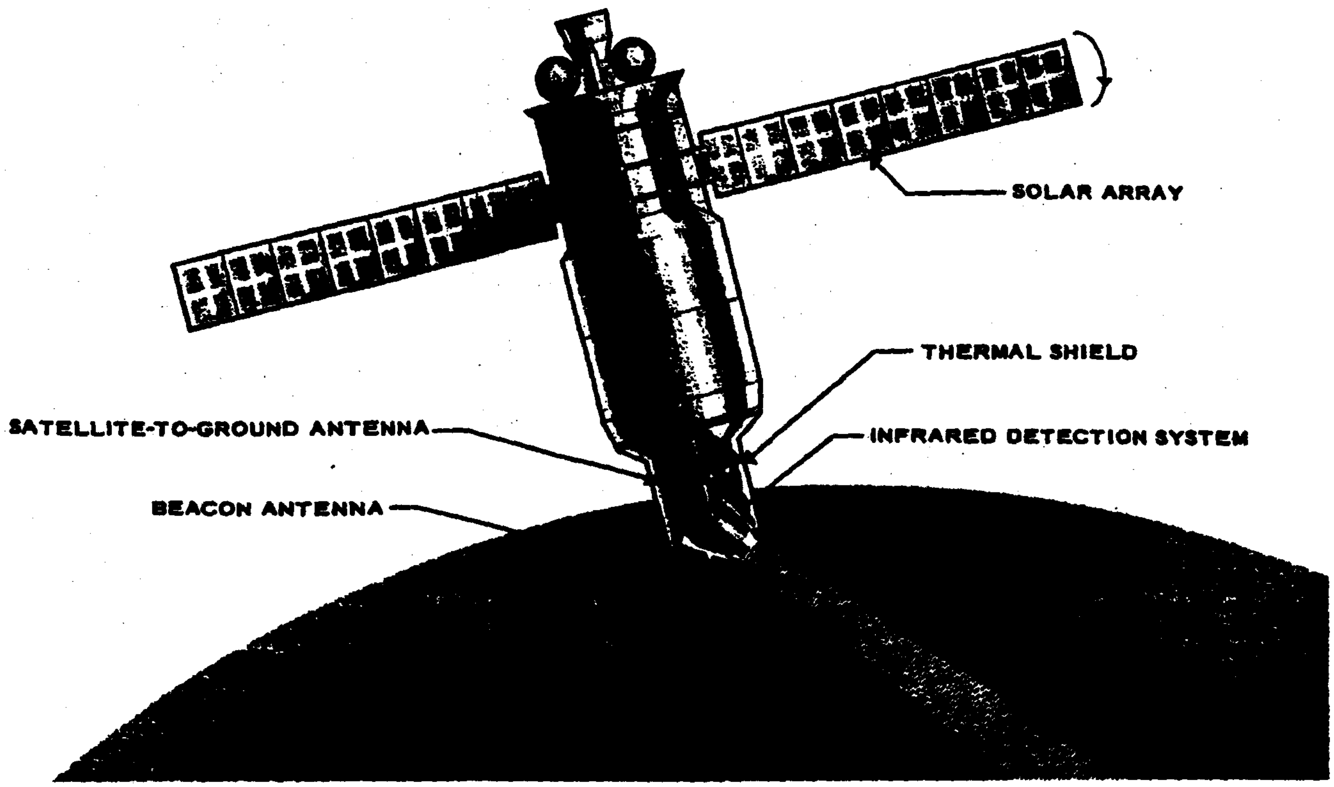
INFRARED SCANNER MOCKUP

SCANNER THERMAL -MECHANICAL EQUIVALENT

~~CONFIDENTIAL~~ [redacted]

The total weight of the infrared detection equipment, communications equipment, and auxiliary power is estimated to be 628 pounds.

An artist's conception of the MIDAS satellite, as it would appear in orbit, is illustrated below.



MISSILE DEFENSE ALARM SYSTEM

For a simple alarm system, MIDAS will employ approximately 20 satellites on 1000-nautical mile polar orbits. From this altitude, each infrared-equipped satellite will be capable of scanning a ground area of 12 million square miles every 30 seconds. Sector scanning may be commanded from ground stations.

As illustrated on the facing page, ICBM launchings will be detected and instantaneously reported to far North readout stations. Data will be relayed by these stations to ZI intelligence and operational centers

This data will then be combined with known satellite space location data to determine and present, on appropriate display units, the following information:

- Number of ICBM's detected
- Approximate location of launch sites
- Approximate direction of ICBM travel
- Approximate burning characteristics of the missiles.

[redacted]

SECTION VII-GEOPHYSICAL APPLICATION

A limited number of geophysical experiments, selected for their application to specific system development problems, will be conducted under the direction of the Geophysical Research Directorate, AF Cambridge Research Center.

A detailed listing of the geophysical instrumentation flights scheduled for the Discoverer program is presented on the chart below. Subject to weight, space, ground-space telemetry availability, and current requirement for data -- consideration will also be given to the flight of geophysical instrumentation during both the Sentry and MIDAS programs.

PROGRAMMED GEOPHYSICAL EXPERIMENTS

	DISCOVERER		
FLIGHT DATES	5/59	7/59	9/59
INSTRUMENT UNITS:			
THERMAL RADIATION	3	3	3
COSMIC RADIATION	1	1	1
DENSITY	1	1	1
ELECTRIC FIELD AND ION DENSITY			1

SECTION VIII–SATELLITE VEHICLE GROWTH POTENTIAL

Substantially increased payloads or orbital altitudes, or combinations of both, can be achieved for either Thor-boosted or Atlas-boosted satellite vehicles. The design changes considered involve:

- Substitution of more advanced propellants for IRFNA - UDMH
- A slight increase in propellant tank size (obtainable with minimum design change)
- Dual-burning propulsion system (see Page 20).

The attendant improvements in specific impulse and payload capability are illustrated below. The case shown is for Thor-boosted vehicles at an orbital altitude of 200 statute miles and employing an N_2O_4 - hydrazine propulsion system; other possible propellant combinations are being intensively investigated. Similar increases in performance can be expected for Atlas-boosted vehicles at orbital altitudes up to 1000 statute miles.

THOR-BOOSTED SATELLITE (200-S. MILE POLAR ORBIT)	*TANK LOAD (PERCENT)	NOMINAL I_{sp} (SECONDS)	PAYLOAD (POUNDS)
PRESENT SYSTEM (IRFNA-UDMH; SINGLE-BURN)	100	280	290
POSSIBLE ALTERNATE SYSTEMS			
IRFNA-UDMH SYSTEMS			
INCREASE IN TANK SIZE	127	280	355
DUAL-BURN	100	280	370
DUAL-BURN PLUS INCREASE IN TANK SIZE	127	280	515
N_2O_4-HYDRAZINE SYSTEMS			
SAME TANK SIZE AS PRESENT IRFNA-UDMH SYSTEM	100	305	560
INCREASE IN TANK SIZE	127	305	635
DUAL-BURN	100	305	710
DUAL-BURN PLUS INCREASE IN TANK SIZE	127	305	905

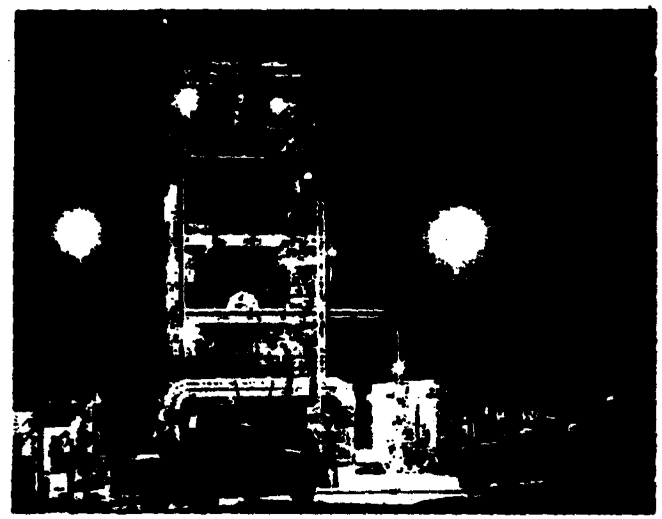
* BASED UPON TANK CAPACITY OF PRESENT IRFNA-UDMH PROPULSION SYSTEM

SECTION IX – FACILITIES

Lockheed facilities for Discoverer, Sentry, and MIDAS purposes presently total some 425,000 square feet of floor space at three principal locations: Palo Alto, Sunnyvale, and Van Nuys, California. By mid-summer 1959, many of the functions now being carried out at these locations will be centralized on one building at Sunnyvale. This building is currently under construction.

An adjacent facility, for use as a Development Control Center, is in the advanced planning stage. Under the direction of an AFBMD assigned System Controller, this center will provide overall direction and control of flight test operations. A temporary installation for this purpose has been constructed in the presently used Palo Alto facilities.

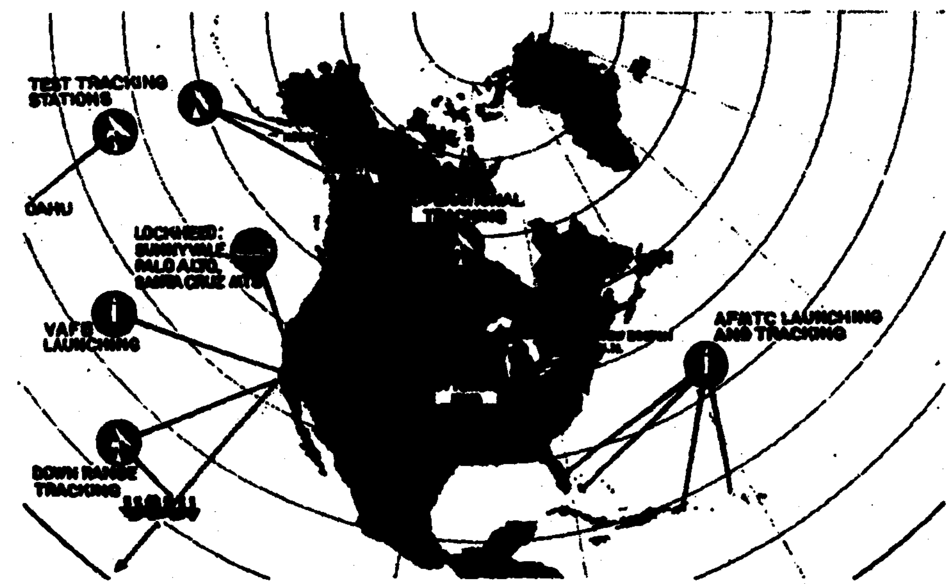
A complete facility for hazardous ground tests, including hot firings of the satellite propulsion system, has been built in the nearby Santa Cruz Mountains.



HOT FIRING AT SANTA CRUZ TEST BASE

Launching and tracking facilities for both the Discoverer series and Atlas-boosted Sentry satellites are either completed or under construction at Vandenberg AFB. Down-range tracking is accomplished by use of both a radar station at Point Mugu and a merchant ship, leased and specially modified for this purpose. AFMTC launching and tracking facilities will be used for low-latitude orbit flight tests related to the MIDAS program.

Tracking and communication facilities required in the far North for MIDAS purposes are currently being determined; maximum use will be made of facilities designed primarily for the operation of early warning air defense systems.



Page