SPACE

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HEADQUARTERS
AIR FORCE BALLISTIC MISSILE DIVISION (ARDC)
UNITED STATES AIR FORCE
Air Force Unit Post Office, Los Angeles 45, California

WDLPM-4

25 February 1960

FOREWORD

Activities summarized in this report include the major space systems, projects and studies for which the Air Force Ballistic Missile Division is wholly or partially responsible. Each space system and project is preceded by a concise history of administration, concept and objectives, making the monthly progress more meaningful in terms of total program objectives. The programs will be revised monthly to reflect major technical and administrative changes. These programs must be sufficiently flexible to permit continuous and effective integration of rapidly occurring advances in the state-of-the-art.

for O. J. RITLAND
Maj. Gen., USAF
Commander

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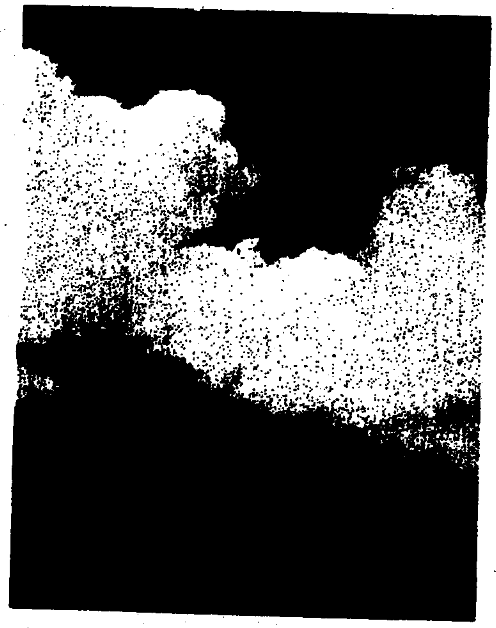
a foreword to...

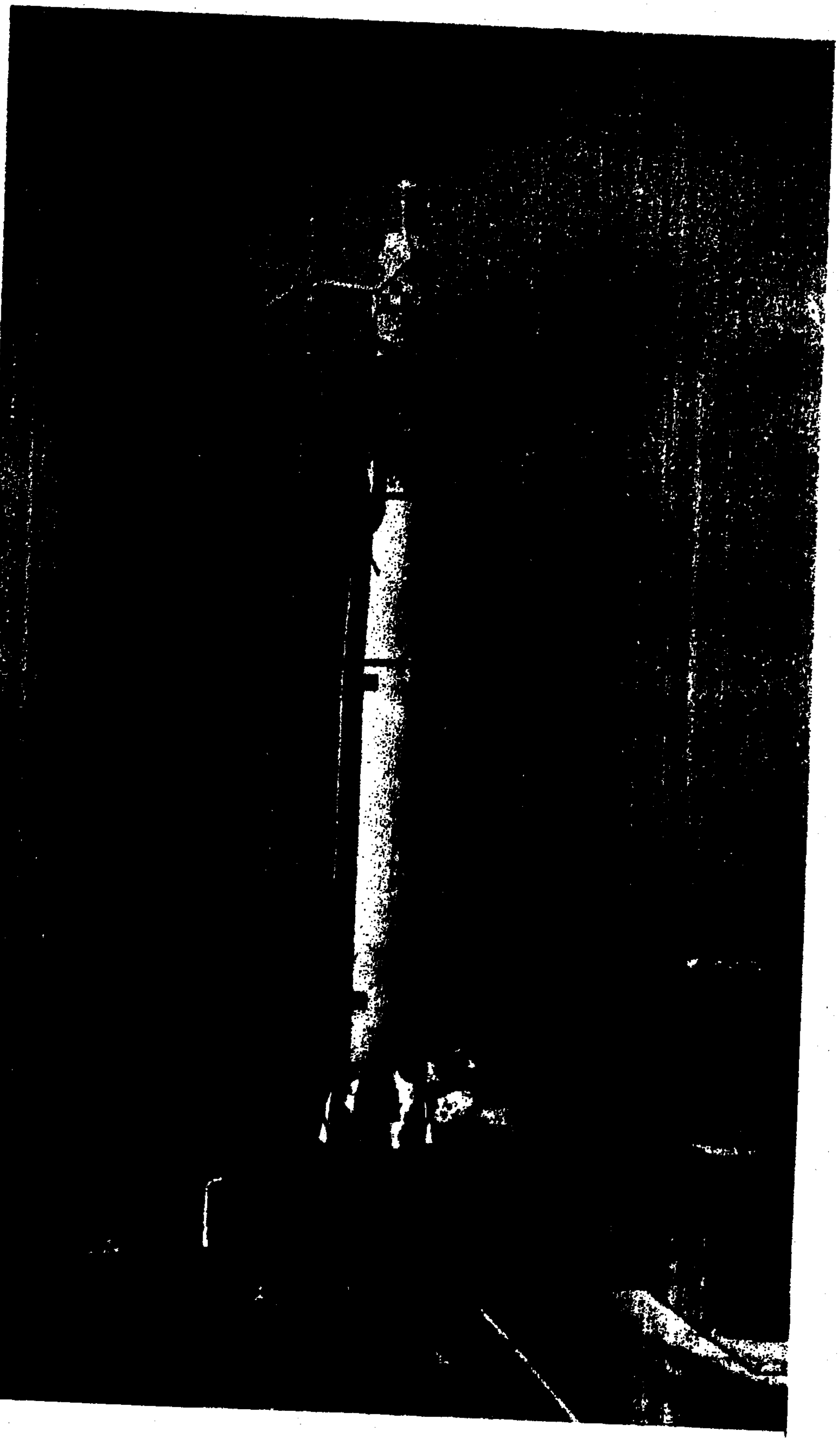


SPACE

SPACE

systems

SPACE SYSTEMS



Discoverer

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—Inert	1,370	1,600
Impulse Propellants	6,550	13,100
Fuel (UDMH)		
Oxidizer (IRFNA)		
Pyrotechnics	67	100
GROSS WEIGHT (lbs.)	7,987	14,800
Engine	YLR81-Ba-5	XLR81-Ba-7
Thrust, lbs. (vac.)	15,000	15,000
Spec. Imp., sec. (vac.)	277	277
Burn Time, sec.	120	240
Restart Provisions	No	Yes
THOR BOOSTER	SM-65	DM-21
Weight—Dry	6,950	5,950
Fuel	33,750	33,750
Oxidizer (LOX)	68,300	68,300
GROSS WEIGHT (lbs.)	109,000	108,000
Engine	MB-3 Block 1	MB-3 Block 2
Thrust, lbs. (S.L.)	152,000	167,000
Spec. Imp., sec. (S.L.)	247.8	247.8
Burn Time, sec.	163	163

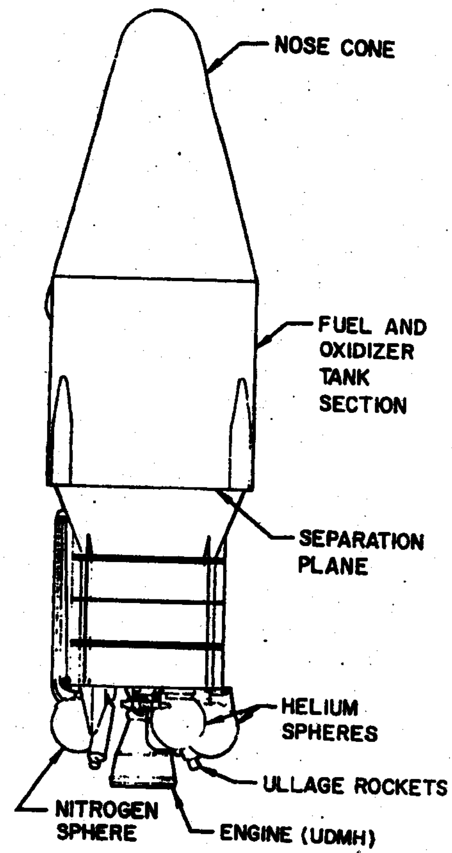


Figure 1. Photograph of two-stage DISCOVERER vehicle (left) and detailed drawing of AGENA, second stage (right).

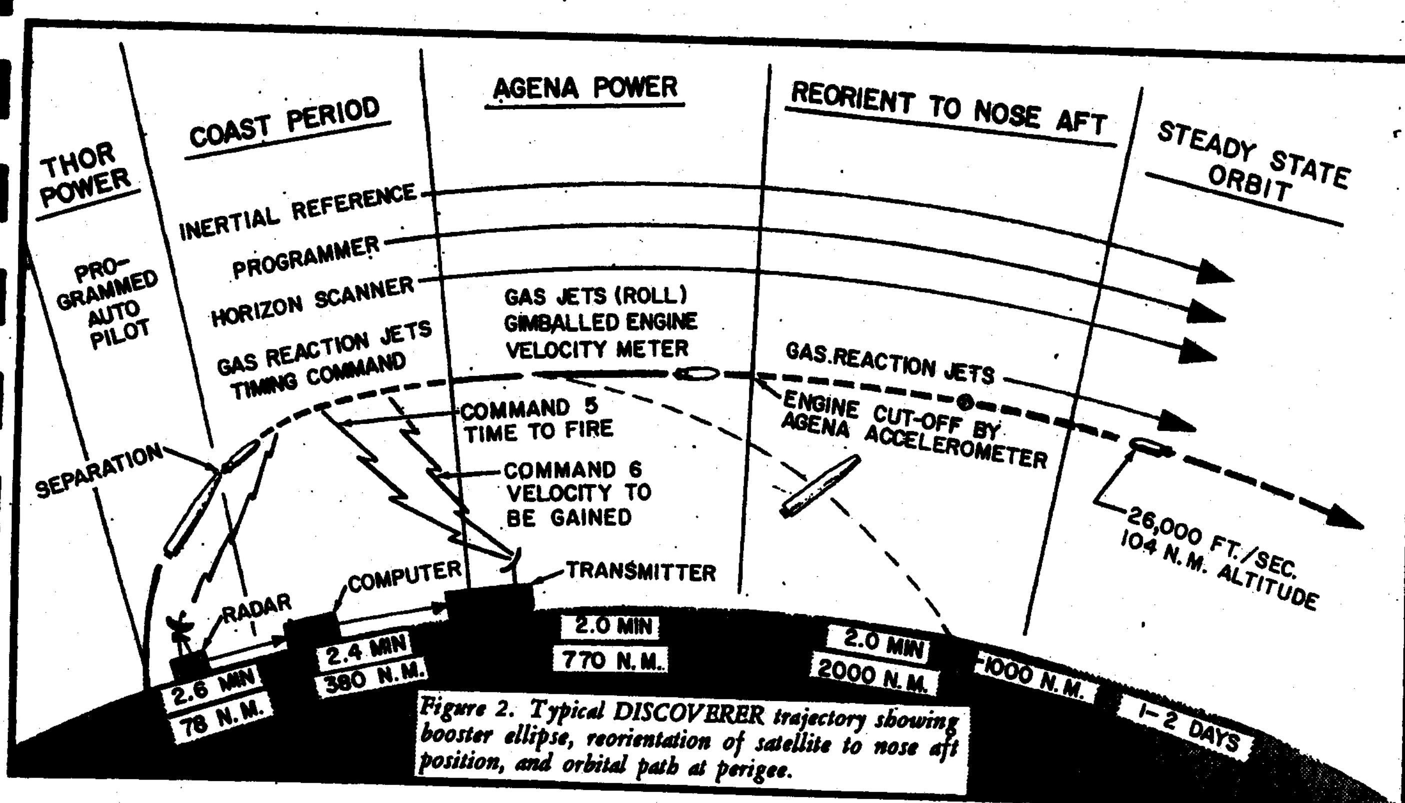
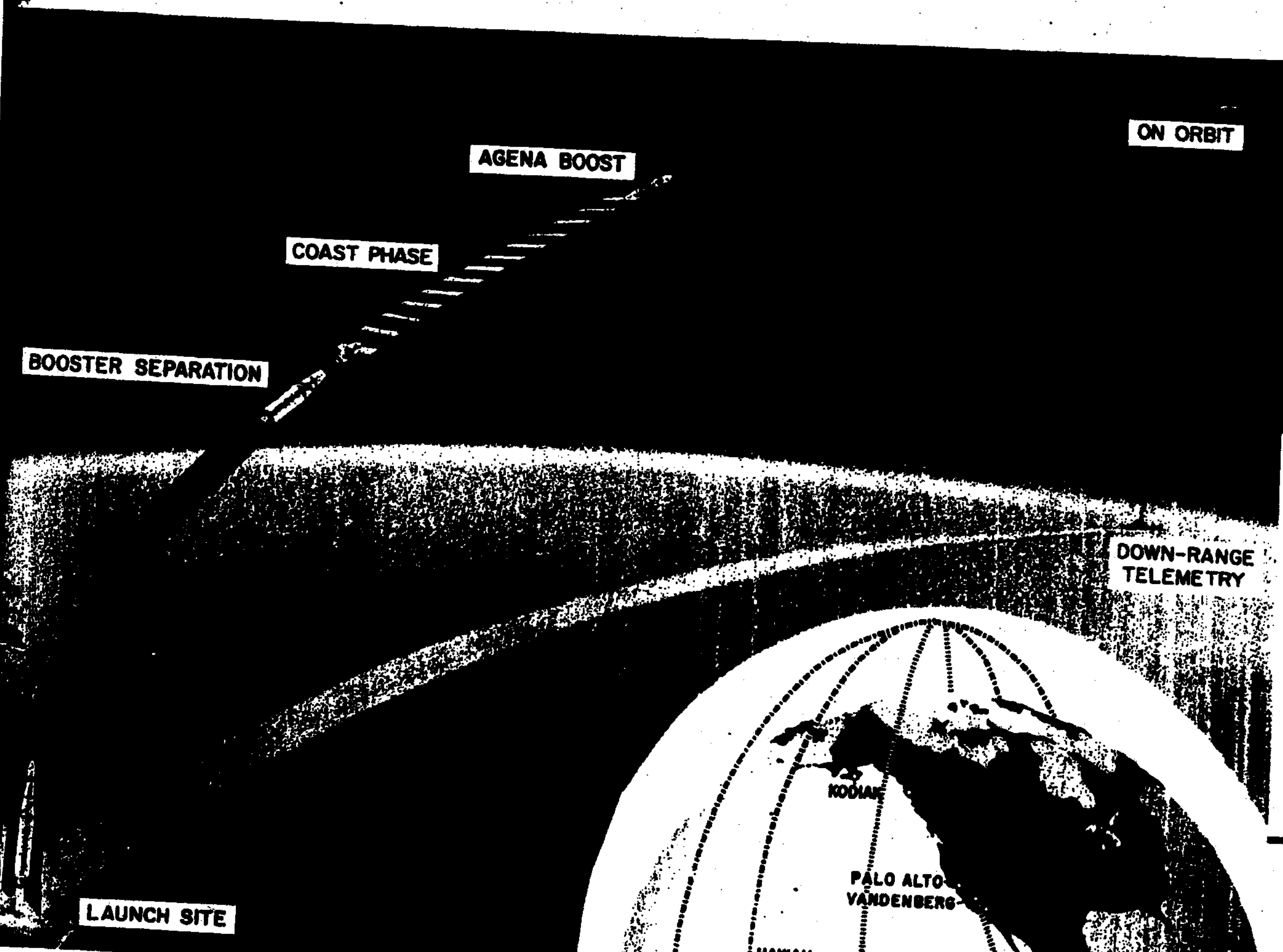


Figure 2. Typical DISCOVERER trajectory showing booster ellipse, reorientation of satellite to nose aft position, and orbital path at perigee.



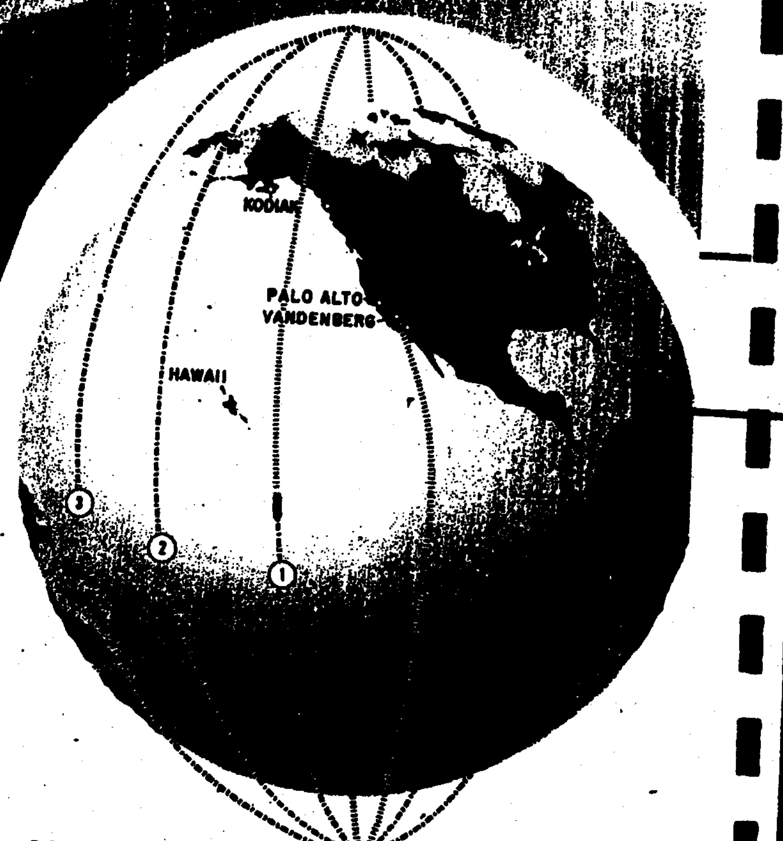


Figure 3. Typical DISCOVERER trajectory (above) from launching at Vandenberg AFB to orbit. Typical satellite orbital path around the earth (right).

The DISCOVERER Program consists of the design, development and flight testing of 29 two-stage vehicles (Figure 1), using the THOR IRBM as a first stage booster and the AGENA vehicle, powered by the Bell LR81 rocket engine series as the second stage satellite. The DISCOVERER Program was established early in 1958 under direction of the Advanced Research Projects Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will provide: (a) space research in support of the advanced military reconnaissance satellite systems programs, (b) test of the ground communications and tracking network for these programs, and (c) flight testing of the AGENA second stage vehicle.

Primary objectives include:

(a) Flight test of the satellite vehicle airframe, propulsion, guidance and control systems, auxiliary power supply, and telemetry, tracking and command equipment.

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

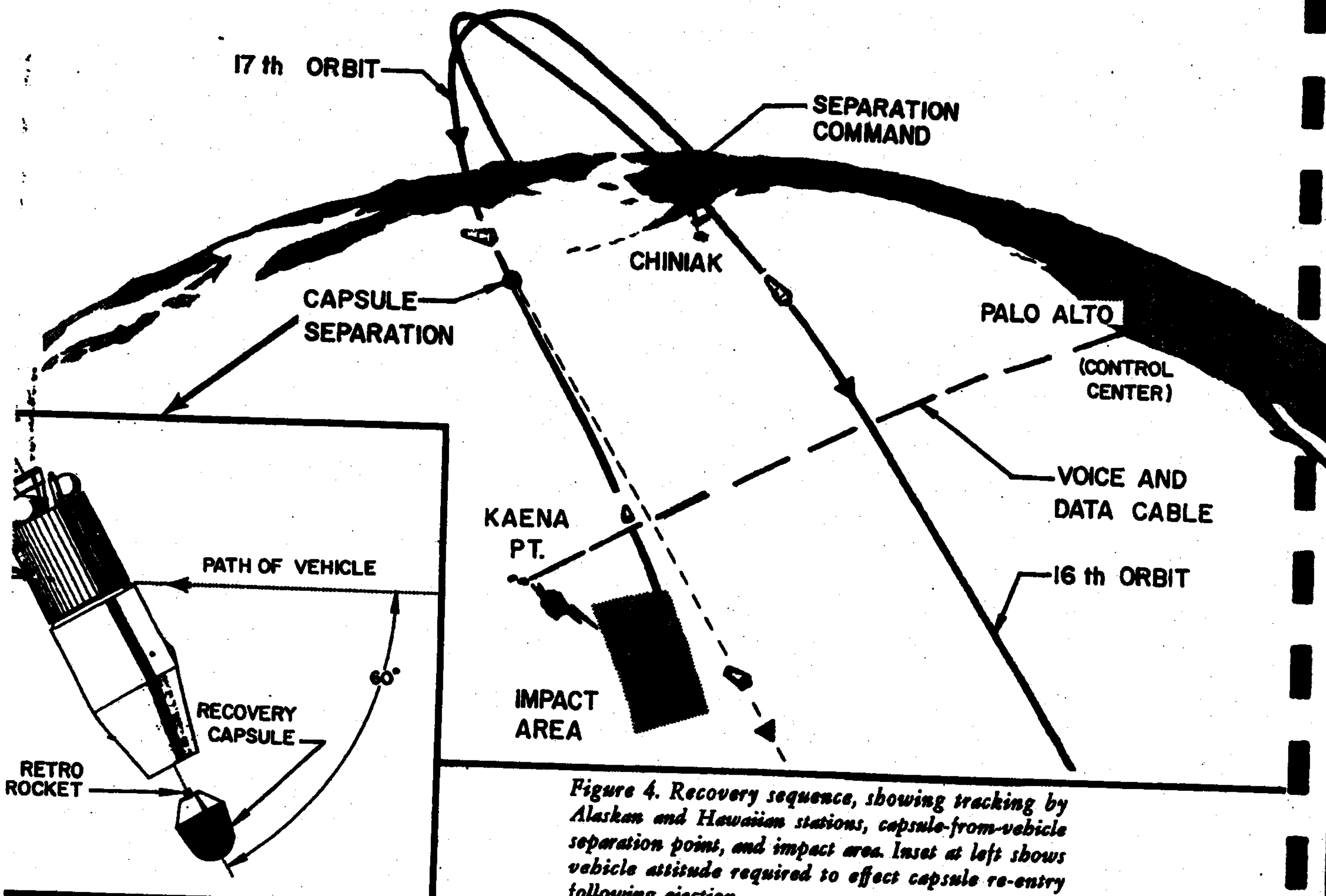


Figure 4. Recovery sequence, showing tracking by Alaskan and Hawaiian stations, capsule-from-vehicle separation point, and impact area. Inset at left shows vehicle attitude required to effect capsule re-entry following ejection.

(d) Testing of techniques for recovery of a capsule ejected from the orbiting satellite.

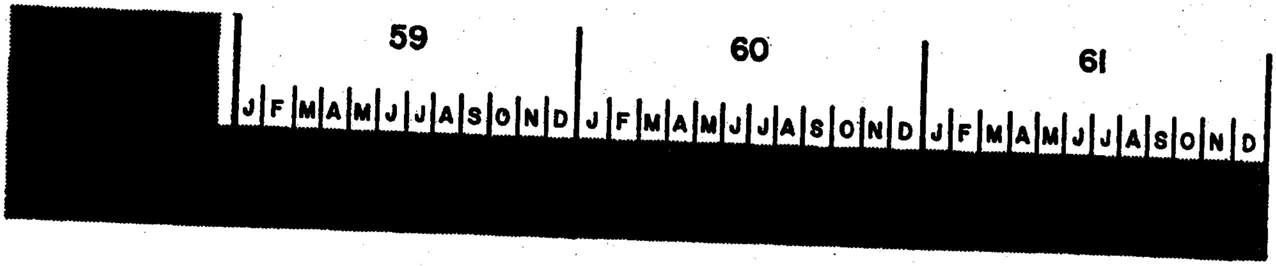
(e) Testing of ground support equipment and development of personnel proficiency.

(f) Conducting bio-medical experiments with mice and small primates, including injection into orbit, re-entry and recovery.

Early tests confirmed vehicle flight and satellite orbit capabilities, developed system reliability and predictability, and established ground support, tracking, and data acquisition requirements. Subsequent flights are planned to acquire scientific data for design of advanced military reconnaissance payload components. Typical data gathering objectives include: cosmic and atomic radiation, magnetic field, total electron density, auroral radiation, micrometeorite measurement, Lyman alpha from space (or stars), solar radiation, and atmosphere density (drag) and composition.

A world-wide network of control, tracking, and data acquisition stations has been established. Overall operational control is exercised by the Control Center in Palo Alto, California. Blockhouse and launch operations are performed at the Vandenberg Air Force Base Control Center.

Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 6 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and recovery capability for the payload capsule (Figure 4). An impact area has been established near the Hawaiian Islands, and a recovery force activated. Techniques have been developed for aerial recovery by C-119 aircraft and for sea recovery by Navy and Air Force surface vessels. The recovery phase of the program has provided advances in re-entry vehicle technology. This information will be used in support of more advanced projects, including the return of a manned satellite from orbit.



Flight History

DISCOVERER No.	Vehicle No.	THOR No.	Flight Date	Remarks
I	1022	163	28 Feb 1959	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	1018	170	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	1020	174	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	1023	179	25 June	*Same as DISCOVERER III.*
V	1029	192	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	1028	200	19 August	*Same as DISCOVERER V.*
VII	1051	206	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	1050	212	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	1052	218	4 Feb 1960	*THOR shut down prematurely. Umbilical cord mast did not retract causing loss of helium pressure.*

MONTHLY PROGRESS—DISCOVERER PROGRAM

Program Administration

● In accordance with amendment 8 to ARPA Order No. 48, dated 17 November 1959, and Hq USAF AFDAT 91935, dated 20 November 1959, responsibility for the DISCOVERER Program was transferred from the Advanced Research Projects Agency to the Air Force.

Flight Test Program

● No flight tests were conducted during December and January to permit a technical review of the recoverable capsule system.

Technical Progress

● A detailed investigation was made of the recoverable capsule system operation during the November flights of DISCOVERERS VII and VIII. The 400 cycle power failure on DISCOVERER VII was determined to have been caused by a malfunction in the load limiter. In DISCOVERER VIII, a malfunction in the accelerometer resulted in a signal error to the integrator which shuts down the AGENA engine when the desired orbital velocity is attained. Because of the signal error, this function was not performed, resulting in a velocity of approximately 800 feet per second over nominal and an eccentric orbit with an apogee considerably greater than planned. During the longer than nominal orbital period, operation of the vehicle guidance system caused depletion of the control gas supply prior to the time at which ejection was commanded. Because of this sequence of events, the satellite was not in the proper attitude at the time of capsule ejection and impact probably occurred approximately 700 miles south of the area patrolled by the recovery force.

● A study was conducted of all areas in which malfunctions have occurred and detailed investigation of responsible components made. This effort resulted in the incorporation of minor modifications to increase component and system reliability.

● An improved procedure for testing the accelerometer prior to launch was initiated. Although considerable modification to the launch facility electrical equipment was necessary, the new procedure gives a more extensive check of accelerometer operation and is expected to provide much greater flight reliability.

● Additional instrumentation was incorporated in the recoverable capsule which will permit telemetry to be transmitted from the capsule over a longer period during the re-entry sequence. A new series of systems checks, including dynamic balance tests, were performed as a result of the changes in instrumentation.

● Recovery capsule ejection occurs nominally on the 17th orbit. As a result of flight experience, an additional command capability has been added for DISCOVERER IX and subsequent flights which will permit the alternate selection of pass 15, 16, or 18 for capsule ejection.

● DISCOVERER VIII satellite had completed over 1,000 orbital passes by the end of January. It is estimated that the vehicle will remain in orbit for a relatively long period of time. Telemetry has not been received from the satellite since the 22nd orbit.

● The final AGENA "A" vehicle for the initial DISCOVERER vehicle configuration program (first sixteen flights) was accepted by the Air Force on 4 January. Additional required modifications to this vehicle are scheduled for completion by 31 March.

● The first two AGENA "B" DISCOVERER vehicles are also in the Modification and Checkout Center. One of these is scheduled for shipment to Santa Cruz Test Base on 24 February.

Figure 5. Final installation of duroid window in outer surface of nose cone. Window will permit R-F radiation for improved telemetering during DISCOVERER IX re-entry flight.

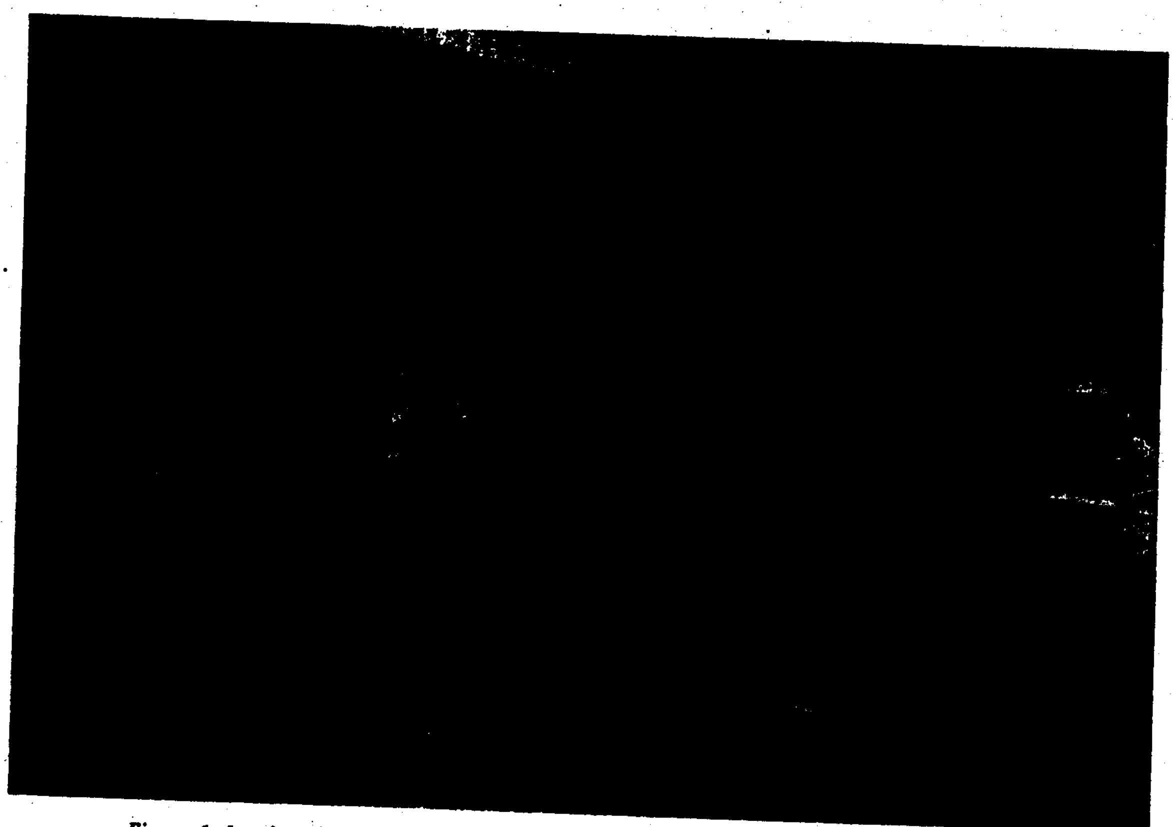


Figure 6. Interior of interim control room, Satellite Test Center (formerly Development Control Center). Installation will be completed for monitoring of the DISCOVERER IX launch.

● For additional information on the AGENA "B" DISCOVERER vehicles, refer to the AGENA monthly progress section.

Biomedical Program

● Resumption of biomedical recovery capsule testing (for a primate passenger) is scheduled to begin on 8 February in the LMSD high altitude temperature simulation chamber. The special General Electric test capsule (USE-72) to be used includes several modifications and techniques resulting from thermal profile testing in November and proof testing by the School of Aviation Medicine in December. These include enlargement of the cooling capacity of the capsule heat exchanger, refined methods of sensor attachment to the animal for EKG readouts, relocation of chest bands and feeder mechanism, and a re-programming of the psychomotor response stimuli to allow the animal more time to respond. Successful completion of this test series will result in fabrication of the final flight capsule, scheduled to be flown on DISCOVERER XV.

Ground Support Progress

● A study is being conducted of the umbilical mast modifications necessary to service DISCOVERER vehicles with AGENA "B" second stages. Modification is needed because of the additional length of the AGENA "B" vehicle.

● The second air-conditioning trailer was received at Vandenberg Air Force Base. Receipt of this trailer will eliminate the necessity of moving air-conditioning units from pad to pad for launch operations.

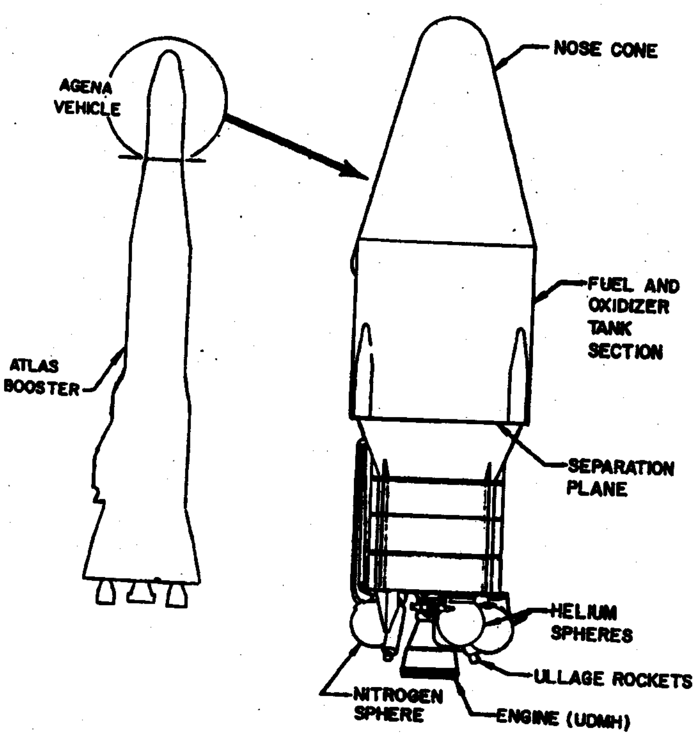
BOOSTER—ATLAS ICBM	
Weight—Wet	15,100
Fuel, RP-1	74,900
Oxidizer (LOX)	172,300
GROSS WEIGHT (lbs.)	262,300
Engine—MA-2	
Thrust (lbs. vac.) Boost	356,000
Sustainer	82,100
Spec. Imp. (sec. vac.) Boost	286
Sustainer	310

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—Inert	1,370	1,600
Impulse Propellants	6,550	13,100
Fuel (UDMH)		
Oxidizer (IRFNA)		
Pyrotechnics	67	100
GROSS WEIGHT (lbs.)	7,987	14,800
Engine	YLR81-Ba-5	XLR81-Ba-7
Thrust, lbs. (vac.)	15,000	15,000
Spec. Imp., sec. (vac.)	277	277
Burn Time, sec.	120	240
Restart Provisions	No	Yes

S a m o s

Figure 1.

Artists' concept of SAMOS satellite. Line drawing of complete flight vehicle (right) and detailed view of basic AGENA upper stage (left).



PROGRAM HISTORY

The SAMOS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency early in 1958. ARPA separated WS 117L into the DISCOVERER, SAMOS and MIDAS programs with the SAMOS objectives based on a visual and ferret reconnaissance system. On 17 November 1959 responsibility for this program was transferred from ARPA to the Air Force by the Secretary of Defense.

PROGRAM MISSION

The primary mission of the SAMOS advanced reconnaissance system is to provide continuous visual, electronic (and other) surveillance of the USSR and its allied nations. Efforts include development of hardware to permit:

a. Determination of characteristics of enemy electronic emissions.
b. Verification of known targets, detection of unknown targets.
c. Location and evaluation of defenses.
d. Evaluation of military and industrial strength.
e. Assessment of high-yield weapons damage.
f. Reconnoitering of troop movements.
g. Location of naval forces throughout the world.

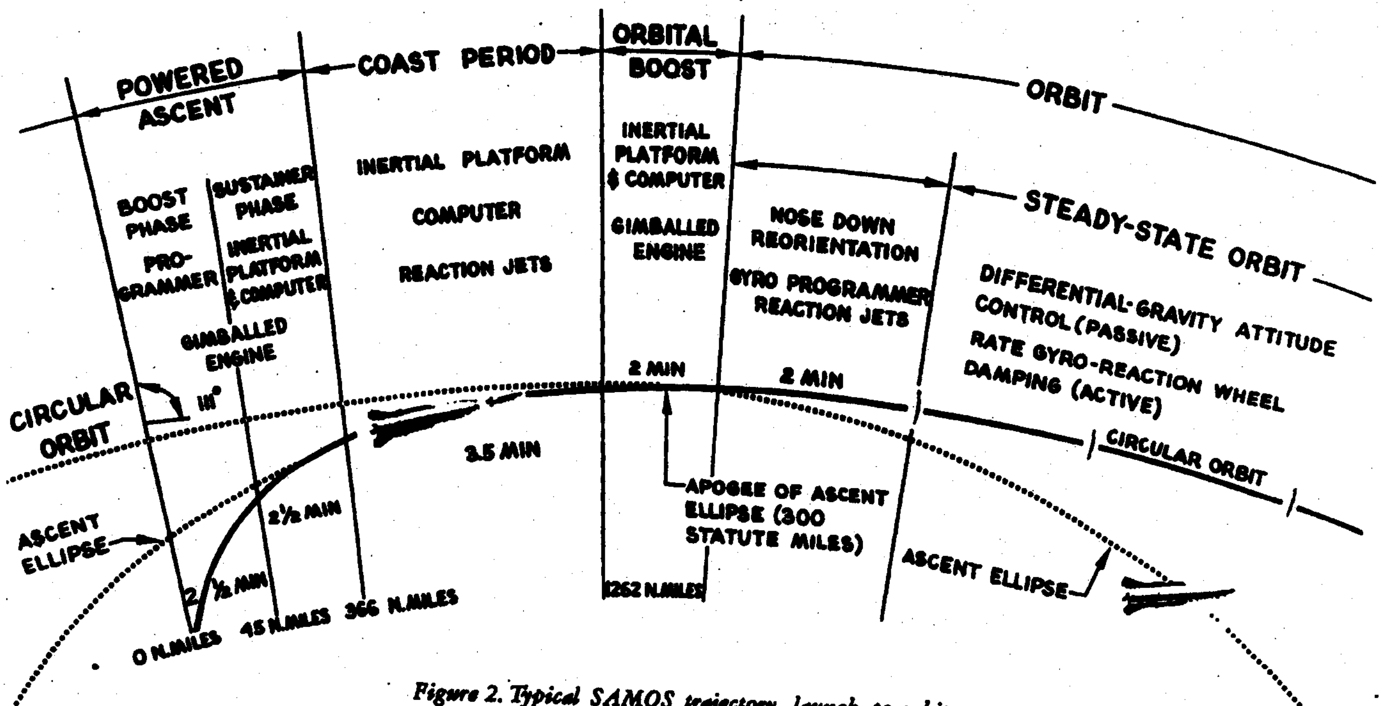


Figure 2. Typical SAMOS trajectory, launch- to-orbit.

Ferret Reconnaissance...

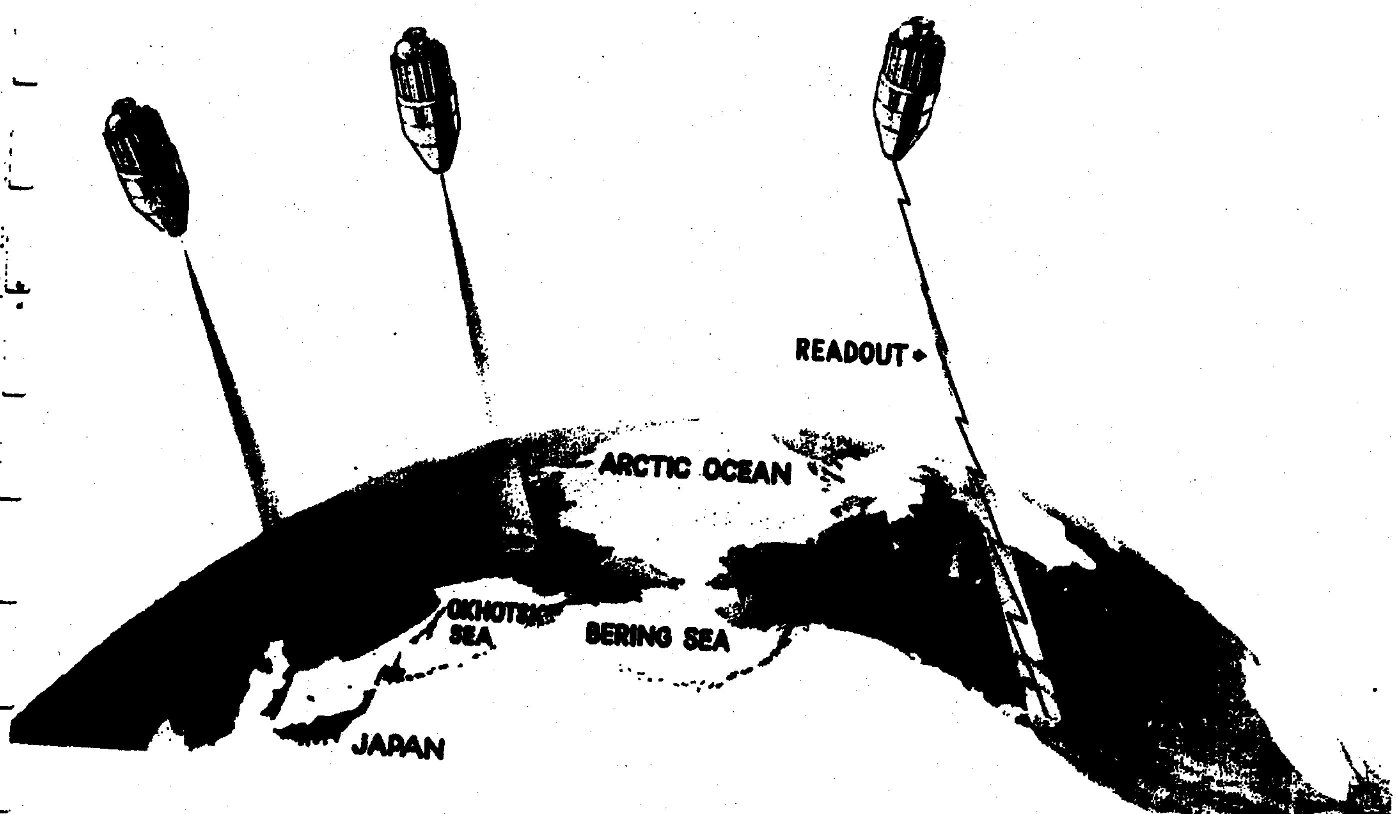


Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over unfriendly territory.

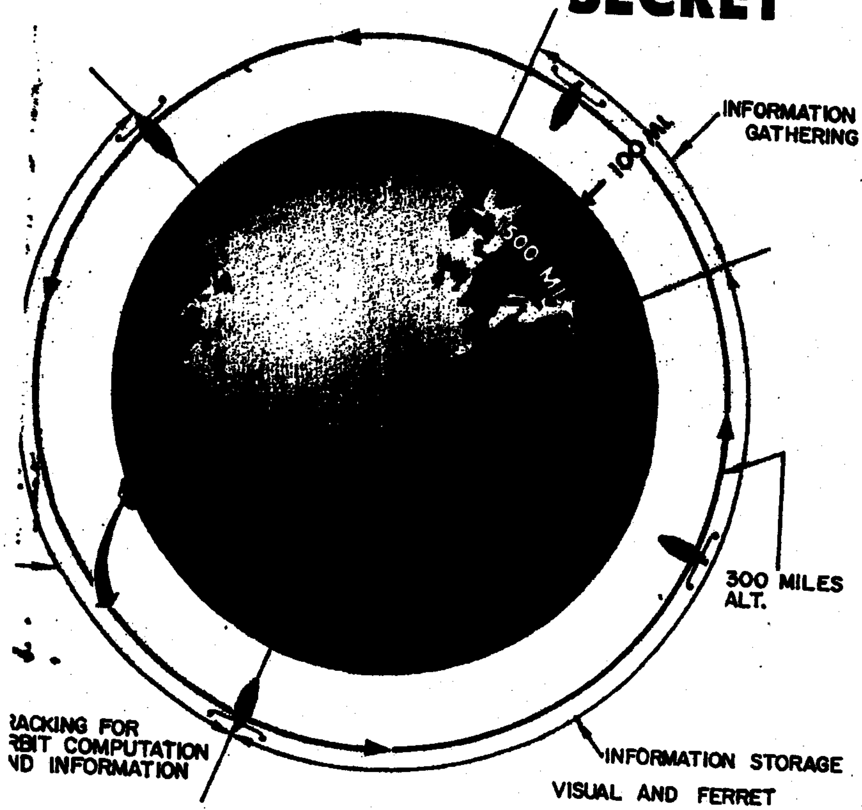


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over unfriendly territory the sensing equipment is turned on (Information gathering). When it leaves unfriendly territory the sensing equipment is turned off and the sensing data is processed (Information storage). When the vehicle comes within range of a ground receiving station, the data will be read-out upon command for processing and transmittal to using agencies. This process is continuously repeated during the useful lifetime of the vehicle.

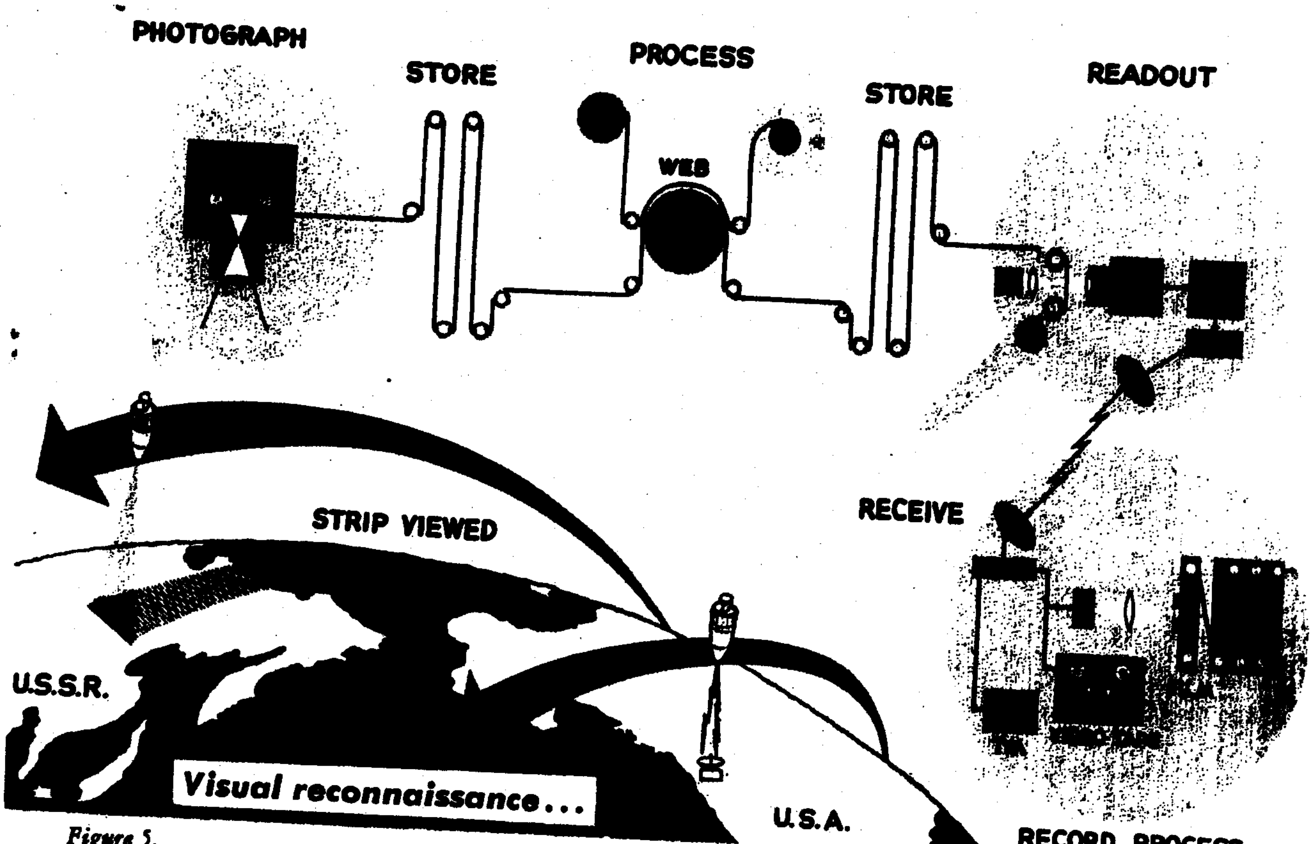


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects 20 feet in length.

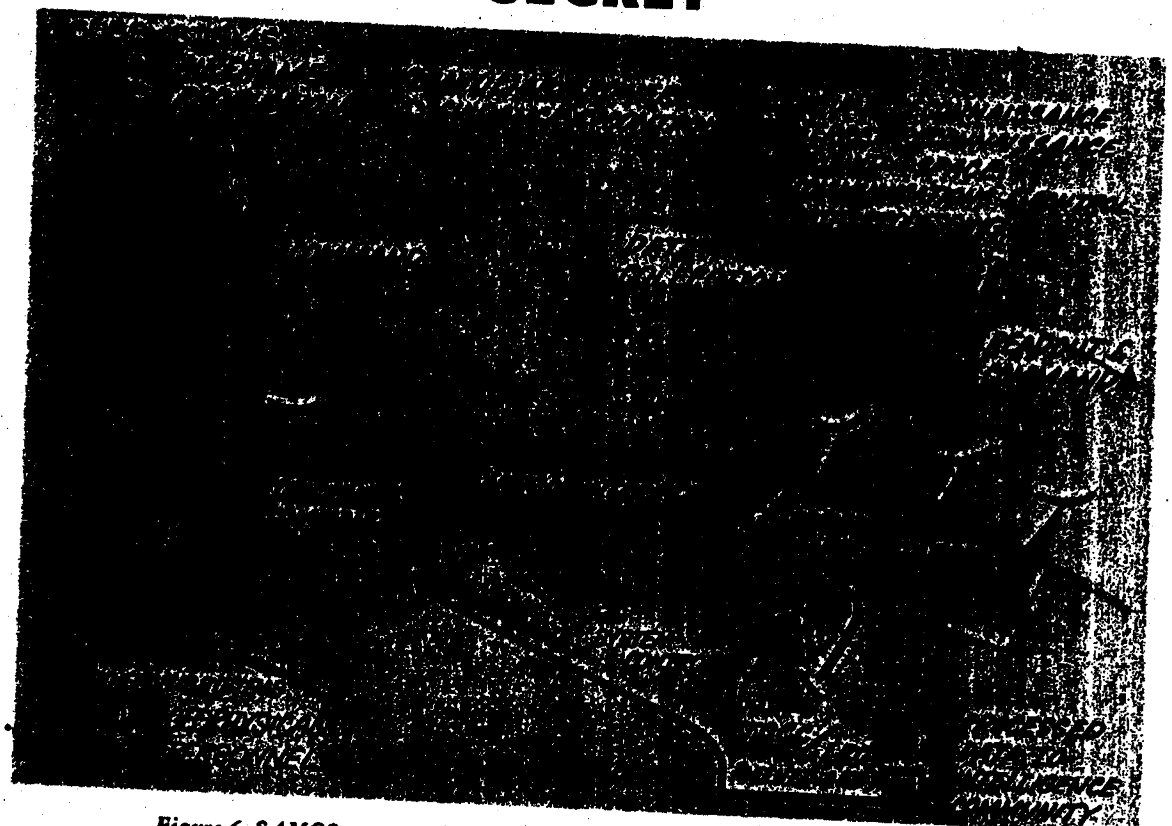


Figure 6. SAMOS concept, showing reception of commands and transmission of data between satellite and ground station; and subsystem functions (schematic).

The reconnaissance equipment will be housed in the AGENA satellite vehicle (Figure 1), which has been flight tested in the DISCOVERER Program. During the development phase a dual-capability visual and ferret payload will be developed for economical test of components. In the operational phase each satellite vehicle will carry only the visual or the ferret payload. The system is composed of the satellite vehicle, ATLAS booster, launch facilities, tracking facilities, and a communications and data processing network.

CONCEPT

In the operational SAMOS Program AGENA satellite vehicles will be boosted into polar orbits from Vandenberg Air Force Base by Series D ATLAS missiles. Injection into near-circular orbits (Figure 2) will be accomplished by the AGENA vehicle rocket engine. The satellite will be stabilized in attitude by a self-contained guidance system using a horizon reference scanner. As the satellite travels in an orbit essentially fixed in space the earth rotates inside the orbit (Figure 3). As a result, each successive orbit is displaced laterally approximately 22½ degrees at the equator, permitting a single vehicle to observe the entire earth in a time period dependent upon the width of the area under surveillance. Early versions will have a useful life of ten to thirty days. Later versions will have a useful life of one year as a design objective.

TECHNICAL HISTORY

a. **Visual Program**—The development of the payload camera, in-flight film processor, and electronic readout were undertaken by Eastman Kodak Company. Cameras with 6 and 36 inch focal length lenses have been developed and the first flyable visual reconnaissance package has been assembled. This package includes automatic film processing equipment, film transport and take-up, electronic readout, and temperature controls.

b. **Ferret Program**—The ferret payloads are being developed in two phases. The F-1 payload was assembled using a maximum of off-the-shelf components for early availability. The F-2 payload is being designed for maximum performance. The F-1 payload has undergone extensive flight testing, mounted in an aircraft, over U. S. radars. The results have been excellent.

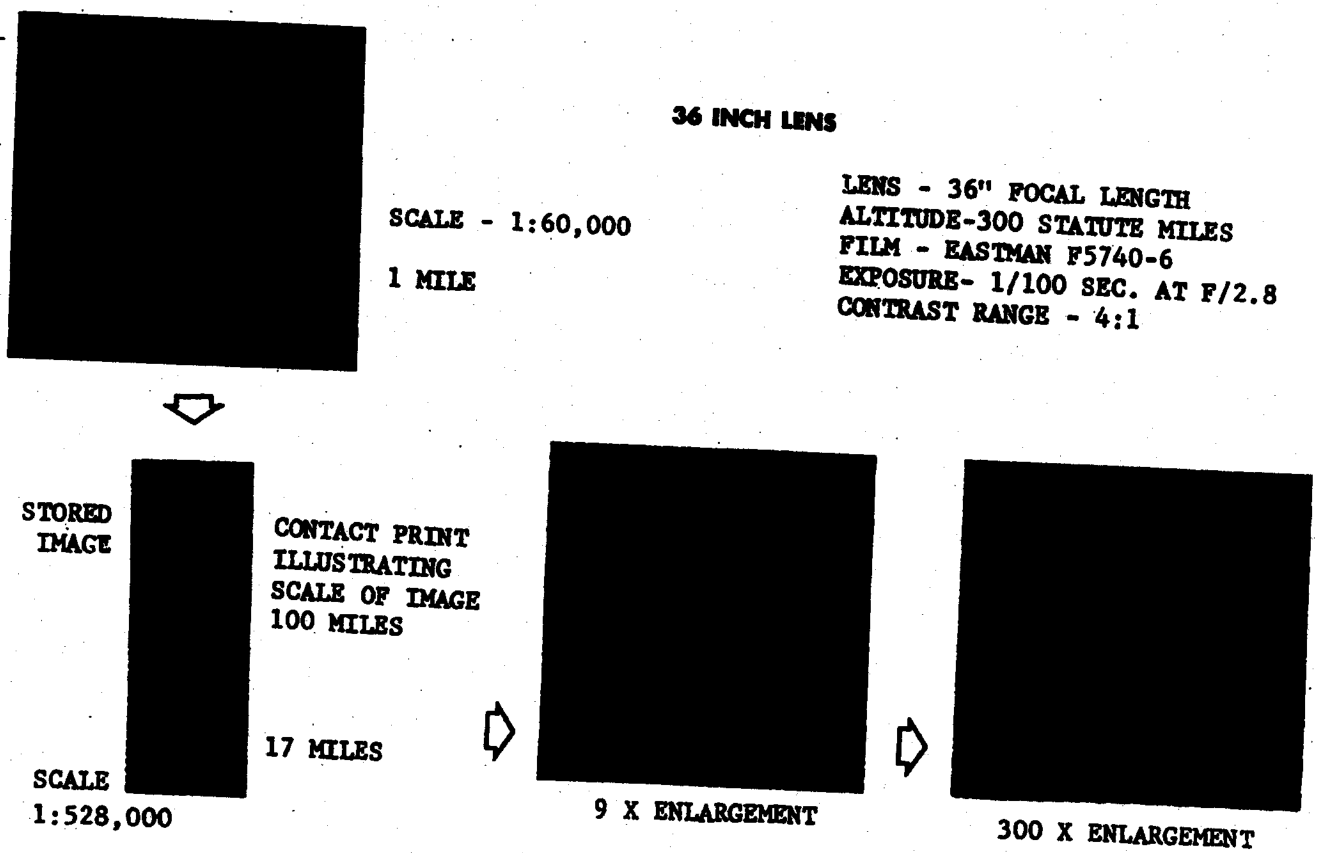


Figure 7. Simulated photography from satellite vehicle.

MONTHLY PROGRESS—SAMOS PROGRAM

Program Administration

● In accordance with Amendment 16 to ARPA Order No. 9, dated 17 November 1959, and Hq USAF AFDAT 91935, dated 20 November 1959, responsibility for the SAMOS Program was transferred from the Advanced Research Projects Agency to the Air Force.

Flight Schedules

● The following Ferret System schedule is the result of program realignment accomplished in December.

SAMOS Flights

Payload	*Original Schedule*	*Revised Schedule*
F-1	*2*	*3*
F-2	*2 (1 F-2A)* *(1 F-2B)*	*4*
F-3	*4 (2 F-3A)* *(2 F-3B)*	*1*

● A combined visual/ferret payload will be used on the first 3 flights. The first seven ferret payloads (F-1 and F-2) will progress to more complete installations of receivers and antennas to provide an increasingly greater electronic measurement capability. The major portion of the original hardware components are usable under the reoriented program.

● Only one F-3 flight is scheduled in the contract period. The F-3 is an analog system designed for specific mission purposes.

Technical Status

● The second stage AGENA vehicle for the first flight is being checked out in the LMSD Modification and Checkout Center. Assembly of vehicles for the second and third flights is progressing on schedule. All three will carry the dual SAMOS package (visual and ferret reconnaissance equipment).

● Interior design of the AGENA satellite vehicles for SAMOS flights 4 and subsequent is underway. Interiors are being standardized, as much as possible with MIDAS Program vehicles for flights 3 and subsequent. These vehicles, for both programs, will be launched into polar orbits from the Pacific Missile Range. A common vehicle airframe design from the forward equipment compartment aft appears to be feasible. Equipment installations need not be interchangeable.

Visual Reconnaissance System

Visual Reconnaissance System payloads are being developed in a minimum number of configurations to attain readout and recovery mission objectives. The designation and purpose of each configuration is as follows:

E-1—Component Test Payloads

E-2—Steerable Reconnaissance Payload (with 20-foot ground resolution).

E-5—High Resolution Recoverable Payload (with 5-foot ground resolution).

● The first deliverable E-1 payload is now being quality-control evaluated, and acceptance testing is scheduled to begin on 4 February. The payload was vibration tested for pressure leaks and shock endurance after a 19-hour operational test. These and subsequent operational tests were conducted successfully. A minor defect in the payload readout was detected and has been corrected. The second E-1 payload is scheduled for delivery to LMSD in March.

● The initial E-2 payload is 95 percent fabricated and 60 percent assembled. Design of a refined version of the E-2 payload, including refined circuitry, and substantially lighter weight, is essentially complete. High altitude temperature simulation testing of the E-2 thermal model payload has been resumed.

● The design control specifications and drawings for the E-5 high acuity panoramic camera have been submitted to AFBMD and the Itek Corporation by LMSD. A contract for heat shielding for the LMSD designed recovery capsule has been negotiated with the AVCO Corporation.

Payload Ground Equipment

● **Ground Reconstruction Electronics**—The second, third and fourth units are being subjected to quality control evaluation prior to LMSD acceptance testing, scheduled to begin during February.

● **E-1 Payloads**—The test console and power supply, primary record cameras, and the 40-inch collimator are undergoing evaluation and modification at Eastman Kodak. This equipment will be shipped to Vandenberg on 25 March for installation in the missile assembly building. The primary record processor and its support equipment have been installed in the missile assembly building.

● **E-2 Payloads**—The 144-inch collimator has been completely assembled at Eastman Kodak.

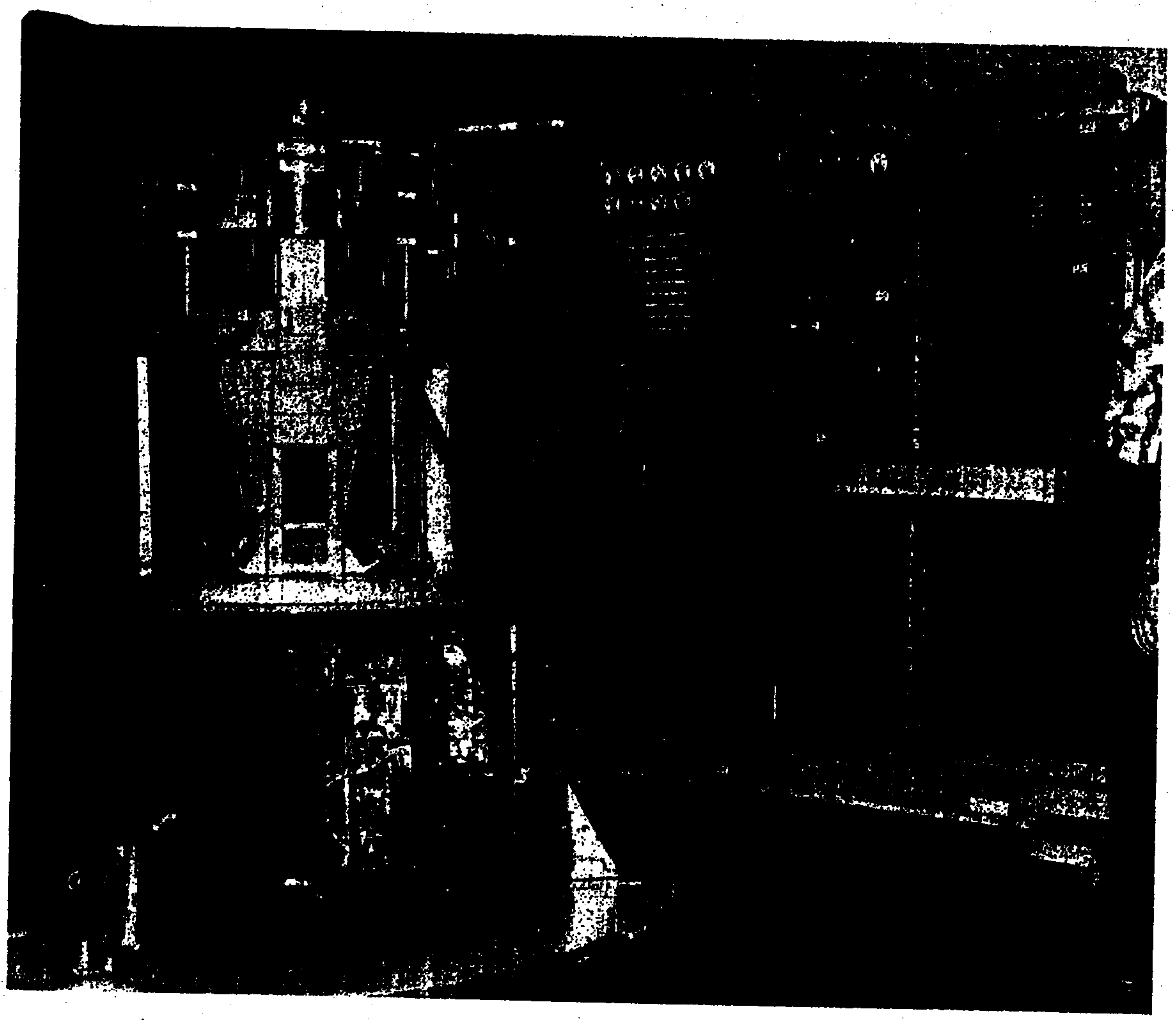


Figure 8. Preliminary functional testing and checkout of the first (F-1) flight payload. This equipment will be flown in combination with an B-1 (photographic) package on the first SAMOS flight.

Ferret (electronic) Reconnaissance System

Ferret Reconnaissance System payloads are being developed in a minimum number of configurations. The designation and purpose of each configuration is as follows:

- ***F-1—R&D Test Payloads***
- ***F-2—Digital General Coverage Payloads***
- ***F-3—Specific Mission Payloads.***

● Quality control inspection of the first two deliverable F-1 payloads was completed during January and payload evaluation tests were started. Preparations for installing these payloads in their respective vehicles is continuing at the Modification and Checkout Center. Systems testing of the third deliverable F-1 payload is proceeding at Airborne Instruments Laboratory. Intermittent time counter errors encountered in previous tests have been greatly reduced by line filtering and desensitizing the counter stages. Delivery of this payload to LMSD is scheduled for 25 March.

● High altitude lifetime testing of a new 120-volt power converter prototype has reached 345 hours to date. This unit is being tested for use as back-up equipment for the F-1 payload. Previous models failed before 100 hours of testing. The prototype incorporates a new package design providing more efficient heat control.

● Nose cone separation tests were successfully completed during January. The tests verified the reliability of the separation mechanism and the absence of physical interference. Bases were established for analyzing the forward velocity imparted by the separation springs and the pitch and yaw characteristics of the nose cone after separation. Tests involving payload separation from a test stand using simulated payload vehicle attachments were started on 28 January.

● Air Force mechanical acceptance testing of the F-1 data conversion equipment was completed on 22 January. This equipment will be installed in the Satellite Test Center. Electrical acceptance testing was started at the end of the reporting period.

Communications and Control Equipment

● Delivery of all airborne communication equipment for the first SAMOS flight will be made prior to 5 February. This schedule will permit all equipment to be installed while the vehicle is in the Modification and Checkout Center. Delivery schedules for ground tracking and data handling equipment are being reviewed to determine compatibility with the 20 August target date for activation of the communications and control network.

Modification of Ground Tracking and Communications Network

● On 8 January AFBMC approved the ground network reorientation proposal required by funding limitation. Vandenberg Air Force Base will be the only station capable of UHF communication with the satellites of the first three SAMOS flights. Vandenberg, Hawaii and Alaska will be able to track and communicate with these satellites in the VHF bands. The UHF tracking capability for Kaena Point, Hawaii, has been deleted. Dynamic plot simulators and some items of TV equipment have been deleted from the Satellite Test Center. The operational date for the New Boston, New Hampshire station has been deferred until March 1961, in time for SAMOS flight 4.

Ground Support Program Progress
Handling and Service Equipment

● Acid transfer tests were completed successfully at the Santa Cruz Test Base on the Point Arguello type propellant transfer set. This unit now will be used to check out the propellant refrigeration system. It will then be flushed and tested with unsymmetrical dimethyl hydrazine prior to undergoing life tests.

● Assembly of launch control equipment for launch pad 1 was completed and checkout is progressing satisfactorily. Delivery to Point Arguello is scheduled for February.

Facilities

● Vandenberg Air Force Base—Construction of all tracking and data acquisition facilities is complete except for the data acquisition and processing building, scheduled for occupancy by 1 March. Installation of equipment has started.

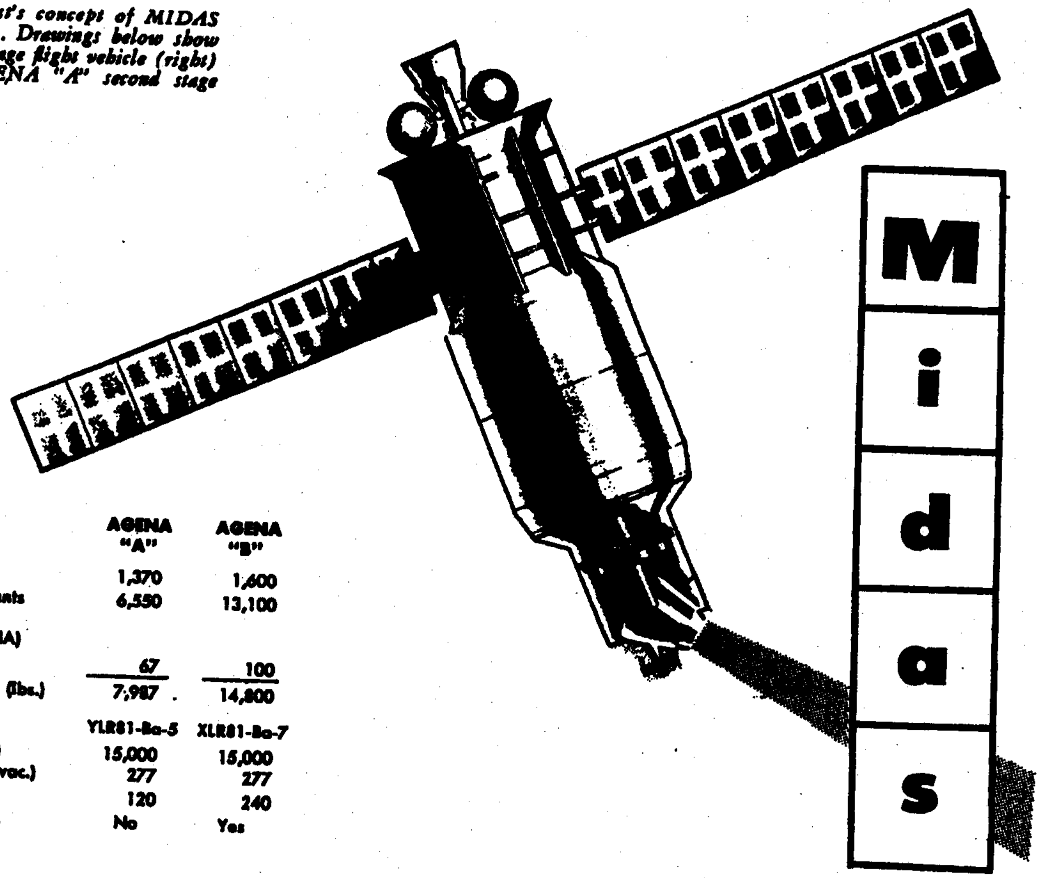
● Satellite Test Center—Increment 1 was completed in December and installation of equipment is in progress. Construction of increment 2 is scheduled for completion on 15 June.

● Point Arguello—The SAMOS program may be seriously delayed by delays in completion of the two launch stands. A sequence of events involving incompetent contractors and inadequate inspection and supervision by the construction agency has occurred. Although the construction agency (BuDocks) has not formally issued new beneficial occupancy dates, AFBMD estimates are 1 April and 1 May for pads 1 and 2 respectively.

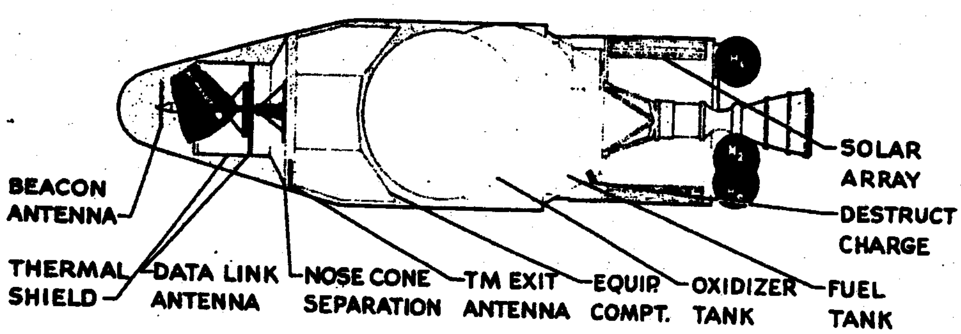
● Design has been completed, but construction of technical support facilities at Vandenberg Air Force Base and Point Arguello is being held up for lack of funding. Work on the following units is also being held in abeyance until firm SAMOS Program decisions have been made:

1. *Support facilities for Ottumwa, Iowa tracking and data acquisition station.*
2. *Design of the Space Operations Control and Data Processing facility, Offutt Air Force Base.*

Figure 1. Artist's concept of MIDAS satellite (right). Drawings below show complete two-stage flight vehicle (right) and basic AGENA "A" second stage vehicle (left).



SECOND STAGE	AGENA "A"	AGENA "B"
Weight—Inert	1,370	1,600
Impulse Propellants	6,550	13,100
Fuel (UDMH)		
Oxidizer (IRFNA)		
Pyrotechnics	67	100
GROSS WEIGHT (lbs.)	7,987	14,800
Engine	YLR81-Ba-5	XLR81-Ba-7
Thrust, lbs. (vac.)	15,000	15,000
Spec. Imp., sec. (vac.)	277	277
Burn Time, sec.	120	240
Restart Provisions	No	Yes



NOTE: AGENA "A" configuration except for solar paddles (AGENA "B" only).

BOOSTER—ATLAS ICBM	
Weight—Wet	15,100
Fuel, RP-1	74,900
Oxidizer (LOX)	172,300
GROSS WEIGHT (lbs.)	262,300
Engine—MA-2	
Thrust (lbs. vac.) Boost	356,000
Sustainer	82,100
Spec. Imp. (sec. vac.) Boost	286
Sustainer	310