AIR FOR ALLISTIC MIS

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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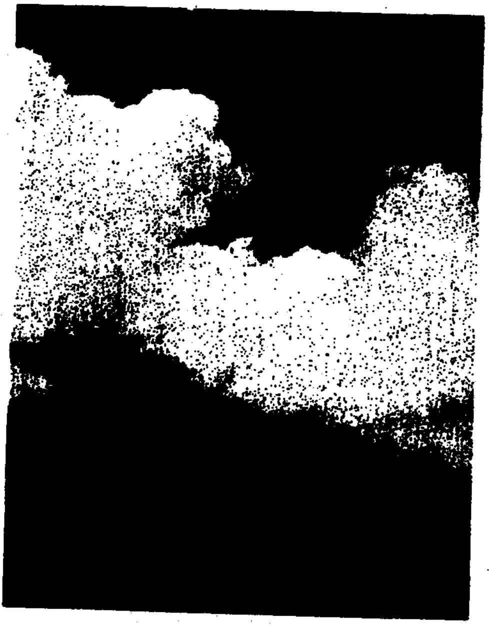
a foreword to...



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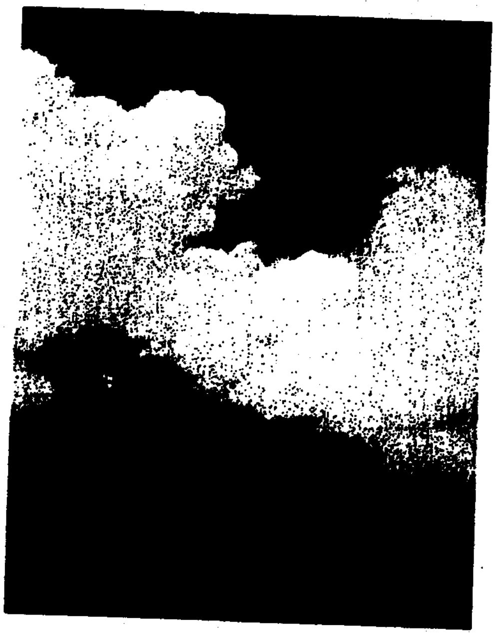
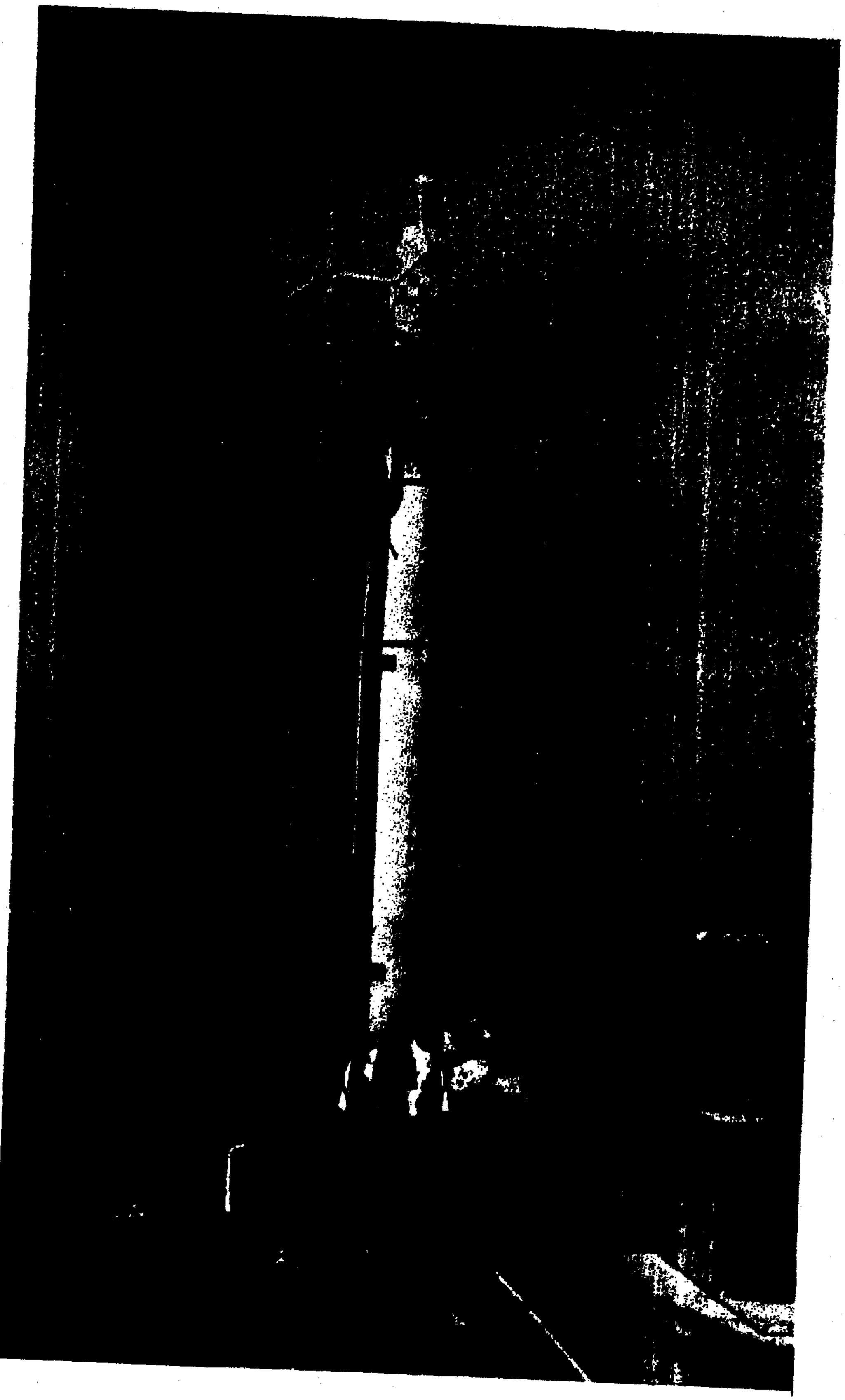
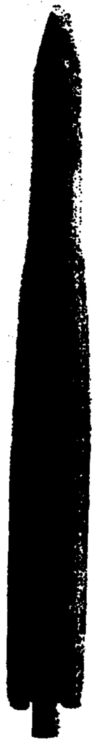


systems



Discoverer



SECOND STAGE	AGENA "A"	AGENA "B"
Weight—Inert	1,370	1,600
Impulse Propellants Fuel (UDMH) Oxidizer (IRFNA)	6,550	13,100
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

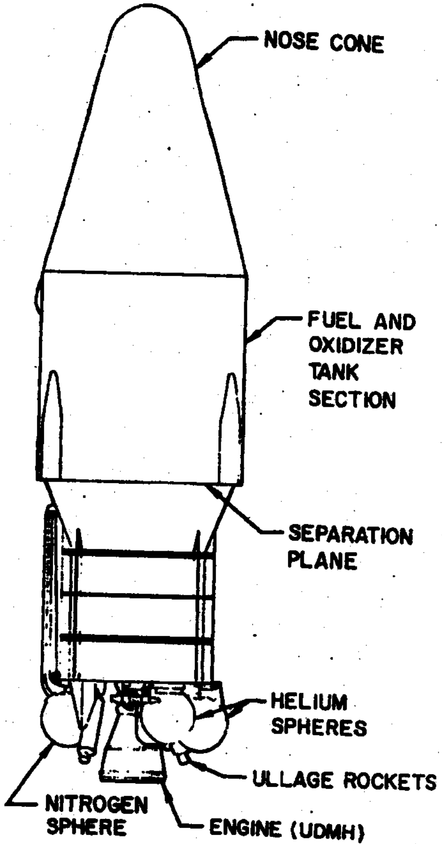


Figure 1. Photograph of two-stage DISCOVERER vehicle (left) and detailed drawing of AGENA, second stage (right).

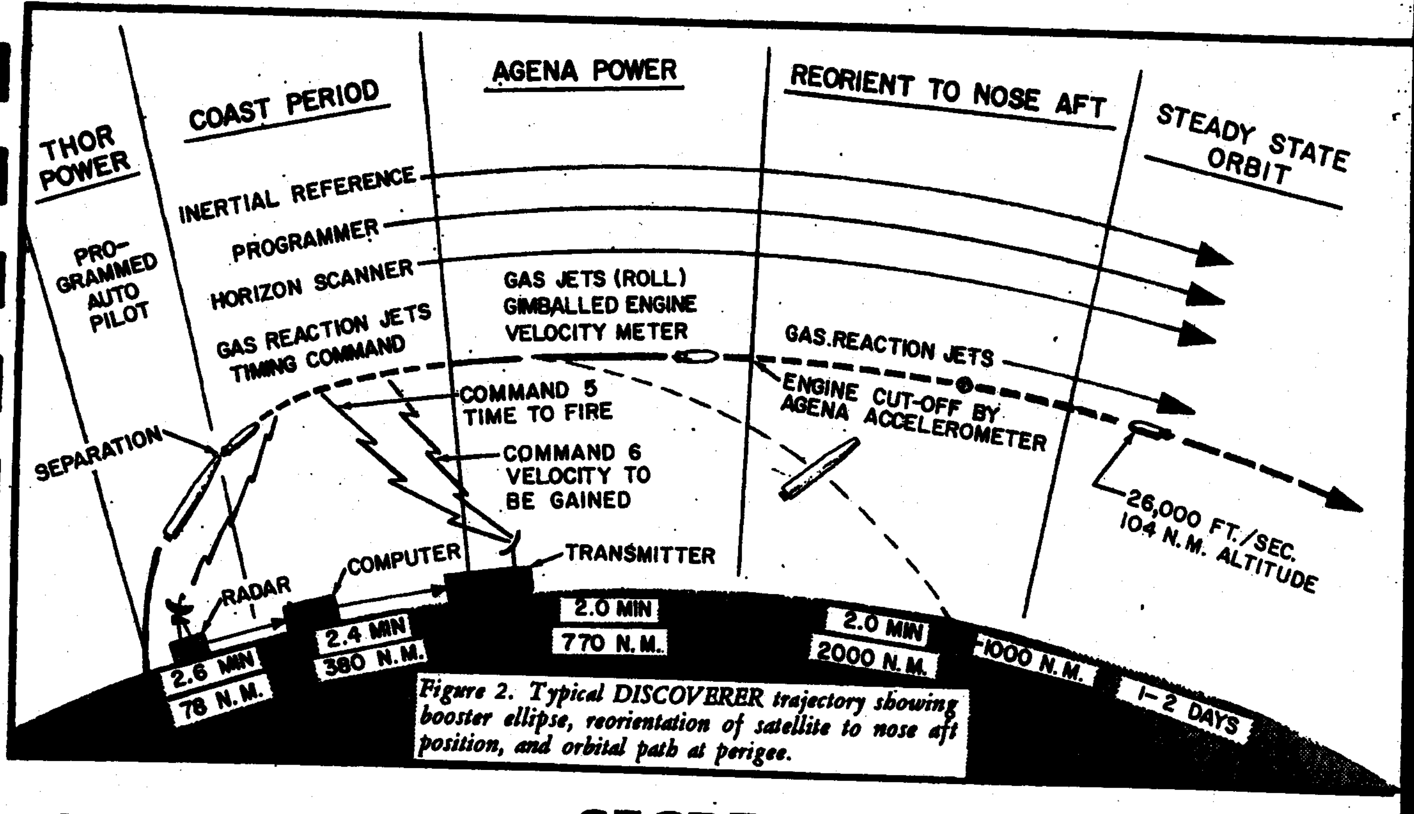


Figure 2. Typical DISCOVERER trajectory showing booster ellipse, reorientation of satellite to nose aft position, and orbital path at perigee.

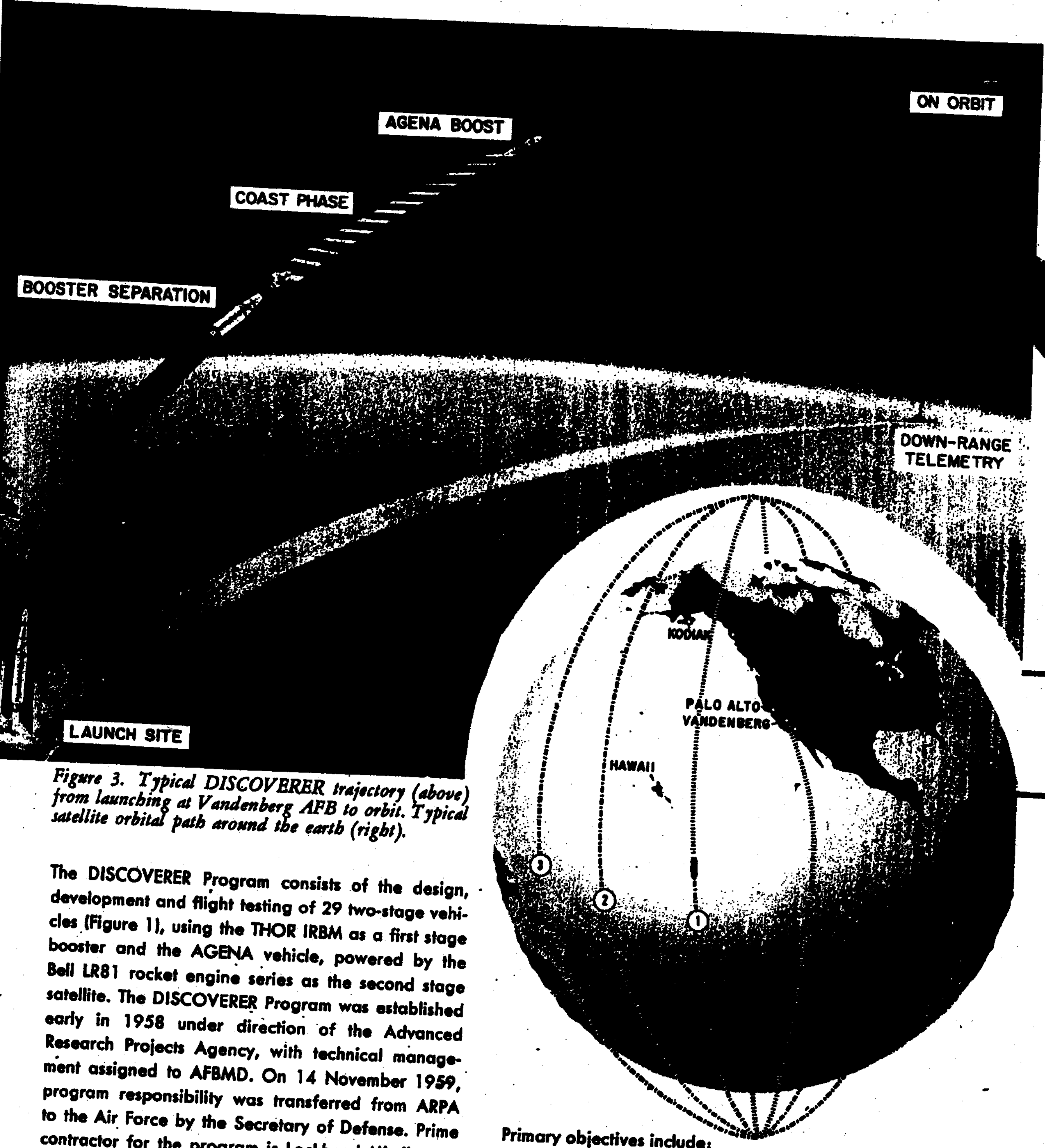


Figure 3. Typical DISCOVERER trajectory (above) from launching at Vandenberg AFB to orbit. Typical satellite orbital path around the earth (right).

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 (e) 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.

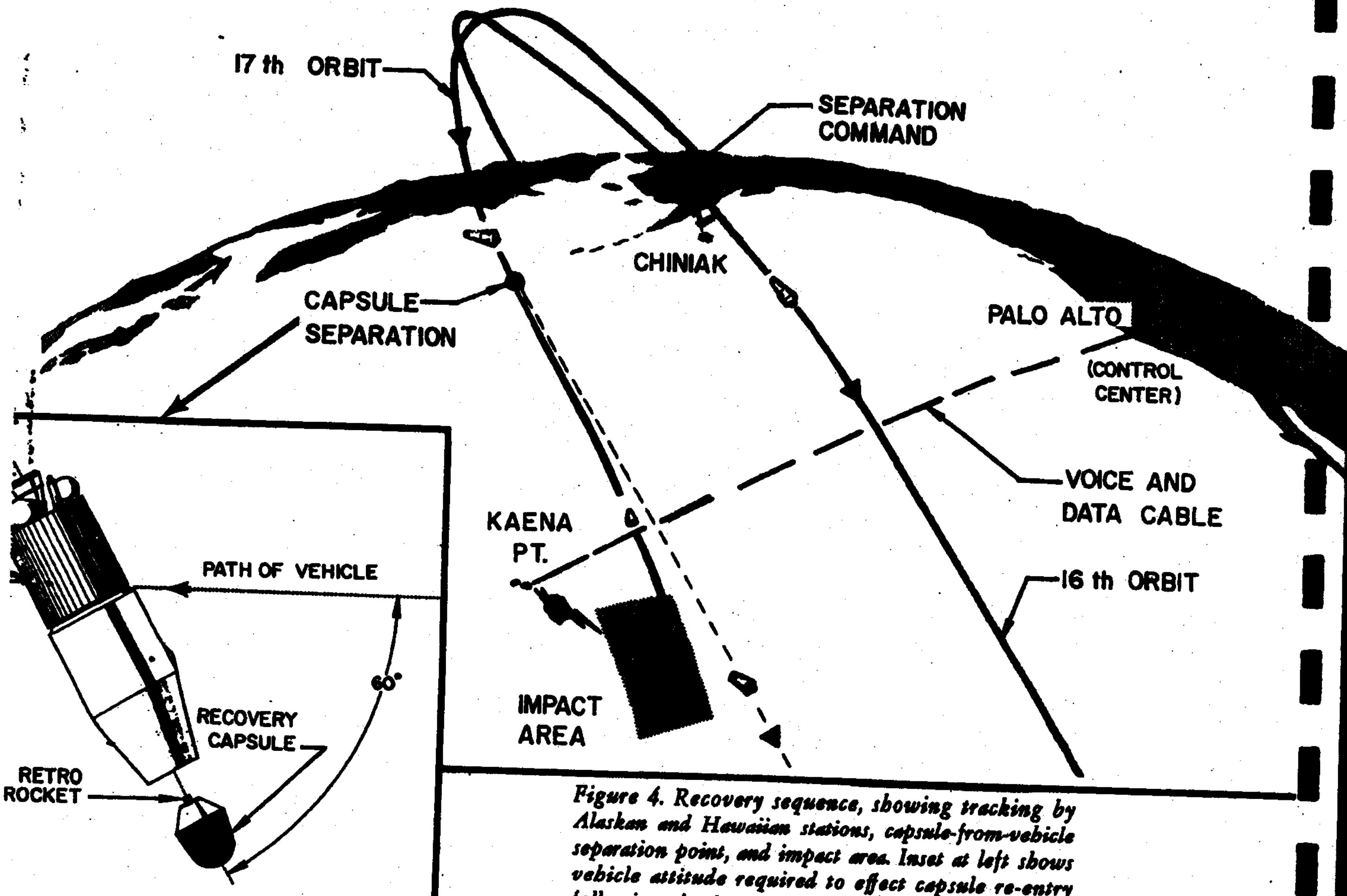


Figure 4. Recovery sequence, showing tracking by Alaskan and Hawaiian stations, capsule-from-vehicle separation point, and impact area. Inset at left shows vehicle attitude required to effect capsule re-entry following ejection.

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

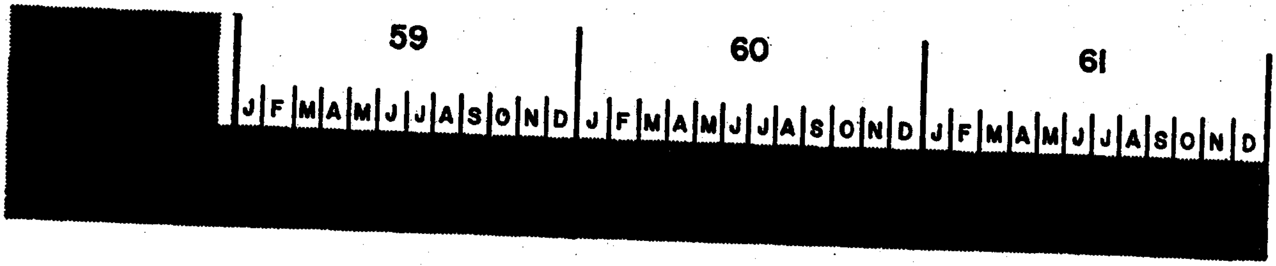
(e) Testing of ground support equipment and development of personnel proficiency.

(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.

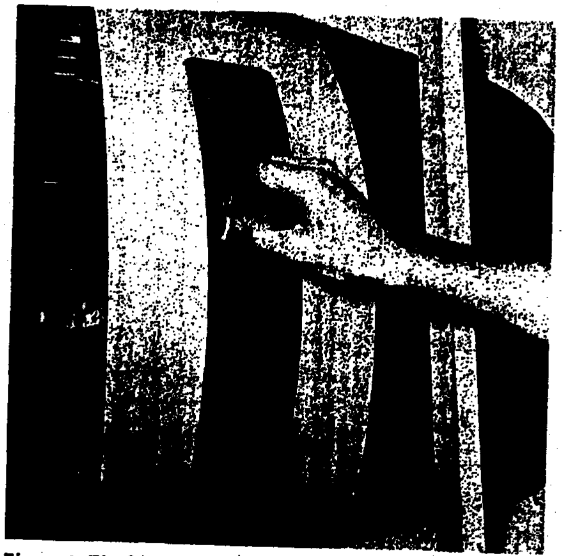


Figure 5. Final installation of duroid window in outer surface of nose cone. Window will permit R-F radiation for improved telemetering during DISCOVERER IX re-entry flight.

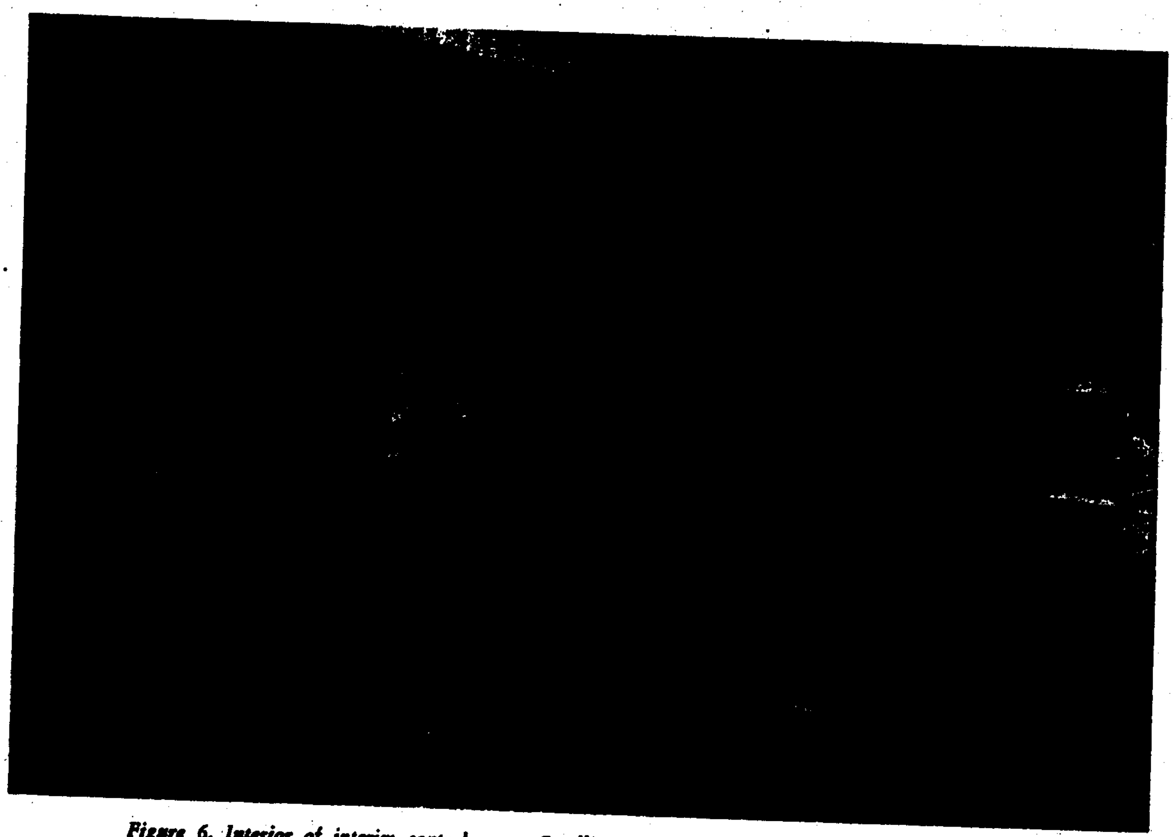


Figure 6. Interior of interim control room, Satellite Test Center (formerly Development Control Center). Installation will be completed for monitoring of the DISCOVERER IX launch.

- 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.

S a m o s

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 Fuel (UDMH) Oxidizer (IRFNA)	6,550	13,100
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

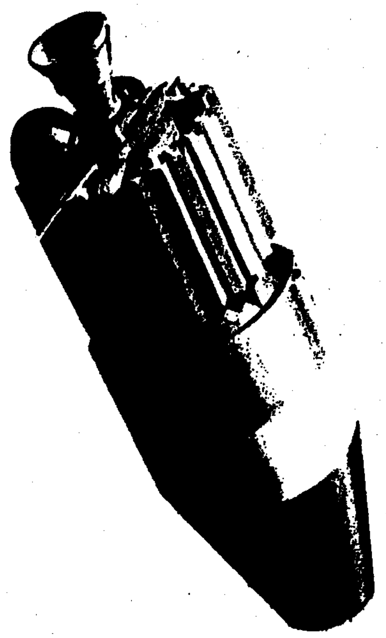
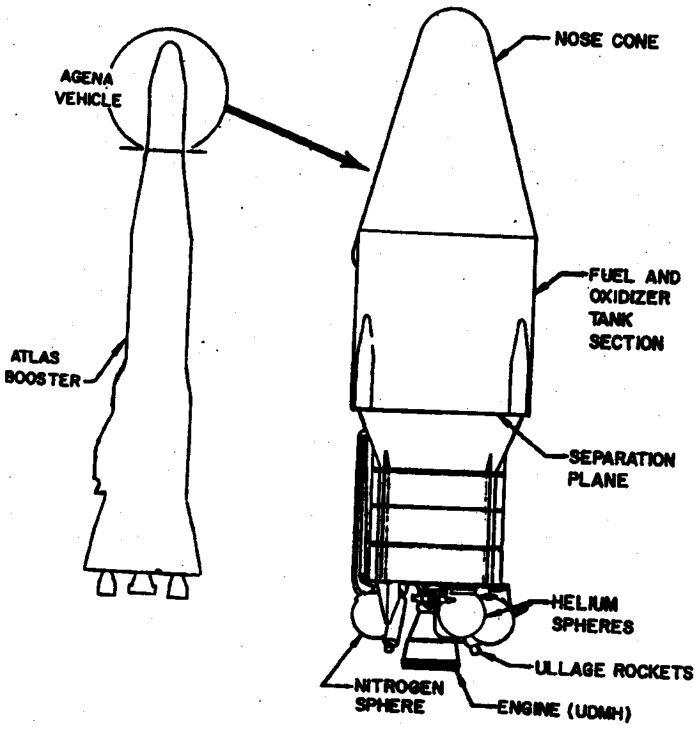


Figure 1.

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.

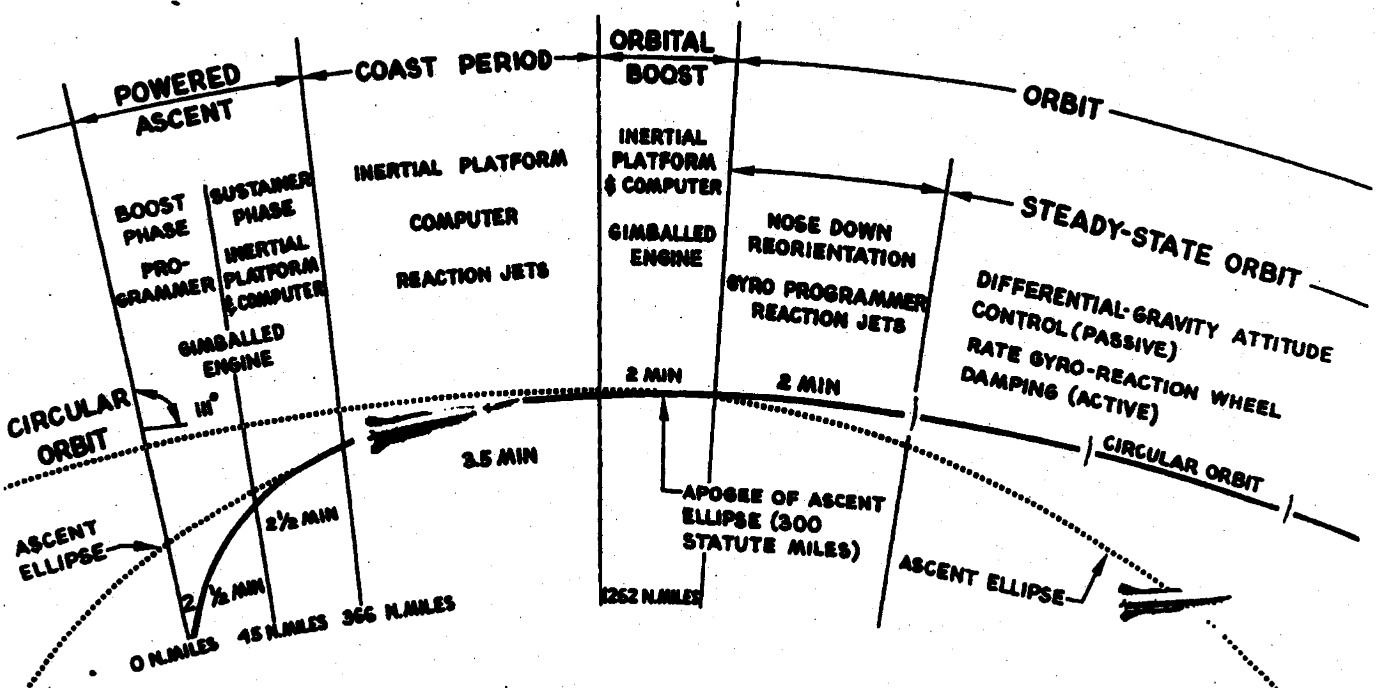


Figure 2. Typical SAMOS trajectory, launch-to-orbit.

Ferret Reconnaissance...

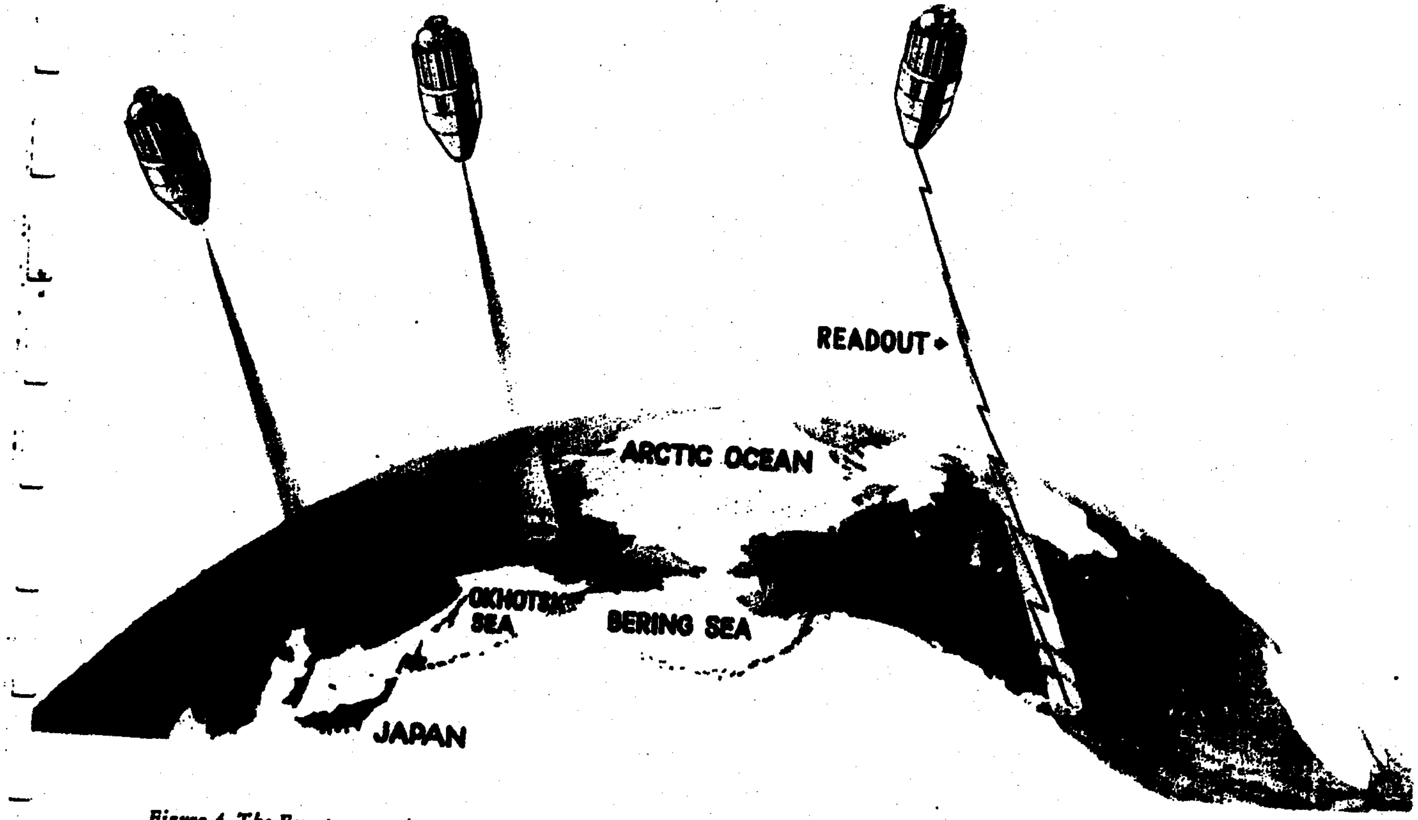


Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over unfriendly territory.

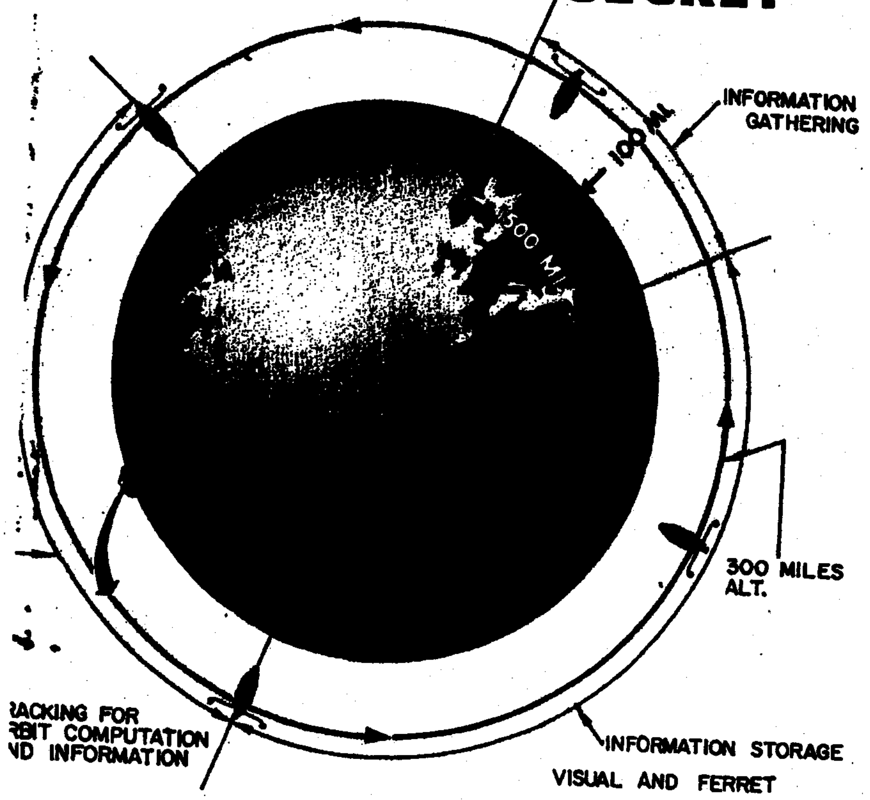


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over unfriendly territory the sensing equipment is turned on (Information gathering). When it leaves unfriendly territory the sensing equipment is turned off and the sensing data is processed (Information storage). When the 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.

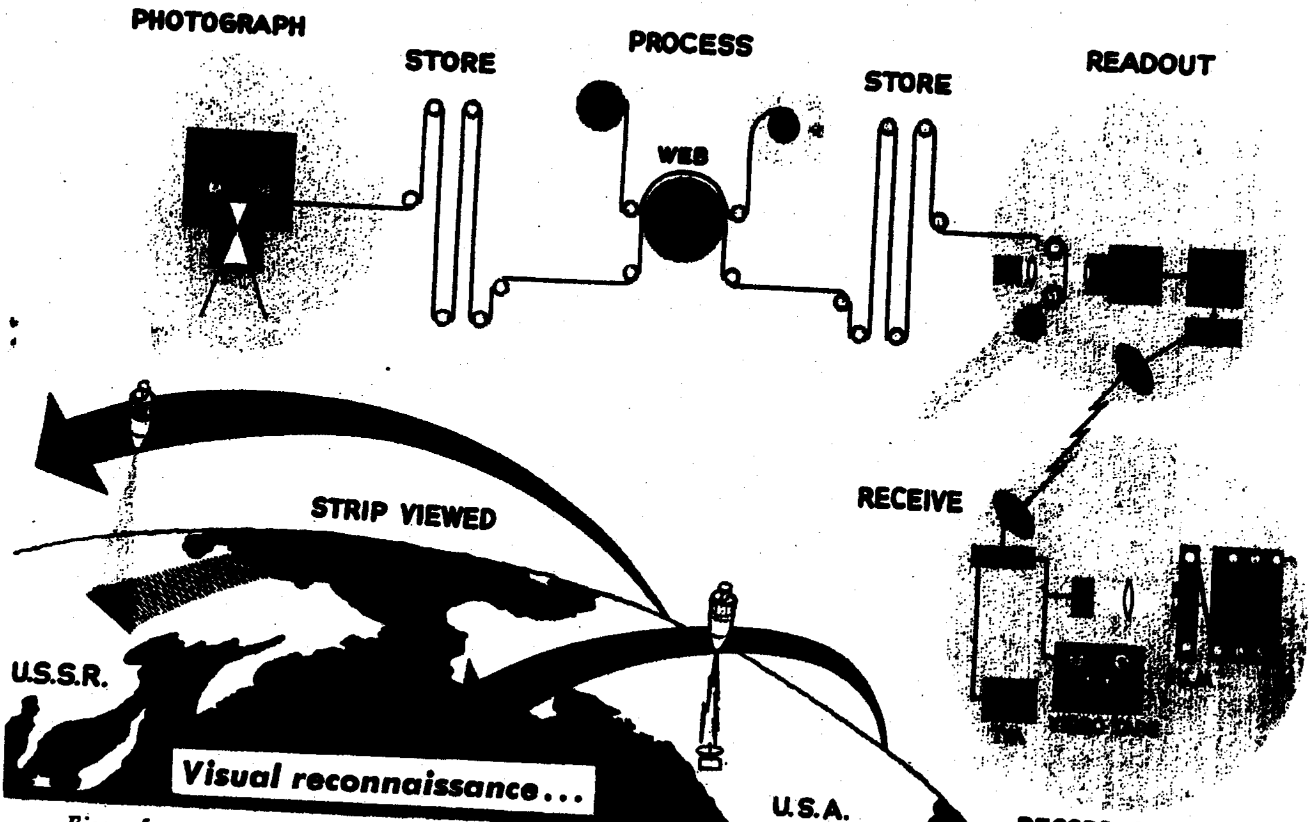


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects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

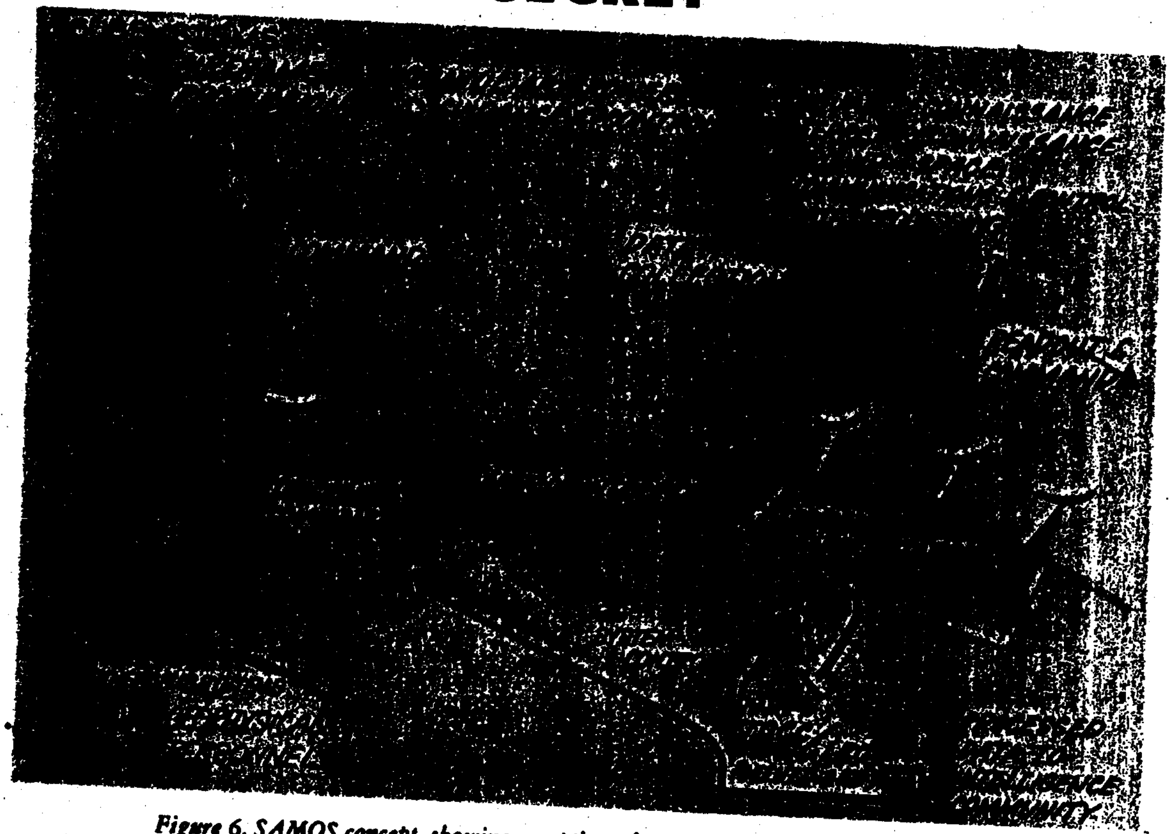


Figure 6. SAMOS concept, showing reception of commands and transmission of data between satellite and ground station; and subsystem functions (schematic).

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.

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36 INCH LENS

SCALE - 1:60,000

1 MILE

LENS - 36" FOCAL LENGTH
ALTITUDE-300 STATUTE MILES
FILM - EASTMAN F5740-6
EXPOSURE- 1/100 SEC. AT F/2.8
CONTRAST RANGE - 4:1

STORED IMAGE

[redacted]

CONTACT PRINT ILLUSTRATING SCALE OF IMAGE
100 MILES

17 MILES

SCALE
1:528,000

[redacted]

9 X ENLARGEMENT

[redacted]

300 X ENLARGEMENT

Figure 7. Simulated photography from satellite vehicle.

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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.

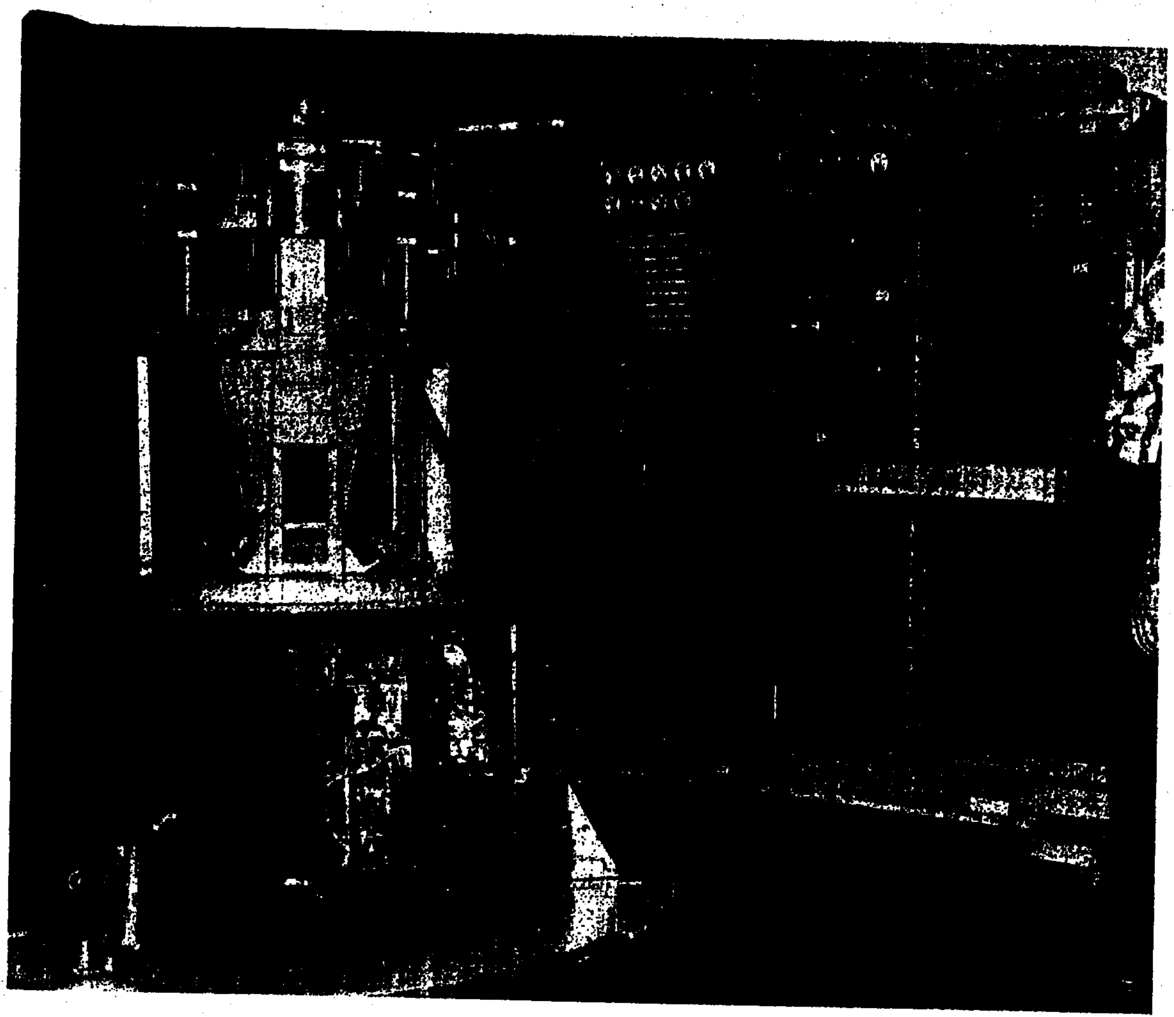


Figure 8. Preliminary functional testing and checkout of the first (F-1) flight payload. This equipment will be flown in combination with an E-1 (photographic) package on the first SAMOS flight.

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.

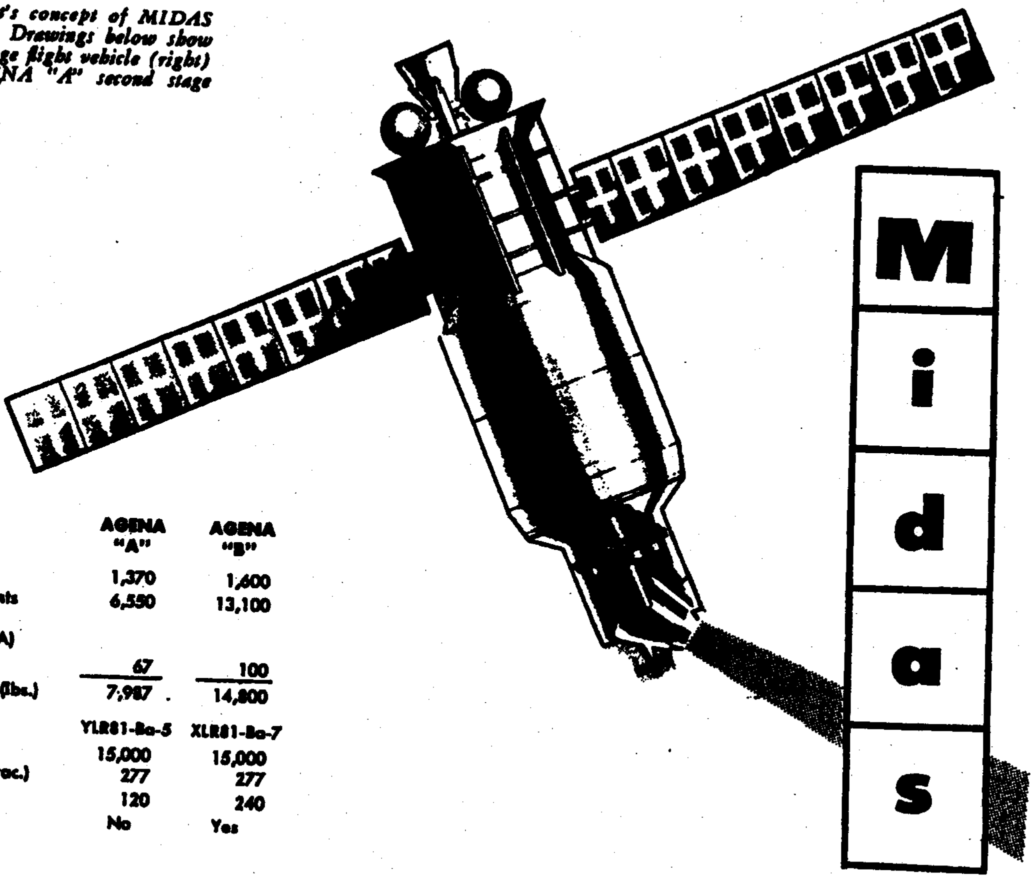
- Satellite Test Center—Increment 1 was completed in December and installation of equipment is in progress. Construction of increment 2 is scheduled for completion on 15 June.

- 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.

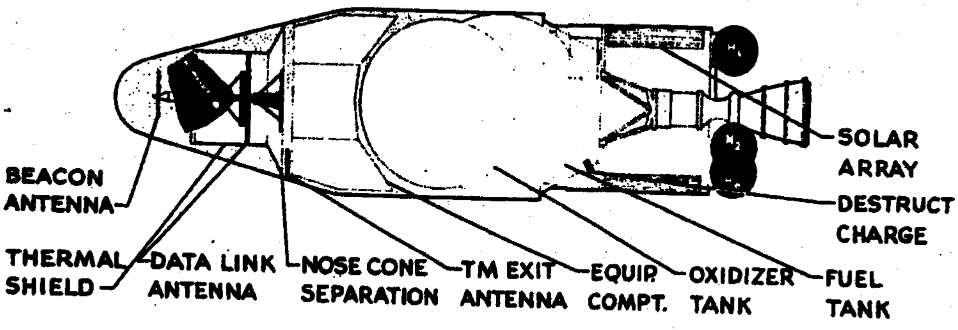
- Design has been completed, but construction of technical support facilities at Vandenberg Air Force Base and Point Arguello is being held up for lack of funding. Work on the following units is also being held in abeyance until firm SAMOS Program decisions have been made:

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 Fuel (UDMH) Oxidizer (IRFNA)	6,550	13,100
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

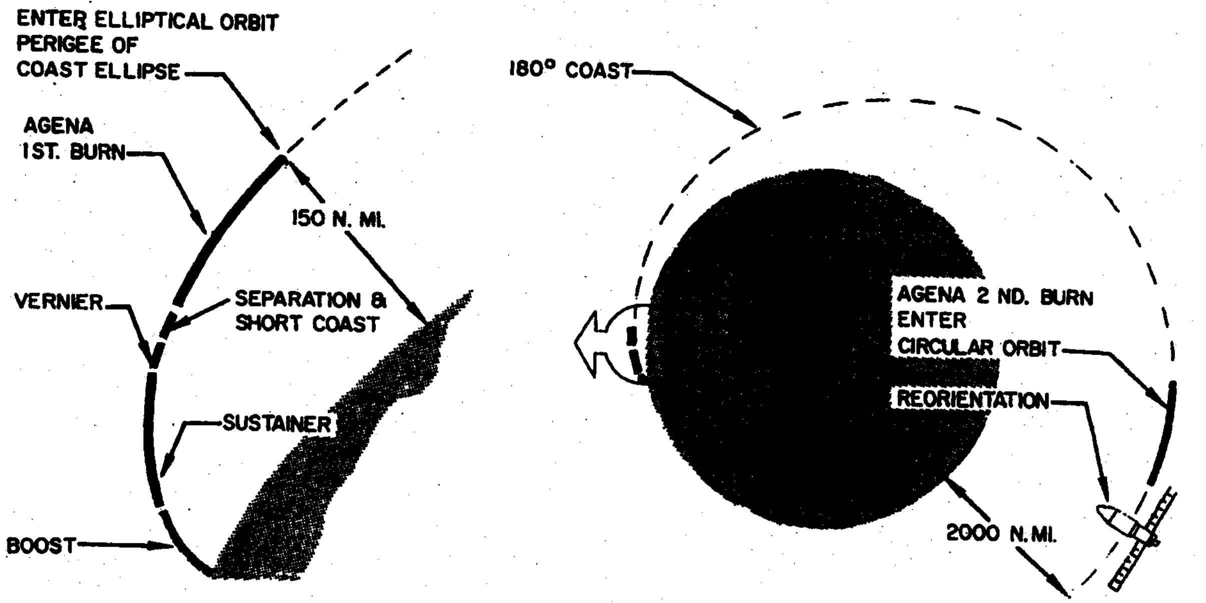


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. Optimum ATLAS boost, guided by radio-inertial system. AGENA ascent (coast, burn, coast, second burn) provides attitude reference. Also governs velocity magnitude and direction by inertial guidance system monitored by horizon scanner. Orbital attitude maintained by reaction wheel and gas jets.

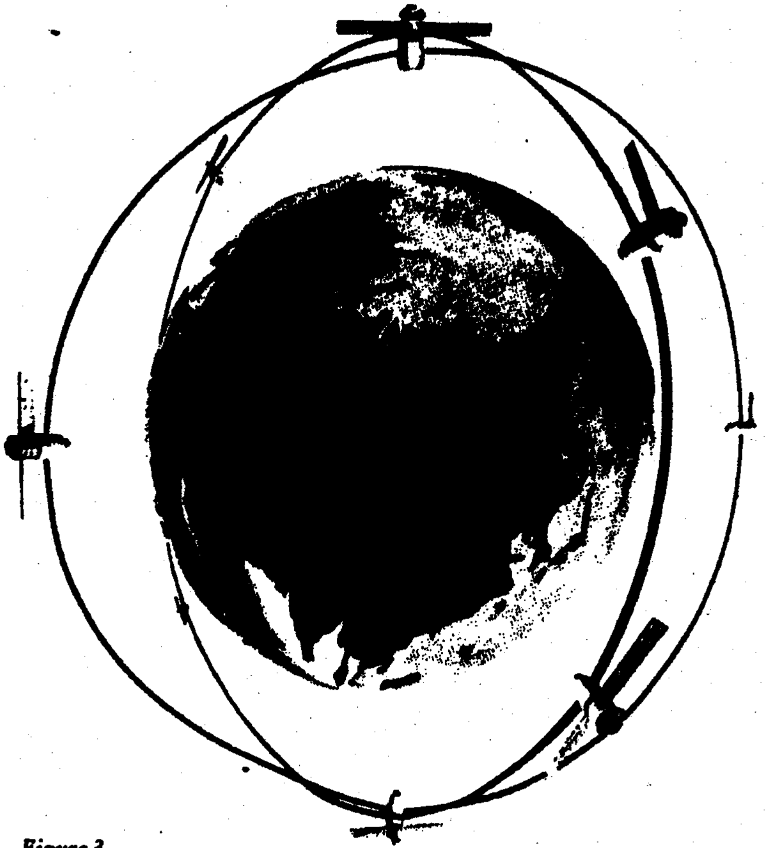


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency early in 1959. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared reconnaissance system. The MIDAS (Missile Defense Alarm System) Program was directed by ARPA Order No. 38, dated 5 November 1958 until transferred to the Air Force on 17 November 1959. Development activities will lead to the first of a ten flight R&D program in February 1960, with a reliable operational system achievable by 1962-1963.

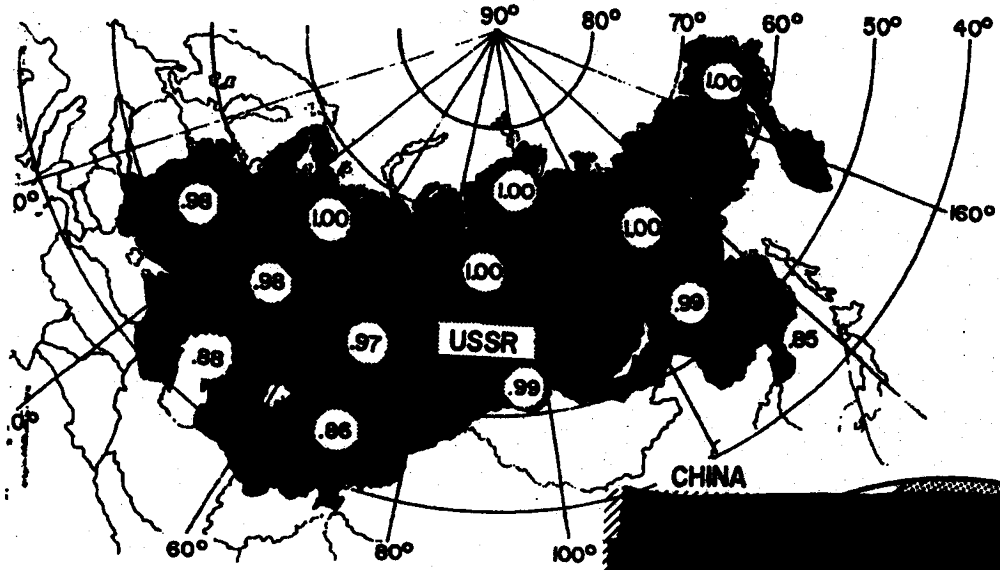


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Figure 4.
Orbiting satellites detect infrared radiations emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveals approximately the number of missiles launched and launch location, direction of travel and burning characteristics. Map above shows percentage of detection probabilities over USSR.

[redacted]

TECHNICAL HISTORY

The MIDAS infrared reconnaissance payload will be engineered to use a standard booster-satellite launch vehicle configuration. This configuration consists of a "D" Series ATLAS missile as the first stage, and the AGENA vehicle, powered by a Bell-Aircraft rocket engine, as the second, orbiting stage (Figure 1). Refinements to the AGENA vehicle will be made as a result of the DISCOVERER flight test program. The first flight article infrared payload has been assembled and installed on an AGENA vehicle, and checkout operations initiated. A solar auxiliary power unit has been developed and fabricated for installation on the third flight. The third major component of the payload, the communications package, also has been designed, fabricated, and tested. The total payload weight is approximately 1,000 pounds. The ATLAS/AGENA configuration with single restart capability and large propellant tanks can place a payload of 1,500 pounds on 2,000 nautical mile altitude polar orbit (see Figure 2). Only the first two R&D flight tests will use the single capacity AGENA vehicle.

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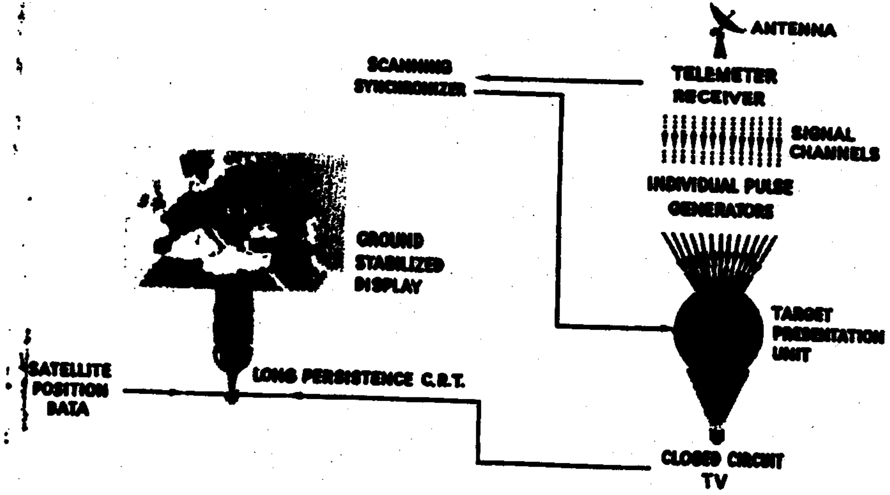
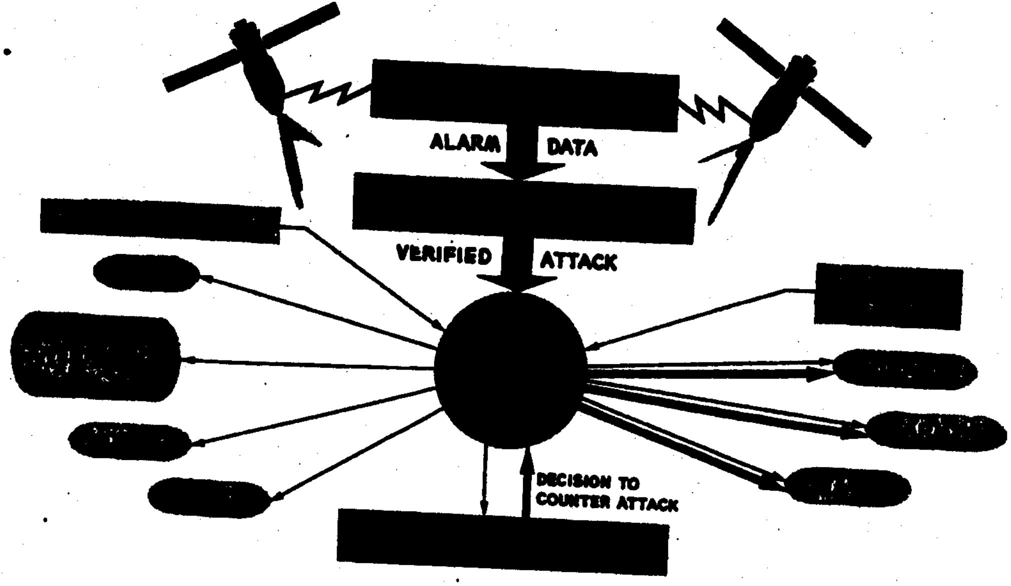


Figure 5. Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having a correlated ground stabilized display, can determine when an actual attack has been launched. The decision to counterattack is made by the President, with all affected agencies reacting as preplanned.

ICBM ATTACK SITUATION



CONCEPT

The MIDAS Program system is designed to provide continuous infrared reconnaissance of the Soviet Union. Surveillance will be conducted by eight satellite vehicles in accurately positioned orbits (Figure 3). The area under surveillance must be in line-of-sight view of the scanning satellite. The satellite operating altitude is determined by system infrared scanning design. Mission capabilities are shown in Figure 4. The system is designed to accomplish instantaneous readout of acquired data by at least one of three strategically located readout stations. The readout stations transmit the data directly to the MIDAS Control Center and other display centers, where it is processed, displayed, and evaluated (Figure 5.) If an attack is determined to be underway, the intelligence is communicated to a central Department of Defense Command Post for relay to the President and all national retaliatory and defense agencies.

[redacted]

MONTHLY PROGRESS—MIDAS PROGRAM

Program Administration

- In accordance with amendment 10 to ARPA Order No. 38, dated 17 November 1959, and Hq USAF AFDAT 91935, dated 20 November 1959, responsibility for the MIDAS Program was transferred from the Advanced Research Projects Agency to the Air Force.

Flight Schedules

- The first MIDAS launch is scheduled for 26 February from the Atlantic Missile Range. An orbit of 261 nautical mile altitude is planned. Final systems checks will be completed in the AMR hangar on 4 February. The readout van installation at AMR is complete and the readout installation at Vandenberg Air Force Base, including the ground presentation equipment, has been installed and checked out. The ground presentation equipment has been installed in the Satellite Test Center.

- The 6594th Test Wing has conducted two flight readiness meetings. The first was held at AFBMD on 22 December and the second at AMR on 26 January.

Technical Progress

- A complete checkout of the MIDAS system, including the infrared scanner payload, the vehicle-borne and ground data links, and the operating personnel, will be conducted in conjunction with the launching of the DISCOVERER IX from Vandenberg AFB. The payload and the vehicle-borne data link will be set up outside the telemetry building, permitting the scanner to track the ascent of the THOR booster. Readout data will be transmitted from the payload to the ground equipment in the blockhouse. Monitoring equipment will provide simultaneous data recordings at the scanner site. The monitor data and data received at the blockhouse will be compared to determine the degree of signal degradation in transmission.

- On 13 January the AGENA vehicle for the second MIDAS flight was hot fired successfully to test stand propellant exhaustion (117 seconds). The test was conducted

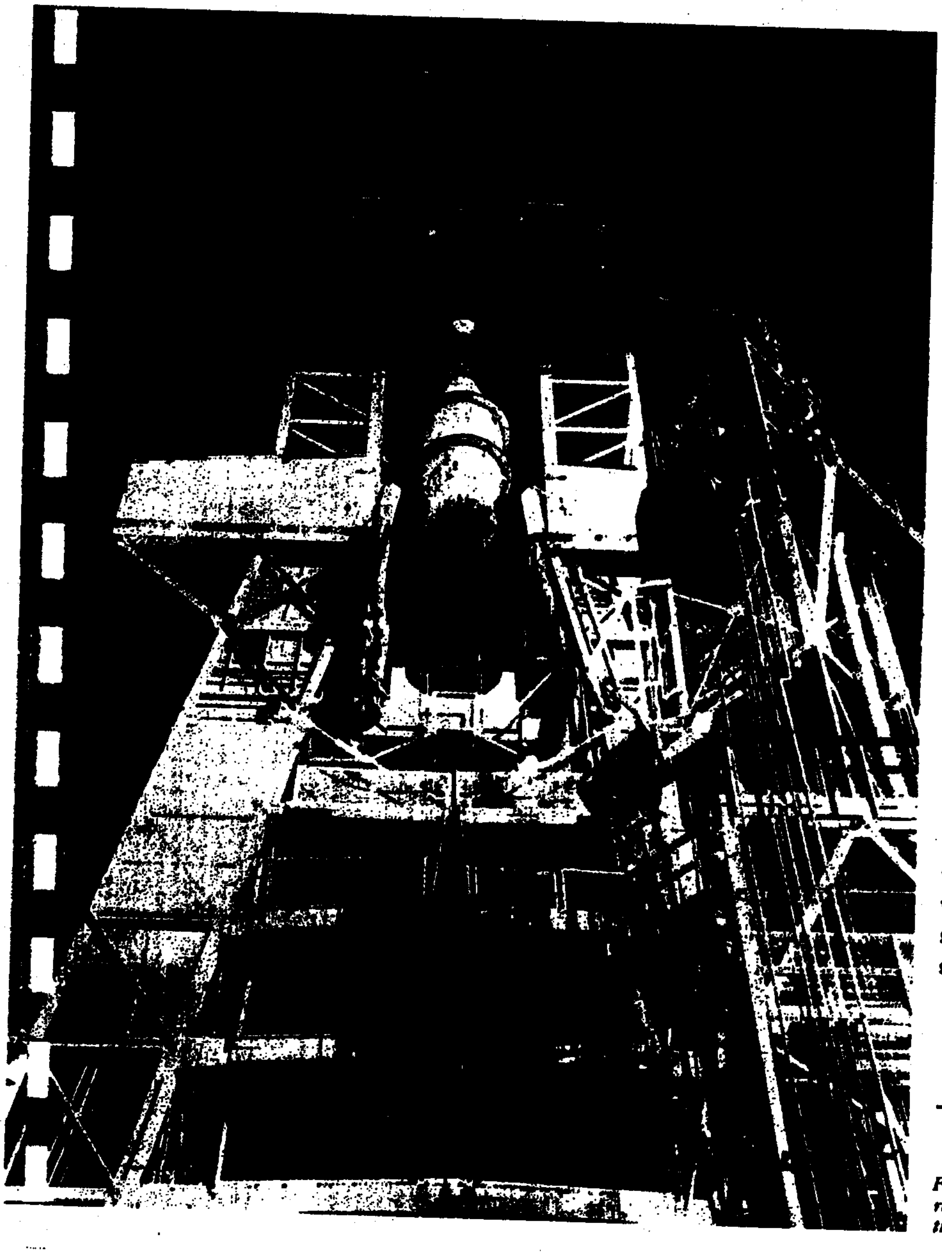


Figure 6. Facilities checkout vehicle being raised on launch pad 14 gantry at Atlantic Missile Range.

at the Santa Cruz Test Base. The vehicle was accepted by the Air Force on 20 January and flown to AMR by C-130 aircraft the following day.

- The fourth infrared scanner unit (flights 1 and 2 configuration) has been rescheduled as the flight article for the second MIDAS flight due to excellent results of a subsystem checkout of this package. The third unit of this configuration was shipped to Vandenberg AFB for use in the DISCOVERER IX tracking experiment. It will be returned to AMR for use as the back-up unit for the second flight.

- High altitude temperature testing of the thermo-mechanical equivalent model of the infrared scanner unit (flights 3-5 configuration) was resumed on 18 January.

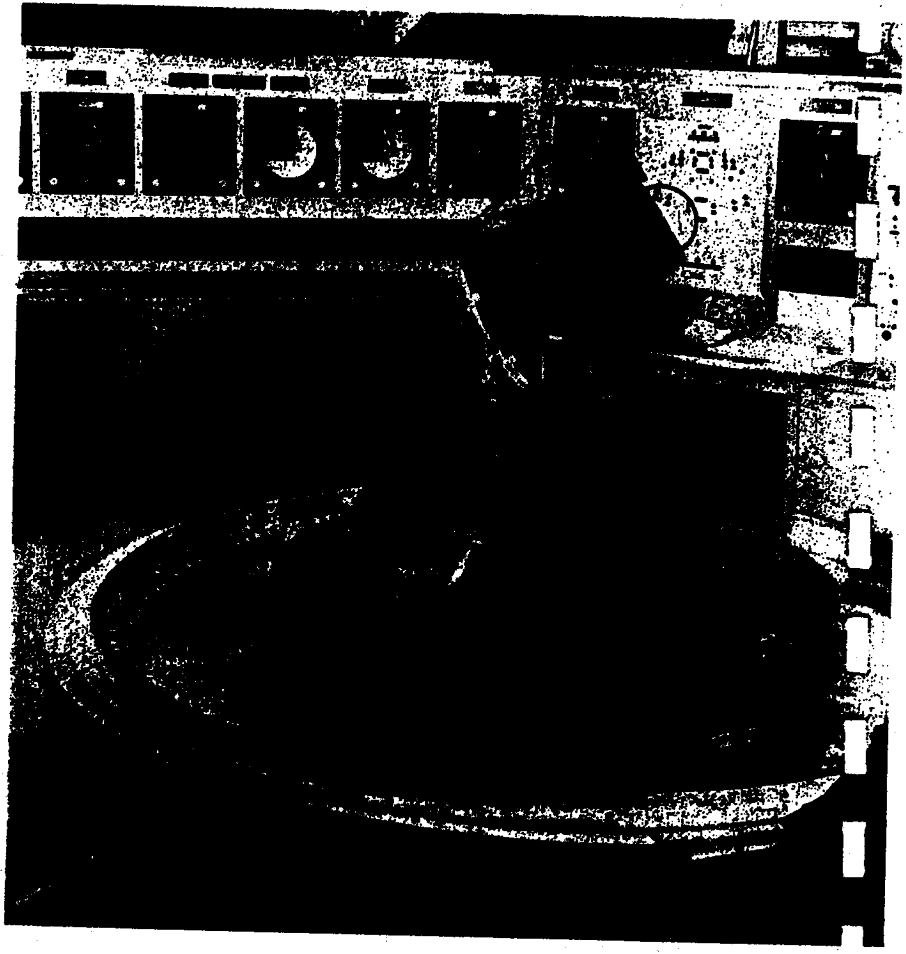


Figure 7. Second infrared scanner unit (Aerojet-General) shown mounted in high altitude temperature simulation chamber prior to testing. This configuration will be used on the first two MIDAS flights.

- A contract with General Electric Company for the development of an advanced presentation unit has been approved by AFBMD and AFBMC. General Electric is proceeding immediately. The contract calls for four units, the first to be delivered in 14 months and the others to follow at one month intervals.

- The plan for using pyrotechnics ignited on the ground as additional readout targets for the first two flights has been developed. A total of ten targets will be ignited during satellite passes. Edwards AFB and Vandenberg AFB will be the target sites.

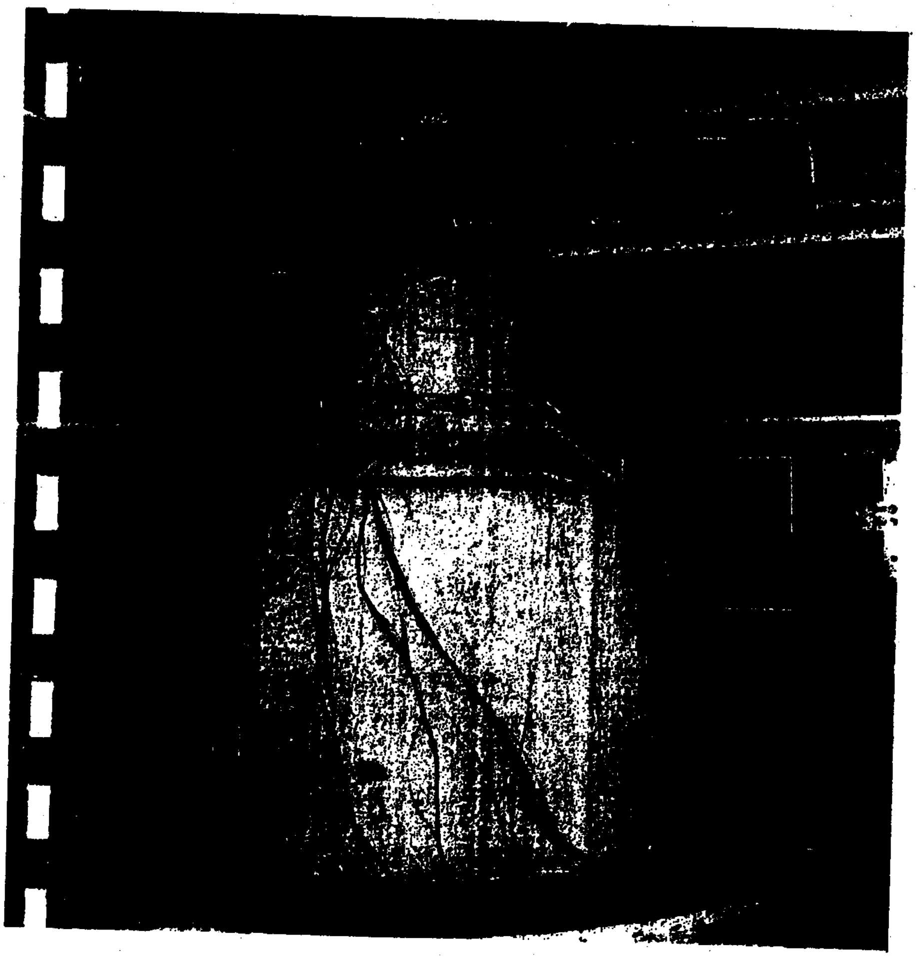
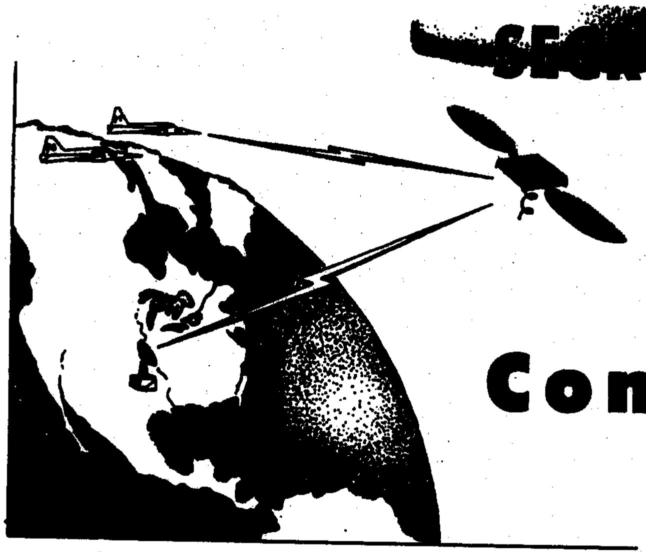


Figure 8. Thermomechanical model of infrared scanner unit (Baird Atomic, Inc.) shown mounted in high altitude temperature simulation chamber prior to initial testing. This configuration will be carried first on MIDAS flight 3.



Communications Satellite

The Communications Satellite Program will investigate, in two phases of increasing complexity, the feasibility of using synchronously spaced satellites as instantaneous repeaters for radio communications. Under ARPA Order No. 54 as amended, AFBMD is responsible for design, development and test of the complete system, including launch, satellite tracking and control, and necessary support facilities and units. Wright Air Development Division is responsible for the development of aircraft communications equipment for both phases. Responsibility for satellite and ground station communications equipment is assigned to WADD (first phase) and to the Army Signal Research and Development Laboratory (second phase). The two phases of the program have been designated STEER and DECREE. The description and objectives of each phase are as follows:

STEER (Figure 1)

This four-flight test phase will use ATLAS/AGENA vehicles to inject satellites into polar orbits with six hour orbital periods. This phase stresses earliest possible availability consistent with program objectives.

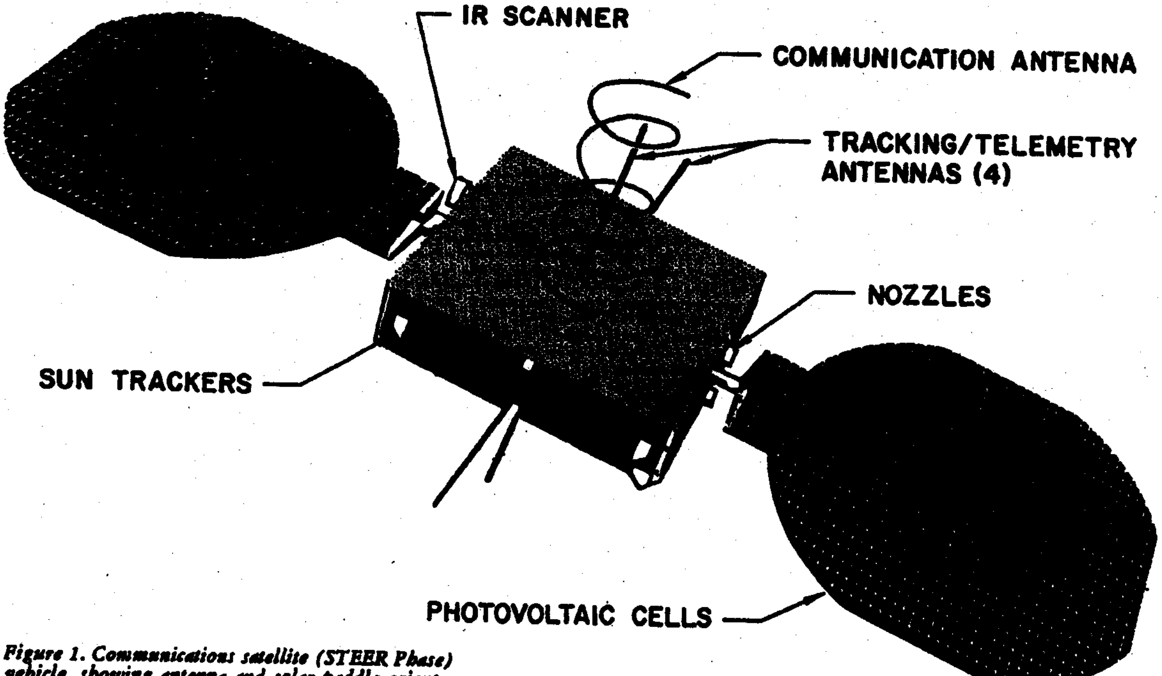
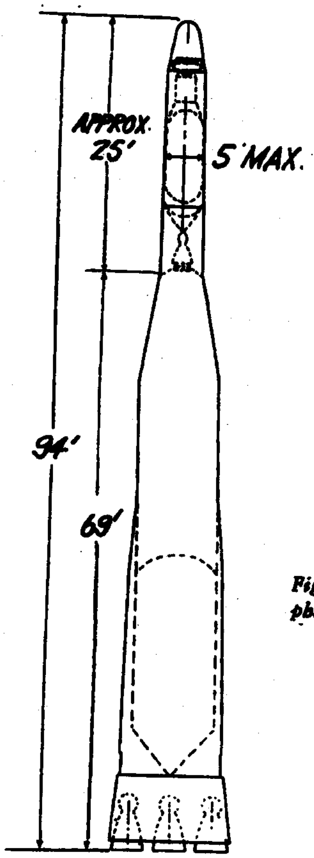


Figure 1. Communications satellite (STEER Phase) vehicle, showing antenna and solar paddle orientation. Small drawing shows operational concept of STEER phase.



AGENA SECOND STAGE

XLR-Ba81-7 engine

ATLAS-D BOOSTER

Thrust (lbs at sea level)	
Main Engines (2)	309,000
Sustainer Engine (1)	57,000
Vernier Engines (2)	2,000
Total at lift-off	368,000

Figure 2. Flight vehicle for STEER and TACKLE phases.

STEER objectives include:

a. Provision of a single channel, two-way voice communication repeater between ground stations in the United States and airborne strike-forces of the Strategic Air Command flying alert missions in northern latitudes.

b. Development of engineering concepts and equipment, and furnish test support data for DECREE phase.

c. Investigation of the effects of vacuum and radiation environment on satellite components over an extended time period.

The four vehicles are to be launched from the Pacific Missile Range starting in March 1961. The vehicle (figure 2) consists of an ATLAS booster and a modified AGENA "B" second stage (double capacity propellant tanks and single restart capability). The payload will be placed into a circular orbit (figure 3) with a period of one-fourth of a sidereal day. The 5,600 nautical mile apogee of the transfer ellipse apogee is reached during a coast phase following first shutdown of the AGENA propulsion system. When apogee is reached the AGENA engine will be reignited to attain orbital velocity. After AGENA shutdown the final stage vehicle will be separated from the AGENA. An attitude control system will then orient the payload antennas toward the earth and solar cell paddles toward the sun to permit communications system operation.

COMMUNICATIONS SUBSYSTEM—The three elements of this subsystem are the ground station, the satellite repeater, and the aircraft communications equipment. The 10 KW ground station transmitter, operating in the lower portion of the UHF spectrum, will use an antenna large enough to provide maximum reliability in the possible presence of interfering signals. Initial test antennas will be 40- and 60-foot parabolic types. These will be replaced with hardened or semi-hardened antennas later in the program to provide compatibility with SAC hardened control centers. The receiver will use the same antenna. The ground antennas will have a tracking capability to keep the antenna properly oriented toward the satellite. Both simple frequency modulation (with a deviation ratio of about 4) and pseudo-noise modulation (spread spectrum) will be tested during this phase.

Since the function of the satellite repeater is the real-time relay of messages, separate reception and transmission frequencies (10 to 15 megacycles apart) are to be used. Satellite transmissions will be at a 40-watt r-f level, using FM modulation and a 10-decibel gain antenna.

When properly oriented toward the earth, the satellite antenna coverage is approximately the same as the angle subtended by the earth at a 5,600 nautical-mile altitude. Coded control circuitry in the satellite

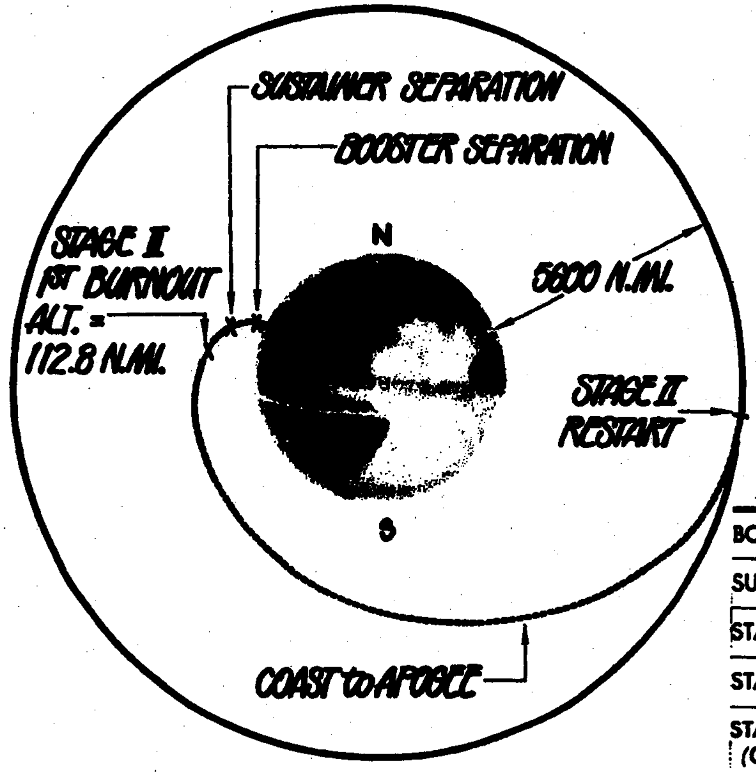


Figure 3. Schematic of STEER phase flight trajectory and orbits showing sequence of operational events.

	TIME (SEC)	ALTITUDE (FEET)	VELOCITY (FEET/SEC)
BOOSTER SEPARATION	139	208,000	9,400
SUSTAINER SEPARATION	295	566,000	21,000
STAGE II IGNITION	297	567,000	21,000
STAGE II 1st CUTOFF	395	570,000	30,800
STAGE II 2ND IGNITION *(ORBIT INJECTION PHASE)*	6694	34×10^6	12,100
STAGE II FINAL CUTOFF	6667	34×10^6	16,000
SATELLITE SEPARATION	6677	34×10^6	16,000

will permit the repeater to be turned on or off to avoid undue power consumption when not in use. Except for the final r-f power stages, the entire repeater will be transistorized. Low noise preamplifiers will be used because of the low-level signal to be expected from the aircraft transmitters.

Aircraft communications equipment will make maximum use of UHF equipment presently installed on SAC aircraft. Minor modifications will provide an adequate signal-to-noise ratio from the satellite transmitter at a maximum range of 8,000 nautical miles. Three different approaches to aircraft-to-satellite transmissions will be tested. The first, a modification of the aircraft ARC-34 equipment to permit FM modulation capability, is expected to be marginal in performance. To provide better performance an FM receiver transmitter is being developed which would replace the ARC-34 unit, providing 150 watts of transmitter power. A 1 KW radio transmitter is also being developed to replace one of the AN/ALT-6 transmitters. This unit will be capable of the secondary function of providing a certain amount of jamming power in the UHF band when not in use as a communications transmitter. Should spread-spectrum modulation be required to overcome interference or jamming on the aircraft-to-satellite link, compatible modifications would be made to aircraft equipment.

GROUND SUPPORT FACILITIES — Ground tracking and data handling capability is required to: (a) Verify that the satellite has been injected into orbit, (b) provide data on performance of the final stage vehicle in orbit, and (c) provide sufficient control to permit synchronization of the satellite position in relation to other satellites in the total system. Investigation is being made of the possibility of using SAMOS and MIDAS Program ground support facilities. Ground stations at Offut Air Force Base and at each of the three numbered SAC Air Force units will provide the capability for two-way communications via the satellite. Each of these stations will be able to compute the precise position of satellites in the operational system.

DECREE

The ten flight tests in this phase will provide the R&D effort for demonstrating the feasibility of a global communications system, using precisely spaced "hovering" satellites which, essentially, have orbital periods of 24 hours.

MONTHLY PROGRESS—

Program Administration

- Fiscal Year 1960 funds for this program have not been released by ARPA. This condition has affected Project STEER as follows:

  1. *Contractors for the final stage vehicle, communications subsystem and systems engineering have reoriented their efforts to maintain existing levels in order to preserve as long as possible the integrity of the present engineering team.*
  2. *Previously programmed schedules, including initial launch date, cannot be met.*
  3. *Contractors have been instructed to plan their schedules tentatively for an initial launch date of 31 October 1961.*
  4. *Firm schedules will be established when funding authorization and further program direction has been received from ARPA.*
  5. *In order to realize maximum value from General Electric and Bendix efforts through February a meeting was held on 6-7 January among AFBMD, WADD, STL, GE and Bendix personnel to establish a coordinated program for the accomplishment of the most essential tasks. Program plans were reviewed in detail and task priorities determined. Available funds for these two contractors will have been exhausted by the end of February.*
  6. *The contract for the second stage booster is being withheld, although a proposal for this unit has been received and evaluated.*

- Preparation of the Project DECREE System Specification and Development Plan is proceeding on schedule. It is anticipated that these documents can be presented to ARPA early in March.

Technical Progress

Project STEER

- Frequency allocation for the communications subsystem has been received. The transmitter center frequency for ground station and aircraft is 295.8 megacycles, which provides for spread-spectrum operation. The frequency for the satellite transmitter is 272.0 megacycles.

- Bendix has experienced difficulty in obtaining the required low angle coverage in aircraft antenna development. The current Bendix recommendation is to use crossed dipoles covered by a radome. Additional experiments will be made.

- A method has been developed for controlling temperature in the final stage vehicle by dissipating electrical power internally in the form of heat to maintain the temperature required for critical components. This concept permits vehicle temperature to be maintained essentially independent of solar radiation and unaffected, therefore, by solar eclipses. The method is totally dependent on the internal electrical power supply. Preliminary calculations show that a continuous dissipation of 70 watts would be required.

Ground Support Progress

Results of a feasibility investigation for a ground communication station at Meade, Nebraska were negative due to (a) excessive interference between the ground station and the ATLAS guidance installation located at Meade, and (b) excessive field strength of the communications equipment would present a potential safety hazard to the explosive equipment located at Meade. Siting criteria for the station have been prepared and a new siting survey in the vicinity of Omaha will be initiated. WADD is investigating the availability of GFE trailers for use at the station.

Studies

Extensive study efforts have been conducted by several contractors to determine parameters on which continued development will be based. The following results have been obtained from some of the study projects:

1. Space Technology Laboratories and Rocketdyne have both investigated the possibility of staging the ATLAS at less than 138 seconds to permit either a gain in terminal velocity or an increase in payload weight capability. Results indicate that staging at 134 seconds would permit a 600-pound payload to be placed into a 6-hour circular polar orbit.

2. Space Technology Laboratories has studied the guidance and staging sequence of the ATLAS/AGENA "B" vehicle combination. The preliminary decision calls for the ATLAS General Electric guidance system to steer the vehicle to the required velocity vector direction. At a velocity of 17,000 feet per second, the GE system will send a signal which initiates operation of the second stage guidance accelerometer. The ATLAS will continue burning until propellant depletion. Following staging, the second stage engine will be started by a timer and shut down by the accelerometer after a velocity increase of 13,700 feet per second. After completion of a coast period, the second stage engine is re-ignited by the timer and shut down by the accelerometer after a velocity increase of 4,000 feet per second.

3. In MLR Report No. R-296, "Project STEER Spread-Spectrum Satellite Receiver Reliability Analysis," Magnavox has detailed the results of the extensive redesign of the spread-spectrum receiver. By using techniques of designing for reliability (including component derating and redundance) the calculated probability of attaining a useful operating life of one year is increased from 0.15 to 0.945. However, the redundancy factor increases the number of

separate components from approximately 2,000 to 8,000. This in turn increases the heat dissipation problem because of the high density packaging made necessary by the increased number of components. High density "welded joint" packaging techniques are being investigated. Bendix has been directed to study this problem and also to investigate the 300 kc hard-limiting linear repeater recommended by Space Technology Laboratories.

4. Studies show that radiation damage to the solar cells can be controlled by covering the cells with a layer of quartz.

5. Studies are being made of the effect of small disturbing torques (such as solar radiation pressure and gravity gradients) on the final stage attitude control and station keeping requirements. Results indicate that the satellite can be located accurately enough in the first two months after injection into orbit that no further orbital corrections would be required for at least one year.

Project DECREE

● A launch trajectory has been selected for the ATLAS/CENTAUR vehicle, using an azimuth of approximately 10 degrees south of due east. Based on this trajectory, the maximum allowable weight of the final stage vehicle, including communications equipment, is approximately 990 pounds. STL report GM 59-0000-18807, "Equatorial Communications Satellite Systems Trajectory and Velocity Study" has been published.

● A study is being made of the adequacy of the Minneapolis-Honeywell all-inertial guidance system in placing the CENTAUR and final stage vehicle into the required equatorial orbit. Indications are that the system is capable of performing the guidance task; however, the computer must be investigated further before a decision can be made. The primary advantage of an all-inertial system is that no ground command stations are required.

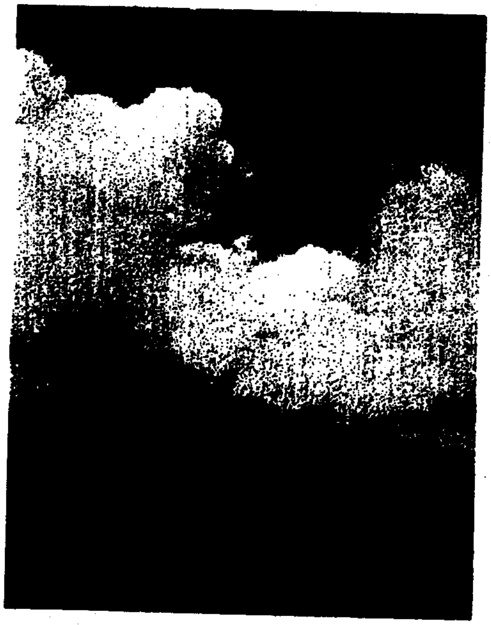
● Final stage vehicle studies currently in progress include:

1. *An impulse program for station keeping corrections.*
2. *Station keeping system accuracy requirements.*
3. *Propulsion system component development.*
4. *Alternate station keeping concepts.*
5. *Alternate command link concepts.*
6. *Methods for controlling solar paddle temperature during ascent.*
7. *Sequence of events within the vehicle from pre-launch to orbit injection.*
8. *"Look" angle required for the vehicle tracking beacon.*
9. *Optimum configuration for vehicle structure.*

● It has been ascertained that each satellite communication channel will require approximately 90 watts of power (twice the amount previously estimated). As a result, the number of channels per satellite has been reduced from 8 to 4 in order to remain within previously specified power limitations. The bandwidth to be used will permit 12 voice carriers per channel.

● General Electric Company, under USASRDL contract, is continuing a detailed study of possible anti-jam operation, particularly in defining problems of automatic frequency control and pseudo-noise generation.

SPACE



projects

ABLE	E-1 to E-8
TRANSIT	F-1 to F-5
COURIER	H-1 to H-3
TIROS	G-1 to G-3
AGENA	J-1 to J-5
ABLE-STAR	K-1 to K-3
MERCURY	L-1 to L-5
609A	M-1 to M-3

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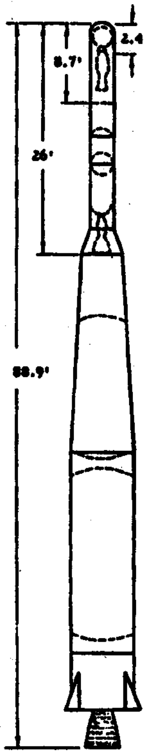

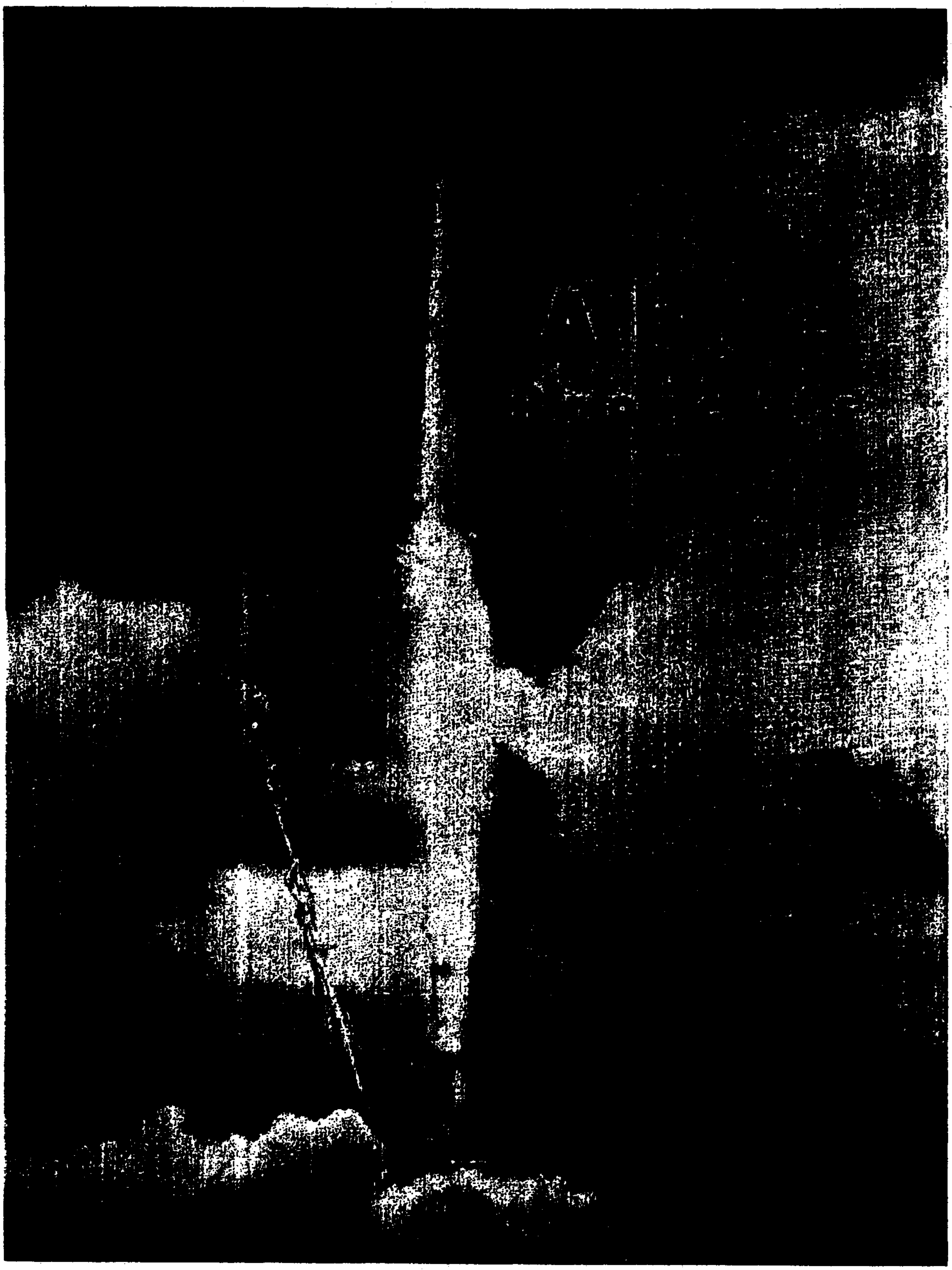

Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.

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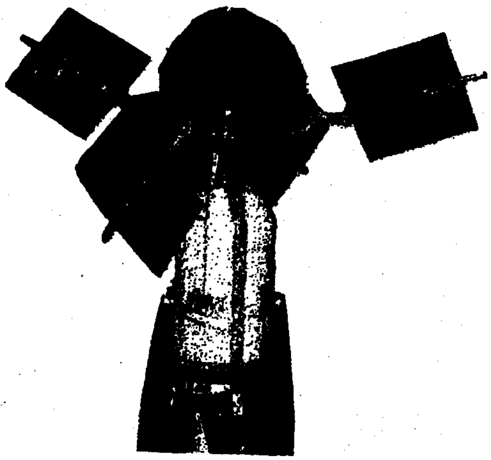

Figure 2. ABLE-3 third stage and payload with solar paddles in fully extended position.

The ABLE Projects Program consists of the development and launching of three vehicles from the Atlantic Missile Range. The program is being conducted by AFBMD under NASA direction. The equipment and objectives of the three flights are as follows:

ABLE-3—This four stage flight vehicle was launched from the Atlantic Missile Range on 7 August 1959. The vehicle consisted of a THOR booster, a second stage using the AJ10-101A rocket engine, a third stage powered by the ABL-248 A3 engine, and a fourth stage consisting of the payload and an injection rocket. In addition to carrying a highly sophisticated payload, the ABLE-3 flight was used to demonstrate the validity of the ABLE-4 vehicle and component configurations. All phases of the launching were successful and the advanced scientific observatory satellite was placed in an extremely elliptical geocentric orbit about the earth. Trajectory

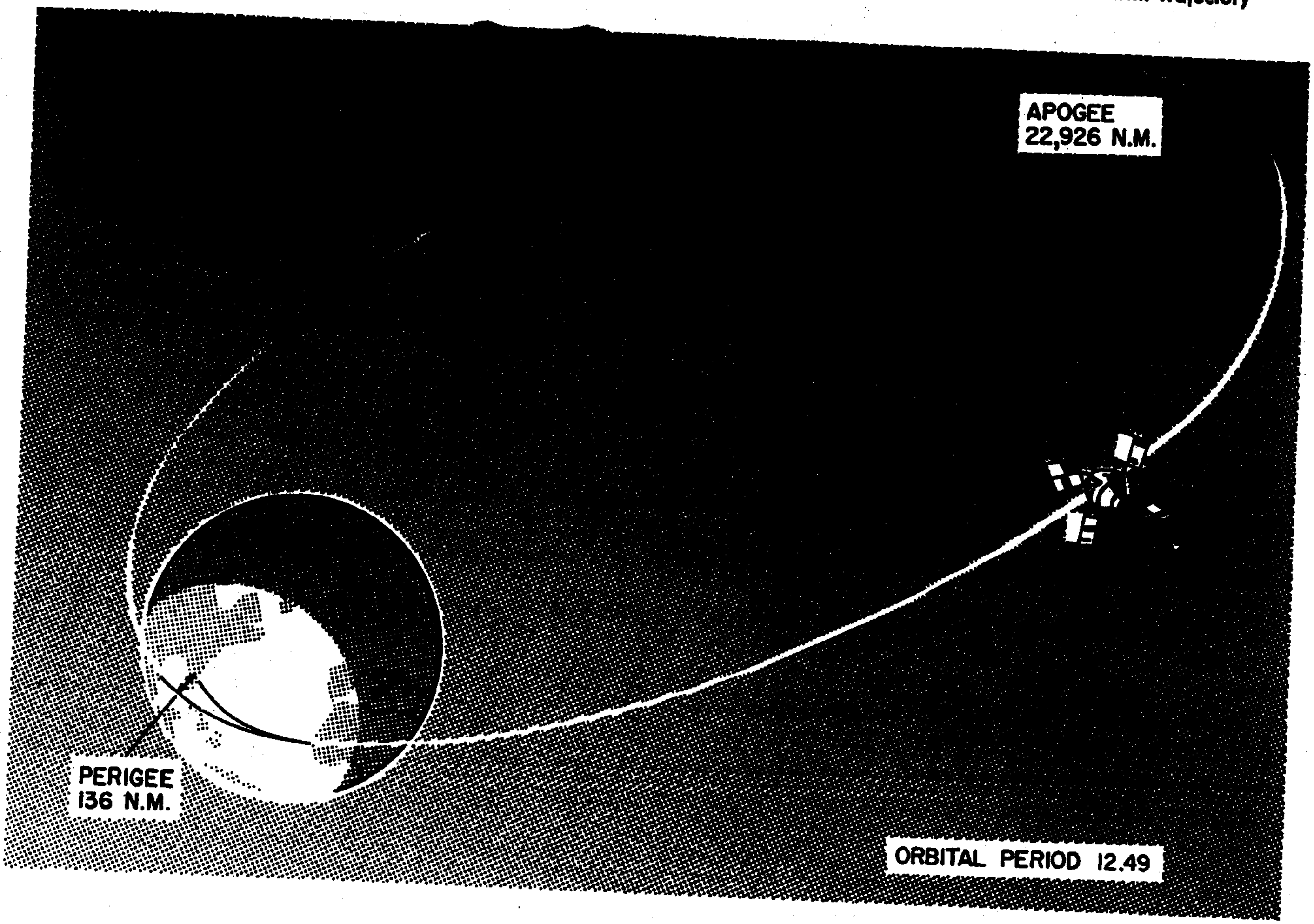

Figure 3. Drawing of extremely elliptical ABLE-3 orbit.

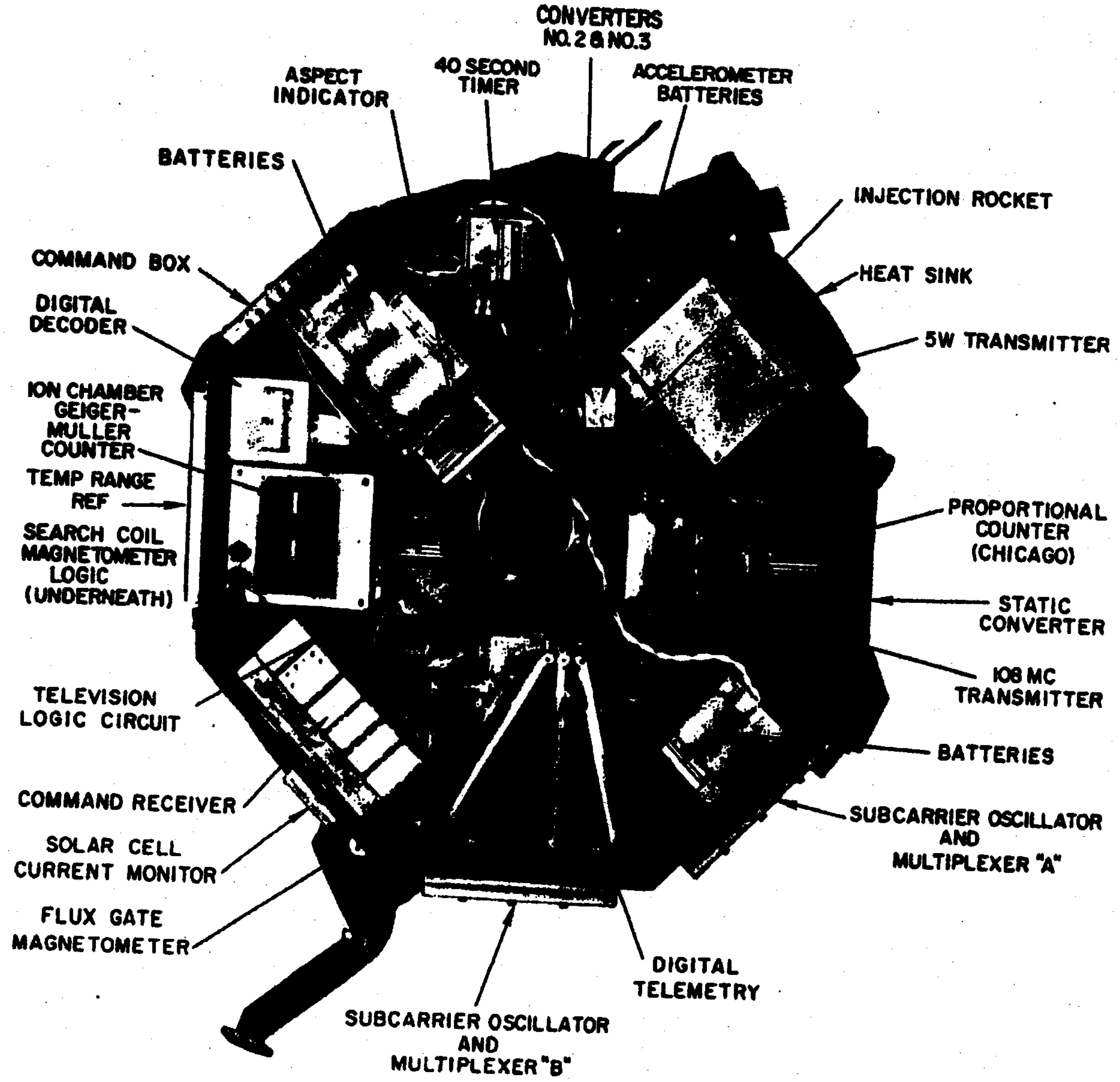

Figure 4. ABLE-3 payload (top view).

and orbit were essentially as predicted with deviations in apogee and perigee occurring on the more than nominal side. The payload was the most sophisticated to have been placed in orbit by this nation at the time and contained provisions for conducting 13 experiments in space environment and propagation. A wealth of valuable data was obtained from satellite telemetry until the last transmission was received on 6 October. It is believed that the satellite, while yet in orbit, is incapable of generating sufficient power for transmitting signals due to solar paddle damage suffered during initial paddle extension and the resultant unfavorable sun "look" angle.

ABLE-4 ATLAS—This vehicle differed from the ABLE-3 only in that an ATLAS ICBM was used as the first stage instead of a THOR IRBM. The unsuccessful launch of the ABLE-4 ATLAS occurred on 26 November 1959. Structural breakup resulted in the third stage and payload parting from the vehicle approximately 48 seconds after launch. The ATLAS performed as planned over its entire powered flight trajectory. The trajectory of this flight, from the Atlantic Missile Range to the vicinity of the moon, was established to achieve the tightest possible circular lunar orbit consistent with the highest probability of success. The final burnout conditions were to have provided an inertial velocity of 34,552 feet per second. The payload was designed to investigate space environment and propagation effects and to transmit crude television images of the far side of the moon. This was the first flight in which an ATLAS ICBM was used as the booster for a multi-stage space flight.

ABLE-4 THOR is a deep space probe which will be launched into a solar orbit intermediate between the orbits of earth and Venus. At its closest approach to the sun, the probe will pass near the orbit of Venus, returning to intersect the orbit of earth at its greatest distance from the sun. The vehicle consists of a THOR first stage, AGC 10-101 liquid fueled, guided second stage, and ABL248A-3 solid-fuel third stage. This vehicle will place a 90 pound payload into space flight. The payload contains no retro-rocket, and no attempt will be made to intercept Venus. The design of the payload components is the same as those which have been proven on the ABLE-3 satellite.

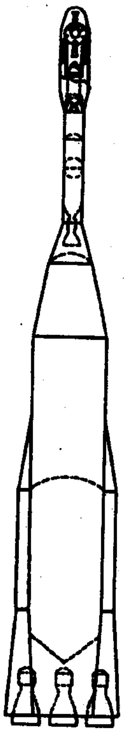

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Figure 5. Line drawing of ABLE-4 ATLAS flight test vehicle. Photos show vehicle on launch pad. Vehicle booster and second-stage were subsequently destroyed during flight firing readiness.

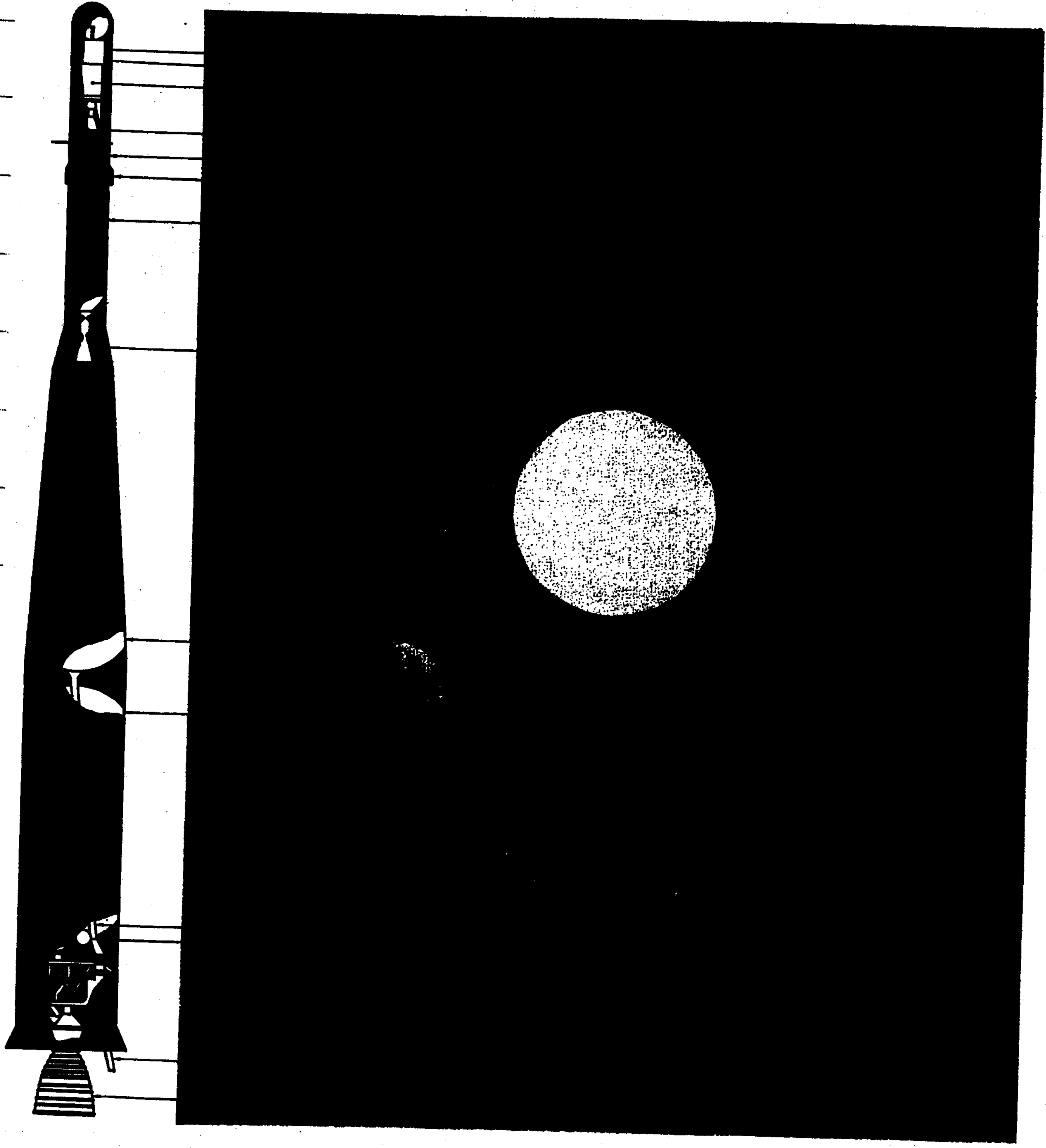


Figure 6. Cutaway view of ABLE-4 THOR flight test vehicle (left). Drawing (right) shows artist's conception of ABLE-4 THOR payload in orbit about the sun.

MONTHLY PROGRESS—ABLE PROJECTS

ABLE-4 THOR

Program Administration

- This vehicle is scheduled for launch on 1 March between 0800 and 0830 hours EST. Launch must take place prior to March 6. Launch azimuth is 88 degrees and burnout azimuth is 94 degrees. Assuming a launch time of 0815, and an unguided flight, 304 days will be required to complete one full orbit around the sun. At the end of the first week the payload will be about 1 million nautical miles from the earth; at the end of 60 days 10 million miles; and at 130 days, 50 million miles. At 104 days the vehicle will reach its closest point to the sun, 62.3 million nautical miles. After leaving the earth's gravitational field the vehicle velocity will be approximately 9,530 feet per second. The velocity will build up to approximately 46,000 feet per second at 140 days.

Technical Progress

- In-flight telemetry from a NASA SHOTPUT vehicle launch on 22 December indicated the presence of high level vibration in the 600 cps region during burning of the ABL-X248 engine (ABLE vehicle third stage). This vibration has been observed in static firing tests, but the data was not considered reliable. An earlier vehicle, instrumented to detect engine vibration, had shown no evidence of a similar vibration. However, observation of this occurrence under flight conditions has necessitated a re-evaluation of the vibration characteristics of the ABLE-4 THOR payload.

Preliminary Vibration Investigation

- Preliminary vibration investigations were completed satisfactorily on a structural dummy payload, prior to imposing severe loads on a type test payload. The altitude testing investigation was completed on a type test payload in a test chamber simulating approximately 400,000 feet.

- An additional investigation will be conducted to determine the mechanical resonance characteristics of the combined X248 rocket motor and the Allegany Ballistics Laboratory test stand system, particularly in the vicinity of 600 cps. In addition, the capability of the test stands to record high frequency thrust fluctuations accurately will be determined.

Major Decisions

- As a result of the preliminary investigations reported above, meetings were held during January among AFBMD, NASA and Space Technology Laboratories personnel to re-evaluate and modify the payload construction and test schedules. The following major decisions were made:

1. **Type Test Payload** This payload will be tested to determine the effect of acceptance test vibration levels on the reliability and mean-useful-lifetime of the Flight Payload. The test will consist of 10 longitudinal acceptance test cycles. The revised vibration acceptance tests are listed under the Flight Payload.

2. **Spare Flight Payload** This payload is to be used as a spare only for component replacement. If the Type Test Payload does not prove acceptable as a vibration test article as described above, the Spare Flight Payload will be used as the Type Test Payload. In any event, vibration and temperature acceptance tests will be performed on the Spare Flight Payload, following evaluation of the Type Test Payload. On this basis Spare Flight Payload components can be considered qualified to replace, on a unit basis, components in the Flight Payload.

3. **Flight Payload** This payload will be assembled and tested as previously specified with the following changes:

   a. *Vibration acceptance test as previously specified, plus addition of a gaussian random noise test requirement. This added test shall be made in three axes—one in the longitudinal direction and two in the transverse directions.*
   b. *Resonance vibration test in three axes.*
   c. *Extended duration thermal vacuum test.*
   d. *Temperature cycling test.*

Payload

- During the first two weeks in January the components of the flight and spare flight payloads were electrically tested and calibrated. During calibration of the University of Chicago experiment (Proportional Counter Telescope) one of the two units was found to be inoperative. This experiment on the ABLE-4 ATLAS spare payload was also found to be inoperative. Both units were returned to the University for repairs and one had been returned to Space Technology Laboratories by the end of the month.

- The following additional work was performed on the ABLE-4 THOR payloads:

1. Continuation of reliability tests on the 5-watt and 150-watt transmitters and investigation of the command circuitry logic for "sneak" circuits or random conditions.

2. Numerous tests for radio-frequency interference within the payloads, especially with the 150-watt transmitter turned on and noting its effect on the receiver. Improved by-pass filtering of power leads resulted in improved receiver sensitivity.

3. Investigation of system noise (relay chatter) which may generate additional counts in the digital telemetry.

● A plastic foam block has been fitted over the stub antenna of the payload, incorporating a small section of unshielded line terminated in an attenuator. This device is used to inject a signal into the receiver to calibrate receiver sensitivity. Test results have been successful.

Ground Station Operations

Manchester, England

● Radiation patterns of the circularly polarized feed have been modified by the addition of a metallic box structure outboard of the feed. New bearing assemblies are being fabricated for the antenna focusing mechanism on the reflector. Modifications to the cone assembly are being completed. The parametric amplifier, Motorola preamplifier, mixer and control box have been completely installed. Tests on the tuning adjustments of the parametric amplifier are being continued, although the amplifier is in operating condition.

Hawaii

● Several modifications and installations are being made to improve the performance of this station. Maintenance difficulties continue to be encountered with the diesel generators. Two of the units developed fuel leakage during one week end and had to be shut down. Later, the third unit also developed a fuel leak which continued intermittently for several days, at which time a voltage regulator became defective. The diesels are under the maintenance supervision of the Pacific Missile Range.

Singapore

● This station is in excellent shape and ready for the ABLE-4 THOR launch.

AMR

● A general overhaul of the station's equipment is now being conducted, with all items in good condition.

ABLE-3

● The ABLE-3 (EXPLORER VI) orbit remains extremely eccentric, with an apogee of 48,800 km and perigee of 6,700 km geocentric. The orbital period is approximately 12¾ hours, and the plane of orbit is inclined 47 degrees with respect to the geocentric equator.

● The scintillation counter aboard ABLE-3 has provided new and significant data relative to the fluctuations and boundaries of the Van Allen Radiation Belt. Two major characteristics which have been revealed by this data are:

1. During periods of increased activity and daily strong magnetic storms, the boundary of the belt moves closer to the earth by some 6,000 to 7,000 kilometers. It is believed that this motion may be the result of removal of particles from the belt.

2. Changes in intensity over a period from a few seconds to a few minutes indicate a rise in intensity up to 5,000 times above the normal base value. This is an uncommon occurrence, observed in 5 passes out of 20 examined. Twenty-five passes remain to be studied, but indications are that fluctuations on these passes are not as strong. These fluctuations suggest a turbulent nature in the magnetic field which may be the factor responsible for removing the particles from the field as described in item 1 above.

● Preliminary data received from the ABLE-3 magnetometer indicate the existence of an extraterrestrial current system, variable in time and space, which strongly disturbs the geomagnetic field at geometric distances of 5-7 times the earth's radius (i.e., the outer zone). The occurrence of both positive and negative deviations are suggested. Variations of several thousand kilometers in the location of the current system, responsible for the deviations, may occur within intervals of 24 hours or less. It might be anticipated that currents exist in the inner zone (distances of less than 5 times the earth's radius) which could also disturb the earth's field.

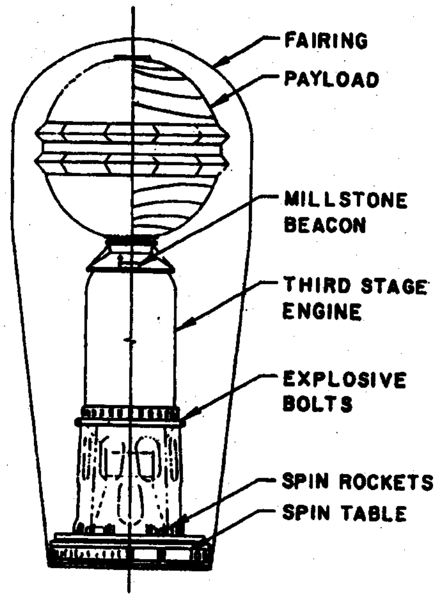
● New data processing equipment has been prepared for the University of Chicago and the University of Minnesota to permit the reduction of tapes not ordinarily processable because of poor signal-to-noise ratio. Representatives from the universities will come to Space Technology Laboratories soon to use this equipment. Considerable additional high-latitude information should be obtained.

● A newly designed auto-correlator is being constructed to be used in processing marginal and heretofore unusable magnetometer data.

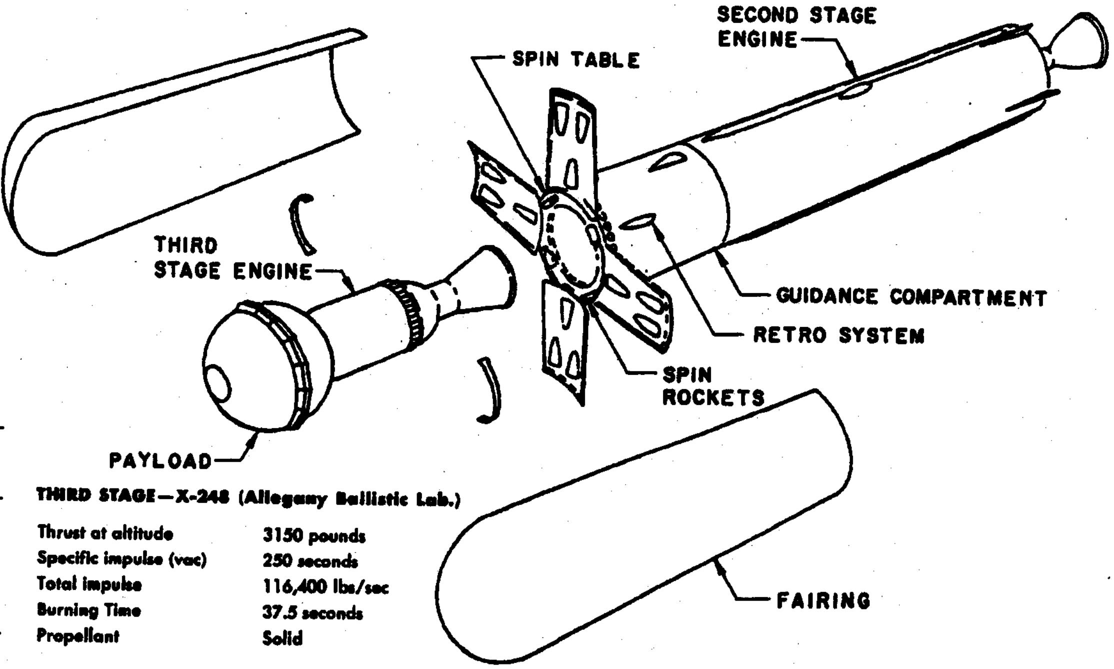
- Computer programming and checkout are nearing completion for the reduction of phase comparator data. Running of tapes has commenced.
- Preliminary discussions with university personnel have indicated the desirability of a joint work session at the University of Chicago in March for comparing data and studying results of experiments.
- Results of ABLE-3 (EXPLORER VI) scintillation counter and magnetometer experiments were reported to the American Physical Society in November, and December, and to the First International Space Science Symposium in January.

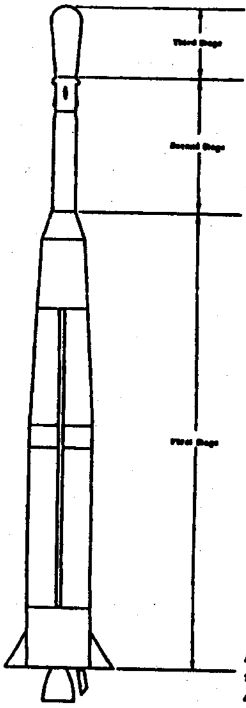
Transit

Figure 1. TRANSIT IA being launched from Atlantic Missile Range



The TRANSIT Program consists of four flights of satellites designed to provide extremely accurate, worldwide, all weather navigational information for use by aircraft, surface, and subsurface vessels. The four vehicles are designated TRANSIT IA, IB, IIA and IIB. TRANSIT IA (Figures 1 and 2) was launched on 17 September 1959 with the remaining flight tests scheduled in numerical order for February, April and September 1960. The primary objectives of the program are: (a) To provide accurate reference information for POLARIS missile navigation accuracy; (b) precise determination of satellite position through use of payload transmitted radio signals (doppler shift measurement); (c) to investigate the refractive effect of the ionosphere on radio transmissions, and (d) acquire additional geodetic and geophysical information by precision tracking of the satellite in orbit. AFBMD responsibilities in this program include: providing the launch vehicle, integration of payload to launch vehicle, communications to the ARPA tracking and data handling agencies during the launch, and flight operations from launch through attainment of orbit. Design, fabrication and testing of the payload will be accomplished by the Applied Physics Laboratory for ARPA. ARPA has retained responsibility for operating, tracking, and recording and processing all satellite data.





THIRD STAGE—X-248 (Allegany Ballistic Lab.)

Thrust at altitude	3150 pounds
Specific impulse (vac)	250 seconds
Total impulse	116,400 lbs/sec
Burning Time	37.5 seconds
Propellant	Solid

SECOND STAGE—AJ10-42 (Aerojet-General)

Thrust at altitude	7700 pounds
Specific impulse (vac)	271 seconds
Total impulse (min)	870,000 lbs/sec
Burning time	115 seconds
Propellant	Liquid

FIRST STAGE—THOR IRBM

Thrust (s.l.)	151,500 pounds
Specific impulse (s.l.)	248 seconds
Specific impulse (vac)	287 seconds
Burning time	158 seconds
Propellant	Liquid

Figure 2. TRANSIT IA, three stage flight vehicle with detail view of payload mated to third stage, and exploded view of second and third stages and payload.

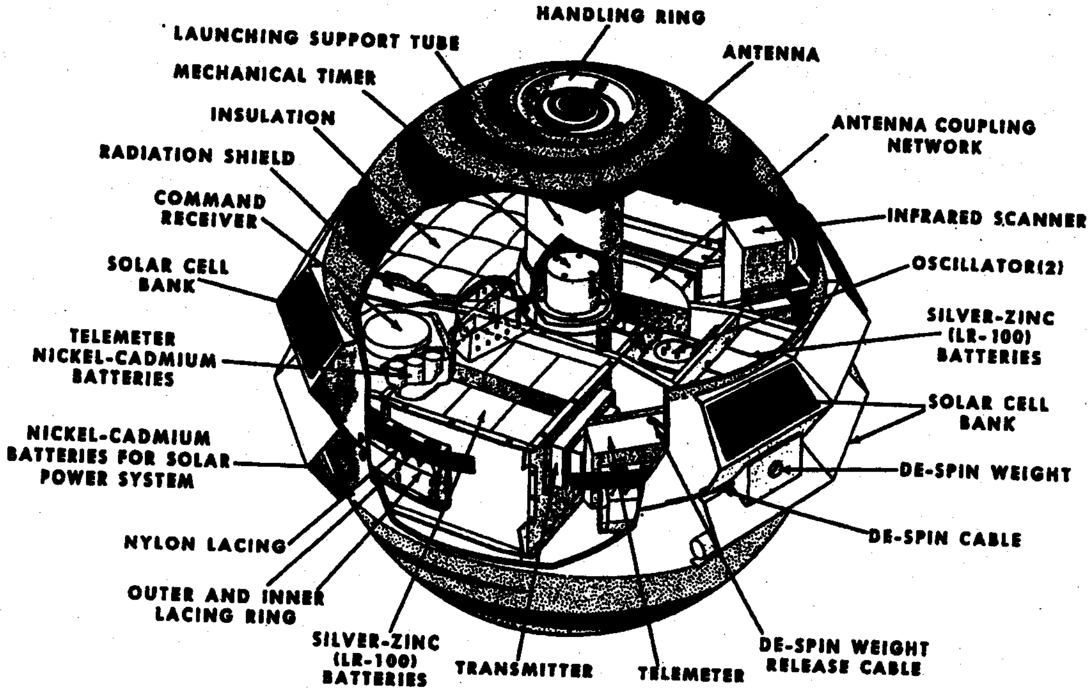


Figure 3. Cut-away drawing of TRANSIT IA payload (NAV 1).

FLIGHT VEHICLE DESCRIPTION

The first flight vehicle (Figures 1 and 2) consisted of three stages, a THOR booster, AJ10-42 (Aerojet-General) liquid propelled second stage with Bell Telephone Laboratories radio-inertial guidance system; and a solid propellant third stage (Allegany Ballistic Laboratory X248). Subsequent flights will use a two-stage vehicle consisting of the THOR booster and the ABLE-STAR (AJ10-104) second stage.

FLIGHT DESCRIPTION

All four vehicles will be launched from the Atlantic Missile Range. The remaining TRANSIT payloads will be injected into a circular orbit with a nominal altitude of 500 nautical miles. The angle between the satellite's orbital plane and the earth's equatorial plane will be approximately 50 degrees on TRANSIT IB and 67.5 degrees for TRANSIT IIA and IIB.

PAYLOAD ORBITAL PERFORMANCE

The spherical TRANSIT payloads are approximately 36 inches in diameter and weigh between 200 and 270 pounds. Payload equipment includes four transmitters (on frequencies of 54, 108, 162 and 216 megacycles), two receivers, and a gate which permits the insertion of data only when the gate has been opened at a previously scheduled time. Power for the first five months will be supplied by batteries, recharged by solar cells located in a 12-inch band around the sphere. Extremely accurate position data can be obtained by measuring the doppler shift of satellite transmissions during a pass over a receiver (aircraft or ship). Since the exact satellite position is known at all times during the orbit, measurement of the doppler shift provides a precise rate of time change between the satellite and the receiver. Studies have shown that the effects of ionosphere refraction on doppler shift measurements can be eliminated by using the transmissions of two satellites. Navigational fixes of 0.1 mile accuracy are expected to be obtained. During the first three months of flight the four transmitters will be operated to obtain experimental confirmation of the theo-

Table I. TRANSIT IA Powered Trajectory Flight Plan.

Vertical lift-off	0 to 10 sec
Apply Stage I pitch program	10 to 12 sec
Constant angle of attack	12 to 130 sec
Constant attitude	130 sec to Stage I main engine cutoff (152 sec approx)
Twelve sec of vernier operation required to allow the BTL guidance system to accumulate trajectory data for second-stage guidance	152 to 170 sec
Stage II separation plus ignition	170 sec
After allowing transients to damp out (approximately 10 sec), initiate the BTL guidance--apply pitch rate	180 to Stage II cutoff minus 13 sec
Apply Stage II pitch program to place vehicle in proper attitude for orbital injection	Stage II cutoff minus 13 sec to Stage II cutoff minus 3 sec
Constant attitude and spin-up third stage and payload (2-3 rps)	Stage II cutoff minus 3 sec to Stage II cutoff
Coast to injection altitude at constant attitude	Stage II cutoff to Stage III ignition
Constant attitude	Stage III ignition to burnout
Separate payload from Stage III	After Stage III burnout
De-spin payload (2-3 rpm)	In orbit

retical mathematical relationship between the frequency and the refractive index of the ionosphere. After four months of tracking the satellite by measurement of the doppler shift the exact position of the satellite should be known at all times during an orbital cycle. Once position of the satellite has been established by precise mathematical computation, reliable and accurate navigational fixes can be obtained. In addition, precise measurements of the earth's geoid can be made.

GROUND SUPPORT STATIONS

Tracking stations will be operated by the Applied Physics Laboratory at Howard County, Maryland; Las Cruces, New Mexico (University of New Mexico); Austin, Texas (University of Texas); Seattle, Washington (University of Washington); and Newfoundland. Second stage guidance and first and second stage tracking and telemetry will be provided by the Atlantic Missile Range.

MONTHLY PROGRESS—TRANSIT PROGRAM

Program Administration

- Launch date for the TRANSIT 1B vehicle has been rescheduled from 15 March to 5 April and for TRANSIT 2A from 15 April to 11 May. The TRANSIT 1B launch was delayed by a slippage in the delivery of the ABLE-STAR second stage propulsion system and resulted in the comparable delay in TRANSIT 2B launch date.
- A systems coordination meeting was held on 12 January at which time TRANSIT 1B action items were reviewed and outstanding items resolved. The preliminary countdown was reviewed in order to integrate the payload contractor into the procedure. In relation to TRANSIT 2A, it was agreed that a second stage pitch maneuver would not be used to obtain payload orientation following injection into orbit. The trajectory will be determined, however, to obtain the best orientation possible in consideration of payload restraints.

Technical Progress

TRANSIT 1B

- A TRANSIT 1B system compatibility test, with all major electronic systems in operation, was completed successfully during December. The components were mounted in the second stage vehicle equipment compartment.
- Studies are being conducted to determine the possibilities of payload contamination resulting from the presence of fuel vapors in the helium gas used to activate the payload spin and separation mechanism. The helium used for this purpose after injection into orbit, is used previously to pressurize the fuel tanks during powered flight. The study includes determination of the amount of fuel vapor likely to be present in the helium and evaluation of the effects of fuel vapor on the payload surface.
- Control system stability was improved during January by relocating the second stage equipment shelf attaching point. This change eliminated excessive deflection in the gyro reference package.
- The ABLE-STAR second stage propulsion unit was delivered on 19 January and passed receiving inspection in the Space Technology Laboratories hangar in Los Angeles. The aft cable and equipment compartment have been installed on the unit. The thrust chamber assembly and attitude control jets were aligned and assembly of the second stage is proceeding on schedule. The completed second stage will be shipped to AMR on 3 March.
- The TRANSIT 1B range safety document has been revised to include first stage engine cutoff in the second stage range safety system.

Ground Support Progress

- Design of the downrange tracking and telemetry van is proceeding on schedule, with systems tests planned to begin on 15 February. This van will be used to obtain tracking and telemetry data at or near the point of injection into orbit. Erding, Germany has been selected as the site for TRANSIT 1B.
- Modification of AMR launch pad 17B in accordance with TRANSIT 1B requirements is proceeding on schedule. Completion is planned for 28 February.

TRANSIT 2A

- Delivery of the second stage propulsion system is scheduled for early in February.
- Present trajectory studies indicate that Punta Arenas, Chile may be the site chosen for the downrange tracking and telemetry van. This is the closest practical location to the point of orbit injection.

TRANSIT 2B

- A meeting was held at AMR on 20 January to review the AMR Program Requirements Document with AMR personnel.
- The release of drawings and specifications to Aerojet-General Corporation and Space Electronics Corporation continued on schedule during January.
- Minneapolis-Honeywell has accepted a gyro delivery schedule, calling for 3 units on 15 February and 7 units before 30 April. Procurement of two additional gyros has been authorized to provide adequate spares. Fabrication and testing problems have resulted in the issuance of temporary "stop work" orders for 3 components.

Courier

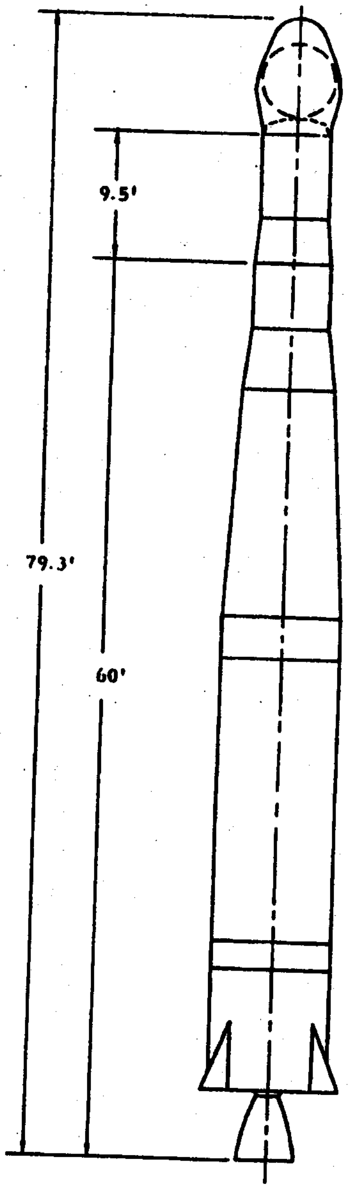
The ARPA COURIER Program consists of two flights from the Atlantic Missile Range in May and July 1960. The program objective is to test delayed repeater communications between a satellite and ground stations. The program also will be used to determine the operating characteristics and capabilities of the ABLE-STAR (AJ10-104) second stage vehicle. The program is being conducted under ARPA Order No. 98, dated 1 July 1959 (Project Code No. 2200). AFBMD responsibility includes development of the launch vehicle, payload integration, launch, injection of payload into orbit, and verification of orbital parameters at injection. The Army Signal Research and Development Laboratory will design, develop and fabricate the payload, and will be responsible for world-wide ground station requirements. Primary payload contractor is Philco Corporation.

Vehicle Description—The two-stage COURIER vehicle consists of a THOR booster, an ABLE-STAR (AJ10-104) second stage and a 500 pound COURIER payload. Booster flight control is exercised by a gyro platform and a programmer. The second stage is controlled by a gyro used to govern engine gimballing during powered flight. Stability during second stage coast is provided by the "on-off" operation of jet nozzles operating from a dry nitrogen supply. The second stage propellants are inhibited red fuming nitirc acid and unsymmetrical dimethyl hydrazine. The engine will have a restart capability. The 500 pound COURIER payload is a 60-inch sphere, containing radio repeaters, storage and memory equipment, and a battery power source.

Flight Description—Both vehicles are to be launched from the Atlantic Missile Range. After first stage burnout, the ABLE-STAR vehicle will place the payload into the desired trajectory and then shut down. The second stage and payload will coast to the desired 650 nautical mile orbital altitude and the ABLE-STAR engine reignited to attain orbital velocity. The orbital angle of inclination will be 28.5 degrees from the equatorial plane. The orbital period will be 110 minutes.

Payload Objectives—Storage and memory elements in the payload will deliver messages, upon command, to each of three ground stations; as well as exchanging "real time" information when the satellite is within line-of-sight of two ground stations. During these periods a ground station can relay messages direct to the next ground station, through the satellite simplex repeater equipment.

Ground Support Stations—These stations will be located at Camp Salinas, Puerto Rico; Torrejon Air Force Base, Madrid, Spain; and Halemano, Hawaii. Station design and development is under contract to International Telephone and Telegraph Corporation.



SECOND STAGE—ABLE-STAR (AJ10-104)

Thrust at altitude	8030 pounds
Specific impulse (vac)	278 seconds
Total impulse (min)	2.3×10^6 lbs/sec
Burning time	294 seconds
Propellant	Liquid

FIRST STAGE—THOR IRBM

Thrust (s. l.)	151,500 pounds
Specific impulse (s. l.)	248 seconds
Specific impulse (vac)	287 seconds
Burning time	158 seconds
Propellant	Liquid

MONTHLY PROGRESS—COURIER PROGRAM

Program Administration

- Launch date for COURIER 1A has been rescheduled from 15 May to 11 June. Slippage of the TRANSIT 1B and 2A launch dates caused a comparable delay in the COURIER launch.
- A system coordination meeting was held during January. General technical areas were discussed and outstanding action items were reviewed.

Technical Progress

COURIER 1A

- Studies are being conducted to determine the possibilities of payload contamination resulting from the presence of fuel vapors in the helium gas used to activate the payload spin and separation mechanism. The helium used for this purpose after injection into orbit, is used previously to pressurize the fuel tanks during powered flight. The study includes determination of the amount of fuel vapor likely to be present in the helium and evaluation of the effects of fuel vapor on the payload surface.
- Work on the downrange tracking and telemetry van, and modification of AMR launch pad 17B in accordance with COURIER program requirements are proceeding on schedule.

COURIER 1B

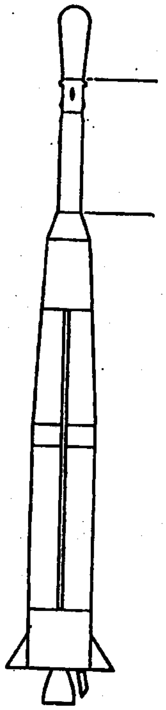
- The release of drawings and specifications to Aerojet-General Corporation and Space Electronics Corporation continued on schedule during January.
- Minneapolis-Honeywell has accepted a gyro delivery schedule, calling for 3 units on 15 February and 7 units before 30 April. Procurement of two additional gyros has been authorized to provide adequate spares. Fabrication and testing problems have resulted in the issuance of temporary "stop work" orders for 3 components.
- A meeting was held at AMR on 20 January to review the AMR Program Requirements Document with AMR personnel.

Tiros

The TIROS Program consists of one flight from the Atlantic Missile Range early in 1960. Primary objectives include: (a) To determine the feasibility of using an earth satellite to measure, record, and transmit synoptic weather conditions; (b) To establish system parameters for weather satellites; (c) To acquire information on electromagnetic propagation through the atmosphere and acquisition of additional geodetic and geophysical data by tracking a satellite in a precise orbit. The National Aeronautic and Space Administration is the primary program agency. AFBMD is responsible for supplying the launch vehicle, integrating the payload to the launch vehicle, and providing communications to the tracking and data-handling agencies from launch through attainment of orbit. Payload design, fabrication and testing will be accomplished by the Radio Corporation of America for NASA. NASA retains cognizance for operating, tracking, and recording and processing of satellite data.

VEHICLE DESCRIPTION

The three-stage TIROS vehicle (Figure 1) consists of a THOR Booster, Aerojet-General (AJ10-42) liquid propellant second stage with Bell Telephone Laboratories radio-inertial guidance system, and the Allegany Ballistics Laboratory solid propellant third stage (248). Design specifications for each of the three stages are shown on Figure 1.



THIRD STAGE—X-248 (Allegany Ballistic Lab.)

Thrust at altitude	3150 pounds
Specific impulse (vac)	250 seconds
Total impulse	116,400 lbs/sec
Burning Time	37.5 seconds
Propellant	Solid

SECOND STAGE—AJ10-42 (Aerojet-General)

Thrust at altitude	7700 pounds
Specific impulse (vac)	271 seconds
Total impulse (min)	870,000 lbs/sec
Burning time	115 seconds
Propellant	Liquid

FIRST STAGE—THOR IRBM

Thrust (s.l.)	151,500 pounds
Specific impulse (s.l.)	248 seconds
Specific impulse (vac)	287 seconds
Burning time	158 seconds
Propellant	Liquid

FLIGHT DESCRIPTION

The sequence of events for the powered flight from launch at AMR to injection into orbit is given in Table 1. The payload will be placed in a 400 nautical mile circular orbit having an inclination angle of 51 degrees. Orbital life is expected to be five months.

PAYLOAD OBJECTIVES

The 270 pound, cylindrical payload will be 42 inches in diameter and 17 inches in height. Payload equipment includes 2 television cameras designed to observe, record and transmit weather data. Power sources include sixty 20-volt nickel-cadmium chemical batteries and 7344 solar cells to recharge the batteries. The solar cells, installed in the top and cylindrical side walls of the satellite will furnish an average output of 13 watts for the first 140 days of vehicle life. Once during each orbit the satellite will be interrogated and reprogrammed from a ground station. The two television cameras have different resolution capabilities and coverage patterns to permit observation of a wide variety of cloud patterns. Two modes of TV system operation are possible. When the satellite is within radio communications range of a ground station, pictures may be taken on command and transmitted directly to earth. When the satellite is beyond radio communication range, camera operation is controlled by a clock and programming circuits and the images recorded on magnetic tape for readout during the next pass over a ground station. Four beacon transmitters are installed on the bottom side of the satellite to facilitate tracking.

GROUND SUPPORT STATIONS

The Air Force ground station at Kaena Point will be used to support this program. Tracking and data acquisition will be conducted on 108 mcs and command transmission on 140 mcs. Required modifications to the TLM and VERLORT radars are in progress. Use of this support station will result in: (a) minimum cost by maximum use of existing facilities, (b) minimum equipment modification and operation effort, and (c) a satisfactory system configuration with minimum complexity. Use of this facility also will benefit the SAMOS and MIDAS programs by attaining an early buildup of experienced personnel.

TABLE I. TIROS POWERED TRAJECTORY FLIGHT PLAN

1.	Vertical lift-off	0-10 sec.
2.	Stage I pitch program begins	10 sec.
3.	BTL guidance begins Stage I closed-loop steering	90 sec.
4.	End Stage I pitch program; end Stage I steering	130 sec.
5.	Stage I constant attitude flight	130-159 sec.
6.	MECO—Stage I main-engine cutoff	159 sec approximately.
7.	3.8 sec of vernier operation prior to Stage I-II separation	159-162.8 sec.
8.	Stage II separation and ignition; begin Stage II pitch program	162.8 sec.
9.	BTL guidance applies yaw rate command to yaw right	166-170 sec.
10.	BTL guidance begins Stage II closed-loop steering	172.8 sec.
11.	Jettison nose fairing	182.8 sec.
12.	BTL discrete ends Stage II pitch program	SECO—10 sec.
13.	BTL guidance ends Stage II closed-loop steering	SECO—7 sec.
14.	BTL guidance applies yaw rate command to yaw left	SECO—6 sec. to SECO—4 sec.
15.	BTL discrete spins up third stage and payload—120 rpm	SECO—2 sec.
16.	Stage II cutoff—SECO; begin coast period	SECO (Approximately 273 sec.)
17.	Stage II-III separation	SECO—1.5 sec.
18.	Fire Stage III rocket	SECO—550* sec to SECO—587 sec.
19.	Separate payload from Stage III	SECO—597 sec.
20.	De-spin payload—12 rpm	In orbit

MONTHLY PROGRESS—TIROS PROGRAM

Program Administration

- During December the scheduled launch date of 27 January was cancelled as a result of a NASA request for additional time to prepare the payload. During January the rescheduling of the ABLE-4 THOR flight prevented the establishment of a firm TIROS launch date. However, 29 March has been accepted as the target date.

Technical Progress

- At the request of NASA, new trajectories were established for powered flight and instantaneous impact prediction. These changes were required to preclude any nominal or 3-sigma probability that impact could occur on any part of the European land mass. The powered flight trajectory selected on a basis of the impact requirement, has the following characteristics:

Launch azimuth	*46.5 degrees*
Inclination angle	*48.3 degrees*
Point of verticality	*20.00 degrees north and 43.97 degrees east*
Coast time	*424 seconds*

The following changes to the TIROS vehicle are required by the new trajectory:

Recalculation of guidance and equations, and constants by Bell Telephone Laboratories (second stage guidance system).
Resetting of first and second stage autopilot control constants.
Resetting of second stage coast timer.

The new trajectory has been submitted to NASA for approval. The necessary changes to the vehicle and the Detailed Test Objectives document can be made without delay to the anticipated launch date, provided NASA approval is obtained early in February. No changes in range safety requirements or in Millstone, Massachusetts beacon antenna locations or patterns appear to be required.

- The design of the second stage retro system was established and qualification tests conducted during December. The design of the third stage/payload separation system was established during December. The design includes:

1. A parallel redundant battery/timer circuit to delay third stage/payload separation approximately 25 minutes after third stage burnout. The timers have the same basic mechanism as those used for the coast period, and have a timing tolerance of 10 percent. They will be started by squib action from the signal that ignites the third stage. The batteries are series connected cells of the same type that are used for the coast timer/third stage ignition circuit. The timers and batteries were delivered and qualification tested during January.

2. A separation spring capable of providing a nominal separation velocity of 5 feet per second. The spring was fabricated and tested during January.

- Development and qualification testing of the third stage/payload separation system components was completed during January. With the delay in the launch date the following additional tests will be performed:

1. Vibration testing of the second stage retro system.
2. Vibration testing of the third stage/payload separation system.

These are in addition to the normal component qualifying testing program and are being made only to provide additional confidence in the system's ability to operate properly during flight. The tests will use flight type hardware and will consist of vibrating the system through an estimated flight predicted environment.

- All system design and qualification testing will be completed early in February.

AGENA

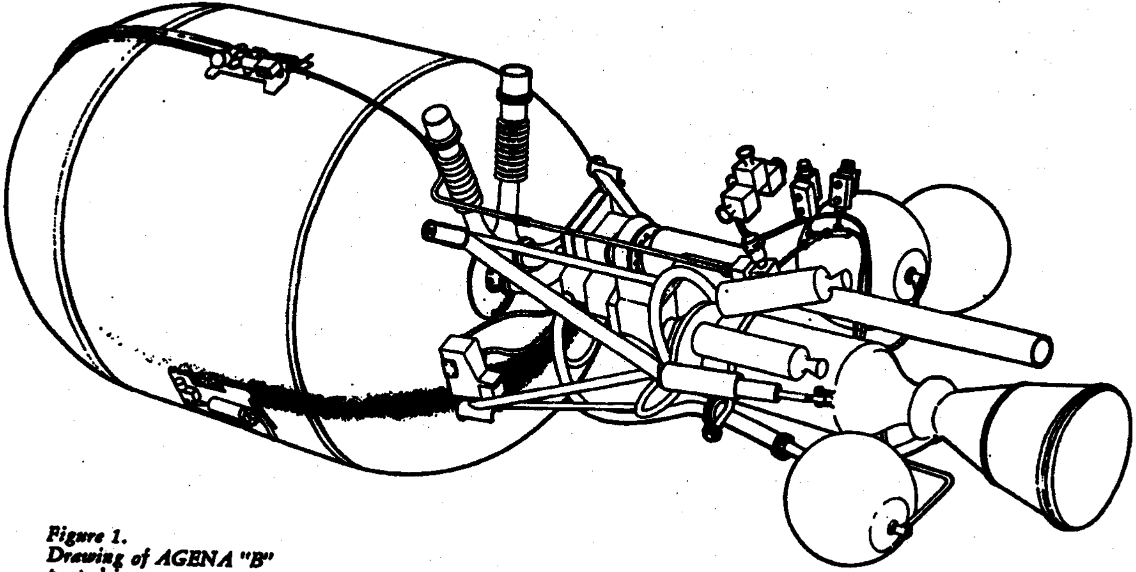
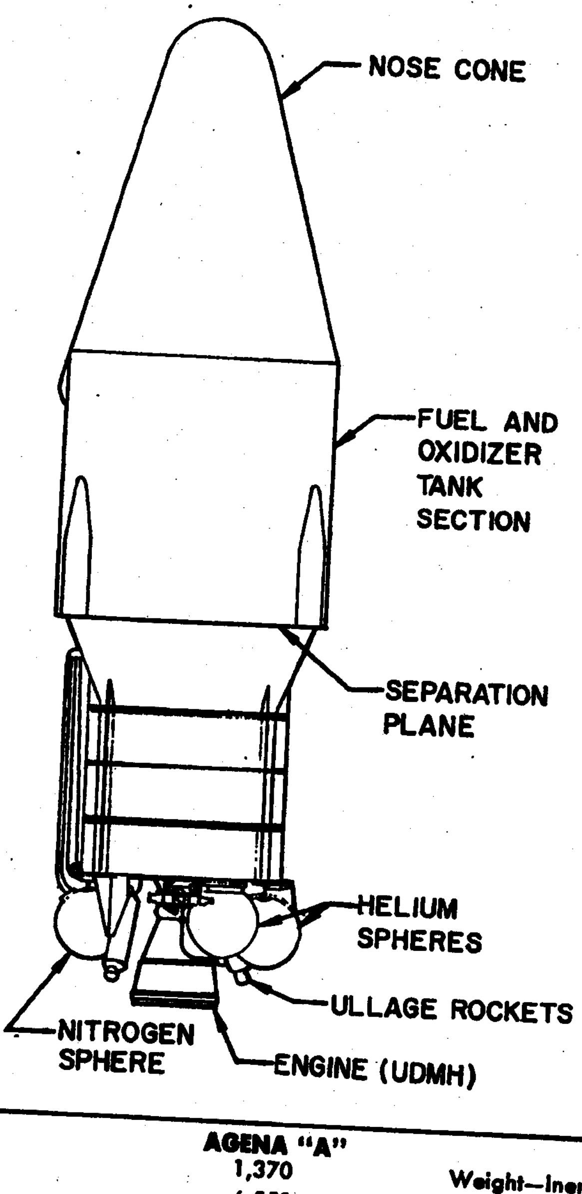


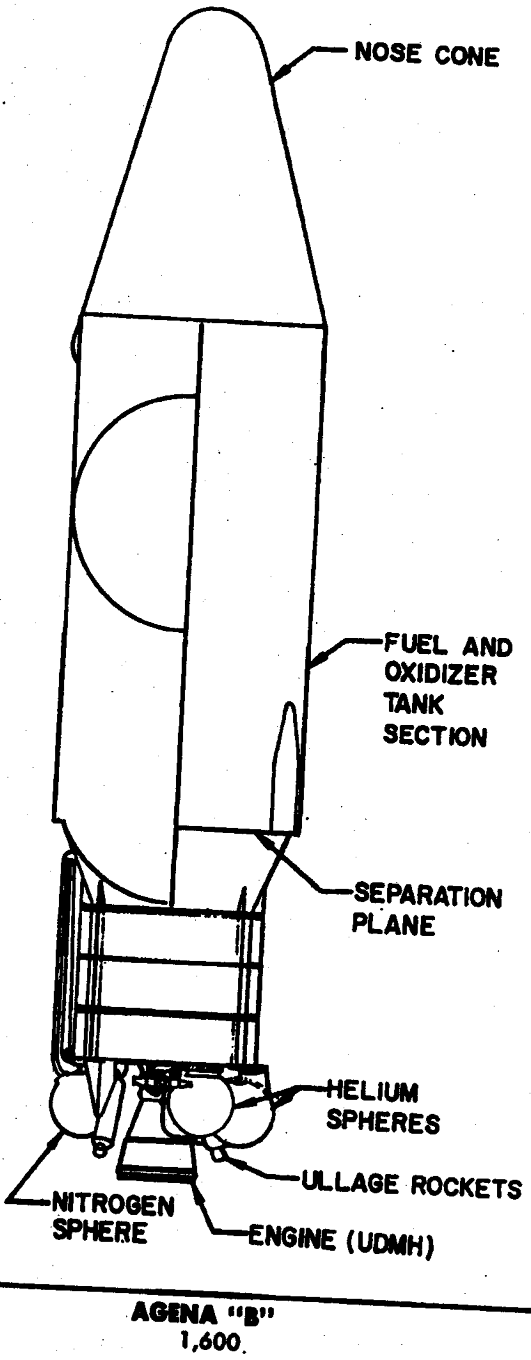
Figure 1.
Drawing of AGENA "B" propulsion system.

The AGENA vehicle was originally designed by the Air Force for use as the basic satellite vehicle for the Advanced Military Reconnaissance Satellite Program (Weapon System 117L). The vehicle was designed to be boosted by an ATLAS ICBM and basic dimensions were derived from this booster selection. The type of trajectory possible using the ATLAS booster, coupled with the stringent eccentricity requirements of these programs, led to selection of a satellite guidance system suited to accomplishing orbital injection in a horizontal attitude. This led to the development for the AGENA of an optical inertial system for vehicle guidance and gas jets for orbital attitude control. The Bell Aircraft LR81-Ba-3 engine (Bell Hustler engine developed for B-58 aircraft) was chosen for AGENA propulsion due to its advanced state of development. The YLR81-Ba-5 version of this engine was developed to provide increased performance through the use of ultra di-methyl hydrazine (UDMH) fuel instead of JP-4. Accelerated flight testing of the AGENA vehicle and its subsystems became possible when the DISCOVERER program was created, based on the low cost and early availability of the THOR IRBM, and a study which indicated that the AGENA could be flight tested successfully in low altitude orbits. DISCOVERER flights to date have been characterized by completely successful performance of the AGENA "A" vehicle.

Progress in the design of payloads for the MIDAS program created an urgent need for the attainment of higher altitude orbits. As a result a modification program was initiated to develop the AGENA "B" configuration. This work was authorized by ARPA Order No. 48 and continued under ARPA Order No. 96. On 17 November 1959 program responsibility was assigned to the Air Force by the Secretary of Defense. The AGENA "B" configuration includes the addition of a single restart and extended burn capability to the engine and propellant tankage of twice the AGENA "A" capacity. The engine (Bell Aircraft Model 8081), for use on this vehicle, is officially designated USAF Model XLR81-Ba-7. A subsequent version, XLR81-Ba-9 (Bell Aircraft Model 8096), with a nozzle expansion ratio of approximately 45:1 will further increase performance capability. The AGENA "B" configuration has increased the effectiveness of the payload weight/orbital altitude relationship for this vehicle. This reduction of payload restrictions has increased greatly the potentialities of using the extremely reliable THOR as an AGENA booster. In order to obtain maximum efficiency from the use of ATLAS as an AGENA booster, modifications to the ATLAS are being made to reduce limitations imposed by trajectory requirements and static load capabilities.

Payloads may be installed on the AGENA forward equipment rack, or distributed throughout the vehicle. An ejectable recovery capsule has been developed for the nose section of the AGENA vehicle and flight tested in the DISCOVERER program.





AGENA "A"		AGENA "B"
1,370	Weight—Inert	1,600
6,550	Impulse Propellants	13,100
	Fuel (UDMH)	
	Oxidizer (IRFNA)	
67	Pyrotechnics	100
7,987	GROSS WEIGHT (lbs.)	14,800

MONTHLY PROGRESS—AGENA VEHICLE

Program Administration

- In accordance with amendment 2 to ARPA Order No. 96, dated 17 November 1959, and Hq USAF AFDAT 91935, dated 20 November 1959, responsibility for the AGENA program is managed by the Air Force.

Technical Progress

- The final AGENA "A" vehicle for use in the DISCOVERER program is in modification and checkout. All prior vehicles are at Vandenberg AFB undergoing prelaunch preparations. The first AGENA "B" vehicle (for the second phase of the DISCOVERER program) is in the Modification and Checkout Center. It is scheduled for shipment to the Santa Cruz Test Base on 24 February. The AGENA "A" vehicle for the first SAMOS flight is undergoing systems checks in the Modification and Checkout Center. The AGENA "A" vehicle for the first MIDAS flight was accepted by the Air Force on 2 December, shipped to the Atlantic Missile Range on 5 December. Modification and checkout of the second MIDAS vehicle was completed and the vehicle shipped to Santa Cruz Test Base on 21 December.
- The results of design studies indicate that a common airframe design from the forward equipment rack aft can be used on SAMOS and MIDAS program AGENA "B" vehicles. Equipment installations need not be interchangeable.
- One XLR81-Ba-7 engine (Bell Aircraft Model 8081) is at the Santa Cruz Test Base for hot firing tests in the propulsion test vehicle assembly. Three full duration firings were made during January. The engine was operated for 236, 251 and 245 seconds during these tests. The second engine is at LMSD, Sunnyvale, California. This engine is scheduled for use on the first four AGENA "B" flights of the DISCOVERER program. The second engine is the first flight article for this phase. Preliminary flight rating tests of the 8081 engine have been started at Bell Aircraft and are scheduled for completion late in February.
- Delivery of the first XLR81-Ba-9 engine (Bell Aircraft Model 8096) is scheduled for 15 February. This engine incorporates a nozzle extension increasing the expansion ratio to 45:1.

Figure 2. Final assembly of AGENA "A" (upper right) and AGENA "B" (lower left) vehicles. AGENA "A" vehicle shown is programmed for first SAMOS flight. AGENA "B" vehicle shown is the first flight article of this configuration and is scheduled for use on DISCOVERER XVII. This "B" configuration includes double propellant tank capacity, and single restart and extended burn (240 seconds) capabilities.

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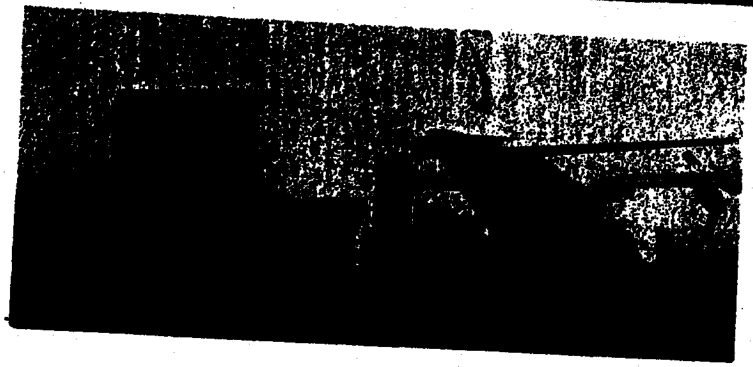
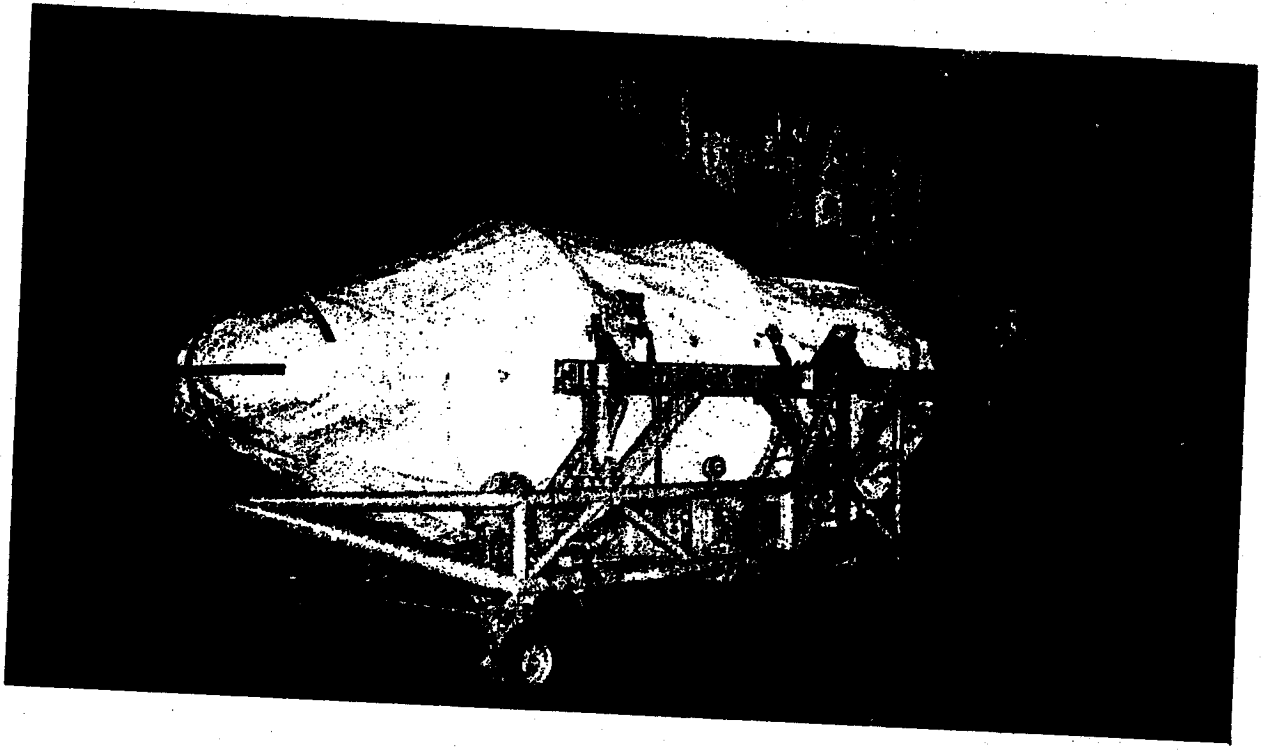
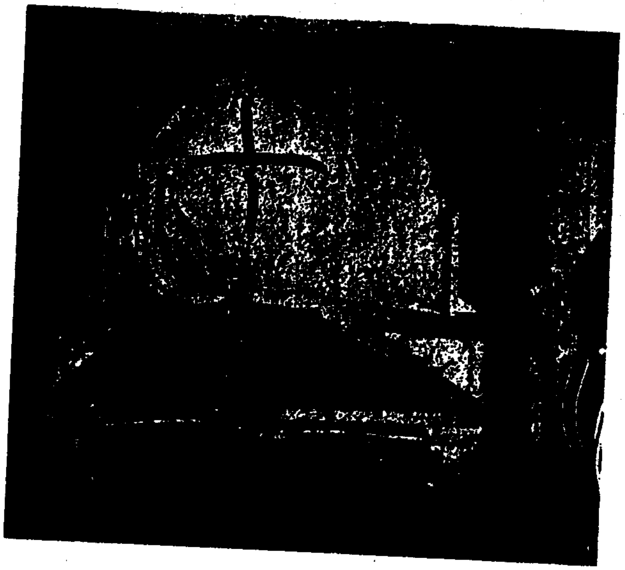


Figure 3. AGENA "A" vehicle, scheduled for use on the first MIDAS flight, being unloaded from van for air shipment to the Atlantic Missile Range. The AMR facilities check vehicle had been air shipped a few days earlier. All handling equipment performed satisfactorily during both of these operations . . .



. . . Vehicle shown just prior to being loaded aboard C-130 aircraft (above). Vehicle mounted in transportation dolly shown loaded aboard aircraft (right).



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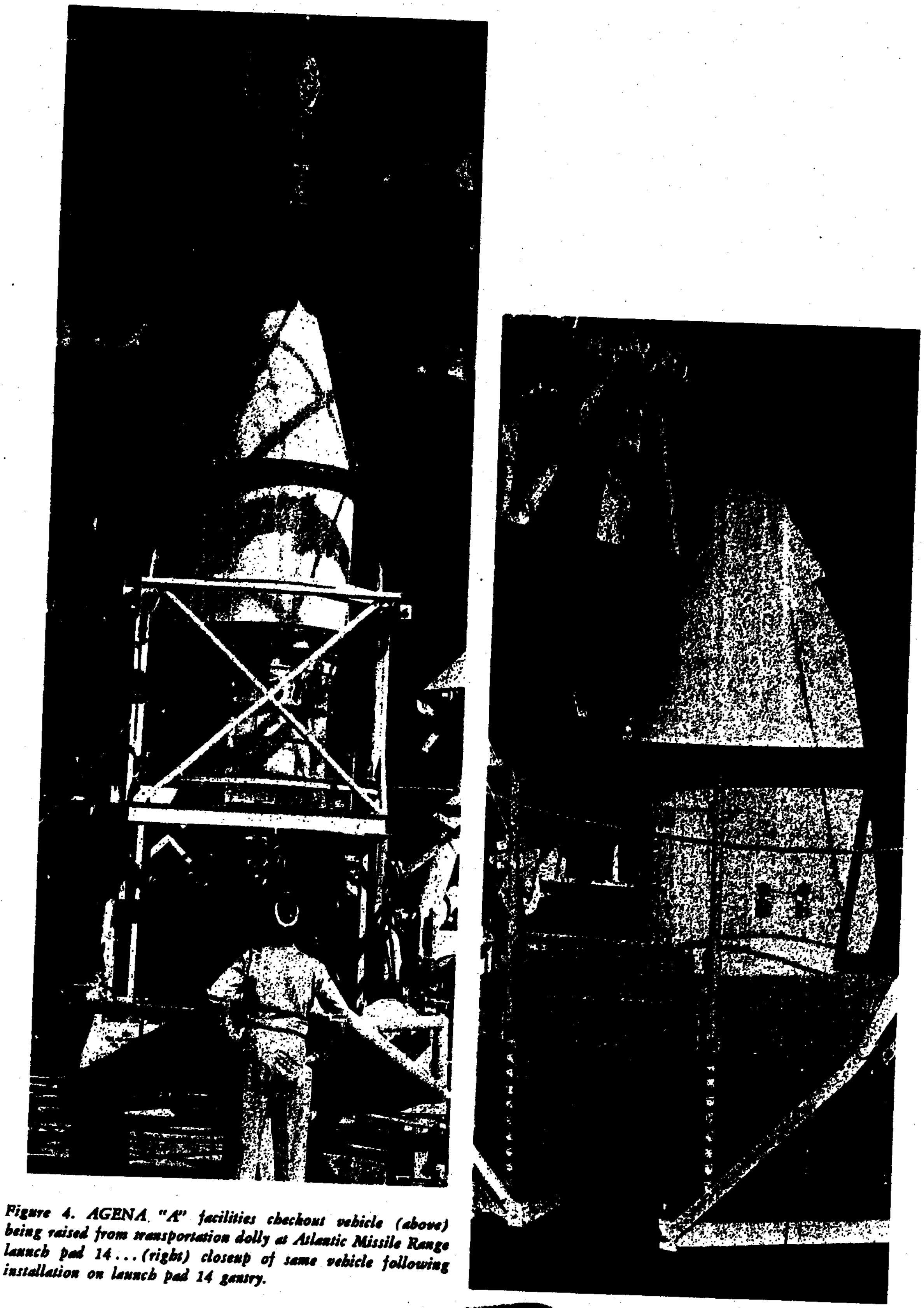

Figure 4. AGENA "A" facilities checkout vehicle (above) being raised from transportation dolly at Atlantic Missile Range launch pad 14 . . . (right) closeup of same vehicle following installation on launch pad 14 gantry.

Able-Star

This program will develop a versatile and efficient upper stage for use with varied booster/vehicle combinations. This stage will have basic design features proven in the dependable AJ10-101 stage used on the THOR/ABLE vehicles. Improvements being made include: (a) increased propellant capacity; (b) a multiple restart capability; and (c) a full-time attitude control system to operate during coast periods as well as powered flight. These improvements will permit a two-stage THOR/ABLE-STAR vehicle to attain weight/altitude performance equal to that of the three-stage THOR/ABLE vehicles. This will provide increased reliability and accuracy.

This stage will be suitable for mating to THOR, ATLAS or TITAN space boosters and can be modified to accept a solid propellant third stage, if needed.

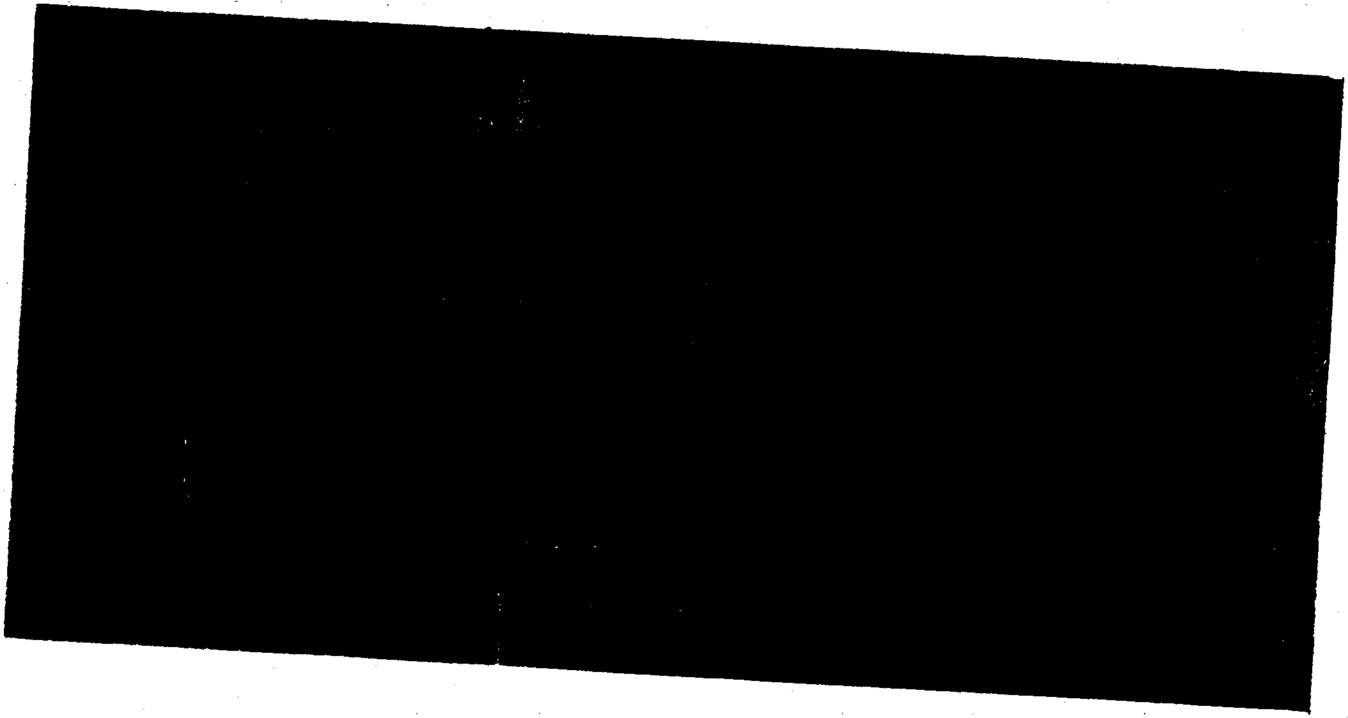

Figure 1. Side view of ABLE-STAR vehicle mounted in handling dolly.

MONTHLY PROGRESS—ABLE-STAR VEHICLE

Program Administration

- The development of the ABLE-STAR (AJ10-104) propulsion system was completed during January. A final report summarizing the program will be submitted to ARPA in March.

Technical Progress

- All preliminary flight rating tests were completed during January. A total of 7 rated, 300-second duration firings were made successfully during December. Four thrust chamber assemblies accumulated approximately 700 seconds of total hot firing time, each with coolant acid temperatures approximately 20 degrees higher than anticipated for flight conditions.

Delivery Schedules

- The first flight propulsion system was delivered to the Air Force on 19 January. Delivery of the remaining four units is scheduled for 6 February, 15 March, 22 April and 20 May.

Flight Schedule

The flight schedules for vehicles using this second stage are reported in the TRANSIT and COURIER sections.

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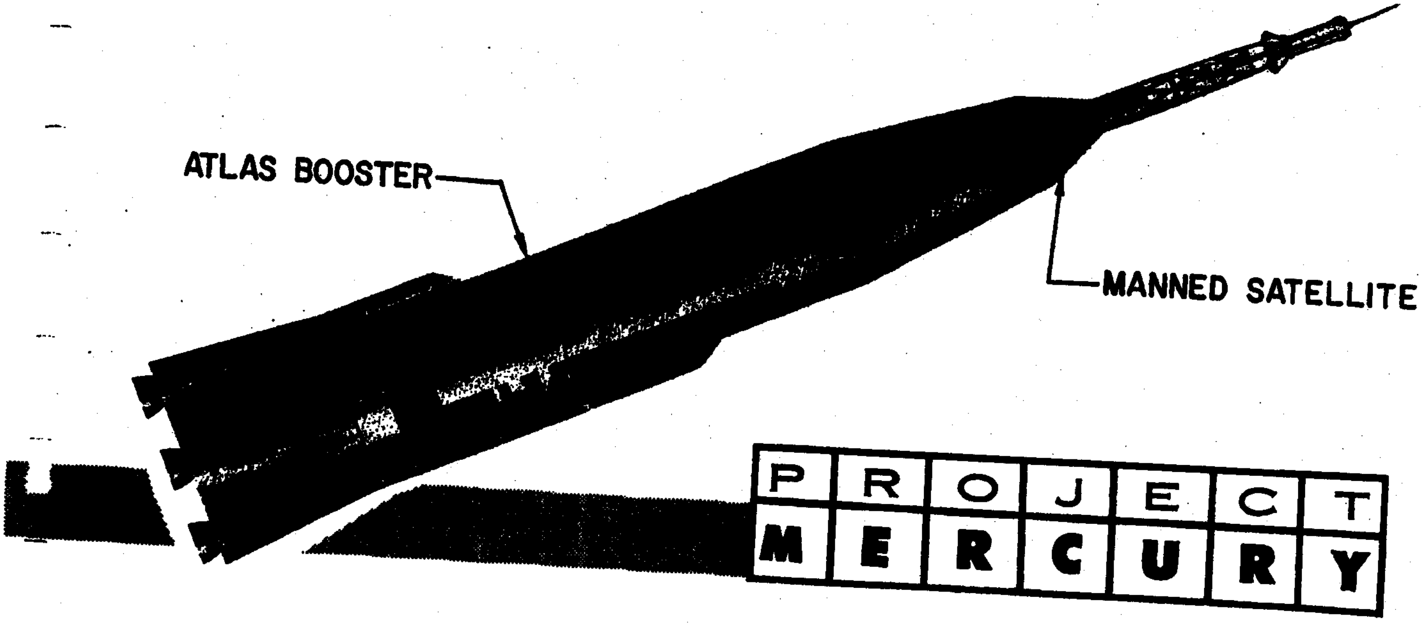

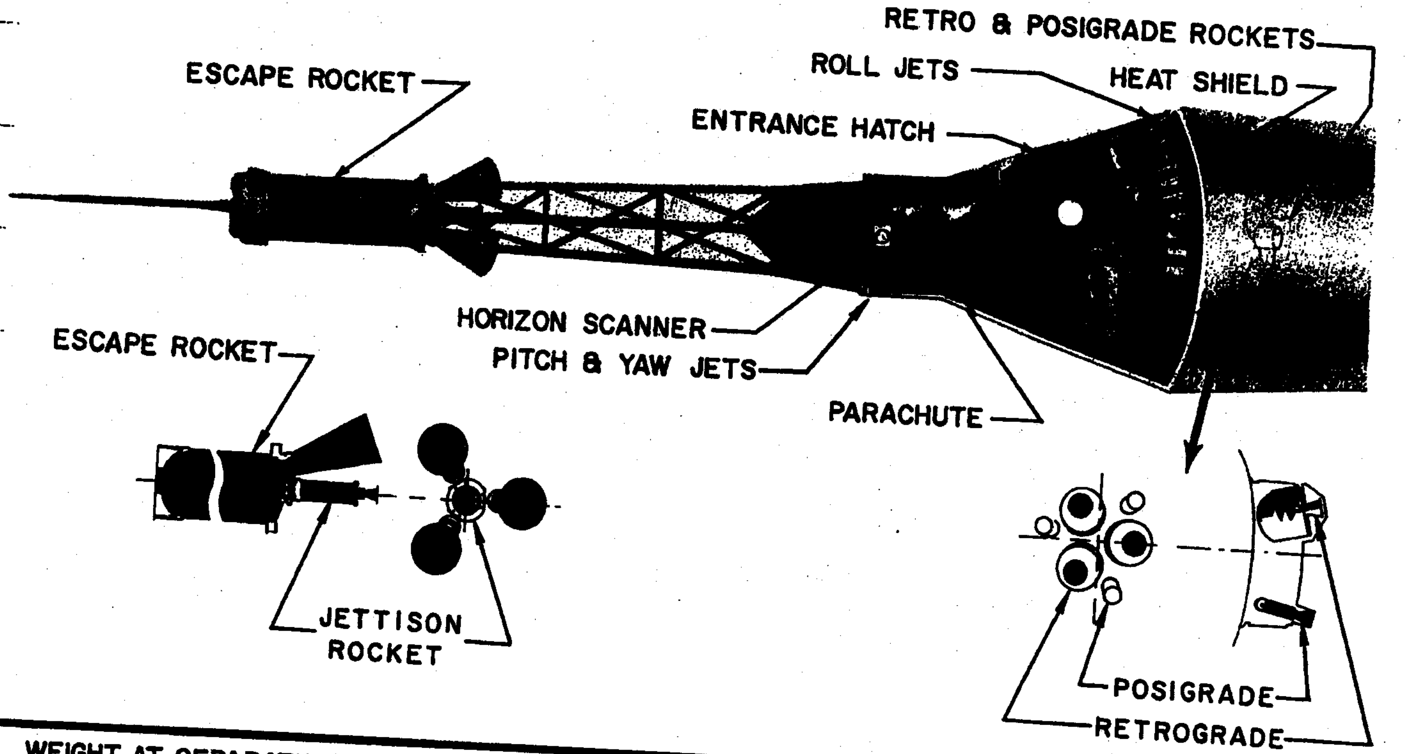

WEIGHT AT SEPARATION	APPROX. 2413 LBS.	ORBIT INCLINATION	33 DEGREES
ORBITAL ALTITUDE	105-115 MILES (n)	HEAT SHIELD	ABLATIVE OR SINK
ORBITAL CYCLES	3-18	RECOVERY	AIR &/OR WATER OR LAND

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Project MERCURY represents the transitional thres[redacted] between this nation's cumulative achievements in space research and the beginning of actual space travel by man. The primary program objective is to place a manned satellite into orbit about the earth, and to effect a controlled re-entry and successful recovery of the man and capsule (Figure 1). Unmanned ICBM trajectory and near-orbital flights, and unmanned orbiting flights will be used to verify the effectiveness and reliability of an extensive research program prior to manned orbital flights (Figure 2). The program will be conducted over a period of nearly two years. The initial R&D flight test was accomplished successfully in September 1959. The total program accomplishment is under the direction of NASA. The primary responsibility of AFBMD to date consists of: (a) providing ten ATLAS boosters modified in accordance with program objectives and pilot safety factors, and (b) determination of trajectories and the launching and control of vehicles through injection into orbit. The division of responsibilities for this program is given in Table 1. Specific details of AFBMD support are given in Table 2.

Major contractors participating in the AFBMD portion of this program include: Space Technology Laboratories, systems engineering and technical direction; Convair-Astronautics, modified ATLAS boosters; GE/Burroughs, ATLAS guidance equipment; and Rocketdyne, engines. All of these companies also provide special studies and engineering efforts peculiar to meeting Project MERCURY requirements.

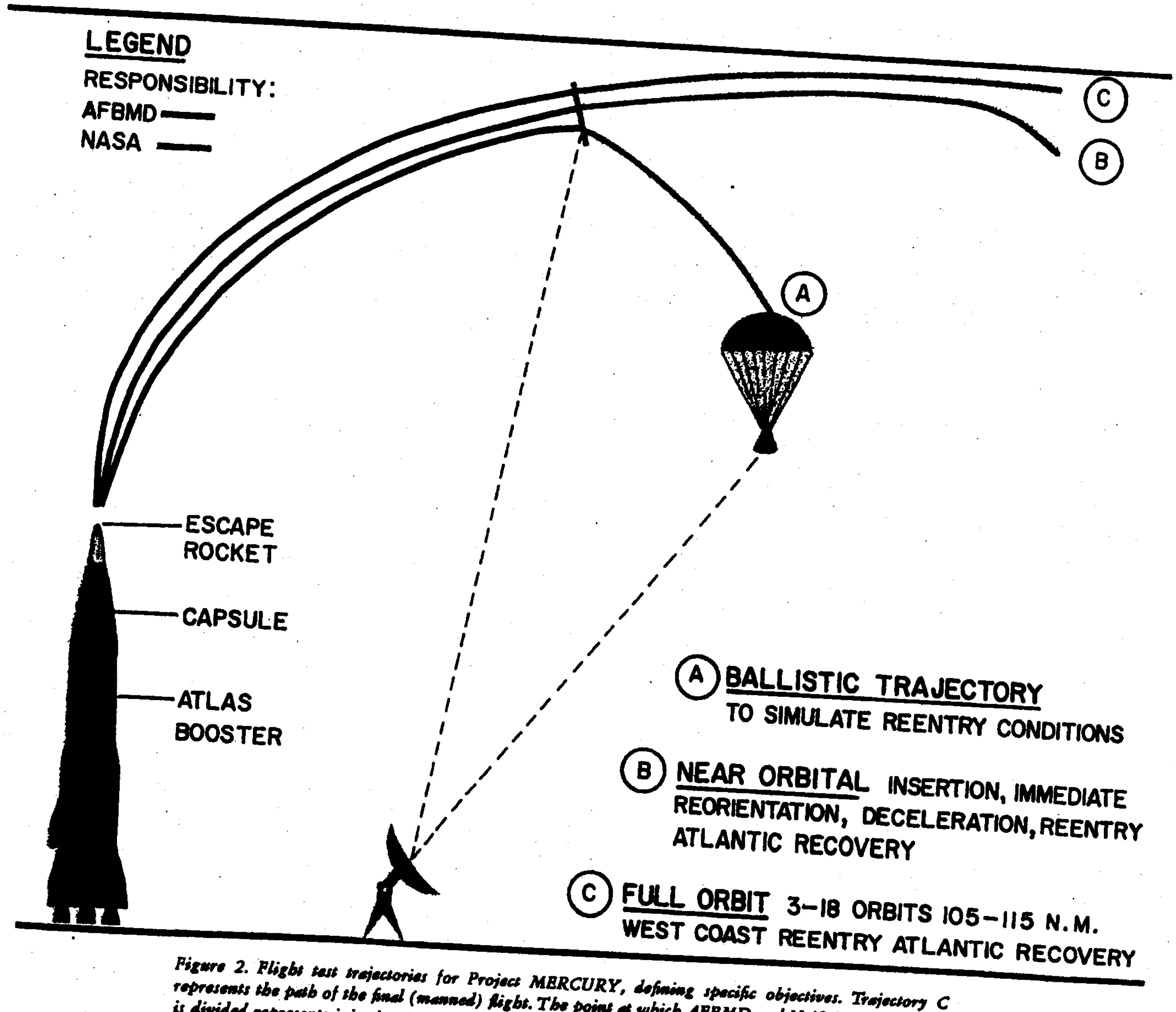
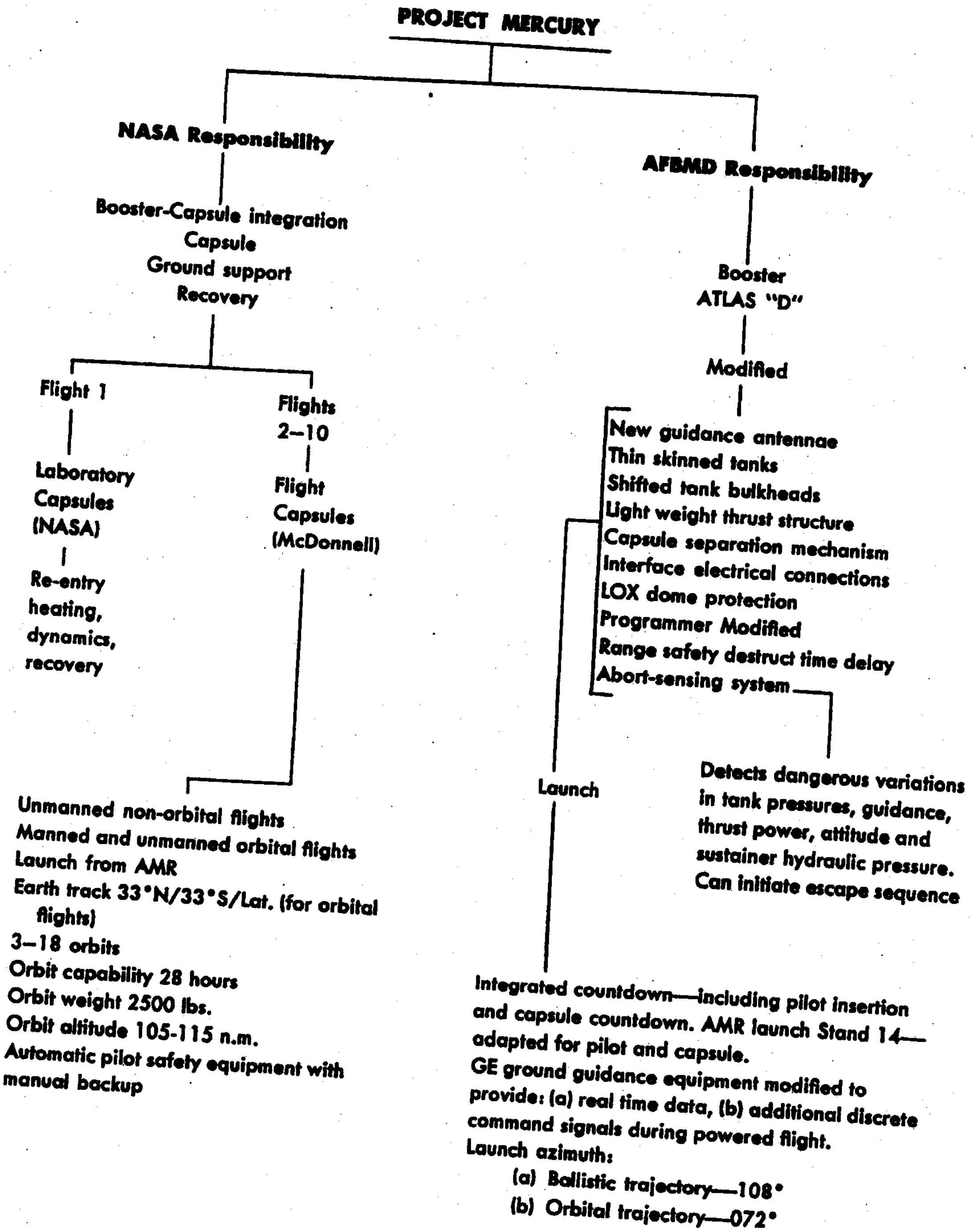


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.



PROJECT MERCURY

- **NASA Responsibility**
  - Booster-Capsule integration
Capsule
Ground support
Recovery
    - Flight 1
      - Laboratory Capsules (NASA)
        - Re-entry heating, dynamics, recovery
    - Flights 2–10
      - Flight Capsules (McDonnell)
        - Unmanned non-orbital flights
        - Manned and unmanned orbital flights
        - Launch from AMR
        - Earth track 33°N/33°S/Lat. (for orbital flights)
        - 3–18 orbits
        - Orbit capability 28 hours
        - Orbit weight 2500 lbs.
        - Orbit altitude 105-115 n.m.
        - Automatic pilot safety equipment with manual backup
- **AFBMD Responsibility**
  - Booster ATLAS "D"
    - Modified
      - New guidance antennae
      - Thin skinned tanks
      - Shifted tank bulkheads
      - Light weight thrust structure
      - Capsule separation mechanism
      - Interface electrical connections
      - LOX dome protection
      - Programmer Modified
      - Range safety destruct time delay
      - Abort-sensing system
        - Detects dangerous variations in tank pressures, guidance, thrust power, attitude and sustainer hydraulic pressure. Can initiate escape sequence
      - Launch
        - Integrated countdown—including pilot insertion and capsule countdown. AMR launch Stand 14—adapted for pilot and capsule.
        - GE ground guidance equipment modified to provide: (a) real time data, (b) additional discrete command signals during powered flight.
        - Launch azimuth:
          - (a) Ballistic trajectory—108°
          - (b) Orbital trajectory—072°

Table 1. Outline of NASA and AFBMD responsibilities in PROJECT MERCURY.

[redacted] MERCURY

AFBMD Responsibility
in support of
PROJECT MERCURY
NASA HS-36
includes:

Design, engineering studies Equipment modification Hardware fabrication	Flight scheduling	Launch support Trajectory data Missile allocation
Provide ten (10) ATLAS boosters.	Modify boosters for NASA preliminary research and manned orbital flight and safety objectives.	Launch, control and define trajectories of booster-capsule vehicle up to, and including, injection into orbit.

Table 2. AFBMD responsibilities in support of PROJECT MERCURY.

MONTHLY PROGRESS—PROJECT MERCURY

Program Administration

- Estimates of Project MERCURY funding are being revised, based upon the cost of 14 ATLAS boosters, modified to satisfy program requirements, and the launching of 13 vehicles. Launch costs for ATLAS 20D were absorbed by the ABLE Project when that booster was transferred to the ABLE-4 program in September. It appears that the revised estimate will be in the area of $50,000,000.

- A revised Project MERCURY Development Plan is being coordinated and, when formalized, will reflect program changes including revised funding estimates, revised launch schedule (to include 4 additional flights), and newly defined task areas requested of AFBMD by NASA.

- NASA has revised the mission of the second MERCURY launch, designated MA-1. Originally scheduled to carry a McDonnell, life sustaining type capsule, the reoriented mission calls for use of a McDonnell Capsule shell containing test components and instrumentation designed by NASA. The change in mission will necessitate alteration of the trajectory, configuration, test objectives and data measurements are that ATLAS booster 50D, already modified and accepted for mating with a McDonnell capsule, can be remodified to match the revised payload in time to support the late May or early June launch date.

Technical Progress

- Performance of the Project MERCURY/ATLAS boosters was discussed among NASA, AFBMD/STL and Convair personnel at meetings held early in December. Although data is still being refined, it appears that a satisfactory velocity pad can be obtained for a 105 n.m. orbit in conjunction with the boosting of a 2,508 pound MERCURY capsule (orbital weight). Weight reductions on both booster and capsule are being considered to enhance marginal performance at an orbital altitude of 115 n.m.

- The first Factory Roll-Out Inspection, one of the special procedures initiated under the Booster Quality Assurance Program, was conducted during January. Under this new procedure, ATLAS 50D was accepted by the AFBMD/STL inspection team in conjunction with the Air Force Plant Representative quality control personnel. As stated earlier, ATLAS 50D must now be remodified to meet NASA's new requirements. After completion of this remodification,

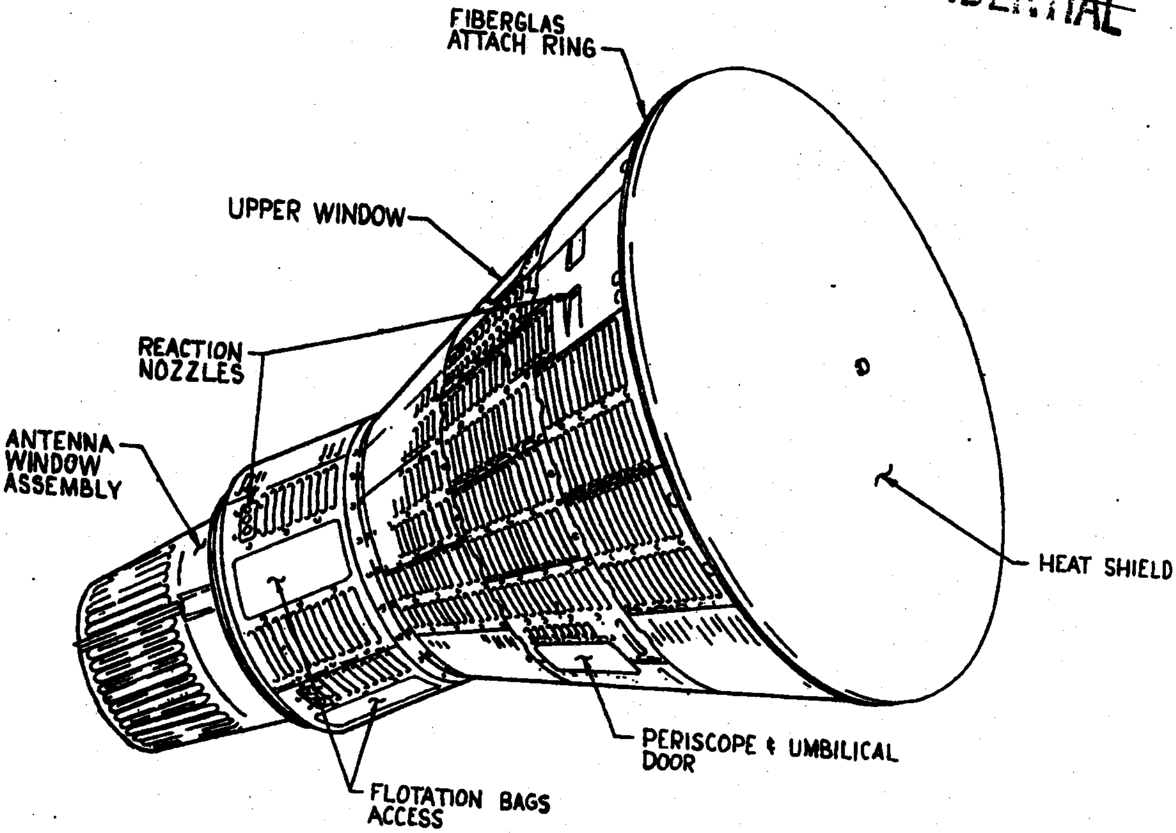


Figure 3. McDonnell capsule shell to be carried on second MERCURY/ATLAS test flight.

it is probable that another Roll-Out Inspection will be performed. It was the stated belief of all inspection personnel that ATLAS 50D represents one of the most satisfactory missiles accepted to date, providing evidence that results from the Quality Assurance Program are being realized. In addition to the Factory Roll-Out Inspection, the Quality Assurance Program includes the special selection and marking of critical components (see figure 3).

- The MERCURY Safety of Flight Review program has been initiated as an additional means of enhancing astronaut safety factors. Meetings were held during January to establish preliminary basic criteria and organizational structure for this program. Included will be a complete review of the ATLAS booster and its integration with the MERCURY capsule, physical mating of the booster and capsule, and checkout of the capsule systems that control, monitor or operate booster functions. Basic objective of this program is to assure flight readiness of the ATLAS and its compatibility with the MERCURY capsule.

Figure 4. (above) Design used to identify components which have been subjected to "added reliability" selection and inspection requirements for Project MERCURY. Symbol in center is astronomical representation used for mercury. R in circle is a "reliability reminder."

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PROJECT 609A

Hyper-Environment Test System

PROGRAM DESCRIPTION—The Hyper-Environment Research Program (609A) is divided into R&D and Operational phases. The R&D phase will be used to develop and flight test vehicles capable of carrying 50 to 1,000 pound payloads to altitudes of 200 to 7,000 miles. The Operational phase will use this standardized vehicle to permit the economical performance of flight test experiments in support of scientific research and advanced military space system programs.

Economy—Reliability—Versatility—In this order of emphasis are the three significant guides to program accomplishment. ECONOMY is being achieved

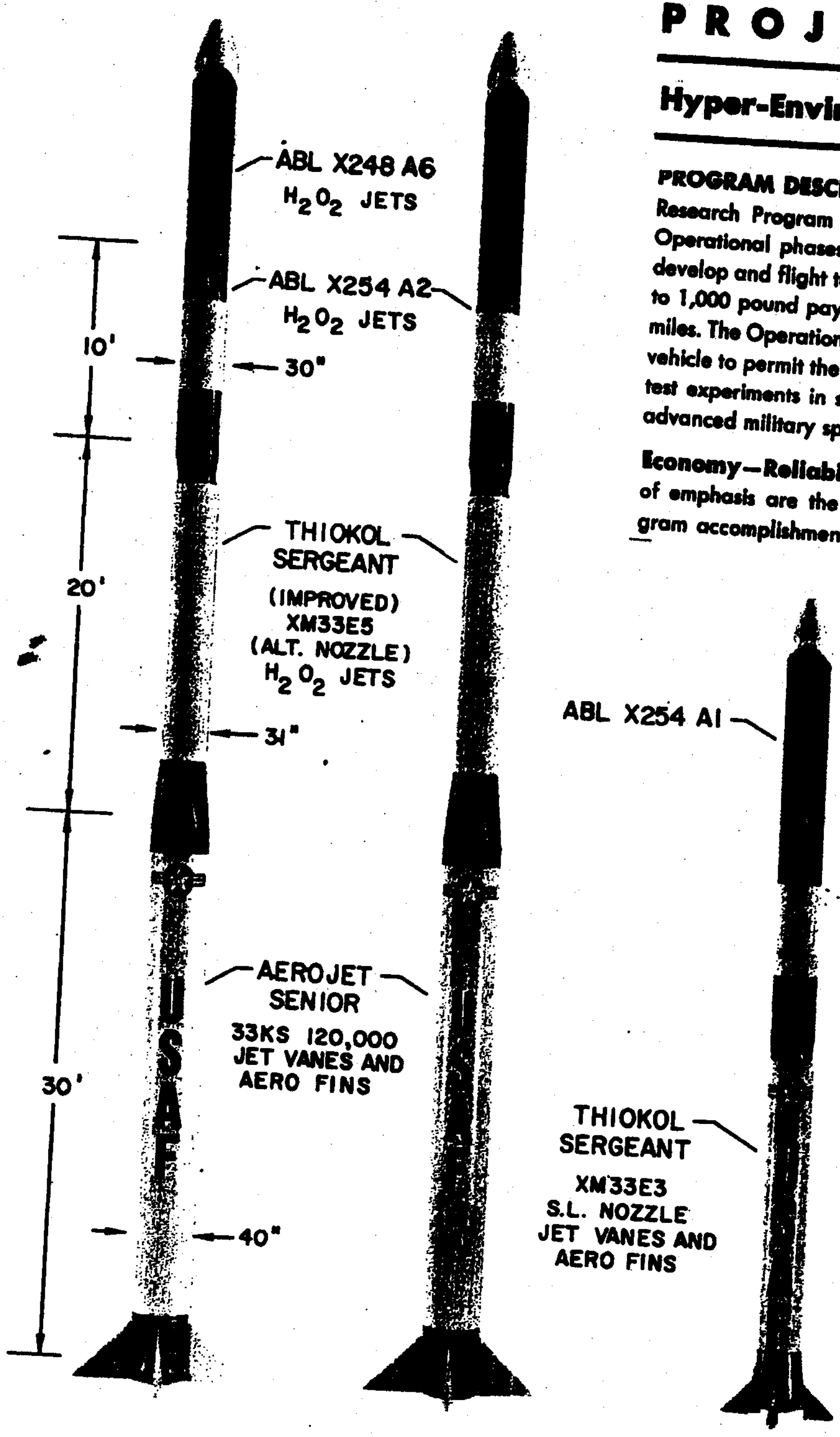

Figure 1. Three variations of Project 609A vehicle demonstrate the mission-versatility of the program.

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by long range planning and maximum integration with other programs. Use of the basic four-stage, solid propellant, SCOUT vehicle, developed by NASA and modified to achieve Program 609A objectives, will effect an economy in vehicle development. Necessary modifications include provisions for stabilizing the fourth stage without spin and use of the vehicle in less than the full four-stage configuration. Close integration with the current ballistic missile program will effect an economy by permitting tests and experiments to be conducted on regularly scheduled ballistic missile test flights whenever possible without delaying schedules. Economy in the operational phase will be exercised by the use of this low-cost vehicle as a standard flight test platform to perform scientific and military experimental research in support of all Air Force facilities. RELIABILITY will be obtained by a nine or ten vehicle R&D flight test program, at least four flights of the basic SCOUT, and maximum use of knowledge gained in prior Air Force ballistic missile flight testing. VERSATILITY will be achieved by designing a vehicle capable of being readily adapted to a wide range of payload variations, and capable of being flown in several configurations of four stages or less. This VERSATILITY results in the following flight capabilities: (a) vertical probes having a wide variance of payload weight/attitude combinations; (b) boost-glide trajectories; (c) ballistic missile trajectories; (d) downward boosted, high-speed re-entry profiles, and (e) full orbit to approximate maximum of 400 miles with 150 pound payloads.

Program Management—An abbreviated development plan, covering the R&D phase only, was approved on 9 January 1959. Funds in the amount of $8,180,000 were made available for this abbreviated portion of the program only. A letter was issued assigning management responsibility to AFBMD, with emphasis on integrating the program with the scientific and military research experiments conducted on regularly scheduled ballistic missile flight tests (Piggyback Program). In June 1959, Aeronutronic Division of the Ford Motor Company was chosen through normal competitive bidding as the Payload, Test, and Systems Integration Contractor. Arrangements have been made for the procurement of vehicle components and associated support equipment, modified to meet Program 609A requirements, through NASA, rather than through the SCOUT Program contractors. Atlantic Missile Range facilities consisting of Launch Pad 18B, its tower, and half of the blockhouse will be made available to the Air Force for this program. A division has been established within the 6555th Guided Missiles Group at AMR to supply Air Force technicians to participate in the assembly, checkout and launch operations of the R&D phase under the direction of the Payload and Test Contractor. An all-military operational capability will be developed from within this group.

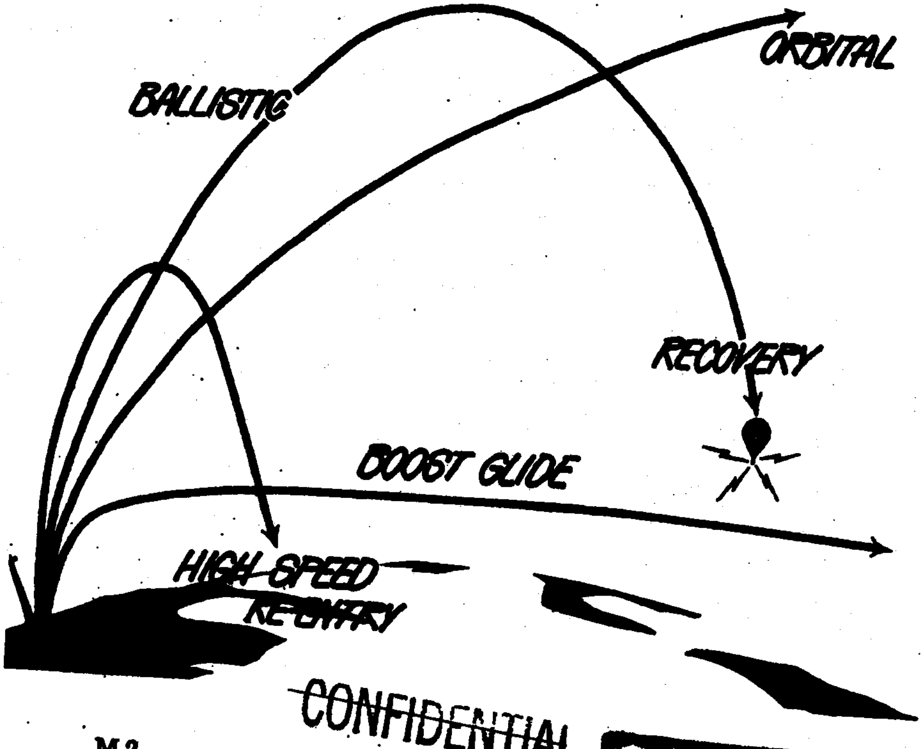


Figure 2. Four different trajectories possible using different arrangements of Project 609A stages.

Program Administration

- On 6 January authorization for commitment and obligation of fiscal year 1960 funds amounting to $4.2 millions was received from Hq ARDC.

- During December, the letter contract with Aeronutronic for payload, test, and systems integration was definitized and a contract was negotiated for a total cost, with no fee, of $2,676,000. A purchase request was initiated for $1,536,000 to increase the previous incremental funding of $140,000 to $2,676,000. Purchase requests were initiated also for the transfer of funds to NASA as follows: $500,000 for rocket motors; $1,000,000 for guidance and control subsystems; and $600,000 for airframes.

- During December, the AFSWC objectives for an advanced JOURNEYMAN space probe vehicle was integrated into Project 609A. The experimental objectives of the development test program will be accomplished in the one unguided 609A vehicle. Since this 609A vehicle is the least dependent upon the results of the NASA SCOUT launches it has been programmed as the initial Project 609A flight vehicle. Launch is scheduled for 11 May. Completion of the ten-vehicle 609A flight program is scheduled for November 1960.

Technical Progress

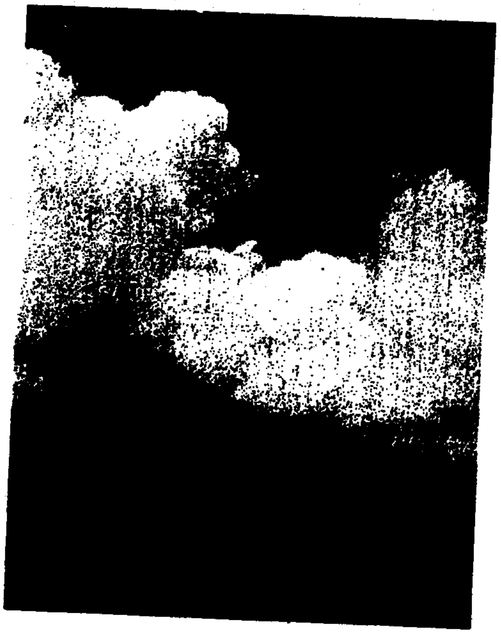
- The design features of the first 609A vehicle (unguided) were established in a meeting held at Chance Vought and attended by AFBMD personnel.

- AFBMD personnel visited the Atlantic Missile Range to present a briefing on Project 609A. Range safety and launch complex requirements were discussed in detail. Launch pad 18A will be used for the unguided vehicle and pad 18B will be used for guided flights.

- The third stage rocket motor has been modified as a result of two instances of case burn through during test runs. Six static test firings of the modified motor are scheduled to be made prior to 1 March. Two of these were accomplished successfully late in January. Two will be performed at simulated altitude in a test cell at Arnold Engineering Development Center.

- Meetings at Langley Research Center in January confirmed NASA's plans to launch the first SCOUT vehicle in late March or early April. This schedule is predicated on the successful completion of ABL X254 motor tests and the proviso that pre-flight tests of the vehicle and its subsystems give reasonable assurance of a successful launch.

SPACE



studies

SPACE STUDIES

ADVANCED SYSTEMS STUDIES

1. The Advanced Systems Studies Division has several space studies in progress. The purpose of these studies is to determine the military missions and mode of operation in space. For the purpose of study, space has been divided into three broad areas; earth orbital, lunar, interplanetary. Studies in the lunar and interplanetary area are being managed and directed at AFBMD. There are two studies in the Lunar area: SR 192 (U) Strategic Lunar System, and SR 183 (U) Lunar Observatory. There is one study in the interplanetary area: SR 182 (U) Strategic Interplanetary System.

2. The objective of SR 192 is to determine a military posture in the lunar area which is defined as the surface of the moon and the area in its surrounding gravitational field. This is a broad conceptual type study which will examine all facets of military operations such as offensive, defensive, and supporting systems. This study was funded with $600,000 in Fiscal Year 1959 and final reports from the contractors are due at AFBMD by February 1960. In addition to the three funded contractors working on this study, there are three voluntary contractors. Consequently, the total effort being applied is estimated as equivalent to one million dollars.

3. An obvious military requirement in the lunar area will be a surveillance and intelligence collection system. Therefore, SR 183 (U) Lunar Observatory was initiated to examine this problem. The objective of this study requirement is to determine a sound and logical approach for establishing a manned intelligence observatory on the moon from which the entire earth and its surrounding area can be kept under continuous surveillance. All earth orbital systems can be monitored and enemy activities in space and on the lunar surface can also be watched. All possible types of sensors and their probable ranges will be examined. This study will also include the means of logistically supporting and establishing the lunar base. This study was funded with $420,000 in Fiscal Year 1959. Three contractors were funded and three additional contractors are performing the study on a voluntary basis. Consequently, it is estimated that this study has the equivalent of $1.5 millions being applied to it.

4. The interplanetary area is being studied under SR 182 (U) Strategic Interplanetary System. The objective of this study is to determine the possible military missions and the type of equipment necessary for operations in the interplanetary area. This area is being studied separately from the lunar area because the operational problems involved appear to be somewhat different, the distances are much greater; our present knowledge of the area is limited, therefore, special types of navigational and propulsion systems will be required. This study was funded with $285,000 in Fiscal Year 1959 which has been distributed among three contractors. Contractors' final reports are due at AFBMD in February 1960.

DISTRIBUTION

Headquarters, United States Air Force	21
Headquarters, Air Research and Development Command	10
Strategic Air Command	1
Air Force Cambridge Research Center	1
Air Force Flight Test Center	1
Rome Air Development Command	1
Air Force Missile Defense Command	1
Wright Air Development Division	1
Air Force Special Weapons Center	1
Air University	4
Arnold Engineering Development Center	2
Air Proving Ground Center	6
Air Defense Command	1
Air Training Command	1
Air Photo and Charting Service	1
Air Force Missile Test Center	1
United States Air Force Academy	4
Air Technical Intelligence Center	1
6555th Test Wing (Development)	2
Air Force Ballistic Missile Division (ARDC)	66
Ballistic Missiles Center (AMC)	15
Assistant CINCSAC (SAC MIKE)	3
Aeronautical Chart and Information Center	1
Rand Corporation	1