ALLISTIC MIS
SPACE

a foreword to...

SPACE

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.

Paul E. Worthman, Col USAF

for RICHARD D. CURTIN
Colonel, USAF
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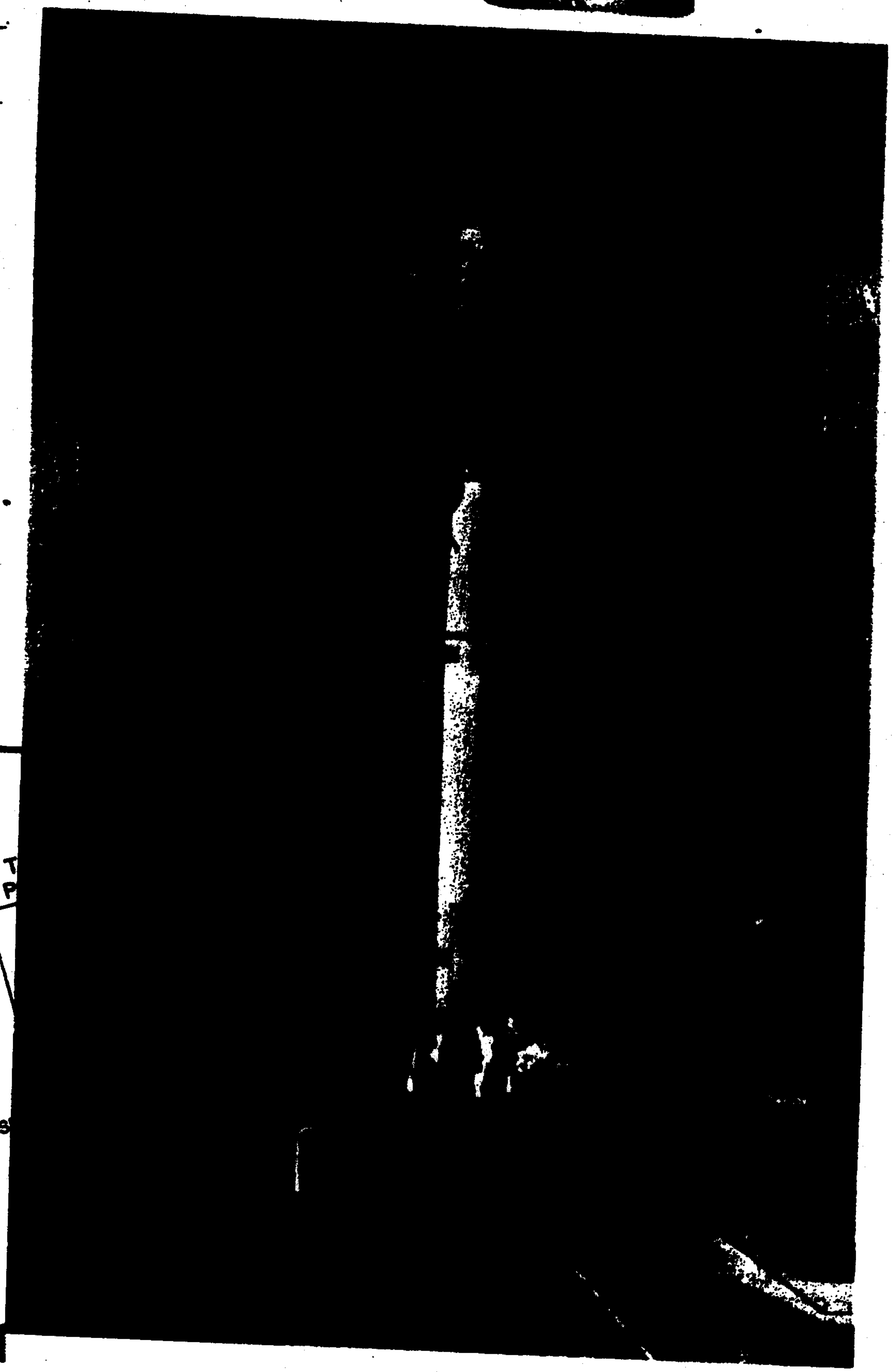
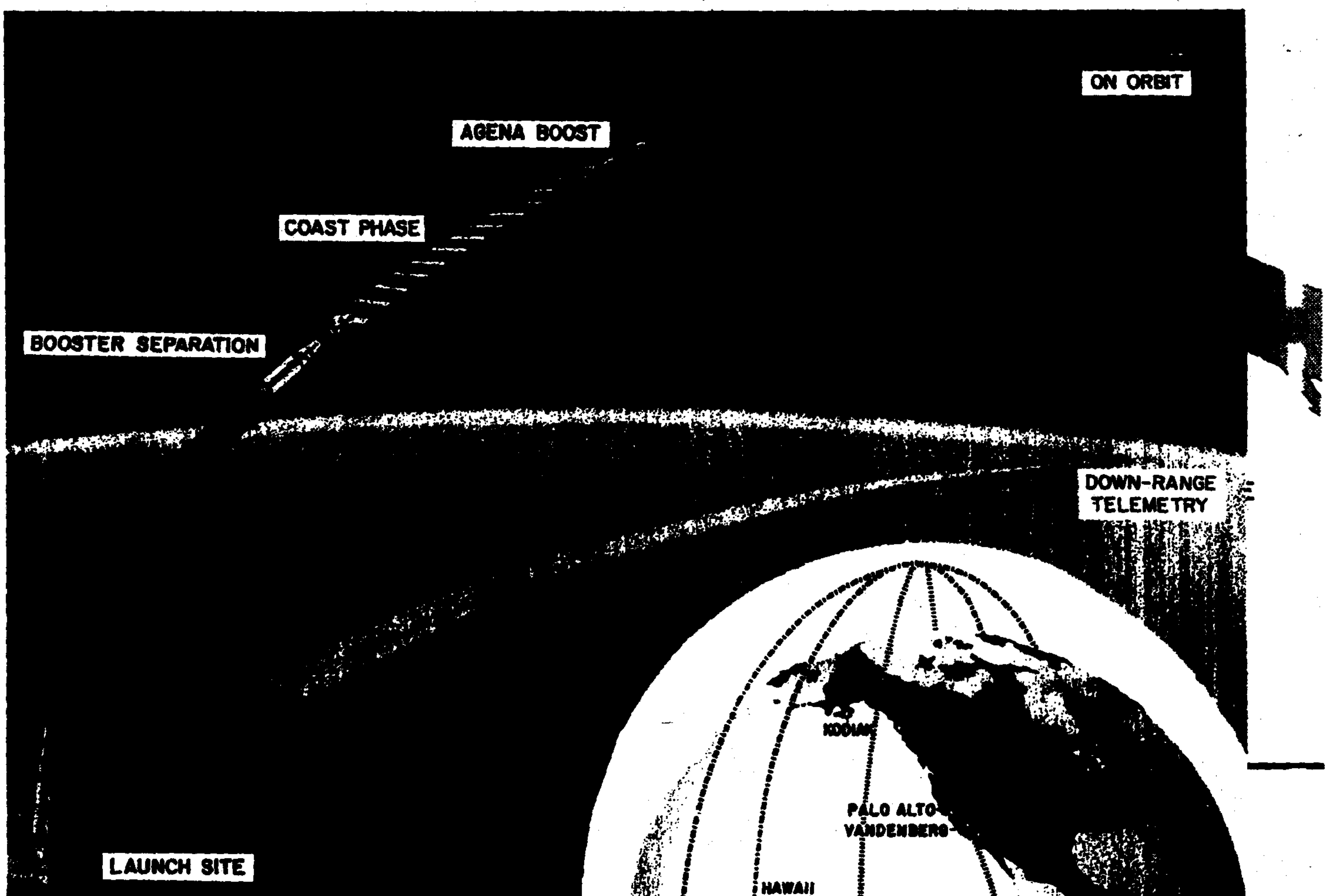
SPACE

systems



Discoverer



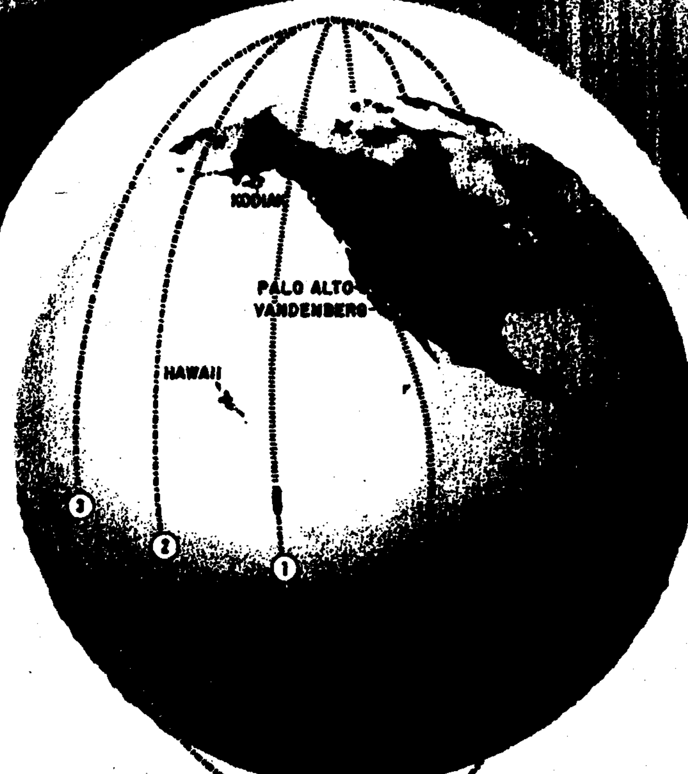


Figure 3. Typical DISCOVERER trajectory (above) from launching at Vandenberg AFB to orbit. Typical satellite orbital path around the earth (right).

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 by the Advanced Research Projects Agency, with technical management responsibility assigned to AFBMD. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform flight testing of the AGENA satellite vehicle and subsystems, and test the ground communications and tracking network in support of the Advanced Military Satellite Systems Programs.

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.

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—Wet	1,400	1,450
Fuel (UDMH)	1,900	3,800
Oxidizer (IRFNA)	4,800	9,600
GROSS WEIGHT (lbs.)	8,100	14,850
Engine	XLR81-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
Wet Weight, lbs. (max.)	275.5	265

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-3I	MB-3II
Thrust, lbs. (S.L.)	152,000	167,000
Spec. Imp., sec. (S.L.)	247.8	247.8
Burn Time, sec.	163	147.5

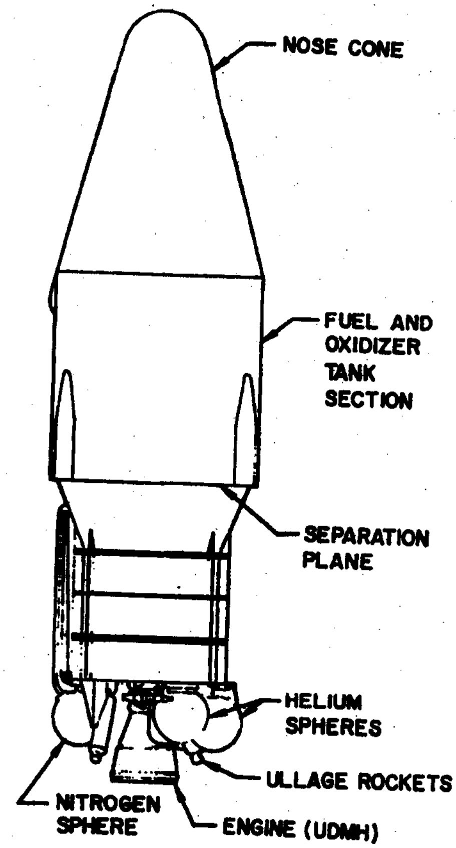


Figure 1. Photograph of two-stage DISCOVERER vehicle (left) and detailed drawing of AGENA, second stage (right).

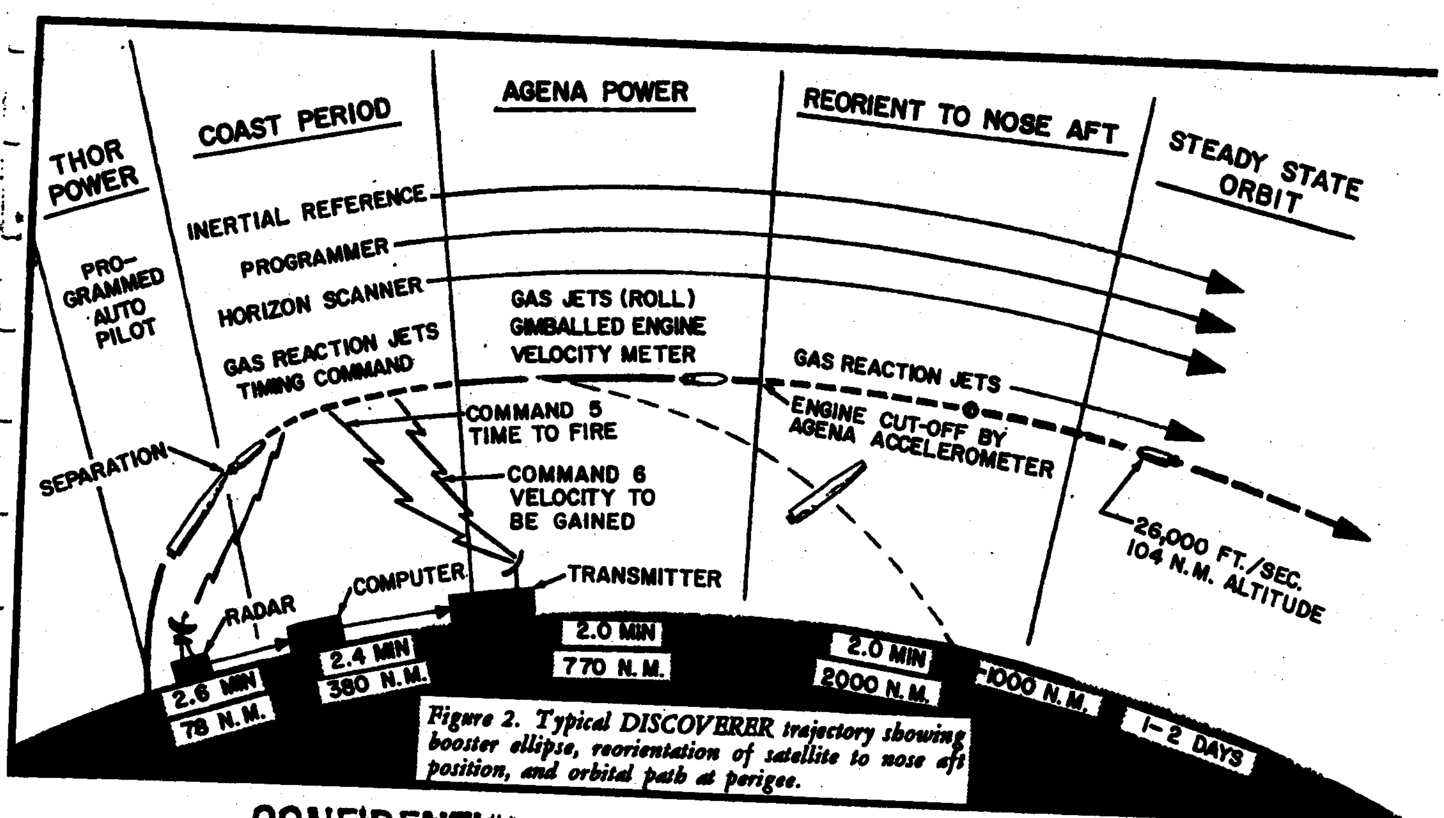


Figure 2. Typical DISCOVERER trajectory showing booster ellipse, reorientation of satellite to nose aft position, and orbital path at perigee.

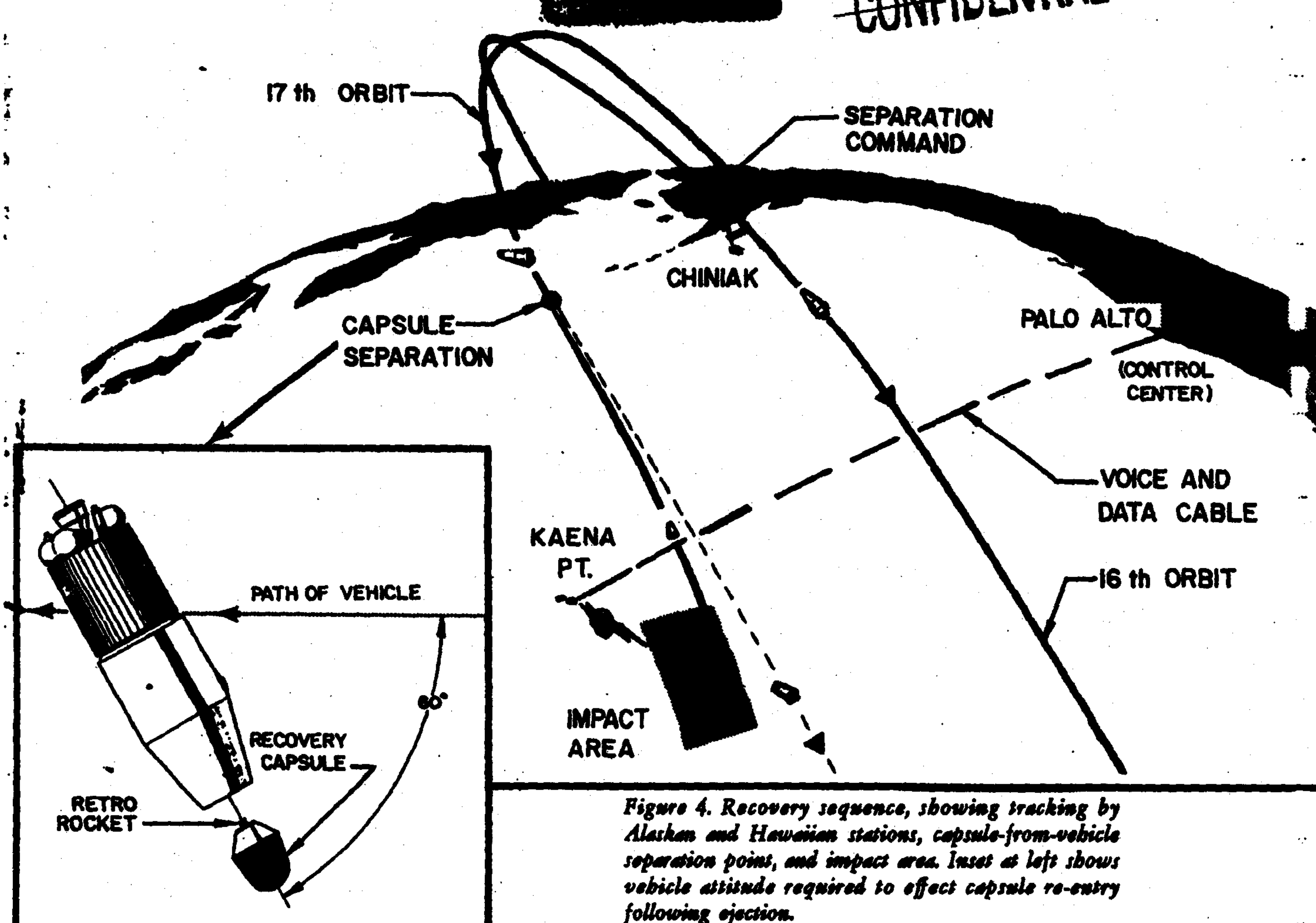


Figure 4. Recovery sequence, showing tracking by Alaskan and Hawaiian stations, capsule-from-vehicle separation point, and impact area. Inset at left shows vehicle attitude required to effect capsule re-entry following ejection.

(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.

[redacted]

	CY 59	CY 60	CY 61
	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
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DISCOVERER No.	Vehicle No.	THOR No.	Flight Date 1959	Remarks
I	1022	163	28 February	*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.*

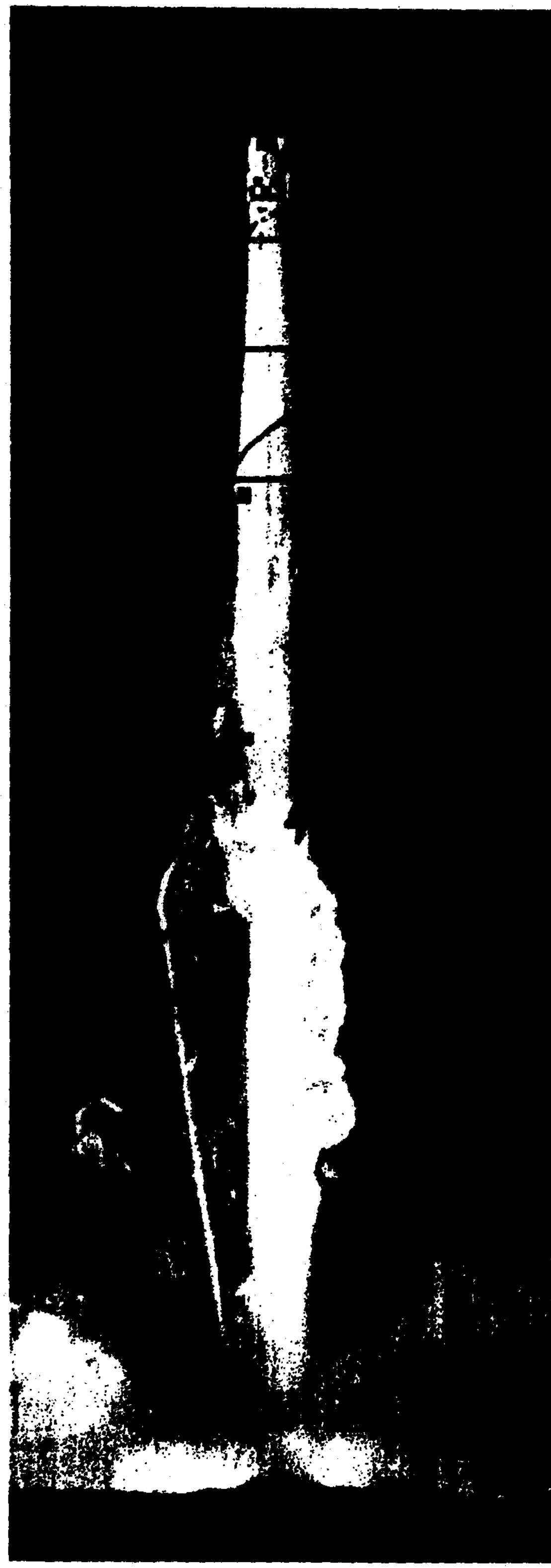

Figure 5. Launch of DISCOVERER VII from Vandenberg Air Force Base on November 7.

DISCOVERER PROGRAM— MONTHLY PROGRESS

Flight Program

Two DISCOVERER vehicles were launched and placed into orbit successfully during the month of November. These were the first DISCOVERER flights since August. The intervening period was used for extensive study and testing of the recoverable capsule system.

* * *

DISCOVERER VII was launched from Vandenberg Air Force Base at 1226 PST on 7 November. On 3 November the first countdown was delayed because of inclement weather and minor technical difficulties. The second countdown began at 0430 on 7 November. Only one hold of 54 minutes was required to correct a leak in the acid fill line and a malfunction of the fuel-fill umbilical quick-disconnect. Liftoff was normal and first stage trajectory accurate. Azimuth

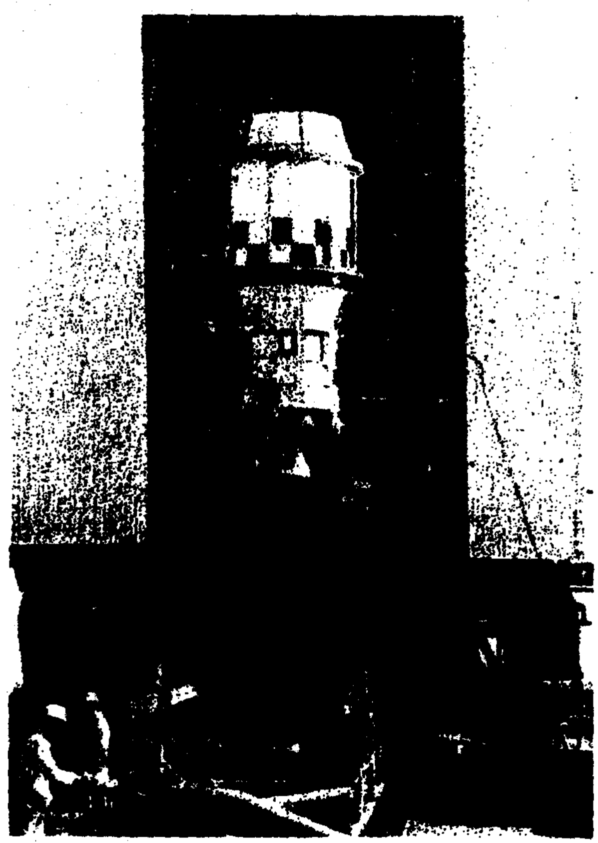

Figure 6. DISCOVERER second stage AGENA "A" vehicle in test stand at Santa Cruz Test Base.

heading was as planned and altitude achieved was only two miles below nominal. The THOR engine operated for 163.85 seconds (one second short of the predicted time). AGENA engine ignition and operation were satisfactory. Orbital status was verified by tracking stations on the first two passes and the orbital period was established as 94.6 minutes. Tracking operations were satisfactory, with Point Mugu obtaining data from 44 to 400 seconds after liftoff and Vandenberg from liftoff to 180 seconds. Data was received by the telemetry ship from liftoff to 690 seconds. Orbit parameters for this flight are given in Table 1.

* * *

Telemetry received at Kodiak and Hawaii on the first pass indicated that the 400 cycle power had failed. Since this power is used by the satellite attitude control system and the D-timer, it is accepted that the vehicle tumbled and the recovery capsule ejection sequence was not initiated. An investigation is being conducted.

	Predicted	Actual
Injection Velocity, ft/sec	26,040	26,230
Apogee, n.m.	380	455
Perigee, n.m.	104	87
Period, min.	93.5	94.6
Inclination Angle, deg.	79.9	81.6
Eccentricity	0.037	0.50
Lifetime, days	24	14*

*Predicted following launch

TABLE 1. DISCOVERER VII Orbit Parameters

Figure 7. Telemetry receiving site at Vandenberg Air Force Base for DISCOVERER flights.

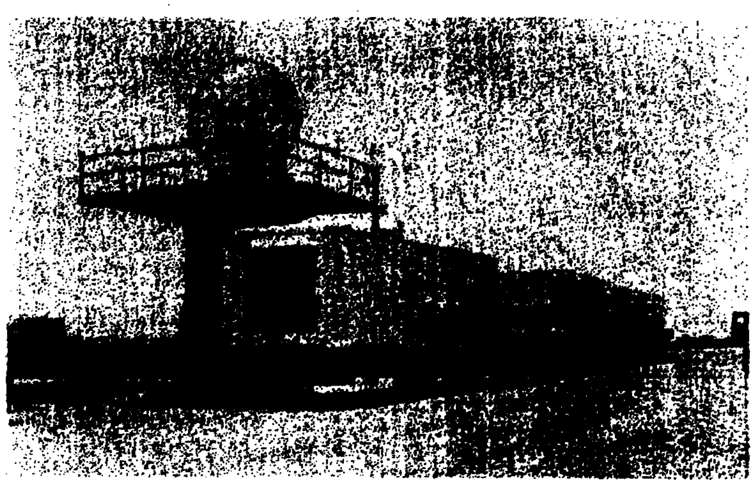

Figure 8. Verlort radar vans at Point Mugu, California. In addition to tracking DISCOVERER flights, this equipment transmits commands 5 and 6 to the AGENA second stage vehicle Command 5 is the "time to fire" correction and command 6 is the "velocity to be gained" correction.

DISCOVERER VIII was launched from Vandenberg Air Force Base pad 5 at 1125 PST on 20 November. The countdown started at 0402 and was highly successful, with only two minor holds totaling 27 minutes being required. The THOR trajectory was nominal and main engine burnout occurred at 164.15 seconds. Commands 5 ("time to fire" correction) and 6 ("velocity to be gained" correction) were transmitted successfully to the second stage AGENA vehicle. A malfunction in the accelerometer-integrator circuit, however, prevented shutdown of the satellite engine when the desired (command 6) velocity had been reached and operation continued until propellant exhaustion. The additional burning time resulted in a terminal velocity 815 feet per second greater than desired, and caused a more eccentric orbit than planned. Orbital parameters for this flight are given in Table 2.

* * *

The longer orbital period necessitated programming of recovery capsule ejection to the fifteenth instead of the seventeenth orbit to permit ejection within range of the recovery forces. The ejection sequence was initiated at approximately 1315 PST on 21 November. Telemetry data indicate that the capsule was ejected. The telemetry ship J. E. Mann, stationed between Alaska and Hawaii, received telemetry from the capsule after separation from the AGENA. This telemetry confirmed the proper operation of the separation and spin-retro-despin rocket sequence, and jettisoning of the rocket thrust cone. Kaena Point tracking station also received capsule telem-

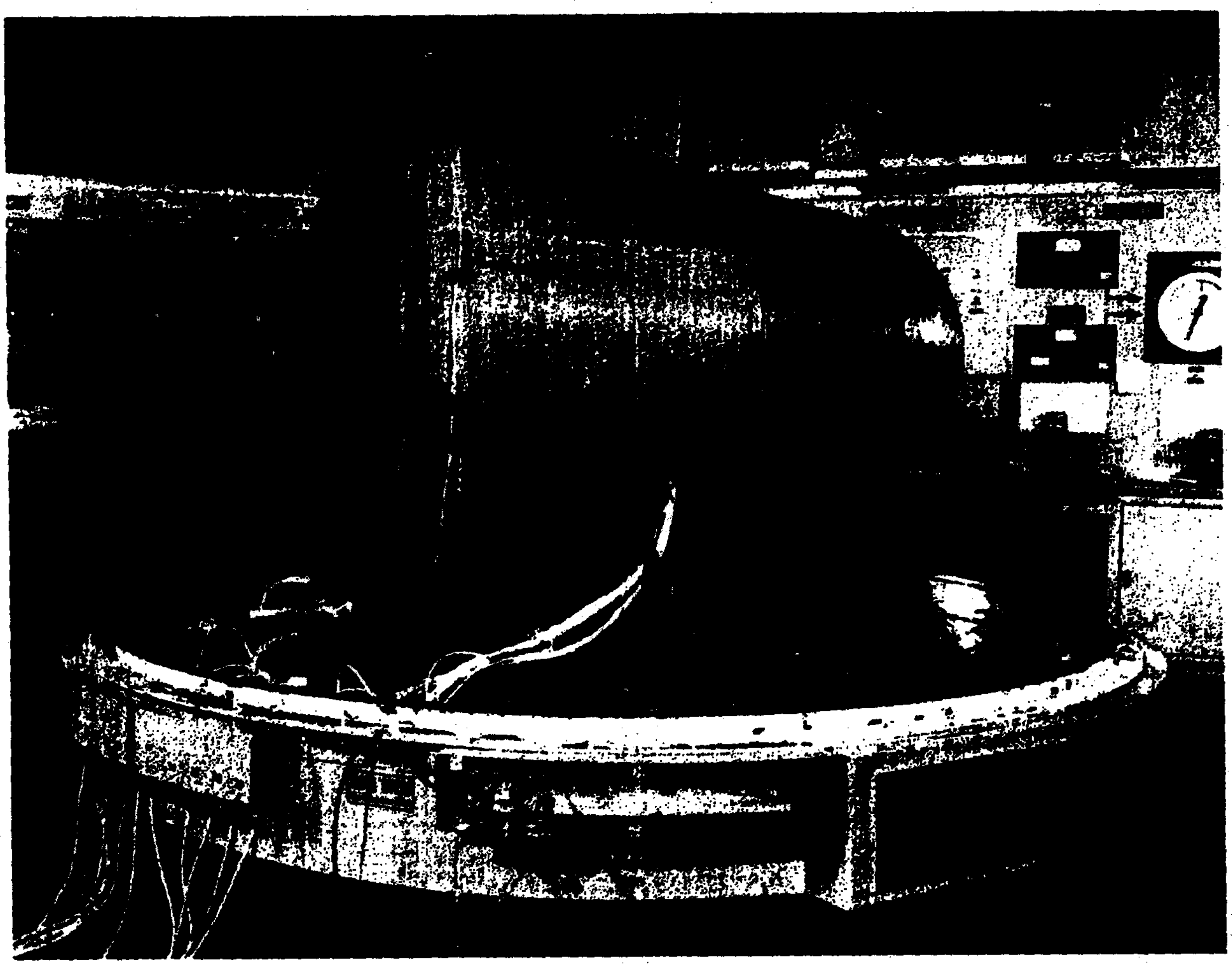

Figure 9. Biomedical test capsule USB-38 prior to thermal profile tests under simulated orbital conditions. Capsule is instrumented between outer shell and life cell.

etry but from a higher elevation than predicted. The recovery forces (eight C-119 aircraft and one recovery ship) received capsule beacon transmission but only for a short period. No further signals were received and the capsule was not recovered. Neither the capsule nor the chaff were detected by the radar aircraft. Preliminary examination of data reveals that capsule tracking and recovery were prevented by the following factors:

1. Although horizon scanner operation was excellent, satellite attitude control was lost because of control gas depletion due to higher apogee and greater orbital period than planned.
2. Satellite angle at time of capsule ejection was probably 90 degrees instead of the programmed 60 degrees.
3. Because of higher than nominal apogee and incorrect satellite angle, capsule impact probably occurred 700 miles south of predicted point.

Detailed investigation of the reasons for non-recovery is being conducted.

	Predicted	Actual
Launch Azimuth, deg.	172	171
Injection Altitude, n.m.	104	101
Injection Velocity, ft/sec	26,040	26,855
Injection Angle, deg.	0	−0.153
Eccentricity	0.037	0.102
Perigee, n.m.	104	101
Apogee, n.m.	380	911
Period, min.	93.5	103.7
Predicted Lifetime, days	24	86*

*Predicted following launch

TABLE 2. DISCOVERER VIII Orbit Parameters

Technical Status

AGENA vehicles for the next five DISCOVERER flights are at Vandenberg Air Force Base undergoing prelaunch preparations. Vehicles for the following three flights are at Santa Cruz Test Base. Two of these were accepted by the Air Force on 17 November.

* * *

As a result of extensive radar tracking of aircraft flights in the Vandenberg AFB and Point Mugu areas prior to November launches probable sources of radar interference were determined. The suspected installations cooperated by shutting down operations during DISCOVERER VII and VIII pre- and post-launch periods. Successful tracking of both flights confirmed the effectiveness of and necessity for the remedial measures.

Biomedical Program

Testing of a special biomedical capsule (USE-38) to determine thermal profile test extremes under anticipated orbital conditions were completed on 25 November. Initiated on 18 November, the tests were conducted in the High Altitude Test Simulator at the Lockheed Sunnyvale facility. The capsule was heavily instrumented to permit determination of the thermal resistance between the ablative shell and the life cell. Results of these tests should determine whether modifications for more heating and/or cooling of the life cell are required.

* * *

Biomedical testing with a live primate will be resumed late in January, using the modified USE-15 capsule. This test capsule is being modified to correct the air conditioning deficiency which caused the abort of the last test with a live specimen. Results of the thermal tests of the USE-38 capsule (reported in previous paragraph) may require further modification to the USE-15 capsule before the live specimen test is initiated.

* * *

Prior to the resumption of live specimen testing, demonstration tests will be performed on an additional life cell at the Aviation School of Medicine, Brooks Field, Texas. Purpose of the demonstration will be to show that the air regeneration problems previously encountered have been solved by the current modifications.

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—Wet (lbs.)	1,400	1,450
Fuel (UDMH)	1,900	3,800
Oxidizer (IRFNA)	4,800	9,600
GROSS WEIGHT (lbs.)	8,100	14,850
Engine	XLR81-Ba-5	XLR81-Ba-7
Thrust (lbs. vac.)	15,000	15,000
Spec. Imp. (sec. vac.)	277	277
Burn time (sec.)	120	240

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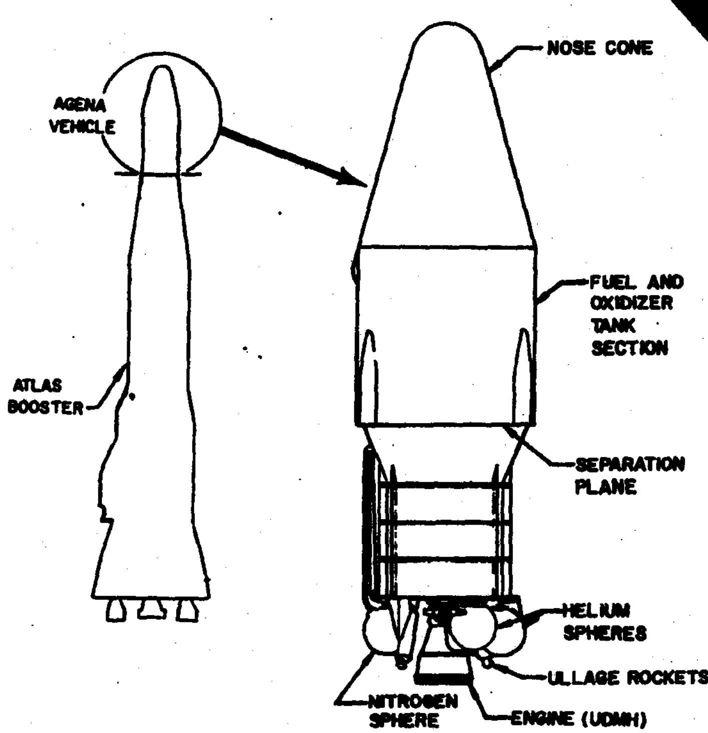
Figure 1.

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 subsequently separated WS 117L into the DISCOVERER, SAMOS, MIDAS programs with the SAMOS objectives based on a visual and ferret reconnaissance system.

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.

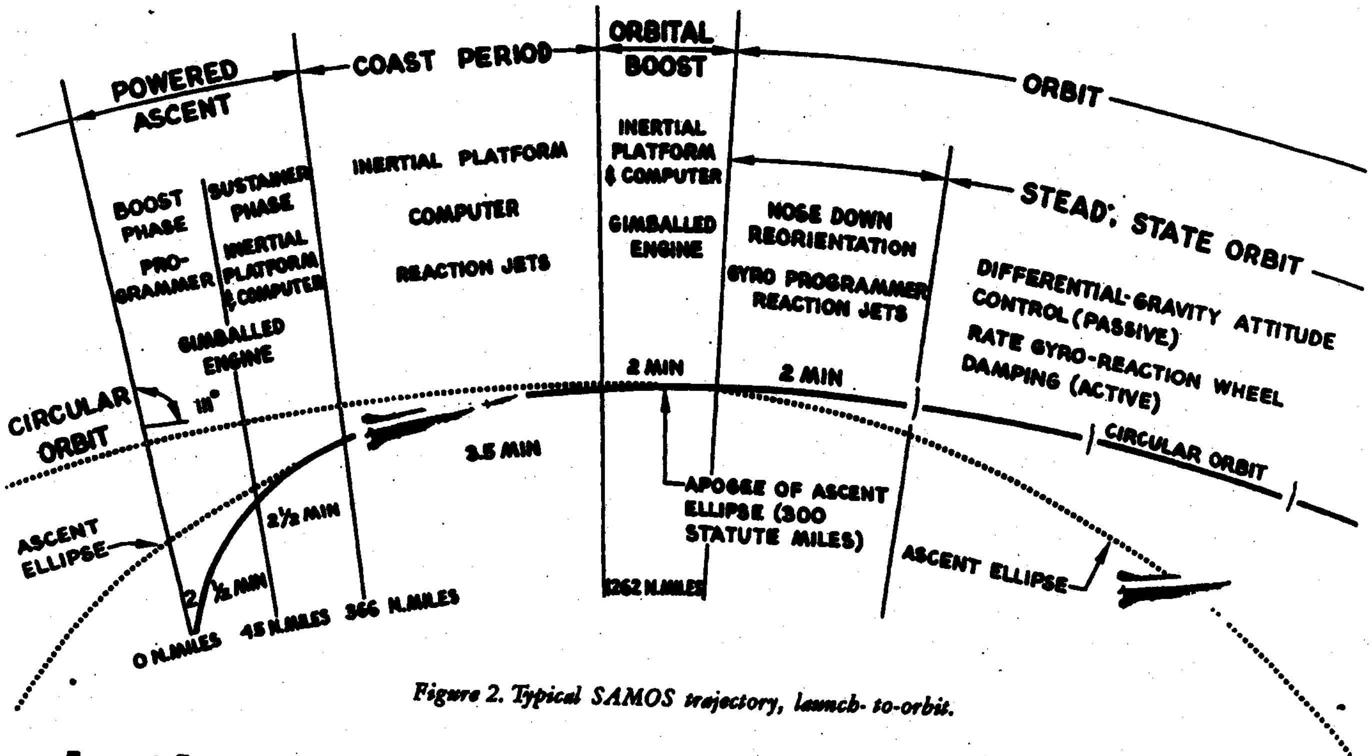


Figure 2. Typical SAMOS trajectory, launch- to-orbit.

Ferret Reconnaissance . . .

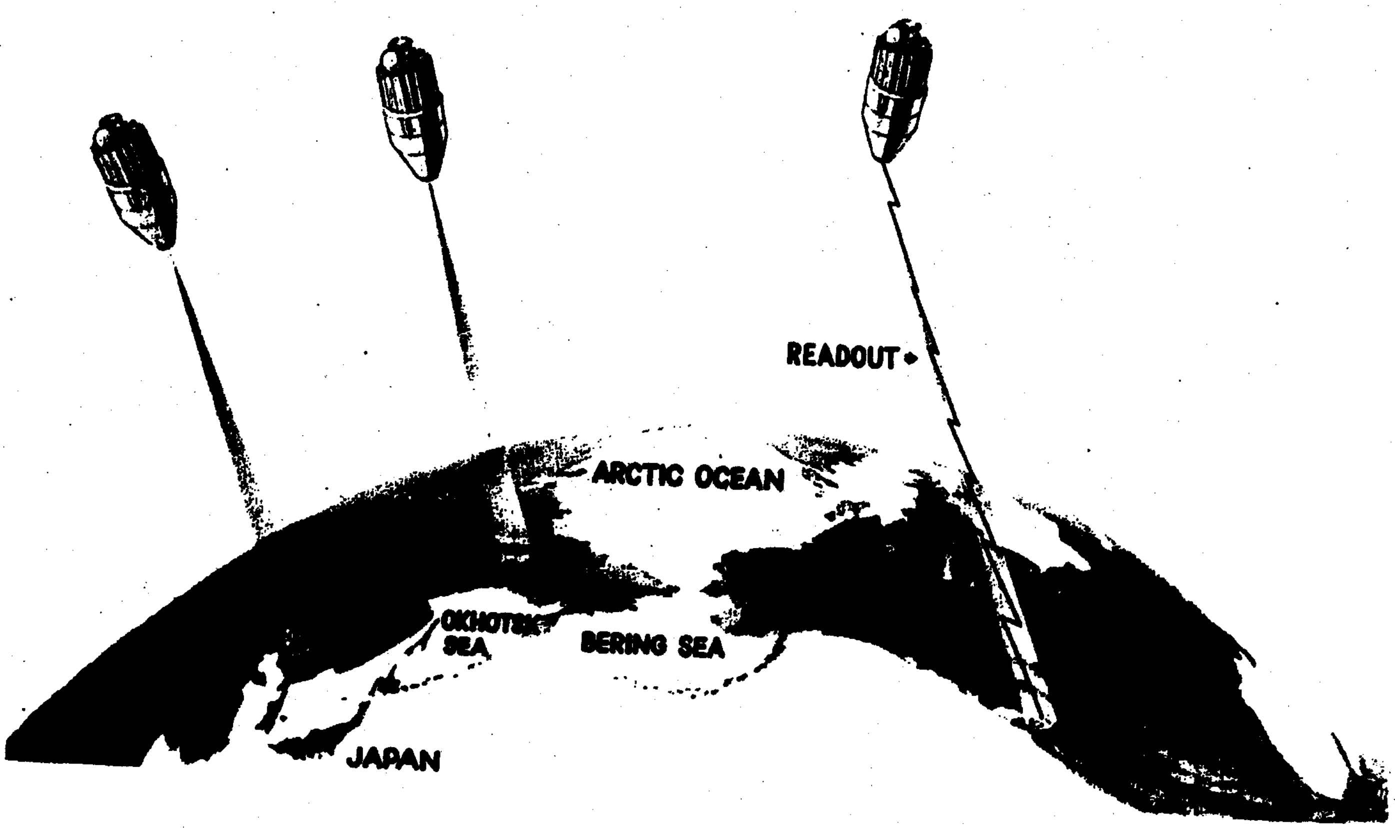


Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over unfriendly territory.

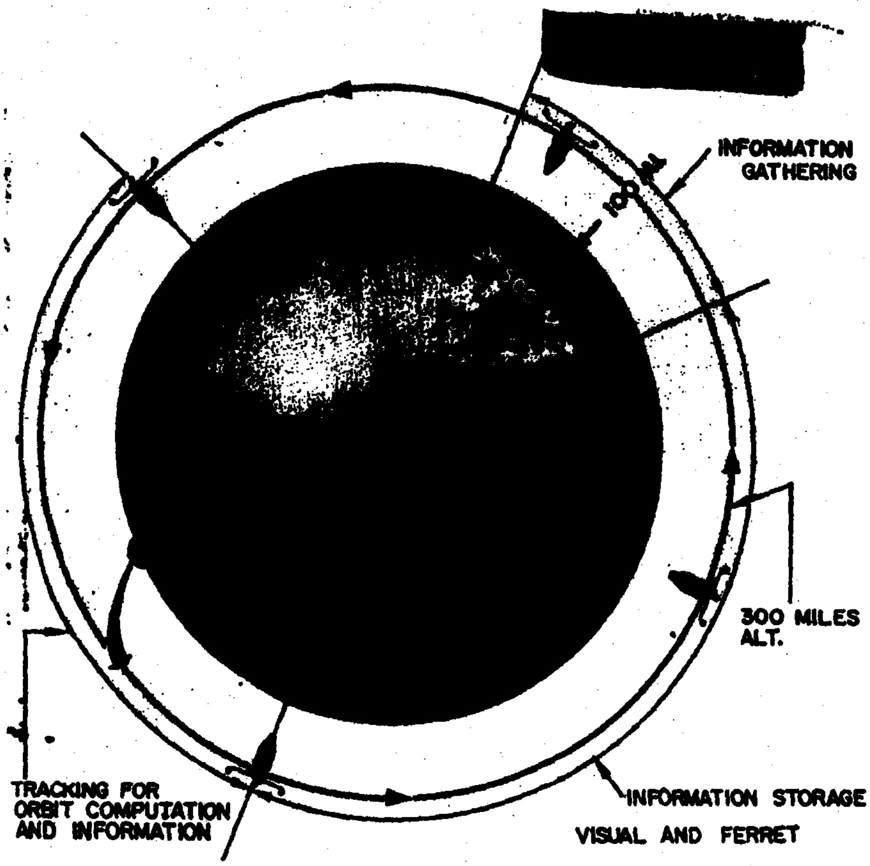


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over unfriendly territory the sensing equipment is turned on (Information gathering). When it leaves unfriendly territory the sensing equipment is turned off and the sensing data is processed (Information storage). When the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

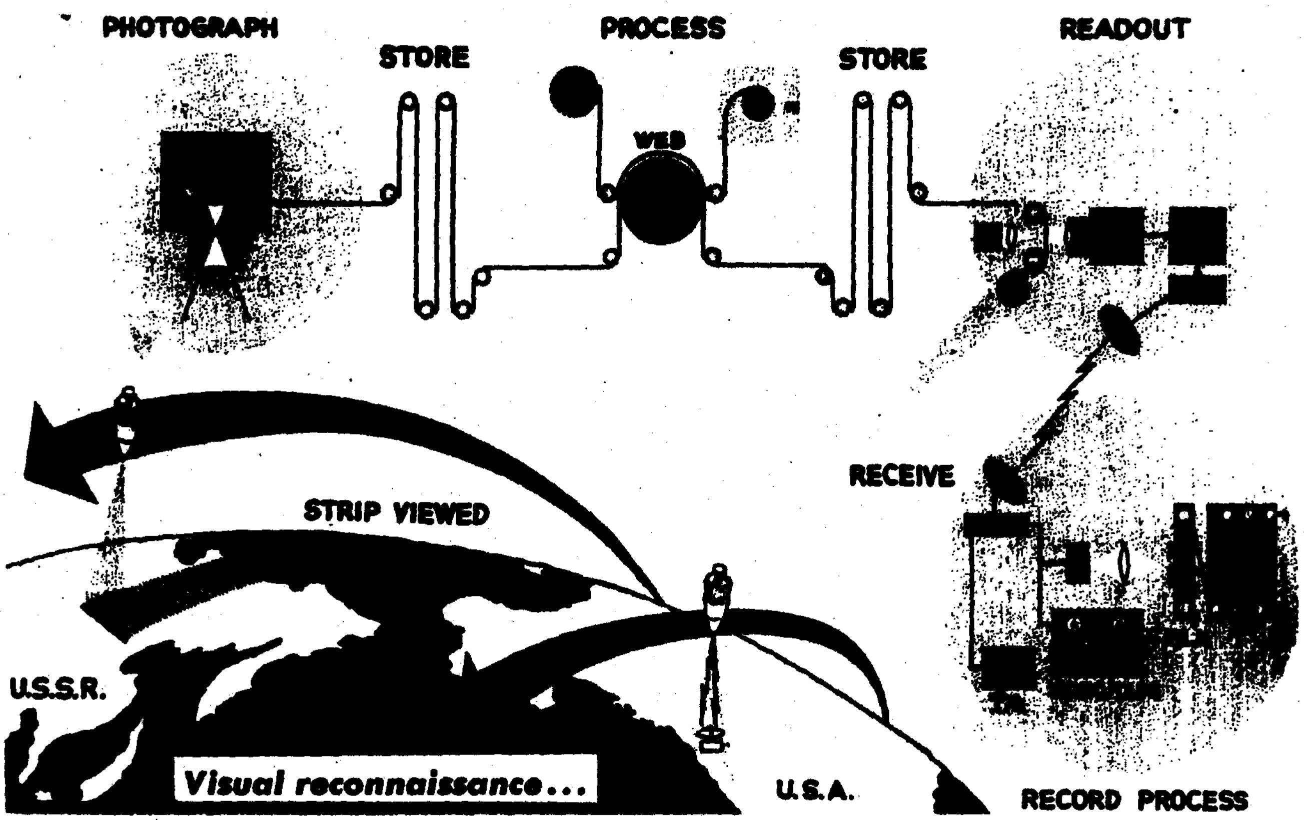


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects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

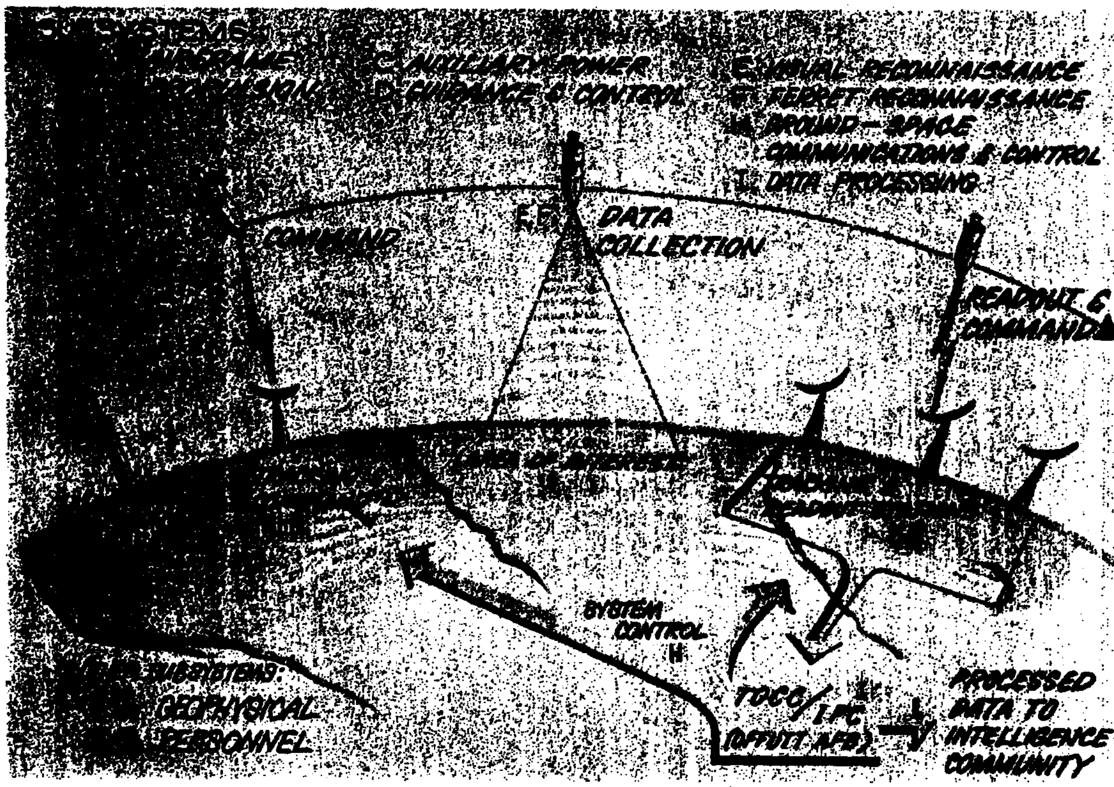


Figure 6. SAMOS concept, showing reception of commands and transmission of data between satellite and ground station; and subsystem functions (schematic).

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 [redacted]

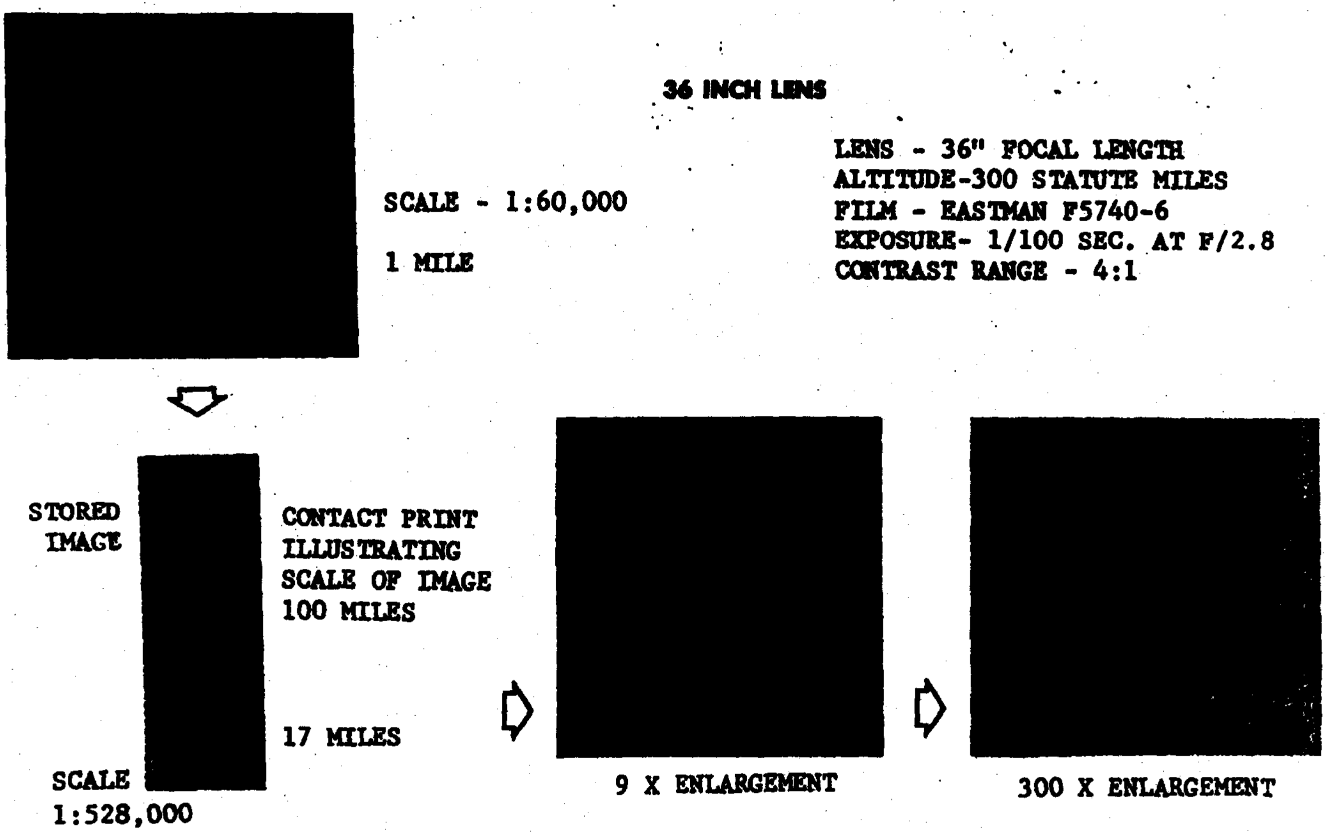


Figure 7. Simulated photography from satellite vehicle.

SAMOS PROGRAM—MONTHLY PROGRESS

Final assembly of the AGENA "B" vehicle for the first SAMOS flight was started on 9 November and is scheduled for completion by 31 December. Operations on this vehicle at the Modification and Checkout Center are scheduled for completion by 15 February and at the Santa Cruz Test Base by 22 March. These dates are compatible with the present launch date of 24 June. Fabrication of second stage components and subassemblies for the second SAMOS flight vehicle are proceeding on a schedule approximately six weeks behind that of the first vehicle. Both flights will carry combined visual and ferret reconnaissance system payloads.

Visual (photographic) Reconnaissance Systems

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

Readout Flights

- *E-1 Component Test Payloads*
- *E-2 Steerable Reconnaissance Payload (with 20-foot ground resolution)*

Recoverable Flights

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

Assembly of the first E-1 payload was completed at Eastman Kodak Company during November. This payload is scheduled to be flown in combination with the first ferret payload on the first SAMOS flight. The E-1 payload was subjected to 72 hours of continuous operation during functional tests under simulated orbital conditions. Low contrast resolution up to 88 lines per millimeter was obtained on web-processed film. During subsequent environmental testing, the payload was damaged extensively when the pressure shell clamping ring was improperly secured. The payload has been diverted for type testing use only. The second E-1 payload, originally scheduled for type testing use, will be delivered as the first flight article on 22 December.

* * *

Fabrication of components for the first E-2 prototype payload is proceeding on schedule. This payload will be delivered to LMSD on 15 March. Testing and evaluation of the engineering development model E-2 payload are continuing. Modifications resulting from this test will be incorporated in the first E-2 prototype payload.

* * *

Delivery of ground support equipment for the visual reconnaissance systems checkout area at LMSD was completed with the arrival of the vehicle power simulator on 24 November. Installation of all other equipment for this facility was completed during October. The primary record film processors for the missile assembly building and the tracking and data acquisition station at Vandenberg Air Force Base were delivered on 23 November on schedule. Installation of this equipment began on 30 November. Technical negotiations for development of the recoverable visual reconnaissance system (E-5) are being conducted with the Itek Corporation. This payload will probably use a mirror system to permit horizontal mounting of the payload in the vehicle. The camera lens will have an aperture of f/5 and a focal length of 66 inches. A ground resolution of 5 feet from a flight altitude of 155 nautical miles is planned.

Ferret (electronic) Reconnaissance System

Ferret Reconnaissance System payloads also 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*

The first and second deliverable F-1 prototype payloads are in modification and checkout for installation of the VHF telemetry commutator and antenna. Subsystem checkout, prior to testing in the vehicle, is scheduled to begin early in December. The first payload is the flight article for the first SAMOS vehicle, and the second payload is a spare. Both payloads were delivered to LMSD on 23 November, following completion of performance compliance tests at Airborne Instruments Laboratory (AIL). The third F-1 payload will be flown as part of the combination visual-ferret payload on the second SAMOS flight. This payload will undergo performance compliance tests on 2 December. Formal compliance testing will begin on 14 December, following vibration and inhibit action tests.

* * *

Performance compliance testing of the Data Conversion Equipment, for use with the F-1 payloads, is continuing. Minor circuit modifications are being made with testing of the fully assembled equipment scheduled to be resumed early in December. This equipment is scheduled for delivery to LMSD on 29 January, for installation in the Development Control Center.

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Delivery of both F-2 payloads to LMSD has slipped approximately 30 days because of procurement and technical difficulties. Deliver is scheduled now for the latter part of April.

* * *

Testing of the F-2 thermal mockup payload in the LMSD high altitude temperature simulator is scheduled to be resumed in December. Results of tests completed in September indicate that skin coating techniques used on the mockup will permit satisfactory component operating temperatures.

* * *

Fabrication and assembly of the F-2 evaluation and command equipment are progressing satisfactorily. This equipment is scheduled for delivery on 3 June 1960, for installation at Vandenberg Air Force Base and the New Boston Tracking and data acquisition stations.

* * *

The design criteria and performance specifications for the F-3 payloads have been received by LMSD and are undergoing technical review. Fabrication of the F-3 payload structure is scheduled to begin in December. The extended capabilities of the F-3 system over the F-2 system made necessary certain modifications and redesign in portions of the vehicle data handler. A breadboard model of this equipment was assembled at AIL and is ready for test.

Ground Support Facilities

The Missile Assembly Building at Vandenberg Air Force Base is nearing completion. Revised beneficial occupancy dates of 1 December for the bulk of the building, and 15 December for the dust-free area, have been scheduled. Beneficial occupancy of the Point Arguello Launch Complex blockhouse began in August, with occupancy of Launch stands 1 and 2 scheduled for January 7 and 8.

* * *

Construction of the VAFB tracking and data acquisition station is progressing on schedule, with completion of various facilities scheduled on an incremental basis through January. Final inspection of the New Boston station angle tracker, command transmitter, and UHF telemetry receiver facilities was made during November. The remainder of the facilities for this station are scheduled for completion incrementally from February to September 1960. Plans and specifications for the Ottumwa, Iowa station are complete and ready for contract advertising. Design of support facilities for this station is being initiated. Construction is scheduled to begin in December, with completion scheduled for February 1961.

* * *

Construction of the Development Control Center increment one will be ready for final acceptance in December. Contract for increment two was awarded in November, with completion scheduled for June. Design completion for the Space Operations Control and Data Processing Facility at Offutt Air Force Base is scheduled for March.

Figure 1.
Artists' concept of MIDAS satellite. Line drawing of complete flight vehicle (right) and detailed view of basic AGENA upper stage (left).

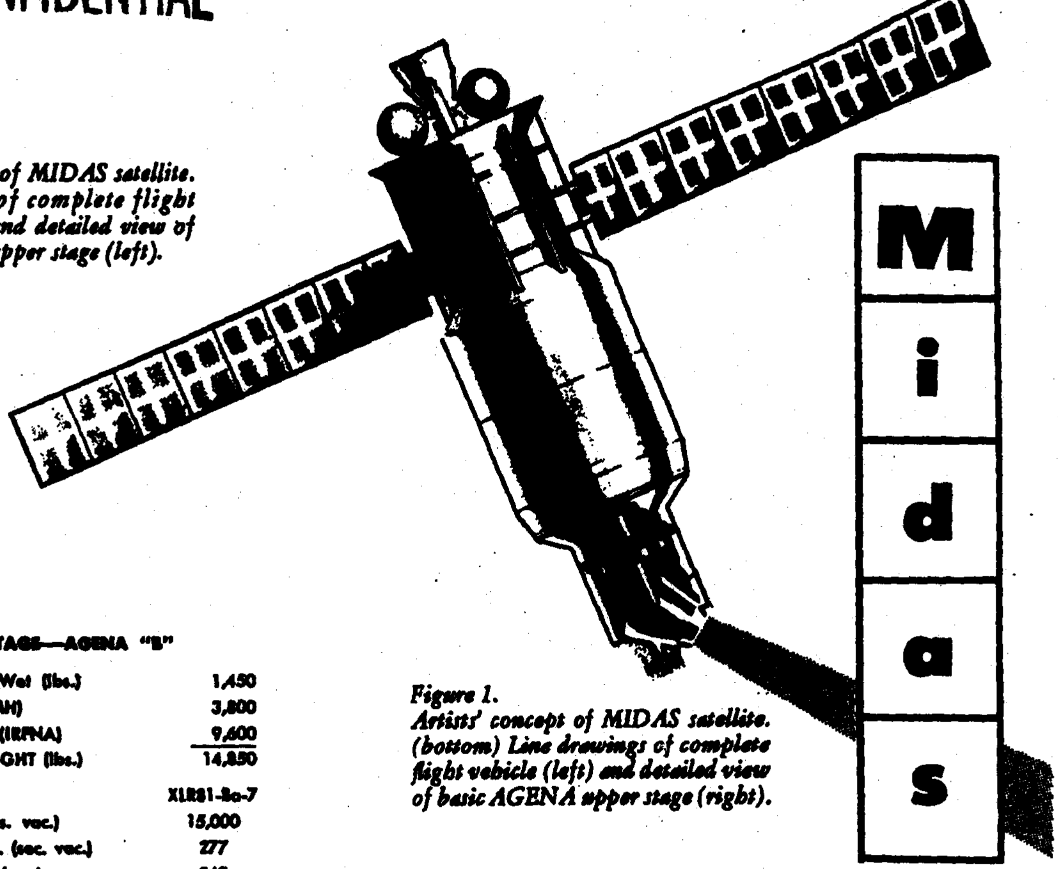
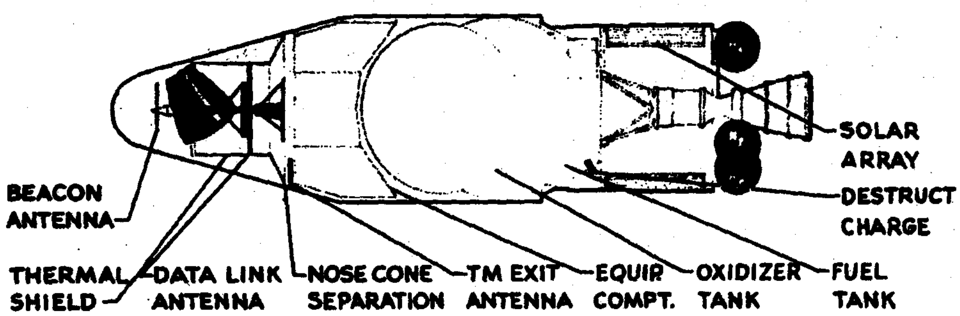
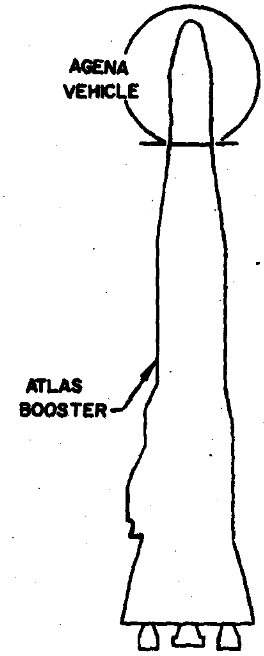


Figure 1.
Artists' concept of MIDAS satellite. (bottom) Line drawings of complete flight vehicle (left) and detailed view of basic AGENA upper stage (right).

SECOND STAGE—AGENA "B"

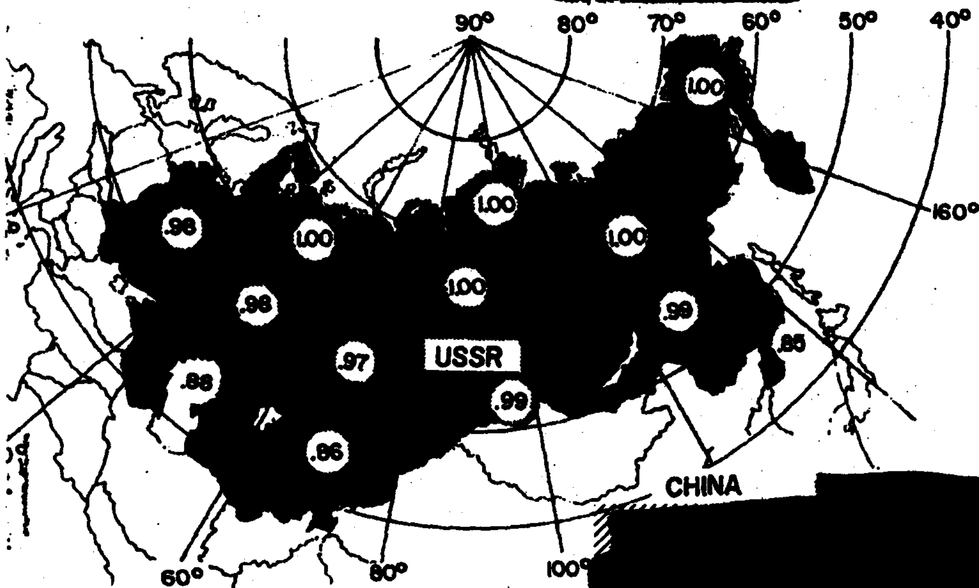
Weight—Wet (lbs.)	1,450
Fuel (UDMH)	3,800
Oxidizer (IRFNA)	9,600
GROSS WEIGHT (lbs.)	14,850
Engine	XLR81-Ba-7
Thrust (lbs. vac.)	15,000
Spec Imp. (sec. vac.)	277
Burn time (sec.)	240





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



CONDITIONS:
2,000 n.m. altitude
8 vehicles in polar orbit
Readout stations
England
North Atlantic
North Pacific

Figure 4.
Orbiting satellites detect infrared radiations released by Soviet ICBM launches. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveals EXACT number of missiles launched and APPROXIMATE 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 has been determined to be 1,014 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.

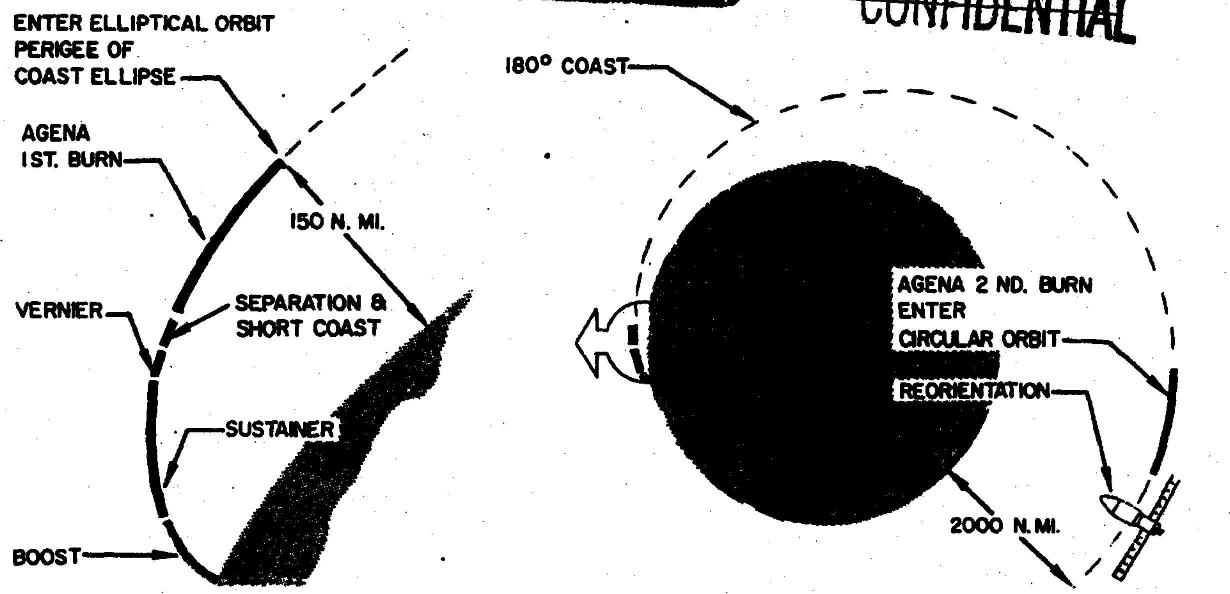
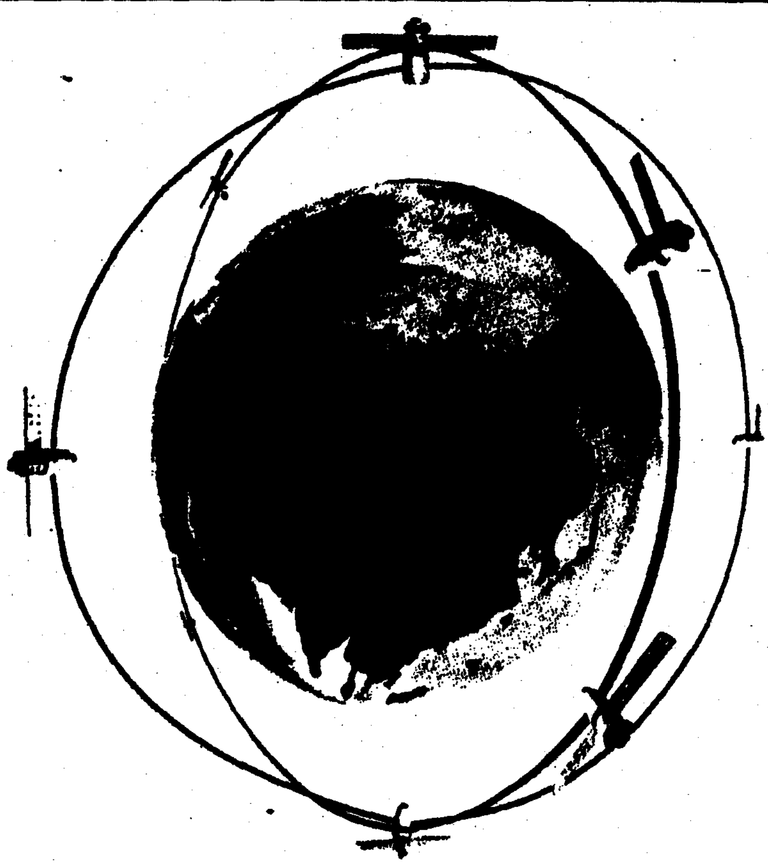


Figure 2.
Launch-to-orbit trajectory. Optimum ATLAS boost, guided by radio-inertial system. AGENA ascent (coast, burn, coast, second burn) provides attitude reference. Also governs velocity magnitude and direction by inertial guidance system monitored by horizon scanner. Orbital attitude maintained by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



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 is directed by ARPA Order No. 38, dated 5 November 1958. Development activities will lead to the first of a ten flight R&D program in January 1960, with a reliable operational system scheduled for 1962.

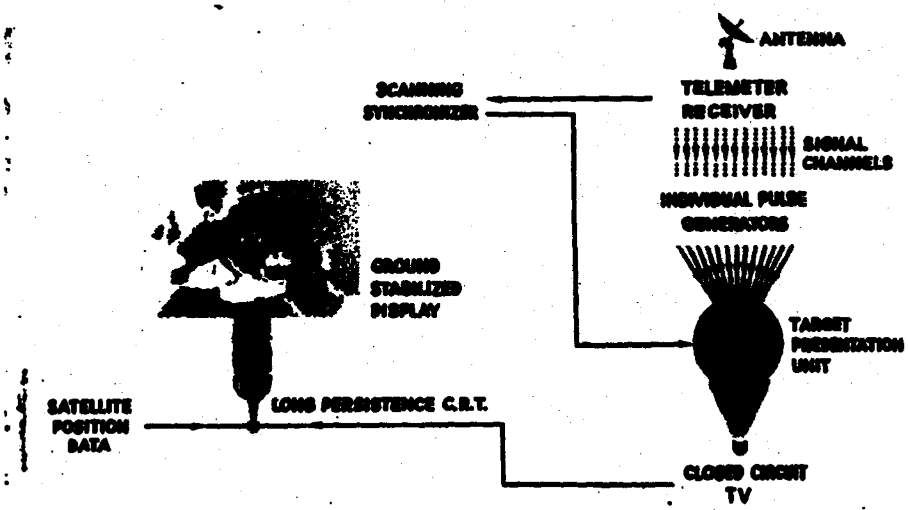
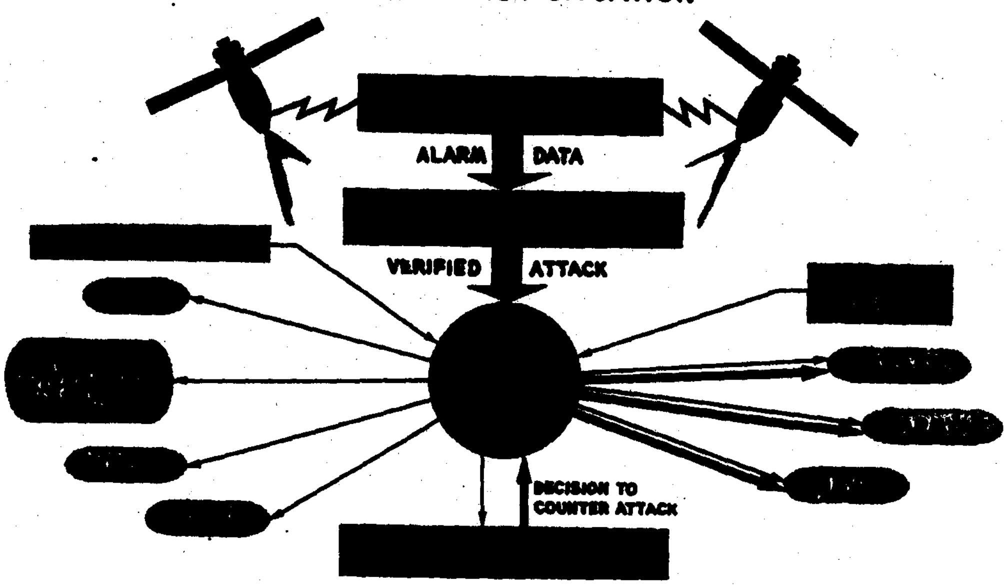


Figure 5.
Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies 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 the accurate positioning of eight satellite vehicles in orbit (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. The decision to counterattack is made by the President of the United States, with retaliatory forces reacting only in response to the Presidential decision.

MIDAS PROGRAM—MONTHLY PROGRESS

Program Administration

Objectives of the MIDAS flight program have been revised to attain polar orbits at 2,000 nautical mile altitude commencing with flight 3. The 1,000 nautical mile orbit flight has been deleted from the program. Flights 1 and 2, scheduled for February and April 1960, remain unchanged.

Technical Status

The second stage AGENA vehicle for the first MIDAS flight will undergo a second hot firing at Santa Cruz Test Base on 2 December. Shipment to AMR is scheduled for 6 December, following Air Force acceptance. The AGENA vehicle for the second MIDAS flight is scheduled for delivery to Santa Cruz Test Base on 12 December.

* * *

An integrated test of the ground-space communications data link van and the Aerojet-General scanner unit has been completed. The test verified compatibility and generated tapes for use in future training and checkout.

* * *

LMSD representatives have evaluated the General Electric proposal for an operational type ground presentation unit. This proposal was the most satisfactory in response to a preliminary work statement. As a result of the evaluation, a detailed work statement is being developed.

* * *

A test program conducted by Infrared Industries, Inc., indicates that the probability of solar damage to the orbiting infrared scanner is negligible.

* * *

The pneumatic attitude and orbital control systems configuration for flight 3 has been established. This system controls attitude variances which exceed the

Figure 6. Second Aerojet-General Scanner unit shown mounted in High Altitude Temperature Simulator prior to test.

limits of the reaction wheel system. The basic electronic module design concepts for the orbital control gas system have also been determined. Mechanization of the complete electronics will follow determination of the number of reaction jets to be used.

* * *

The vibration PAM/FM telemeter, planned for ascent instrumentation, will be converted to a high-response PAM/FM telemeter for flights 3, 4 and 5. This will allow the unit to be used in orbit for radiometric data in addition to the ascent vibration functions.

* * *

Launch complex 36, Patrick Air Force Base. Beneficial occupancy dates for the blockhouse and launch stand are scheduled for 18 May and 15 July respectively. Final plans for the propellant loading system and the service towers were reviewed on 10-11 November. Plans and specifications will be released for construction on 1 December.

* * *

Tracking and Data Acquisition Stations. All foundation work for the technical facilities at Donnelly Flats, Alaska, has been completed, and the administration and data acquisition building, and the power plant, have been enclosed. The contractor closed down operations on 1 November for the winter and will resume work on or before 1 April. Completion of the various facilities is on schedule, and will be completed on an incremental basis between June [redacted]

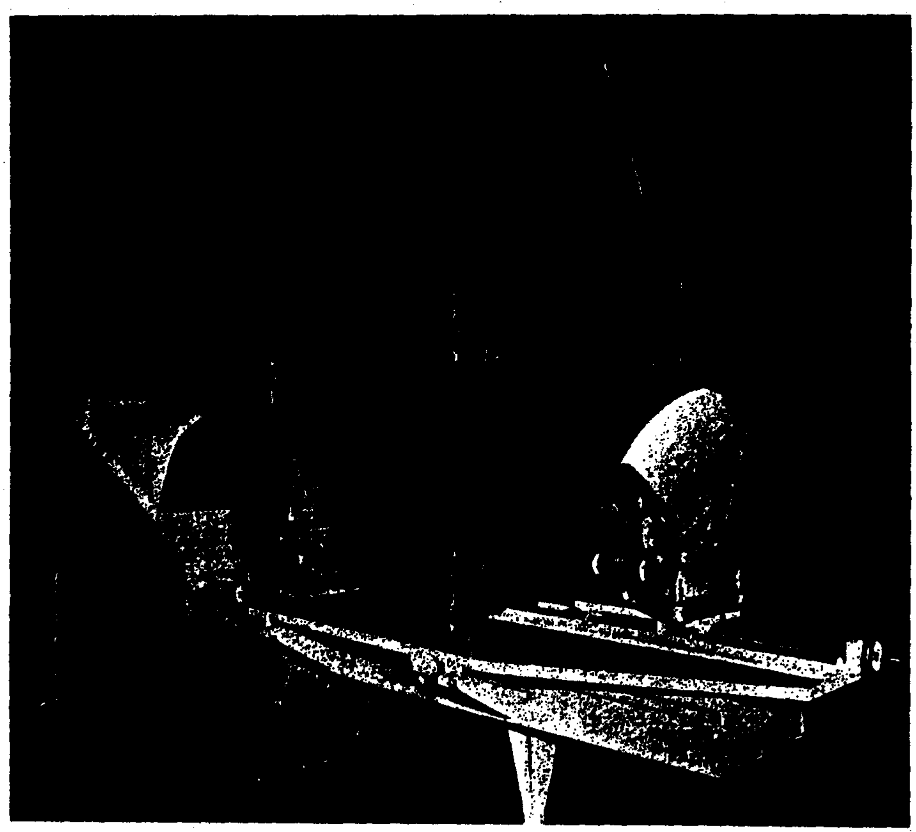


Figure 7. Collimator for use with the infrared scanner unit at the Atlantic Missile Range, Missile Assembly Building.

Figure 8. (left) AGENA second stage vehicle (No. 1007), being subjected to booster separation alignment procedure. This vehicle is scheduled for installation on the second MIDAS flight vehicle.

Figure 9. (above) Second stage of first MIDAS flight vehicle undergoing vertical weighing at the conclusion of the modification and checkout procedure. Nozzle of AGENA vehicle engine is visible at bottom of photograph, with nitrogen and helium spheres on either side.

Figure 10. (left) Initial hot-firing of AGENA second stage vehicle (for first MIDAS flight) at Santa Cruz Test Base.

Communications Satellite

The Communications Satellite Program will investigate, in three 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 Center is responsible for the development of aircraft communications equipment for all three phases. Responsibility for satellite and ground station communications equipment is assigned to WADC (first phase) and to the Army Signal Research and Development Laboratory (second and third phases). The three phases of the program have been designated STEER, TACKLE 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.

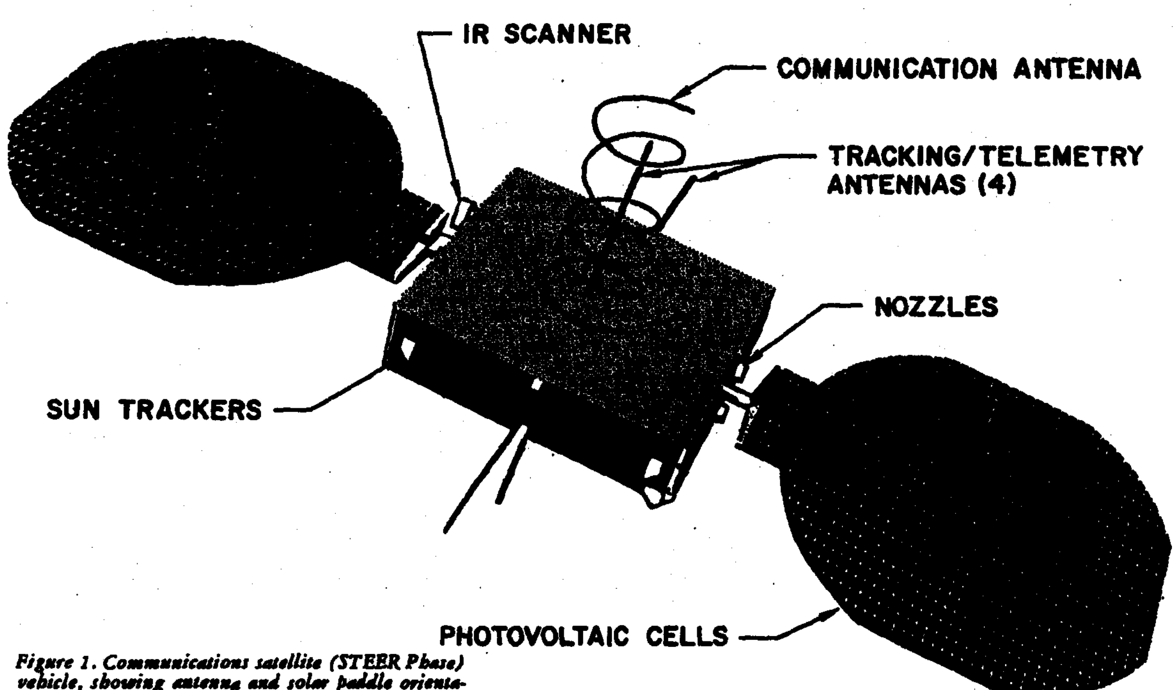
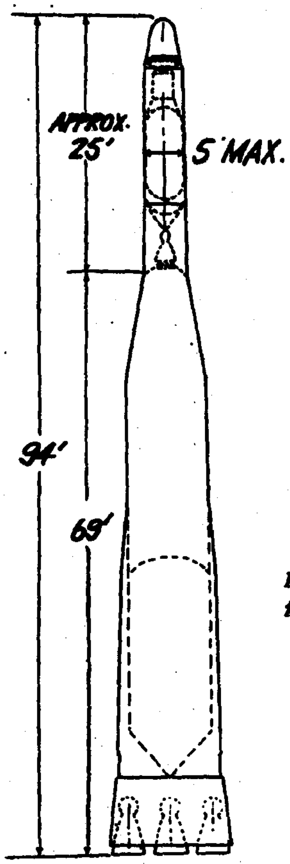


Figure 1. Communications satellite (STEER Phase) vehicle, showing antenna and solar paddle orientation. Small drawing shows operational concept of STEER phase.



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 TACKLE and DECREE phases.

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 the 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 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

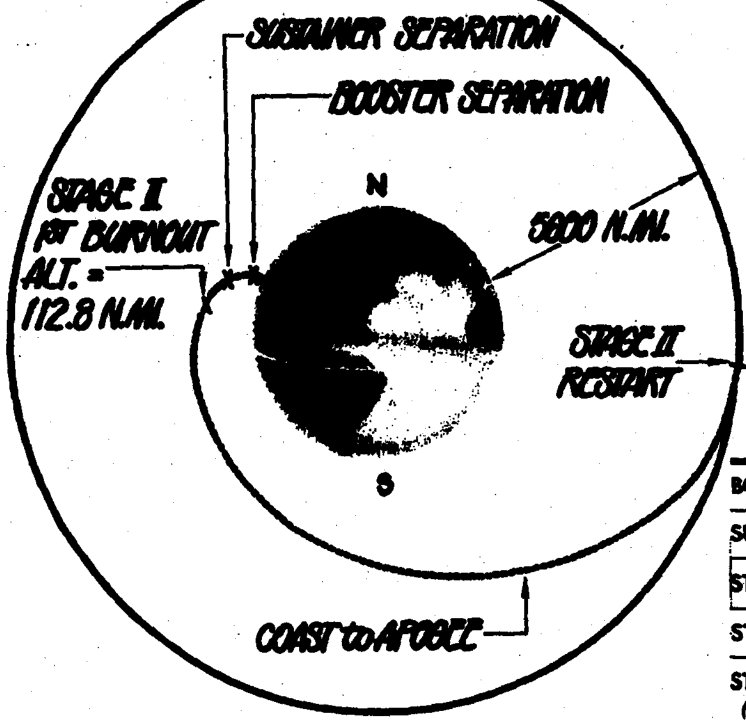


Figure 3. Schematic of STEER phase flight trajectory and orbits showing sequence of operational events.

	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)	6649	34×10^6	12,100
STAGE II FINAL CUTOFF	6667	34×10^6	16,000
SATELLITE SEPARATION	6677	34×10^6	16,000

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 Offutt 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.

TACKLE

The four flights in this phase also are programmed for use of ATLAS/AGENA vehicles to attain polar orbits having six-hour orbital periods. TACKLE objectives are based on the use of the STEER phase test vehicle to permit early flight testing of microwave components and other equipment required for DECREE phase. Flight trajectory and orbital parameters are the same as for the STEER phase.

DECREE

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

COMMUNICATIONS SATELLITE SYSTEM—MONTHLY PROGRESS

Because of the long-life requirements of the Communications Satellite, great emphasis is being placed on reliability in the design and fabrication of systems, circuits and components. Since many of the required components have not yet demonstrated the necessary useful life expectancy, extensive design analysis, supplemented by laboratory studies will be necessary. Redundancy will probably be one of the primary means of attaining the required reliability. However, the five-months postponement of the first launch date, will permit increased reliability to be incorporated into initial design efforts. The present reliability requirement is for a life expectancy of one year in orbit.

* * *

A new launch schedule has been formulated for Point Arguello Complex #1 to integrate the Communications Satellite launchings with the scheduled SAMOS and MIDAS flights. This new schedule provides an additional five months to be used for design efforts toward increasing reliability, development of orbital correction capability, and studies of optimum anti-jamming techniques. Action has been initiated to obtain approval for location of a ground communication station at Mead, Nebraska.

PROJECT STEER

Program Administration

A contract for the satellite vehicle has been negotiated with the General Electric Company, Missile and Space Vehicle Department. The contract probably will be signed during December. A contract for the communications subsystem was signed on 29 October with the Bendix Corporation, Systems Division. Space Technology Laboratories has completed a study of the Bendix proposal for the subsystem. Results of this study will be presented to WADC and Bendix in December. If the required funds are released immediately by ARPA, the contracts for the first and second stages will be negotiated in December. A work statement for the ATLAS first stage booster has been prepared and is in final coordination before being submitted to Convair, Astronautics Division. The Lockheed proposal for the second stage vehicle was received on 2 November, and has been evaluated. A briefing for the Ground Tracking and Data Acquisition contract is scheduled for early in January 1960.

* * *

A Project STEER Development Plan, reflecting revised flight schedules and funding requirements, is being prepared. This Plan will be submitted to ARPA in January 1960.

* * *

A special ten-man team from the WADC Electronics Technology Laboratory has been formed to monitor the Bendix effort to insure that required component reliability is attained in the communication subsystem.

Technical Progress

Technical direction meetings held during October emphasized satellite vehicle and communications subsystem development plans, including the new program schedules and orbit correction equipment. The following agreements were reached:

1. The satellite vehicle contractor will submit revised schedules immediately, and the program plan by 1 December.

2. The communications subsystem contractor will submit a program plan for FM clear transmission and anti-jamming equipment by 1 December. The feasibility of combining the FM and anti-jamming equipment will be studied. Simultaneous, as well as alternate, operation of FM and anti-jamming equipment will be investigated. A fail-safe feature would select the FM receiver if the anti-jamming receiver should fail.

* * *

The first complete satellite flight vehicle will be available by 15 December 1960. A flight proofing test will be conducted during January and the vehicle will be delivered in February 1961.

* * *

Trajectory studies, using the most recent performance figures for the ATLAS/AGENA "B" propulsion systems, indicate the maximum allowable final stage vehicle weight to be 600 pounds. General Electric Company is evaluating the estimated weights of components based on this maximum vehicle weight.

* * *

During a reliability discussion on 17 November, ARPA expressed concern about the reliability of the satellite-borne pseudo-noise (spread-spectrum) equipment. As a result, Magnavox will redesign this system extensively to incorporate the latest circuit reliability techniques. Bendix engineers are assisting to insure that reliability prediction calculations are consistent with those being used by Bendix and Space Technology Laboratories.

* * *

On 13 November, a meeting was held in Washington, D.C. to discuss the communications frequency to be used by Project STEER. WADC/Bendix were directed by Hq USAF (AFOAC) to study the effects of using a frequency in the vicinity of 400 MC instead of the requested 225-280 MC range. The study revealed that the most severe effect would be to the satellite-borne equipment. The presently planned transistorized signal amplifier stage would have to be replaced with a hard tube stage, resulting in decreased reliability. Also, the aircraft equipment would require tube development to obtain the power output specified within size and weight limitations.

PROJECT TACKLE

It has been recommended that this Project be incorporated into Project DECREE.

PROJECT DECREE

Program Administration

Available payload space on the last three CENTAUR program R&D flights will be used by Project DECREE for preliminary development of the satellite vehicle and communications payload. This will result in decreased booster costs and provide the additional advantage of using the satellite vehicle in its required orbit.

* * *

The DECREE Development Plan, currently being prepared, is scheduled for presentation to ARPA during February 1960. A preliminary specification for the DECREE system was presented to ARPA on 10 November. This specification proposed the use of a 2 KMC communication system as capable of providing greater over-all system reliability than an 8 KMC system. However, in accordance with an ARPA memorandum to AFBMD, dated 13 November, design is being oriented toward use of 8 KMC transmission to the satellite and 2 KMC reception from the satellite. Capabilities of both X-band and S-band high power amplifiers, and other X-band components, are being investigated by USASRDL.

Technical Progress

An itemization has been prepared of the supporting research and development which must receive early funding. An investigation is being made to determine if similar developments are in existence prior to submitting this list for ARPA approval.

* * *

General Electric Company has been directed to obtain more detail on possible anti-jam operation, particularly in defining problems of automatic frequency control and pseudo-noise generation.

* * *

A contract has been awarded RCA for a 24-month effort in the development of a highly reliable pencil tube, Type 5876, intended to be used as a frequency multiplier driver.

SPACE

projects

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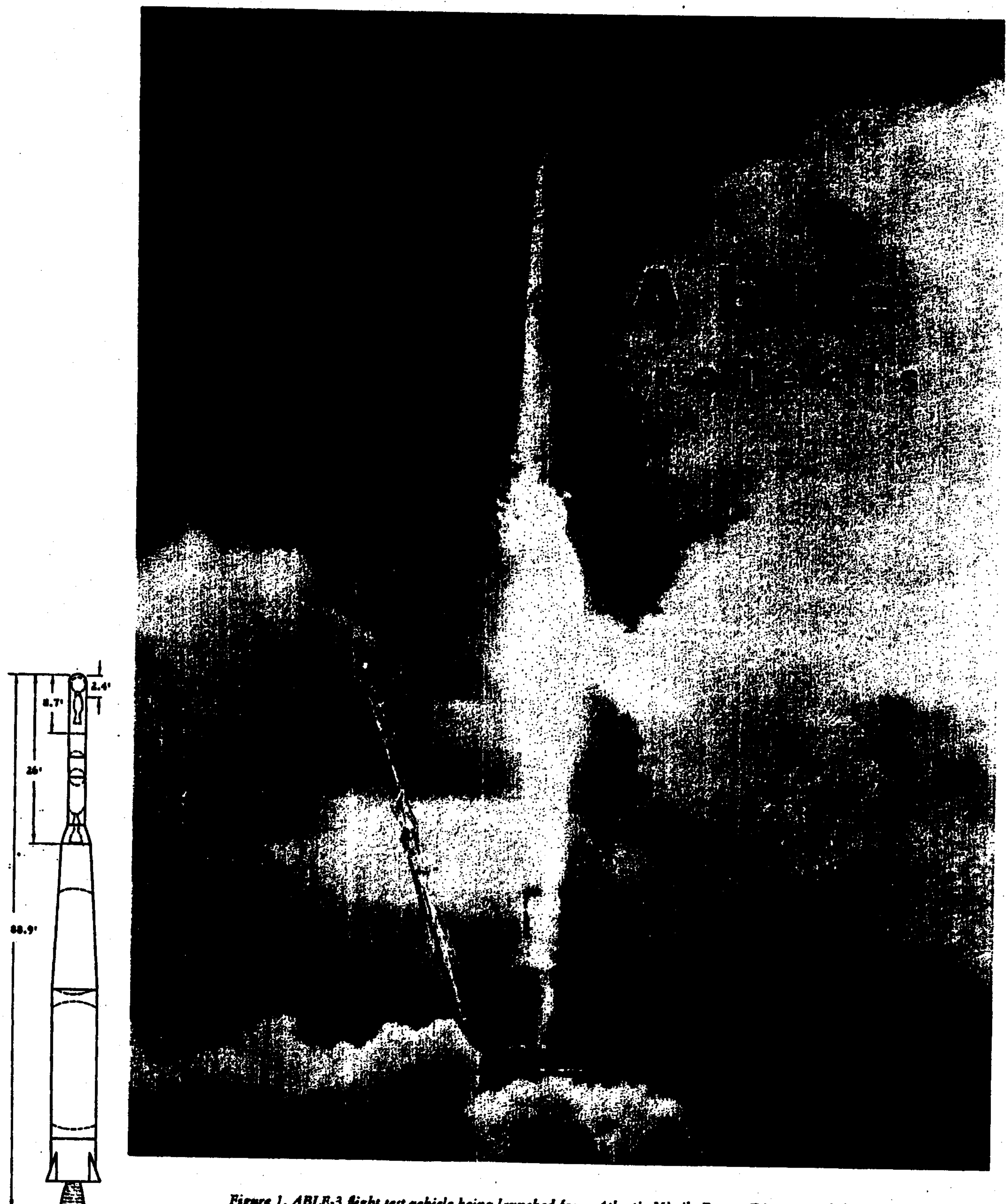


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing. (left) of four-stage ABLE-3 vehicle.

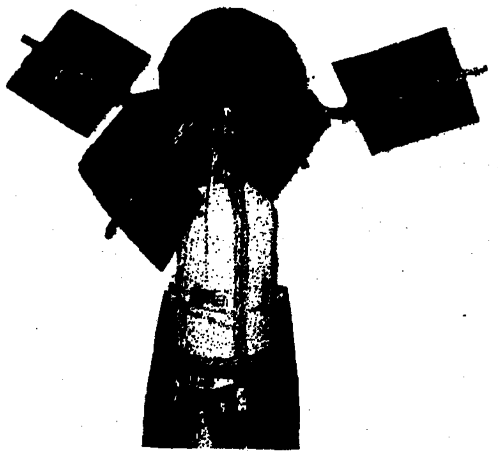


Figure 2. ABLE-3 third stage and payload with solar paddles in fully extended position.

The ABLE Program consists of three flights with primary missions as follows:

a. ABLE-3: This initial flight placed an advanced scientific observatory satellite in an extremely elliptical geocentric orbit about the earth. The payload contained instrumentation for thirteen experiments, and solar power sources for long term electrical power supply. This satellite is obtaining unique and original scientific data as well as testing components for the ABLE-4 program.

b. ABLE-4 ATLAS: The second flight will place a 371 pound instrumented payload in orbit around the moon. This flight will investigate the space environment in the vicinity of the moon, and provide crude television images of the far side of the moon. The large percentage of the equipment used is identical to that installed in the ABLE-4 deep space probe and Lunar satellite vehicle.

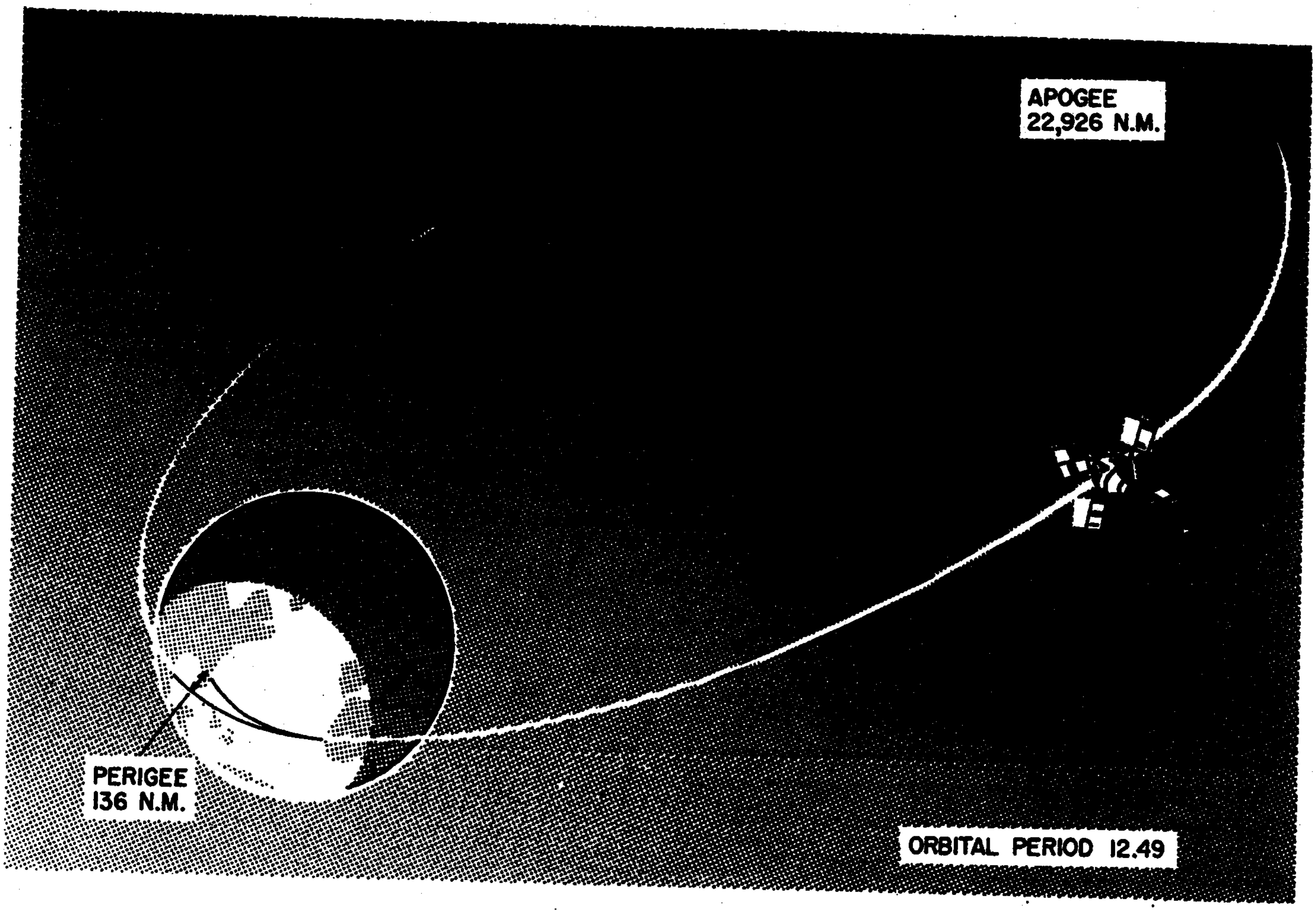
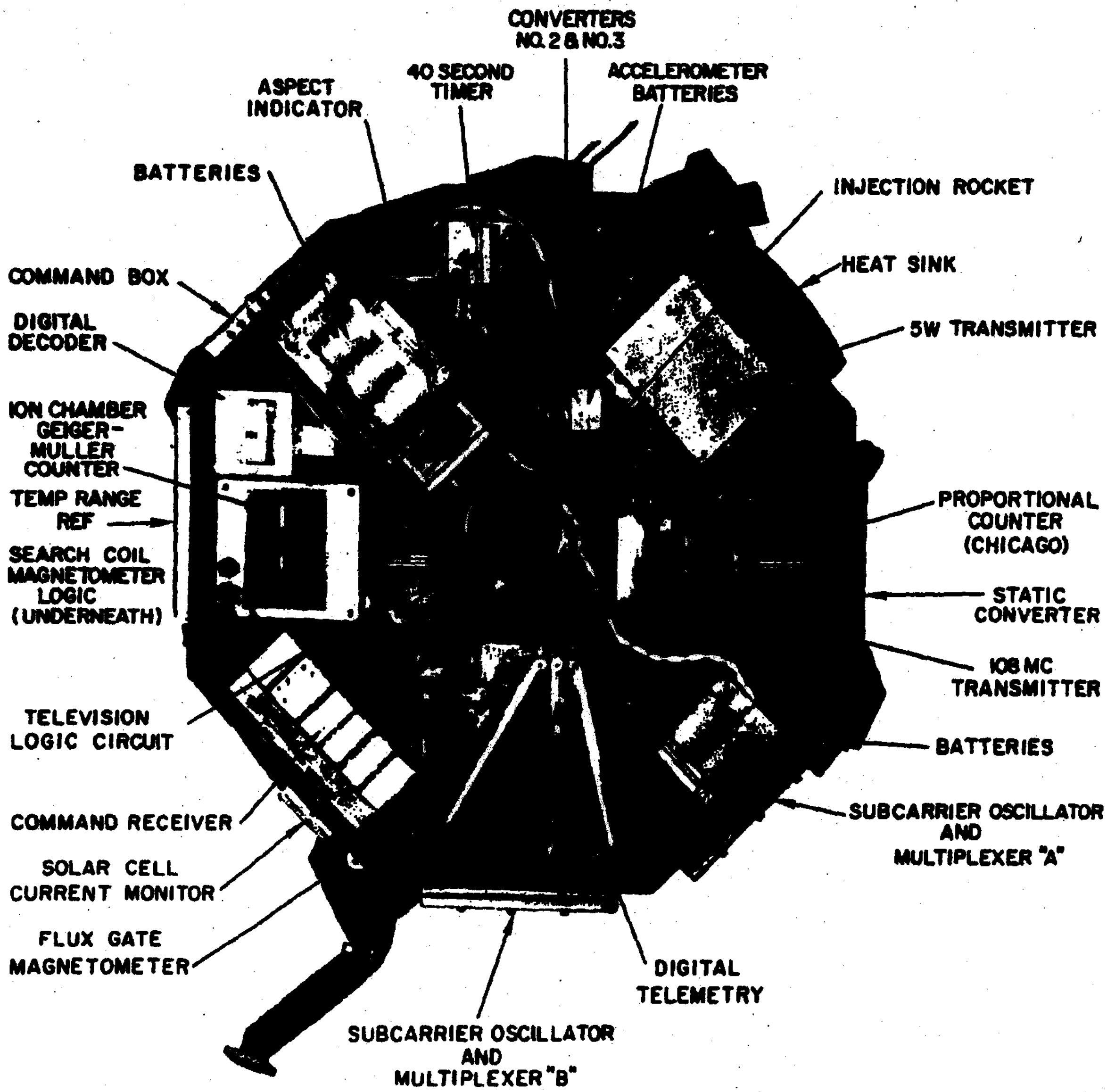


Figure 3. Drawing of extremely elliptical ABLE-3 orbit.



THOR-ABLE III PAYLOAD (TOP VIEW)

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

c. 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 an 88 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.

The ABLE-STAR 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.

ABLE-3 SELECTED TRAJECTORY INFORMATION, PREDICTED VERSUS ACTUAL

		Launch	End of Vertical Flight	* Maximum q	Stage I Burnout	Vernier Burnout	* Stage II Burnout	Stage III Burnout	Apogee (1st pass)	Perigee (1st pass)
Time, Sec.	Predicted	0	10	64	160.016	162.016	275.802	315.654	12,900	38,148
	Actual	0	10		160.098	162.998	279.3	321.2	23,138	45,938
Altitude, Ft.	Predicted	0	633	35,932	300,226	310,917	853,563	963,901	19,581	144
	Actual	0	637		323,690	338,357	1001,995	1145,771	22,926	136
Surface Range NMI	Predicted	0	0	2.30	86.15	90.67	409.1	574		
	Actual	0	0		84.49	89.85	413.5			
Inertial Velocity Ft/Sec.	Predicted	1342.7	1348.9	2457.8	15,922.0	15,910.1	24,029.8	33,367.6	5208.6	32,426
	Actual	1342.7	1348.7		16,073.2	16,056.1	24,003.7	33,498.4	4588.0	33,760
Inertial Velocity Angle, Deg	Predicted	90.00	84.43	59.44	70.41	70.54	81.76	87.03	90.02	89.94
	Actual	90.00	84.39		67.66	67.81	79.29	83.81	90.00	90.00
Inertial Velocity Azimuth, Deg	Predicted	90.000	89.98	73	52.10	53.64	54.67			
	Actual	90.000	90.02		53.33	53.37	54.62	55.50		
Air Velocity Ft/Sec.	Predicted	0.0	130.9	1551.1	14,945.9	14,932.7	22,979.6	32,304.2		
	Actual	0.0	131.9		15,097.7	15,078.8	22,940.0			
Air Velocity Angle, Deg	Predicted	0.0	0.19	36.33	69.07	69.21	81.38	86.93		
	Actual	0.0	0.34		66.13	66.29	78.79			
Dynamic Pressure, lb/Ft^2	Predicted	0	20	854.2	0	0	0	0	0	0
	Actual	0	0.9		0	0	0	0	0	0
Angle of Atach, Deg	Predicted	0	0.05	+0.31	+0.98	+1.2	-20.98	-12.97		
	Actual	0	0.0002		+1.55	+1.80	-21.86			

* Not available for this report.

*Preliminary (Questionable)

[redacted]

Improvements being made include: (a) increased propellant capability; (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 will also accept the ABL248A-3 third stage, if needed.

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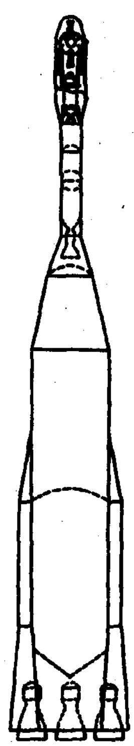

Figure 5. Line drawing of ABLB-4 ATLAS flight test vehicle. Photos show vehicle on launch pad. Vehicle booster and second-stage were subsequently destroyed during flight firing readiness.

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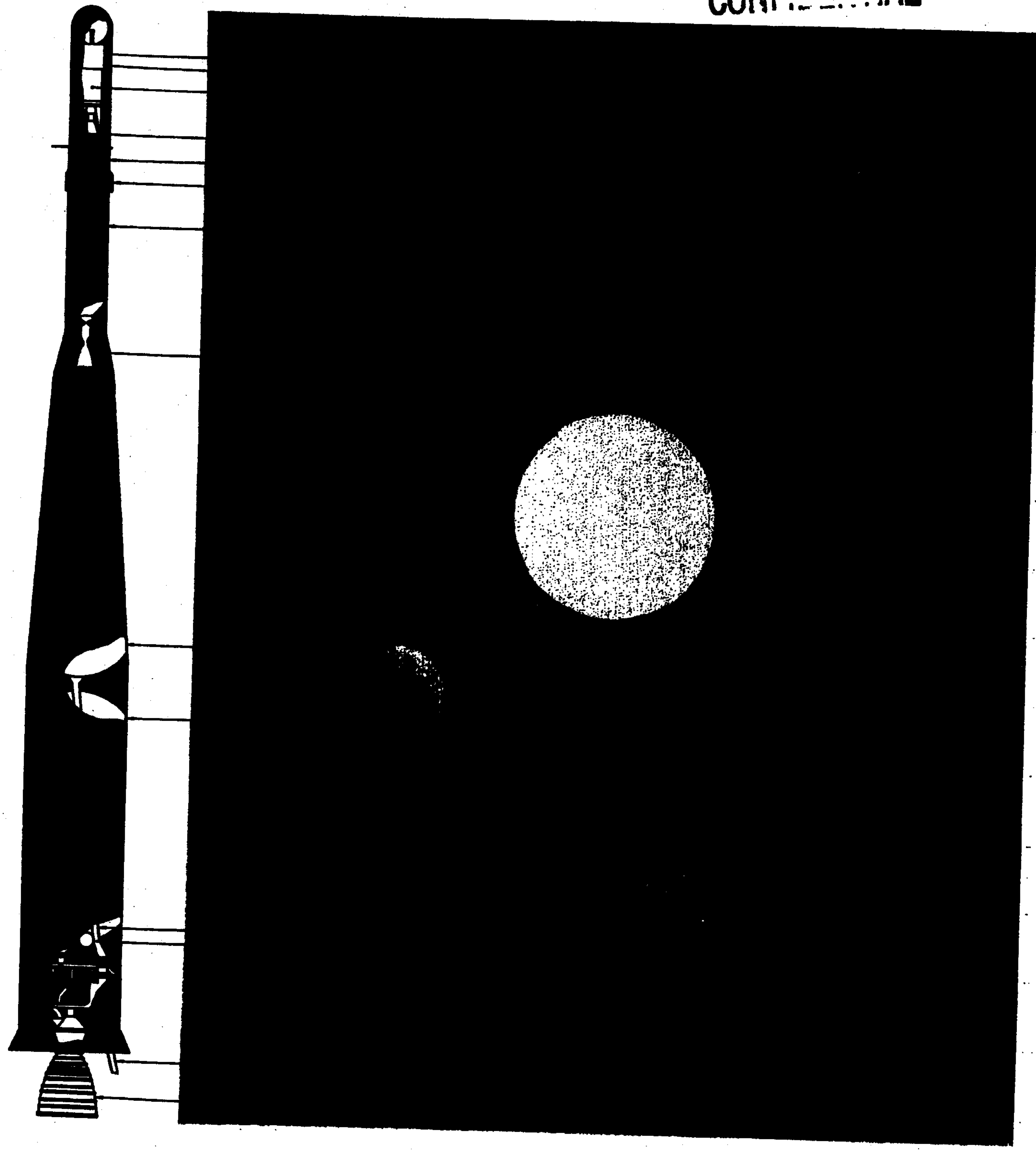

Figure 6. Cutaway view of ABLE-4 THOR flight test vehicle (left). Drawing (right) shows artist's conception of ABLE-4 THOR payload in orbit about the sun.

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ABLE PROJECTS—MONTHLY PROGRESS

ABLE-4 ATLAS

ABLE-4 ATLAS was launched on schedule from the Atlantic Missile Range at 0226 EST, 26 November. At approximately T plus 48 seconds, the second stage Advanced Guidance System transponder ceased operation, and parts were seen to break away from the upper stages. Four to five seconds seconds later, additional parts were observed falling away. At that time the rate gyros in the ATLAS recorded a disturbance of about three seconds duration and the axial accelerometer indicated a slight decrease in vehicle acceleration and a change in attitude for approximately 4 seconds. These indications tend to confirm the breakup of the upper stages. Second stage telemetry equipment ceased to operate at approximately 104 seconds. The ATLAS continued until shut off by its guidance system after successful completion of the planned first stage portion of the flight. Two factors indicate that second stage ignition occurred at the planned time: (a) the ATLAS axial accelerometer indicated a decrease in acceleration which could have been caused by second stage engine blast impinging on the ATLAS, and (b) the ATLAS control system gyros recorded conditions similar to those observed on THOR boosted flights at the time of second stage ignition. The nose fairing, payload and third stage probably broke away from the second stage at T plus 48 seconds causing the disturbances recorded by the first stage equipment. Indications are that this failure was caused by one of the following three malfunctions, in order of greatest probability:

1. The nose fairing parted due to structural or latch failure.
2. Accidental ignition of the payload propulsion system created excessive pressure inside the nose fairing.
3. The payload broke away from the third stage; or, payload and third stage broke away from the second stage, due to structural failure.

Recovery of some payload parts in the surf off Cape Canaveral confirm that the payload was detached from the vehicle after approximately 48 seconds. Studies are being continued and it is anticipated that a final evaluation will be available for inclusion in next month's report.

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The ABLE-4 ATLAS project was the first use of an ATLAS ballistic missile with stages as booster for a space payload. The ATLAS booster performance was

Figure 7. ABLE-4 ATLAS payload (solar paddles not installed).

completely as planned. This flight lends confidence to the reliability of ATLAS performance in future flights. The ATLAS is programmed for use in the Advanced Military Satellite Programs and the Project Mercury (Man-in-Space) effort.

* * *

The ABLE-4 ATLAS trajectory from Cape Canaveral to the vicinity of the moon was selected to achieve the tightest circular satellite orbit around the moon consistent with the highest probability of success. The final burnout conditions were established at an energy level corresponding to an inertial velocity of 34,552 feet per second at a total distance from the center of the earth of 23,290,000 feet.

ABLE-4 THOR

Program Administration

The Detailed Test Objectives trajectory was made available during the month. However, changes were made necessary late in the month by the change in second stage. Launch is scheduled for 15 December, between 0715 and 0745 EST. Free flight and pow-

Figure 9. Checking solar cell paddle installation on ABLE-4 ATLAS payload.

Figure 8. ABLE-4 ATLAS payload assembly for third stage (solar paddles installed and extended).

ered flight trajectories for four days subsequent to 15 December also have been computed. The payload weight estimate at the present time is 90.4 pounds.

* * *

The ABLE-4 THOR payload is a deep-space probe. A communication range of 60 million miles has been set as the goal for the tracking, telemetry, and command subsystem for this experiment. In order to achieve this range objective, more sensitive receivers are being installed in this payload, and the Manchester station equipment is being very carefully reworked to achieve full transmitter power and best possible receiver sensitivity. The transmitted commands from the Manchester station, at 60 million miles range, are almost exactly at the level required for the payload receiver threshold in the narrowband position. It can be concluded from this that the command subsystem is very likely to function properly to at least 30 million miles, and may function to 60 million miles.

Testing Program

During the months of October and November 191 environmental acceptance tests, type tests, R&D tests, and parts evaluations were performed, with only five unsatisfactory performances. All five of these were of a minor nature and have been corrected satisfactorily.

Ground Support Program

An improved set of guidance and telemetry antennas was fabricated and checked out in Los Angeles. A high temperature material (fiber glass) with a high temperature resin was used. This material will not begin to ablate until temperatures of 1200-1400 degrees F. are reached. Ablation on the other antenna set began at temperatures between 500 and 600 degrees F.

* * *

MANCHESTER—During the week of 9 November, the linear polarized UHF feed was shipped to Manchester. The work of mounting the Rantec antenna assembly on the roof of the Telescope Control Building was completed. Use of this location will permit improved low elevation angle visibility towards the west. Following modifications to the 10KW transmitter, accomplished in October, satisfactory operation has been obtained several times for extended periods. At present, the 10KW transmitter is not operable at full power because of unsatisfactory transmitter tubes. New tubes are being delivered which are expected to meet specific performance requirements.

* * *

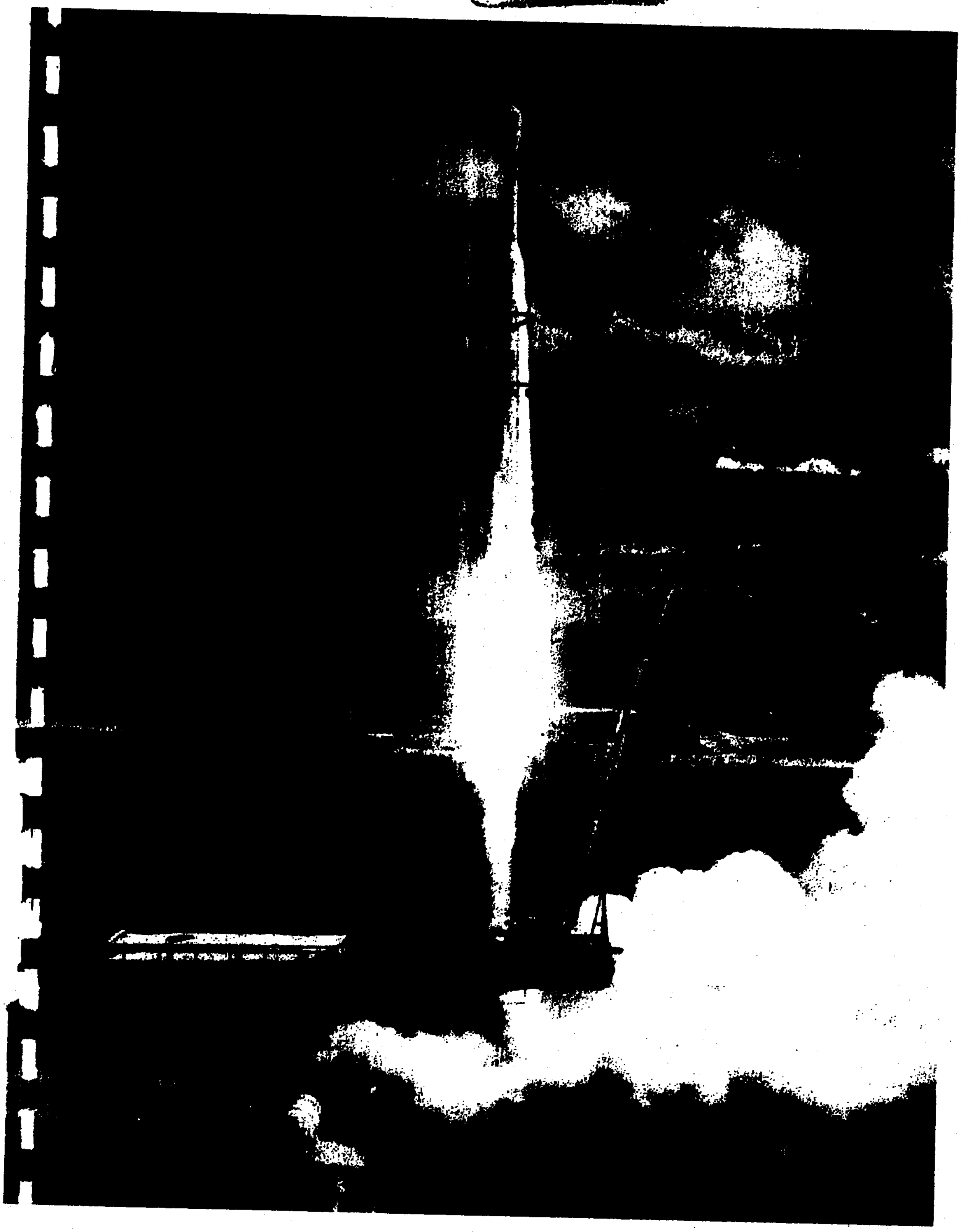
HAWAII—Effective 12 October, the full time maintenance of the three diesel generators was assumed by the Pacific Missile Range. The UHF 10KW transmitter is not operable at full power because of unsatisfactory transmitting tubes. Because of feed difficulties on the 60-foot antenna, arrangements have been made to permit the use of the Rantec antenna for transmission purposes, if necessary.

* * *

SINGAPORE—This station is ready for the ABLE-4 THOR launch.

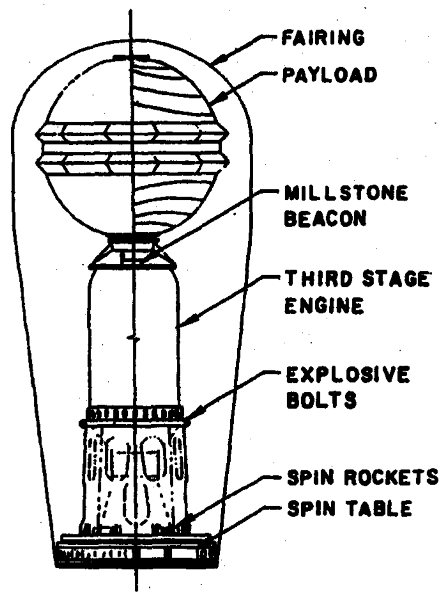
ABLE-3

The Space Technology Laboratories Space Physics Data Library is now in operation. Already stored within the Library are 600 magnetic tapes from ABLE-3, as well as tapes from Pioneer I and Pioneer II (ABLE-1). The Library is preparing a catalog of ABLE-3 trajectories. The bulk of the ABLE-3 digital data had been reproduced by 9 November. After having been checked and cataloged, the applicable data was mailed to Stanford University, University of Chicago, or the University of Minnesota. The second oscillogram reading table was installed in the Library during November.

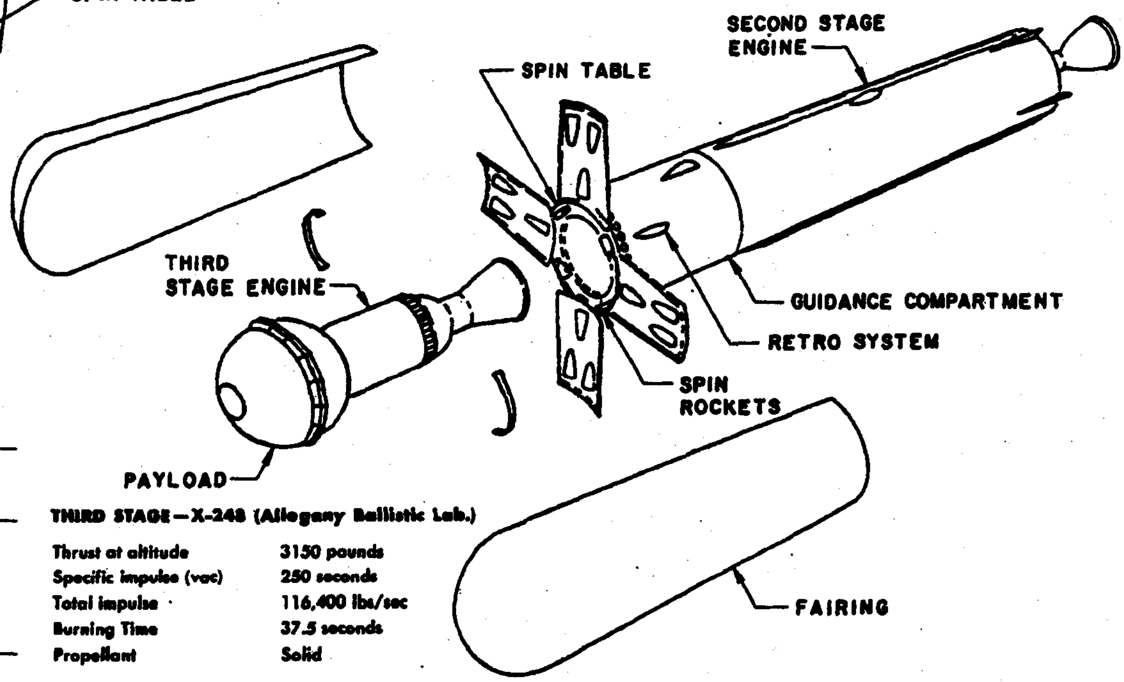


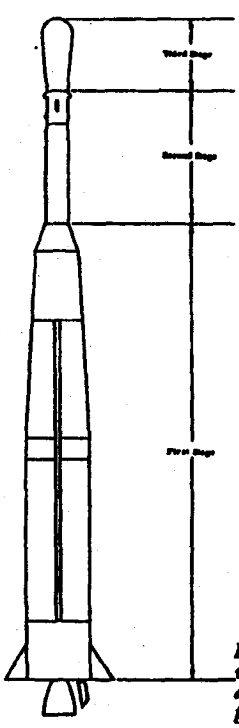
Transit

Figure 1. TRANSIT 1A being launched from Atlantic Missile Range



The TRANSIT Program consists of four flights of satellites designed to provide extremely accurate, world-wide, 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 1A, three stage flight vehicle with detail view of payload mated to third stage, and exploded view of second and third stages and payload.

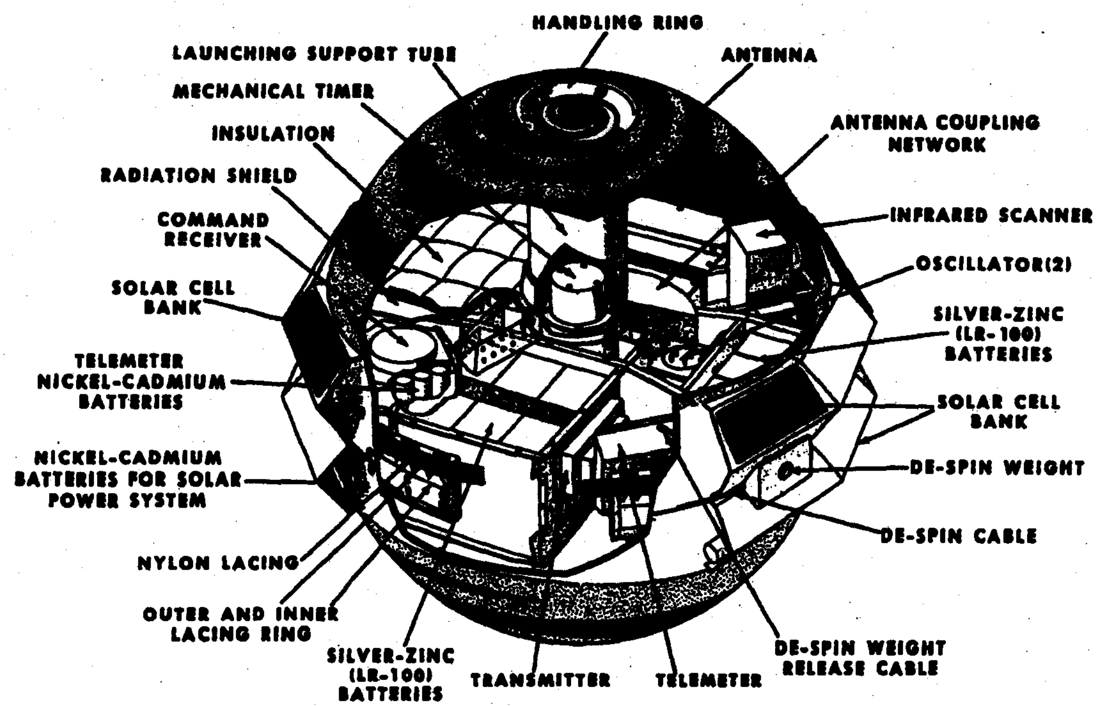


Figure 3. Cut-away drawing of TRANSIT IA payload (NAV 1).

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.

TRANSIT PROGRAM—MONTHLY PROGRESS

Program Administration

TRANSIT I-A. The final report on the launch of this vehicle has been prepared and will be distributed during December. STL Report TR-59-0000-00893, which delineates specific causes of problems encountered on this flight, also has been published. This report also recommends certain design changes and modifications for the TIROS vehicle as a result of data obtained from the TRANSIT I-A.

* * *

TRANSIT I-B. This navigation satellite will be placed into a 500 nautical mile circular orbit with an inclination angle of 49.9 degrees. The launch date for this vehicle has been rescheduled to 15 March 1960 because of second stage propulsion difficulties (see ABLE-STAR Vehicle Monthly Progress section), and down range tracking and telemetry van availability (see technical progress section). The Detailed Test Objective document was issued during November. The First and Second Stage Flight Termination System document has been transmitted to the Atlantic Missile Range for approval of the range safety system. The range safety trajectory data will be completed during December.

* * *

TRANSIT II-A. Launch is scheduled for 15 April 1960. This navigation satellite payload will be placed into a 500 nautical mile circular orbit with an inclination angle of 67.5 degrees. A slight "dog-leg" will be flown by the first stage, due to range safety considerations.

* * *

TRANSIT II-B. Aerojet-General Corporation, Azusa Division, has been selected as the second stage contractor. A meeting was held on 19 November at which ground rules were established for program management and contractual responsibilities were defined. The first technical direction meeting will be held during December. The initial major milestone schedule, including work on the second stage, was established and given to the contractors. Complete schedules will be established and distributed during December. The delivery of required drawings and specifications was begun during November.

Technical Progress

TRANSIT I-B. Validation of the TRANSIT I-B checkout van was completed at Space Technology Laboratories in Los Angeles. Subsequently, several system and subsystem compatibility tests were completed successfully. These tests will continue into December. Functional tests on the nose fairing were completed with excellent results.

* * *

TRANSIT II-A. The payload will be comprised basically of two spheres whose size precludes the use of the TRANSIT I-B nose fairing. Studies indicate that the COURIER I-A nose fairing design can be used on this vehicle. Additional fairings are being procured.

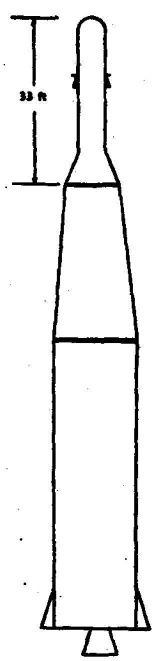
* * *

Delay in the release by ARPA of funds for the down range tracking and telemetry van contributed to the 30-day slippage in the launch date. However, these funds have been released and approval was obtained during November for design and fabrication work. Design of all components is now in progress. Systems tests are scheduled to be initiated during February.

he TIROS Program consists of one flight from he Atlantic Missile Range in January 1960. Primary objecitves 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 and an infra-red scanner 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. The infrared scanner unit will have eleven sensors of differing spectral responses and orientations, permitting a comprehensive accumulation of reflection and radiation characteristics data. The infrared detectors operate continuously during each orbit and the readin data is recorded on magnetic tape for accelerated playback during each pass over a ground station. Four beacon transmitters are installed on the bottom side of 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

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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

TIROS PROGRAM—MONTHLY PROGRESS

Program Administration

The TIROS launch date has been rescheduled for January 1960 due to payload availability. Launch, trajectory and orbit details were established during November. Launch will take place from Atlantic Missile Range launch stand 17A on 27 January at approximately 0625 EST. To achieve the proposed orientation of the satellite in relation to the sun and the earth, the launch must take place within 20 minutes of the nominal time. The vehicle will be launched at an azimuth of approximately 90 degrees, and roll programmed into a nominal flight azimuth of 44.5 degrees. During flight a pitch program will place the satellite into the proper injection attitude. The orbital path of the satellite about the earth will be nearly circular at approximately 380 nautical miles. The orbital period will be 100 minutes.

* * *

With the exception of the redesign of two systems (reported in technical progress section) all system design and development testing has been completed and all major subsystems are undergoing pre-launch checkout at the Atlantic Missile Range. Redesign of the two systems is scheduled for completion with no revision to the launch date. The final trajectory has been completed and given to the Bell Telephone Laboratories for insertion into the guidance system. The final revised Detailed Test Objectives document has been completed and distributed. A new weight budget was established in accordance with the new trajectory and the new BTL programming.

Technical Status

Based on information obtained from the flight of TRANSIT I-A, the second stage retro-rocket system is being redesigned to insure proper operation. Results of a study made by Douglas Aircraft Company indicate that the use of nitrogen, and the orientation of the nozzles in pitch and yaw, provide adequate safety in case of a single bottle failure. Design revisions were finalized during November and fabrication and testing is scheduled to be completed in accordance with the present launch date.

* * *

Altitude firing tests at Arnold Engineering Development Center indicate a need to revise the present stage three/payload separation method. One solution being considered is the delay of separation until the residual thrust of the third stage is below the energy limits of the separation spring. Analytical studies show that the separation can be delayed approximately 30 minutes without seriously affecting the attitude restraints on the payload at the time of separation. To give the desired time delay, and to increase assurance of a satisfactory separation, the Douglas Aircraft Company has been directed to make the following changes in the stage three/payload separation mechanism:

1. Provide a timer that will delay separation for a nominal period of 25 minutes, with a tolerance of 10 percent. The timer should be started by the same signal that starts the present 70 second timer.
2. Increase the separation spring force so that the nominal separation velocity is approximately 4 feet per second.

Douglas also has been directed to study the following areas affecting the reliability of stage three/payload separation:

1. Use of a separation command for the payload.
2. Effects of temperature environment on batteries and timers during the delayed separation period.
3. Amount of tip-off imparted to the payload by the increased spring force.

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.

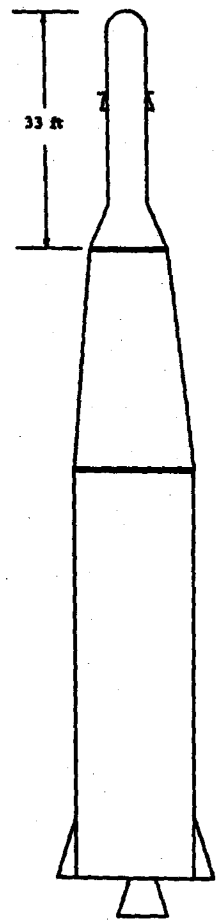
Vehicle Description—The two-stage COURIER vehicle consists of a THOR booster, an ABLE-STAR (AJ10-104) second stage and a 500 pound COURIER payload. Booster flight control is exercised by a gyro platform and a programmer. The second stage is controlled by a gyro used to govern engine gimballing during 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 capabiltiy. 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.

COURIER



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

COURIER PROGRAM—MONTHLY PROGRESS

Program Administration

COURIER I-A. The launch date is 15 May 1960. The payload will be placed into a 650 nautical mile circular orbit with an inclination angle of 28.5 degrees.

* * *

COURIER I-B. Aerojet-General Corporation, Azusa Division, has been selected as the second stage contractor. A meeting was held on 19 November, at which ground rules were established for program management and contractual responsibilities were defined. The first technical direction meeting will be held during December. An initial major milestone schedule, including work on the second stage, was established and given to the contractors. Complete schedules will be established and distributed during December. The delivery of required drawings and specifications was begun during November.

Technical Progress

COURIER I-A. Validation of the checkout van was completed at Space Technology Laboratories in Los Angeles. Subsequently, several system and subsystem compatibility tests were completed successfully. These tests will continue into December.

* * *

Following the release by ARPA of the necessary funds, work was initiated on the down range tracking and telemetry van. Design and fabrication approval was obtained and the design effort has been started. Systems tests are scheduled to begin during February.

A G E N A

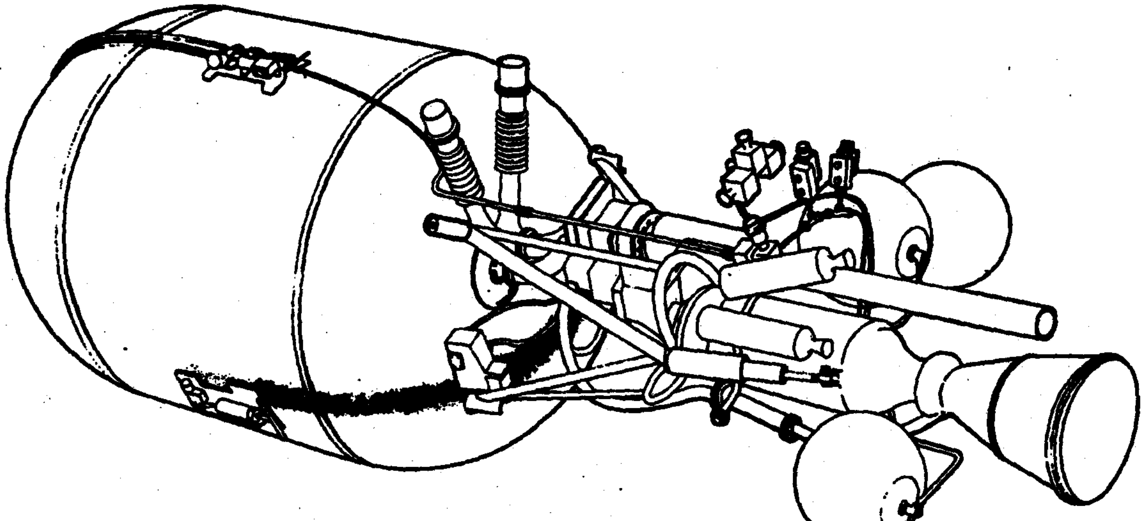


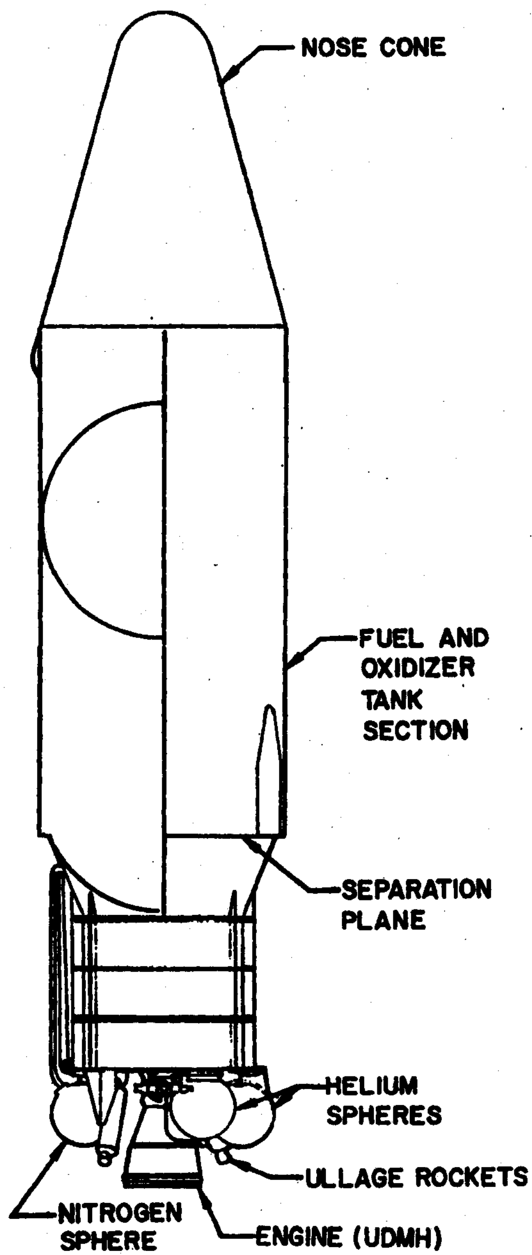
Figure 1.
Drawing of AGENA "B" propulsion system.

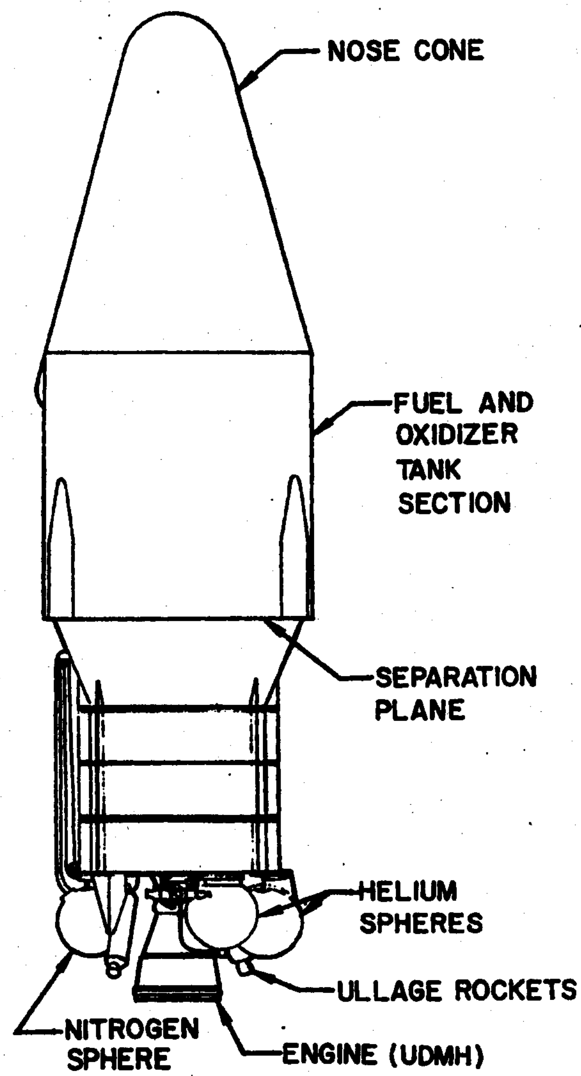
The AGENA vehicle was first designed by the Air Force as the basic satellite vehicle for the Advanced Military Reconnaissance Satellite Program (Weapon System 117L). The vehicle was designed to be boosted by an ATLAS ICBM, and basic AGENA dimensions were derived from this booster selection. The type of trajectory possible with the ATLAS booster, coupled with the stringent eccentricity requirements of the program, led to satellite guidance selection suited to orbital injection in a horizontal attitude. This in turn led to the development for the AGENA of the horizon scanner attitude control system. The Bell Aircraft LR81-Ba-3 engine (Bell-Hustler rocket engine developed for the B-58 Bomber) was chosen for AGENA propulsion since it was in an advanced state of development. Subsequent modifications to this engine to change the fuel from JP-4 to UDMH for increased performance resulted in development of the XLR-81-Ba-5 engine. In an effort to accelerate flight testing of the AGENA stage and subsystems, the low cost and early availability of the THOR IRBM caused a study of this missile as a booster for the AGENA to be made. When results indicated that the AGENA could be successfully flight tested in low altitude orbits, utilizing the THOR as the first stage, the DISCOVERER Program was initiated. This program has resulted in five launches of the AGENA vehicle to date, three of which attained orbit. The last two launches resulted in very satisfactory performance of the entire vehicle, including the AGENA stage and all subsystems. The only malfunction noted was failure of a battery designed to activate the recovery aids of the recoverable capsule fitted to the vehicles for biomedical research purposes. Satellite propulsion, guidance, stabilization, and auxiliary power systems functioned as programmed. As a result the AGENA vehicle has become a flight-tested and proven vehicle in advance of the date it will be needed to place advanced military reconnaissance payloads into operational orbit with the use of ATLAS boosters.

The AGENA vehicle forward section contains satellite guidance, power conversion, telemetry, and command equipment. The aft equipment section supports the engine thrust vector hydraulic control system and the pressure storage vessels for propellant pressurization and attitude controls. The center section consists of propellant tankage. The vehicle attaches to the booster by means of an adapter section surrounding the aft section.

Progress in the design of payloads for the MIDAS Program developed an urgent need for higher altitude orbits. This resulted in a program for development of the XLR81-Ba-7 engine, which has a single restart and extended burn capability. This capability permits placing a given payload weight on a higher orbit. This development eased the payload restrictions in use of the extremely reliable THOR as a booster for AGENA. The AGENA was redesigned to double the capacity of the propellant tanks, providing increased performance.

Payloads may be installed either as a package on the forward equipment rack or distributed throughout the AGENA vehicle. Payload capability is as much dependent upon available space within the vehicle as upon propulsion energy available. Generally, payloads in excess of 1,500 pounds must be integrated throughout the AGENA stage. A program for development of maximum efficiency of the first stages was also underway. The ATLAS ICBM was modified to reduce limitations imposed by trajectory requirements and static load capability.





AGENA "A"

Weight—Wet	1,400
Fuel (UDMH)	1,900
Oxidizer (IRFNA)	4,800
GROSS WEIGHT	8,100 lbs.

AGENA "B"

Weight—Wet	1,450
Fuel (UDMH)	3,800
Oxidizer (IRFNA)	9,600
GROSS WEIGHT	14,850 lbs.

AGENA VEHICLE—MONTHLY PROGRESS

Centrifugal testing of the AGENA "B" test article propellant tanks has been completed satisfactorily and vibration testing is now in progress. Tank design stressed use of components proven in the AGENA "A". For manufacturing simplicity, hemispherical ends were made uniform except for material thickness. This permitted the use of straight cylindrical sections between end pieces, which are machined flat, then rolled into cylinders.

* * *

The AGENA "A" engine (8084) will be used for test procedures until the AGENA "B" engine (8081) becomes available. The 8081 will incorporate two solid propellant turbine starters and necessary electrical modifications. The main pressure regulator fuel and oxidizer vent devices have been redesigned, developed and produced for the propulsion system. This unit will be tested during the propulsion test vehicle assembly program now in progress at the Lockheed Sunnyvale facility.

* * *

Massachussetts Institute of Technology progress on development of an advanced orbital attitude control system for the MIDAS/SAMOS and AGENA configuration was reviewed in November. Pitch control appears to pose no immediate problem, however, roll-yaw, controlled mainly by a large gyro, will present difficulties for the following reasons:

1. The gyro size depends to some extent on the vehicle inertias which are not constant at this time.
2. A survey indicates that even the most suitable gyro available will require considerable modification.

Kearfott has been selected as the gyro contractor.

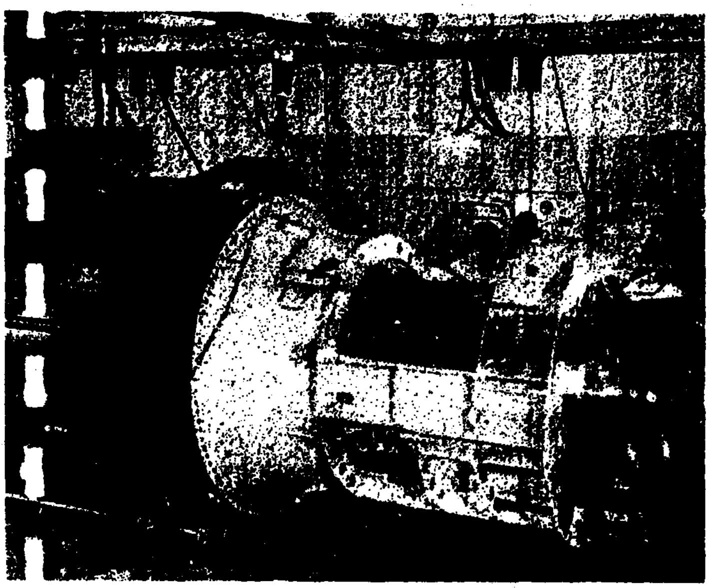


Figure 3. Strain gage testing of AGENA "B" (double-capacity) fuel tank.

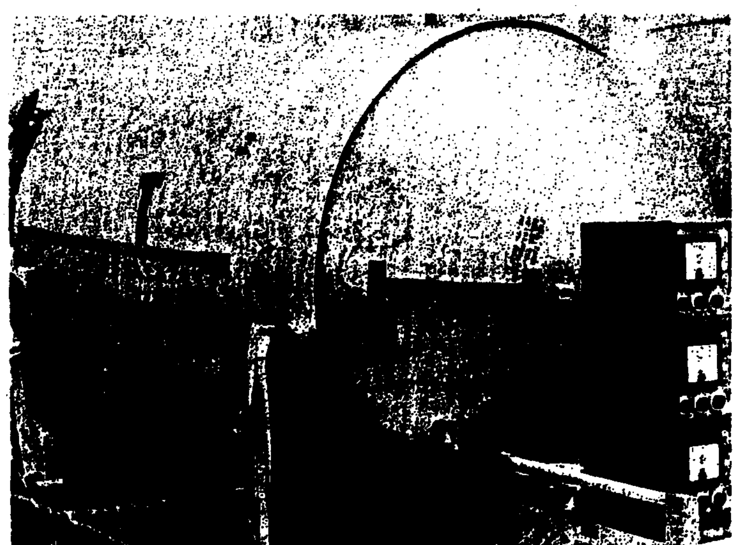


Figure 4. Final systems check-out procedure being conducted on the final AGENA "A" vehicle (1058). All subsequent vehicles will be AGENA "B" configuration.

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.

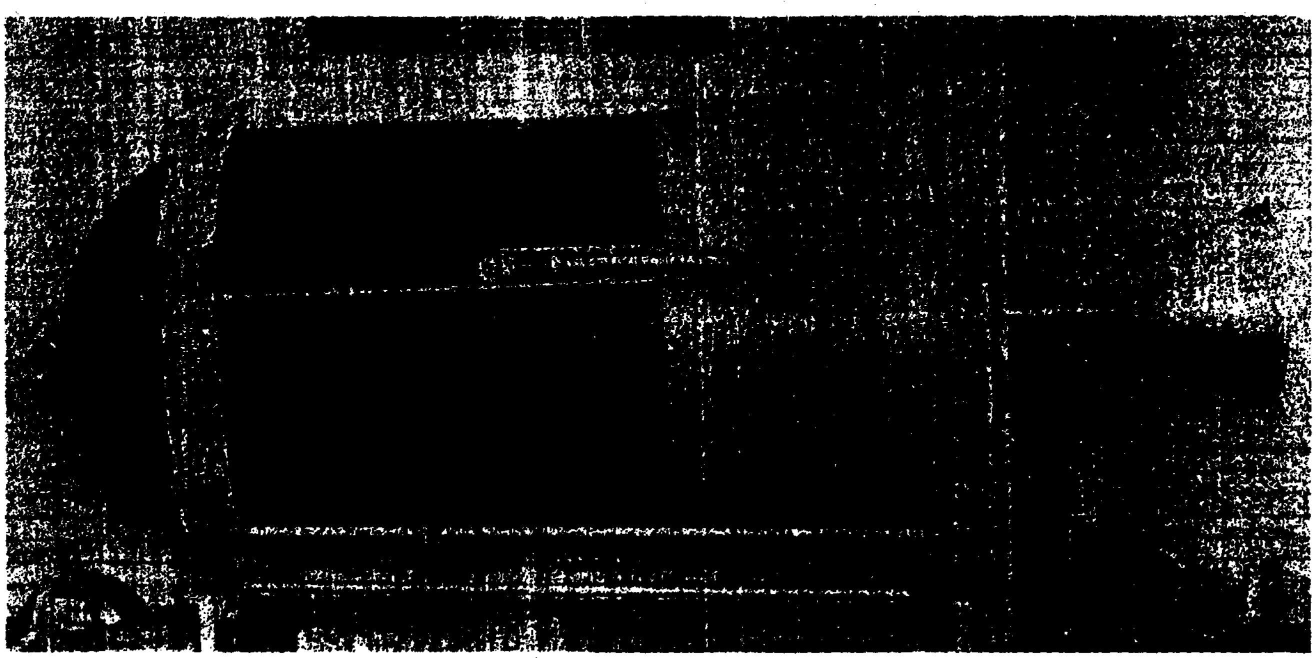


Figure 1. Side view of ABLE-STAR vehicle mounted in handling dolly.

ABLE-STAR VEHICLE—MONTHLY PROGRESS

A requirement for five test runs of 300 seconds duration was established to provide a demonstration of full duration propulsion system performance. Although the ABLE-STAR (AJ10-104) thrust chamber is practically identical with the earlier AJ10-40 and AJ10-42 series engines, this additional requirement is necessary since the earlier models were tested for only 115 seconds duration. These full duration runs must be performed successfully prior to delivery of the first flight unit.

* * *

The full duration test runs were initiated during November. Injector cooling problems, caused by injector manifold design and use of IRFNA as a coolant, resulted in burn-through of the injector plate and the cooling tubes close to the injector. These problems subsequently were solved and two thrust chamber assemblies were operated successfully for full duration, 300 seconds periods. Three additional thrust chamber assemblies are scheduled for full duration operational tests.

* * *

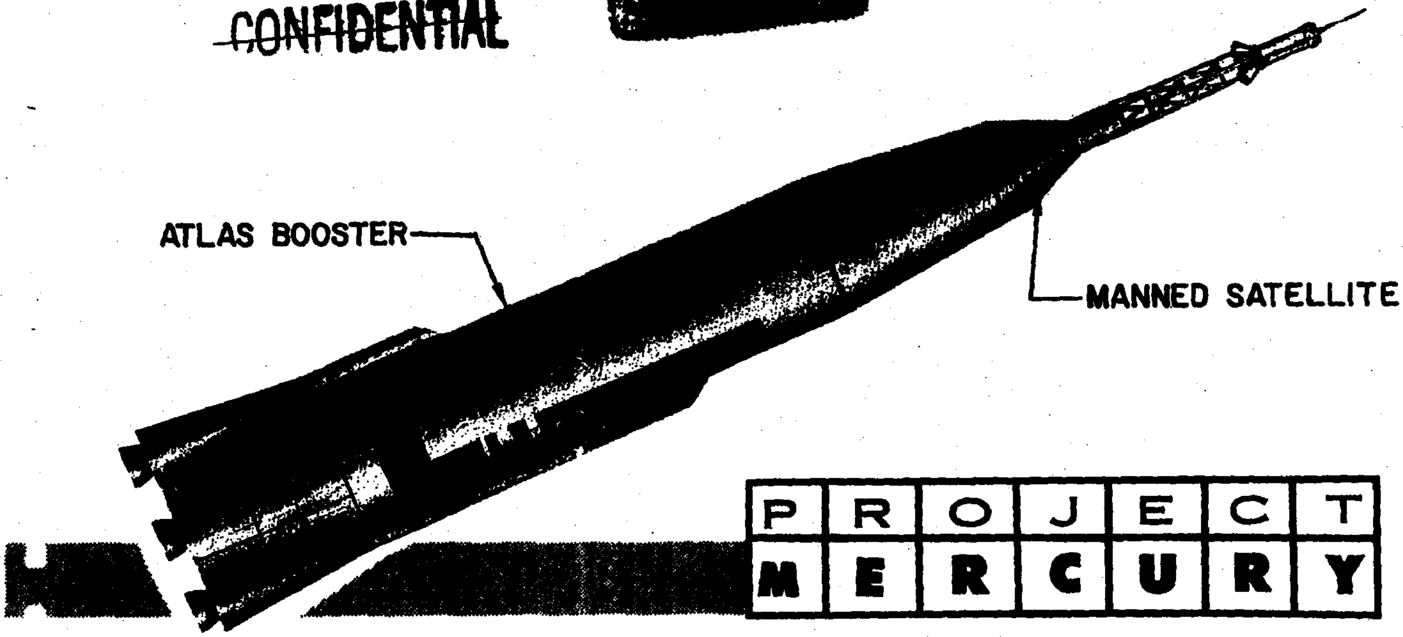
The Preliminary Flight Rating Test engine was accepted by the Air Force on 19 November. The first flight test engine also passed acceptance testing. However, the propellant tanks on this unit were subsequently damaged beyond repair due to the contractor's use of improper decontamination procedures.

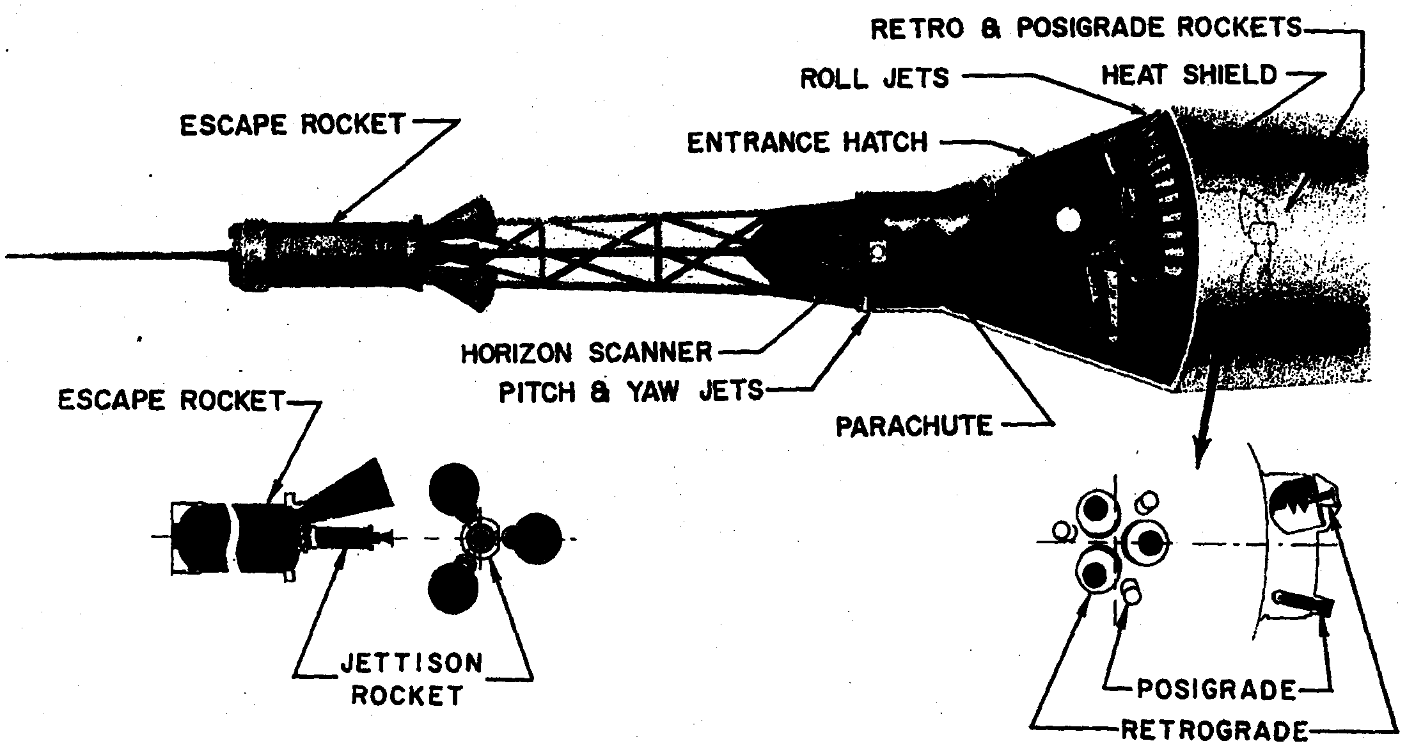
* * *

As a result of the problems reported in the preceding two paragraphs the delivery schedule of ABLE-STAR units has been revised as follows:

1. First Flight Unit............. 31 December
2. Second Flight Unit........... 1 February
3. Third Flight Unit............ 1 March

The Preliminary Flight Rating Test Program is scheduled for completion by 4 January. Flight schedules for vehicles using this propulsion system are given in the TRANSIT and COURIER Program sections.





WEIGHT AT SEPARATION	APPROX. 2413 LBS.	ORBIT INCLINATION	33 DEGREES
ORBITAL ALTITUDE	105-120 MILES (n)	HEAT SHIELD	ABLATIVE OR SINK
ORBITAL CYCLES	3-18	RECOVERY	AIR &/OR WATER OR LAND

Figure 1. Complete vehicle (top view) with satellite installed on ATLAS booster. Manned satellite (bottom view) showing pilots' flight position, and detail views of retro and posigrade rockets and pilot safety system escape rockets.

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.

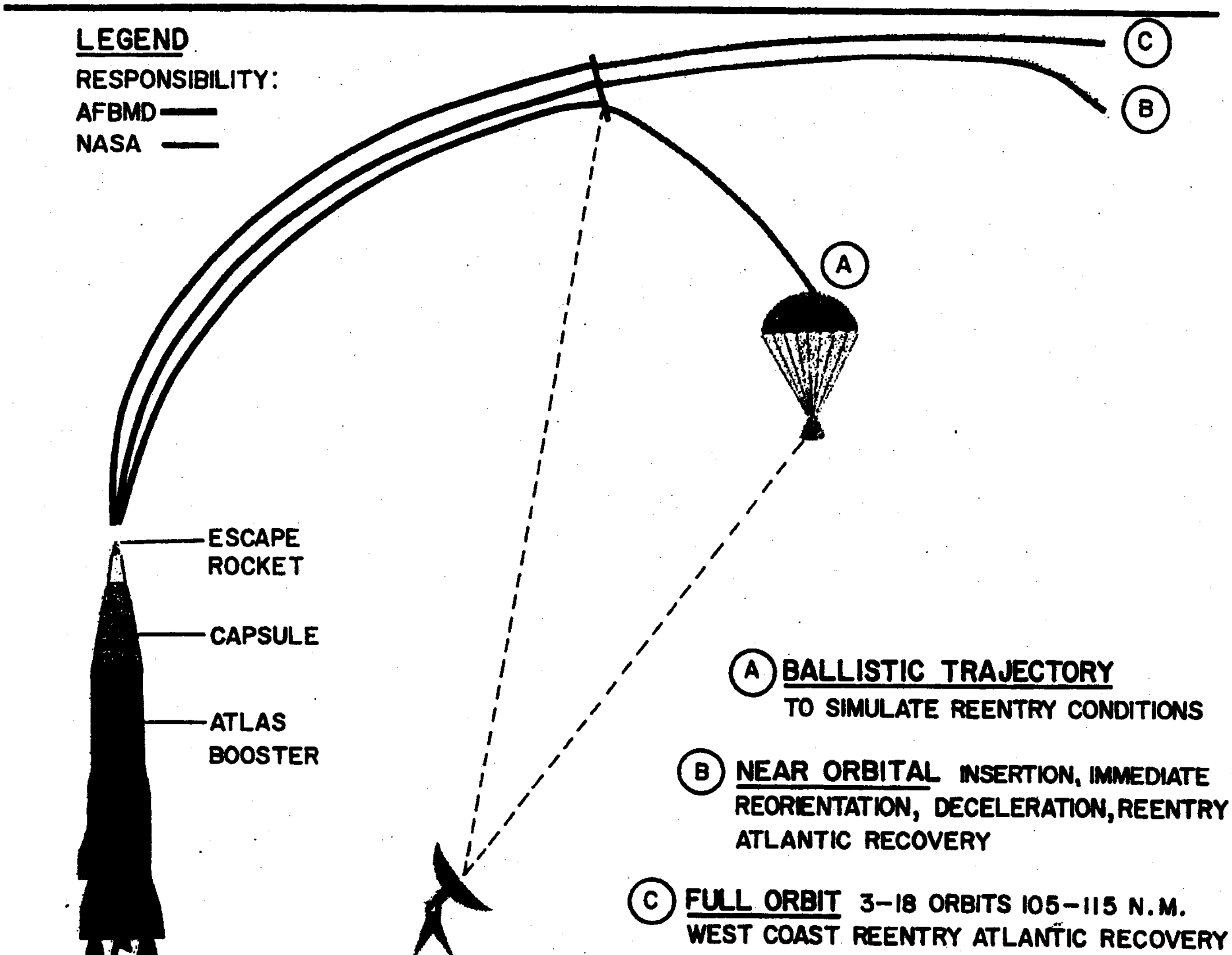


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.

PROJECT MERCURY

- **NASA Responsibility**
  - Booster-Capsule integration
  - Capsule
  - Ground support
  - Recovery
    - Flight 1
      - Laboratory Capsules
        - 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. 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.

PROJECT MERCURY

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

Design, engineering studies	Launch support
Equipment modification	Trajectory data
Hardware fabrication	Missile allocation
Flight scheduling	

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.

PROJECT MERCURY—MONTHLY PROGRESS

Program Administration

NASA has requested the addition of four ATLAS boosters to the present nine flight test vehicle Project MERCURY Program. These additional launches would extend the overall program through February 1962. Final agreement on the expanded program is pending. Originally consisting of ten flight test vehicles, the program was reduced to nine when the second flight test was cancelled in September. This flight was cancelled because of the high level of success in attaining the test objectives of the first flight (Big Joe I). The ATLAS booster for the cancelled flight was subsequently transferred to the ABLE-4 Program. The remaining eight currently scheduled flight test vehicles will consist of modified ATLAS boosters and Flight Capsules (McDonnell) capable of sustaining human life.

Technical Progress

The next Project MERCURY flight test is scheduled to occur in June 1960. Designated MA-1, this flight will carry a McDonnell Aircraft Corporation capsule on a trajectory similar to that used on the Big Joe I R&D test. The capsule will be boosted by ATLAS 50D, modified to meet Project MERCURY Program requirements. On board will be components of the Abort Sensing System which is under development to insure pilot safety on manned flights. These components will be tested open loop. Closed loop tests of the complete Abort Sensing System will begin with the third ATLAS/MERCURY flight test, designated MA-2 and scheduled for August 1960. Components of the Abort Sensing System also will be tested on 5 ATLAS R&D flights to provide additional data prior to use on a manned flight vehicle.

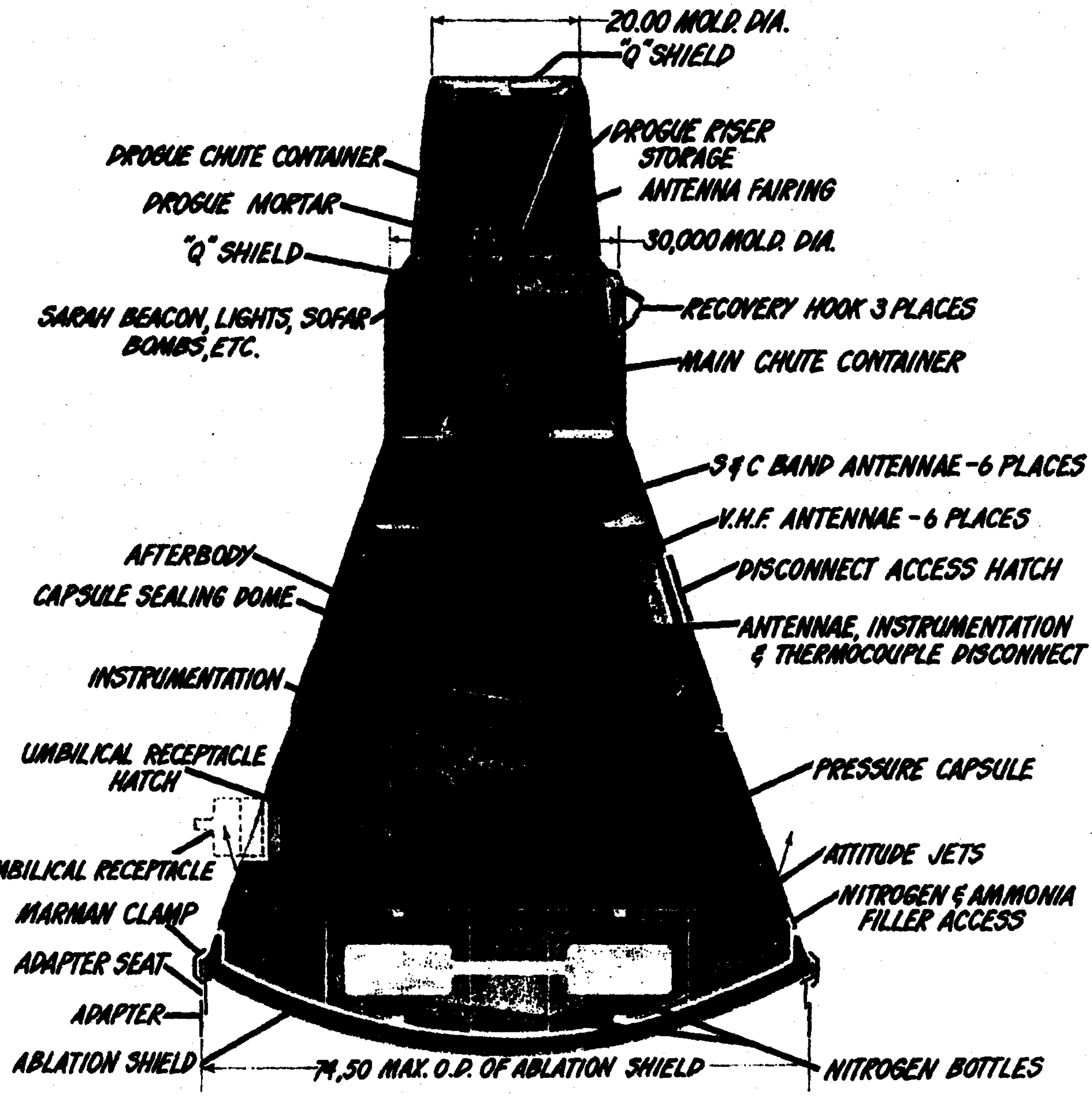


Figure 3. Drawing of "Big Joe" capsule successfully tested on first MERCURY flight test.

The rough draft of the Detailed Test Objectives Document for ATLAS 50D is being coordinated at the present time. Formal publication is anticipated by February 1960. Current test objectives for flight MA-1 are as follows:

1. Evaluate the performance of the capsule and its systems on a simulated re-entry from orbit.
2. Determine the capsule full-scale motions during a simulated re-entry from orbit.
3. Determine the performance of the ablation shield and measure the afterbody heating of the capsule during simulated re-entry from orbit.
4. Establish the adequacy of the capsule track and recovery procedures.
5. Establish the adequacy of the capsule landing systems.
6. Recover the capsule.
7. Evaluate the loads on the capsule during the actual flight environment.
8. Establish prelaunch checkout procedures for the flight capsule.

* * *

On 13 November at Langley Air Force Base, Virginia, a joint AFBMD/Space Technology Laboratories team presented a briefing for NASA on the AFBMD proposed Booster Quality Assurance and Safety Program. In addition to informing NASA of AFBMD actions related to booster responsibility, the briefing suggested that an overall capsule/booster safety-of-flight inspection be initiated by NASA. AFBMD safety actions were endorsed, and NASA indicated that a conference would be convened early in December to consider action on a safety-of-flight inspection for the complete Project MERCURY system. Convair-Astronautics has been directed by AFBMD to begin implementation of all aspects of this program related to booster responsibility.

PROJECT 609A

Space 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

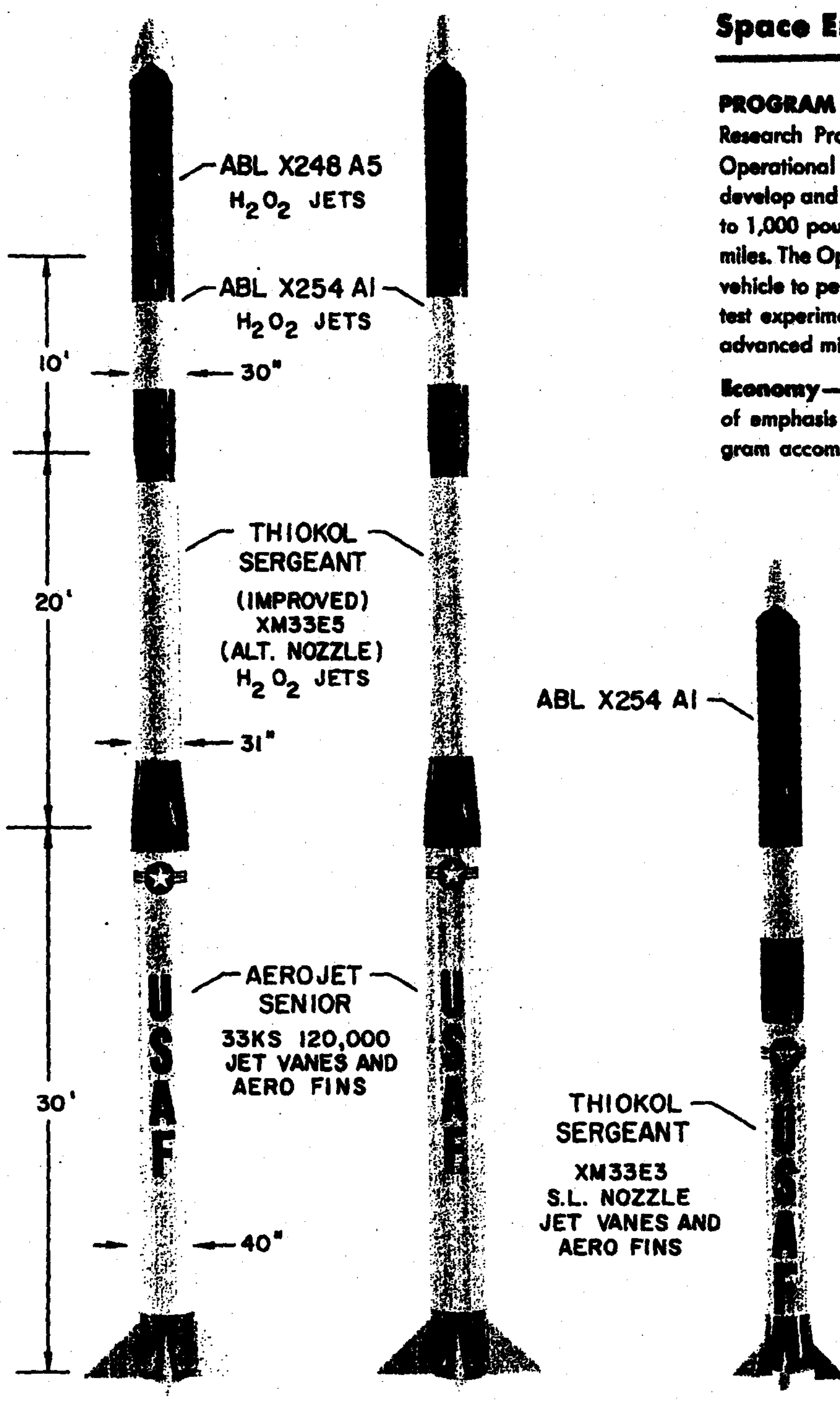


Figure 1. Three variations of Project 609A vehicle demonstrate the mission-versatility of the program.

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 18A, 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.

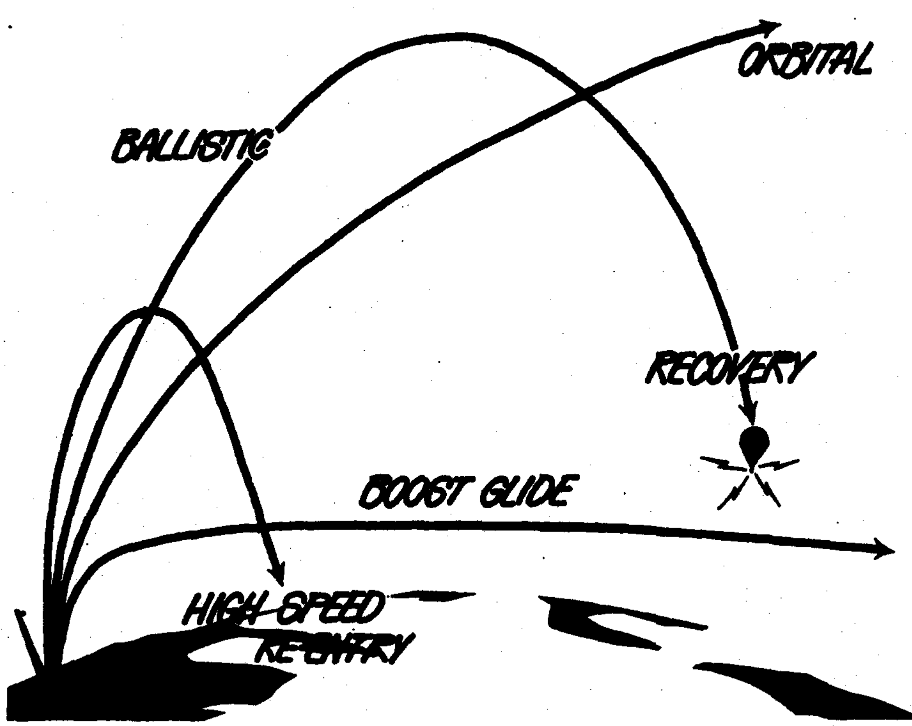


Figure 2. Four different trajectories possible using different arrangements of Project 609A stages.

PROJECT 609A—MONTHLY PROGRESS

Hq USAF (AFDAT) approval of the 609A Development Plan carried the stipulation that launch schedules be arranged to gain maximum advantage from the results of NASA SCOUT test launches and from experiments carried on 609A R&D flights. USAF also stated that there is no firm date by which the 609A development-test program must be completed. This stipulation was significant, since the original flight schedule would compromise both objectives. In accordance with Hq USAF instructions, 609A program schedules have been revised to better attain both objectives.

* * *

Launch of the first NASA SCOUT vehicle is scheduled for 15 January 1960, approximately three months behind the originally scheduled mid-October date. Further delays in this date as well as in the frequency of subsequent launches may occur. This delayed schedule has caused a similar effect upon the 609A flight scheduling.

* * *

Test stand 18B at the Atlantic Missile Range will be available for Project 609A about 15 March 1960. This stand has air conditioning facilities required for payloads during countdown, adequate pad space for maneuverability, greater hoisting capability, and required electrical facilities.

* * *

A Design Review Conference, held at NASA Langley Research Center on 17-19 November, was attended by representatives of all organizations involved in determining the design concept of the 609A family of vehicles. AFBMD and NASA contractors have completed design modification studies sufficiently to permit recommendations to be made regarding 609A vehicle configurations. USAF decisions were made regarding 609A modifications to the SCOUT vehicle. The decisions were based on compatibility of SCOUT design with 609A requirements, 609A performance and growth potential, modification cost and time required, and the desire for a cooperative USAF-NASA effort in developing an interchangable family of research support vehicles. NASA has decided to incorporate many of the USAF 609A modifications in its future SCOUT vehicles, decreasing the differences between the two vehicles.

* * *

The 609A vehicles will be launched by Air Force personnel assigned to the 6555th Guided Missile Group, presently attached to the 609A Test Office at Patrick Air Force Base. A familiarization program was conducted for this group at the contractor's facilities from 9 November to 20 November. ARDC personnel will receive short-term, periodic familiarization tours throughout the flight test portion of the program. The major portion of the experience and proficiency in assembly, checkout and launch (by military personnel) will be attained by actual participation, under Aeronutronic supervision, during the flight-test phase of the program at AMR.

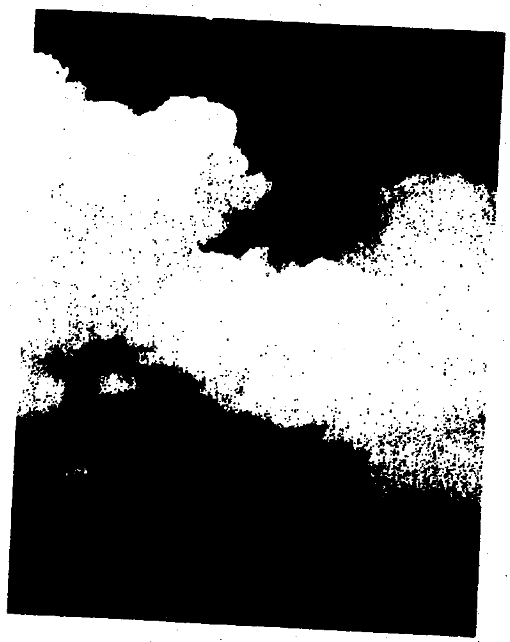
* * *

Hq ARDC (RDRRB) has requested the 609A Project office to compile, validate and integrate the proposed experiments from the ARDC Centers for the Phase II (operational) portion of the program during the interim period of ARDC reorganization. This function was formerly performed by the various RDR Staff Offices at ARDC.

* * *

On 1 October, it was learned that the entire FY 1960 funding program has been deferred by the Office of the Secretary of Defense. This will have no impact on the program provided funds are released prior to 15 December. After this time serious program slippage will occur. This information was transmitted to ARDC with a request for action to obtain early release of the funds. On 19 October, a message was received which authorized initiation of the funds. Although authority for commitment and obligation was specifically excluded, this action indicated that complete release of the funds may be expected soon. As of 30 November, FY 1960 funds remain frozen.

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

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 192 (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

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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.

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DISTRIBUTION

Headquarters, United States Air Force	19
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 Center	1
Air Force Special Weapons Center	1
Air University	4
Arnold Engineering Development Center	1
Air Proving Ground Center	1
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
Assistant Commander for Missile Tests	2
Air Force Ballistic Missile Division (ARDC)	60
Ballistic Missiles Center (AMC)	12
Assistant CINCSAC (SAC MIKE)	3