a foreword to...

SPACE

FOREWORD

WDAT 60-1495

[redacted] ~~CONFIDENTIAL~~

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

WDLPM-4

25 March 1960

FOREWORD

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

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

~~CONFIDENTIAL~~

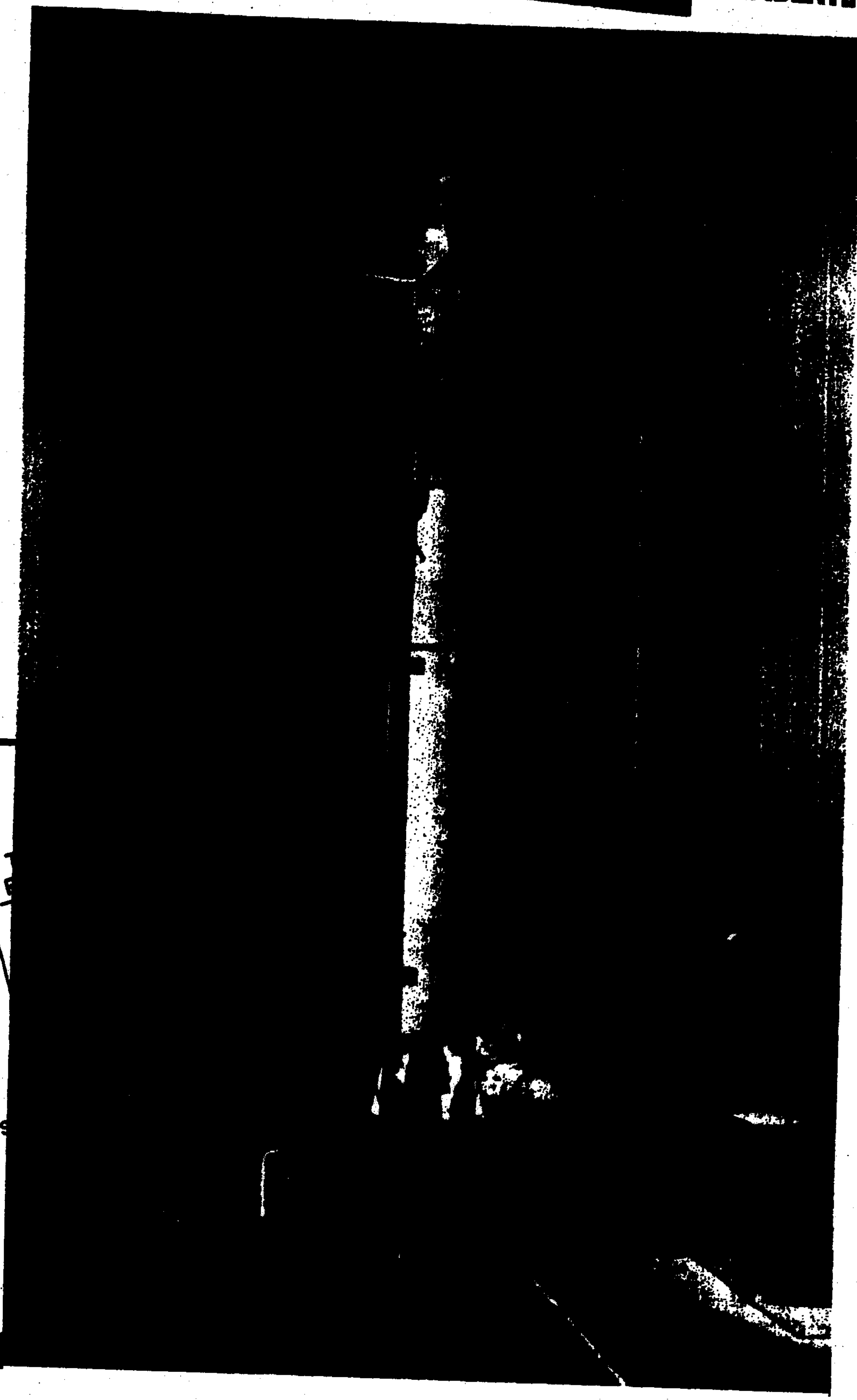
[redacted]

SPACE

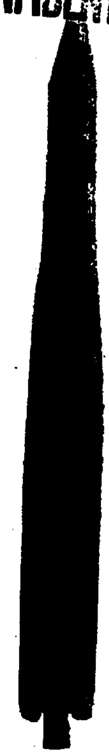
systems

- DISCOVERER
- SAMOS
- MIDAS
- COMMUNICATIONS SATELLITE

SPACE SYSTEMS



Discoverer



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

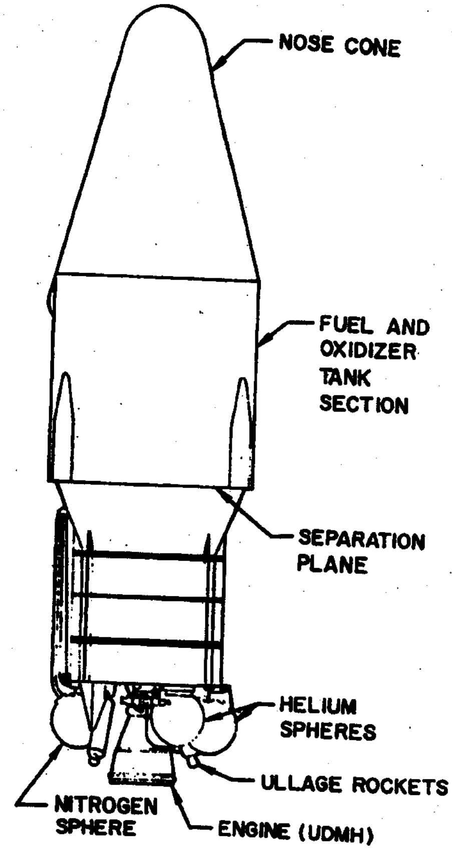


Figure 1. Photograph of two-stage DISCOVERER vehicle (left) and detailed drawing of AGENA, second stage (right).

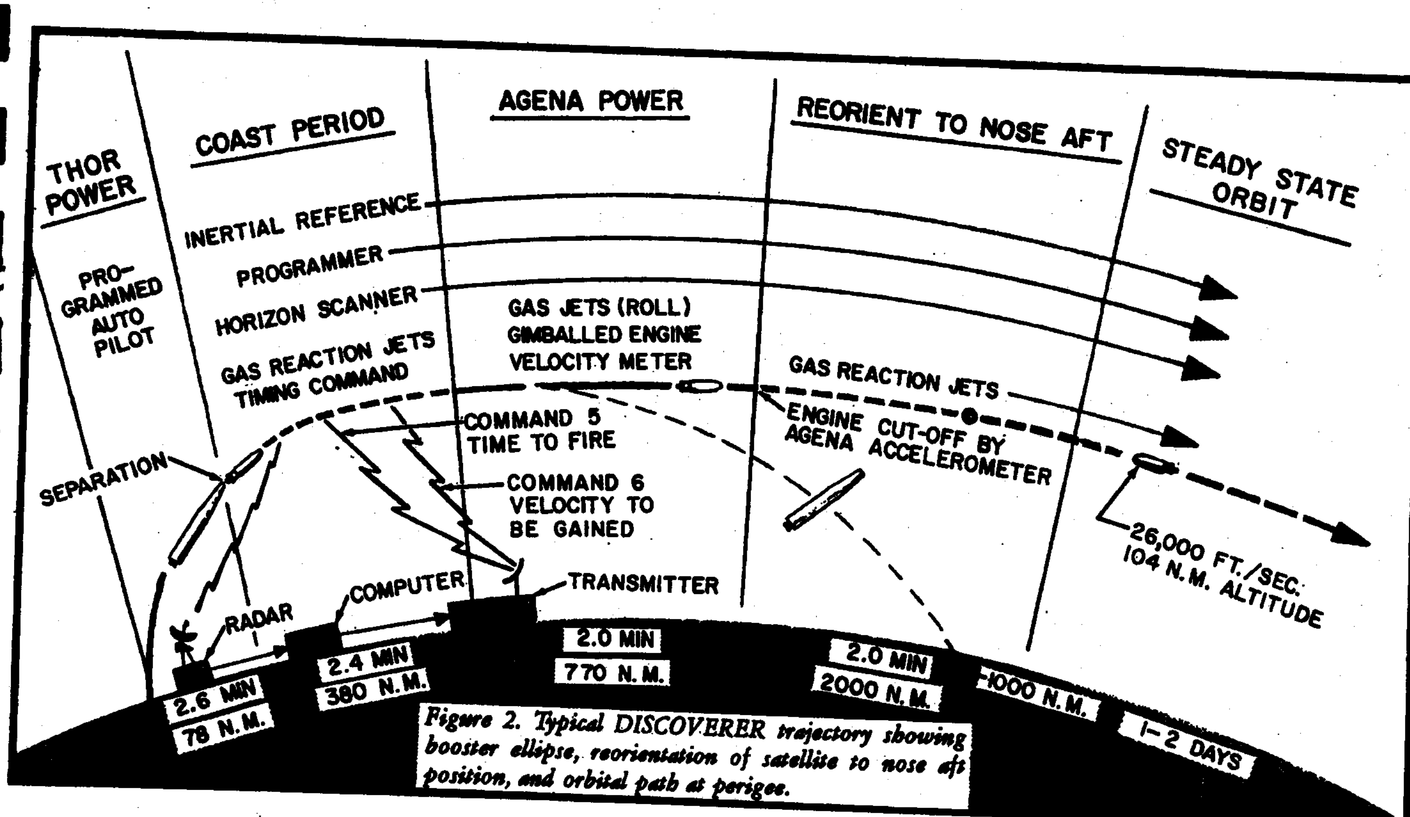


Figure 2. Typical DISCOVERER trajectory showing booster ellipse, reorientation of satellite to nose aft position, and orbital path at perigee.

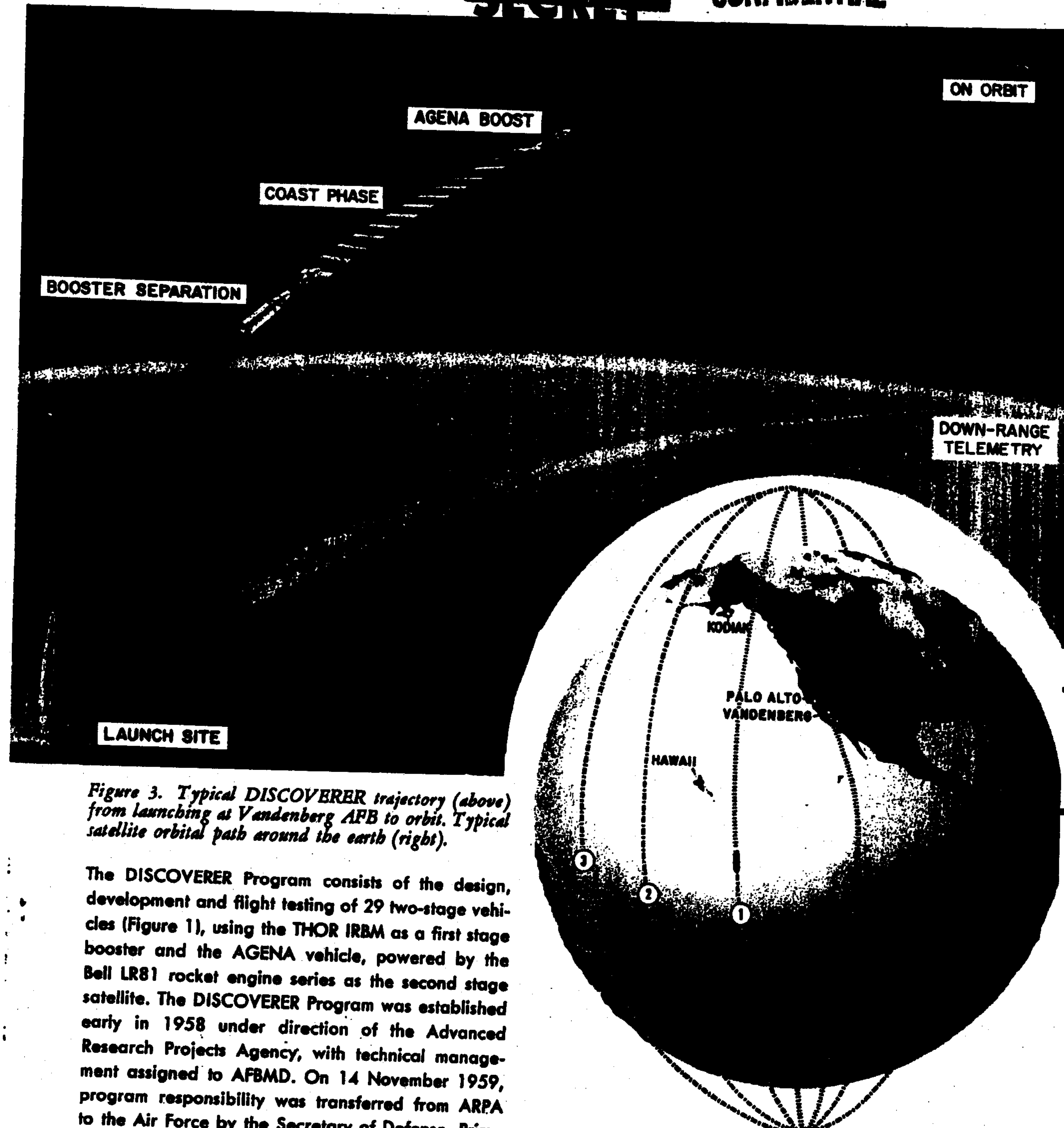


Figure 3. Typical DISCOVERER trajectory (above) from launching at Vandenberg AFB to orbit. Typical satellite orbital path around the earth (right).

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

Primary objectives include:

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

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

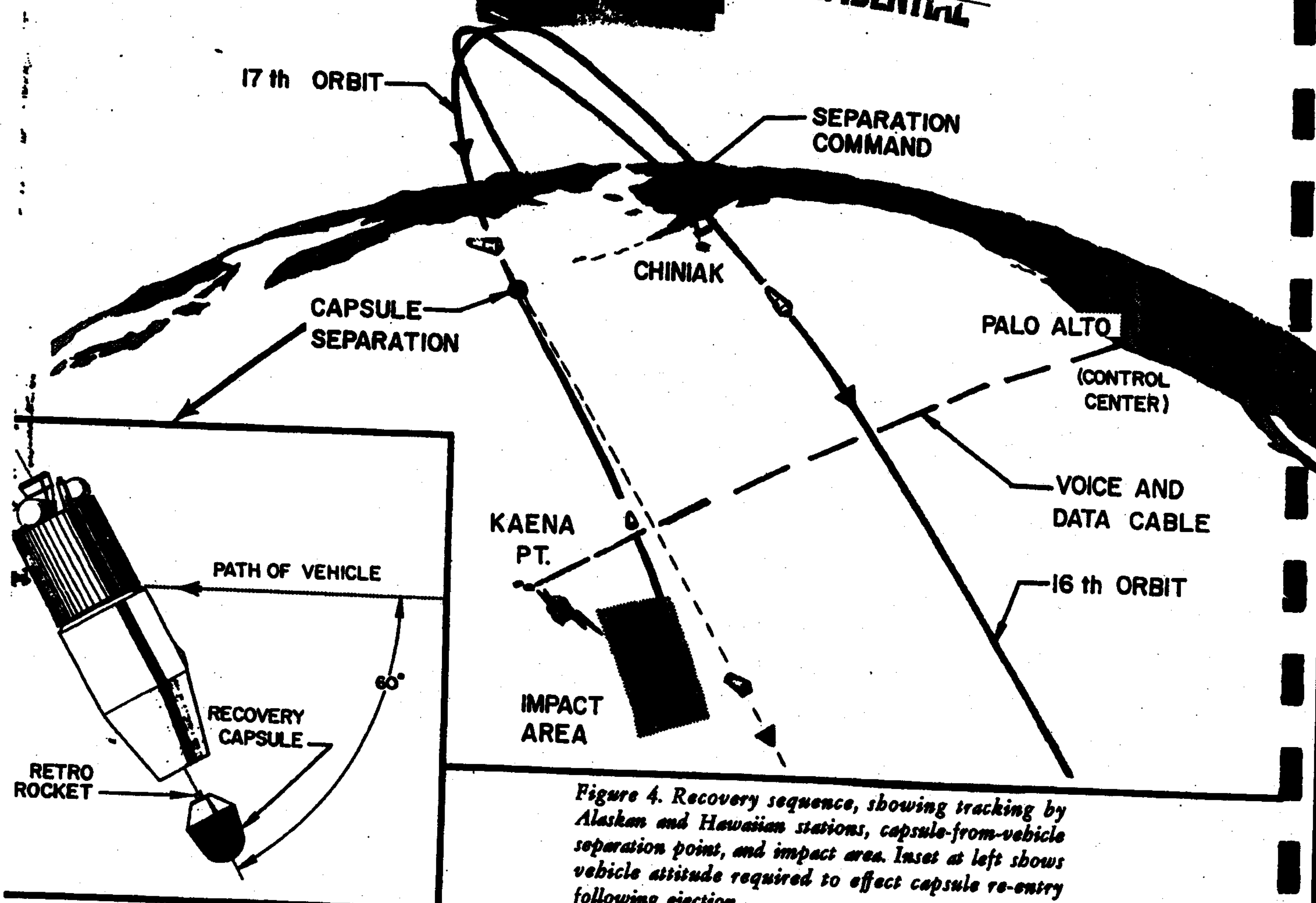


Figure 4. Recovery sequence, showing tracking by Alaskan and Hawaiian stations, capsule-from-vehicle separation point, and impact area. Inset at left shows vehicle attitude required to effect capsule re-entry following ejection.

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

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

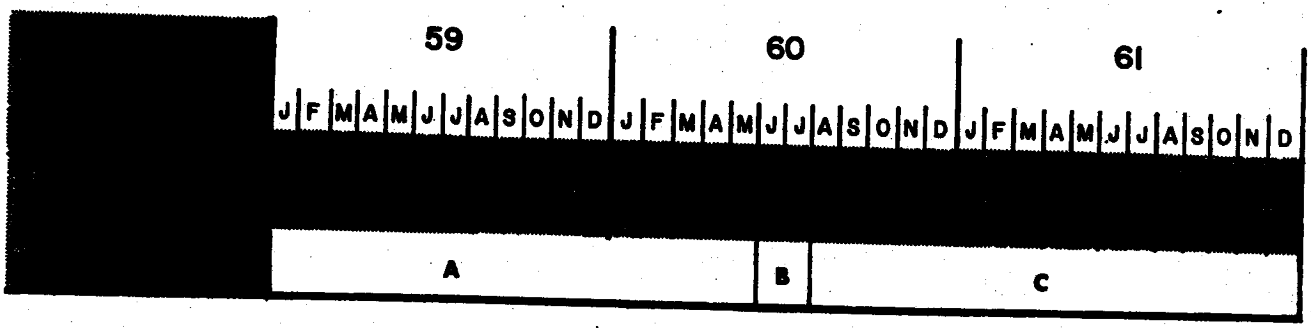
(f) Conducting bio-medical experiments with mice and small primates, including injection into orbit, reentry and recovery.

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 3 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 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] CONFIDENTIAL



A. THOR—SM-75 / AGENA "A"

B. THOR—DM-21 / AGENA "B"
MB-3 Block 1 XLR81-Ba-7

C. THOR—DM-21 / AGENA "B"
MB-3 Block 2 XLR81-Ba-9

Flight History

DISCOVERER No.	AGENA No.	THOR No.	Flight Date	Remarks
0	1019	160	21 January	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	1022	163	28 Feb 1959	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	1018	170	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	1020	174	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	1023	179	25 June	*Same as DISCOVERER III.*
V	1029	192	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	1028	200	19 August	*Same as DISCOVERER V.*
VII	1051	206	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	1050	212	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	1052	218	4 February	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	1054	223	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer.*

CONFIDENTIAL

MONTHLY PROGRESS—DISCOVERER Program

Flight Test Progress

DISCOVERER IX

● DISCOVERER IX was launched from Vandenberg AFB pad 4 at 1051 PST on 4 February. No problems were encountered during the final countdown. Liftoff was normal except for a malfunction of the helium quick disconnect. Although the initial ascent portion of the flight appeared normal, instrumentation indicated early termination of both THOR and AGENA burn periods. Data analysis revealed that the THOR engine shut down approximately 19 seconds early, resulting in a velocity loss of about 4,000 feet per second. Premature shut down of the AGENA engine resulted from the loss of propellant tank pressurization caused by the helium quick disconnect malfunction at liftoff. AGENA impact occurred in the ocean about 400 miles south of the launch site.

Quick Disconnect Problem

● At the time of DISCOVERER IX liftoff, the helium quick disconnect coupling released 1.1 second late. During this delay, the release lanyard was broken, resulting in a pull on the coupling. The vehicle mounting bracket broke, allowing the airborne half of the coupling to be pulled out of the vehicle. The coupling was recovered and has been subjected since to over 200 assorted release tests with no failures experienced. Failure of the coupling at launch is attributed to an accumulation of water inside the coupling which blocked the release action. Drain holes have been incorporated to prevent a recurrence of the problem.

DISCOVERER X

● DISCOVERER X was launched from Vandenberg AFB pad 5 at 1215 PST on 19 February. The countdown proceeded smoothly and launch was accomplished on the first attempt. Immediately after liftoff, THOR booster pitch oscillations began and, at T plus 56.4 seconds the vehicle was destroyed at 20,900 feet by the Range Safety Officer. Both the THOR and AGENA destruct systems operated satisfactorily. Many major components were recovered and are being examined and analyzed. No personnel injury or property damage was sustained. Preliminary analysis indicated that a THOR autopilot malfunction caused the main and vernier engines to oscillate between hardover stop positions, starting at liftoff. Extensive studies are underway to ascertain and correct the responsible conditions.

Flight Schedule

● DISCOVERER XI is scheduled for launch from Vandenberg AFB in late March. This vehicle will carry an advanced engineering test payload and an instrumented recovery capsule.

Technical Progress

Second Stage Vehicles

● All of the remaining AGENA "A" vehicles (DISCOVERER flights XI through XVI) are at Vandenberg AFB in various stages of launch preparation. Three of the first four AGENA "B" vehicles are in various stages of completion at the Modification and Checkout Center. The fourth vehicle (first AGENA "B" flight article) is at the Santa Cruz Test Base.

AGENA Propulsion System

See AGENA Monthly Progress section.

Guidance and Control

● A hydraulic control system driven by fuel pressure is being developed to save weight and electrical power. The system replaces the electric motor driven hydraulic pump used on AGENA "A" vehicles and is being tested currently at Santa Cruz Test Base. A weight saving of approximately 20 pounds will be realized. The system is planned for incorporation on DISCOVERER 21. This flight will be the first to use the improved configuration of the AGENA "B" (XLR81-Ba-9 engine and thrust chamber extension).

Figure 5. Optical tracking lights installed on aft equipment rack of DISCOVERER IX AGENA vehicle.

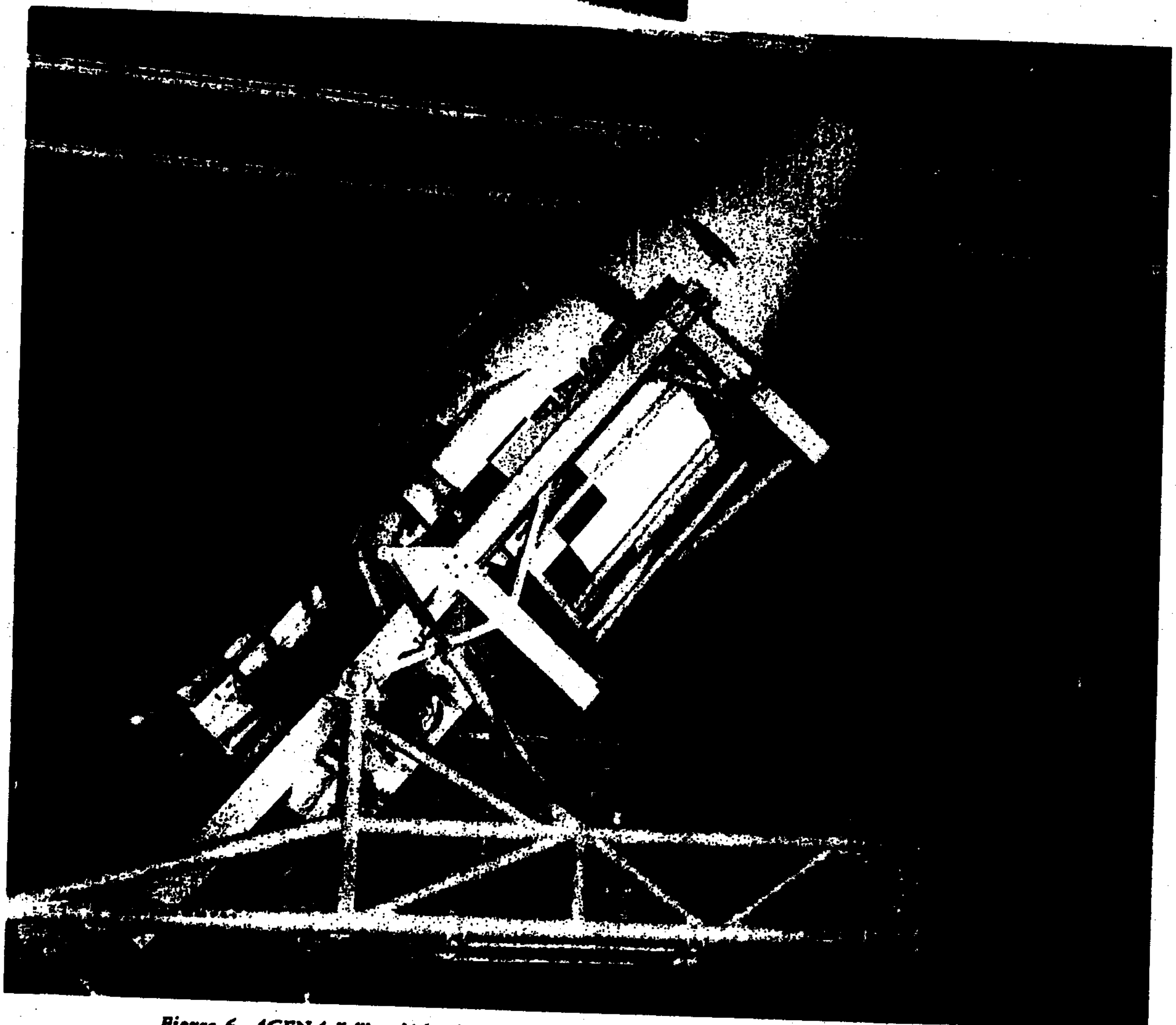


Figure 6. AGENA "A" vehicle shown mounted in transporter-erector at Modification and Checkout Center. This is the final AGENA "A" vehicle scheduled for this program (DISCOVERER XVI).

Biomedical Recovery Capsule

- Tests of the biomedical capsule designed for a small primate were resumed in the Lockheed high altitude temperature simulation chamber on 8 February. The General Electric capsule tested utilized several modifications and techniques derived from thermal profile tests in November and proof tests by the School of Aviation Medicine in December. These include increased cooling capacity, refinement of sensor-to-animal attachment methods for telemetry readout, relocation of life chamber components, and reprogramming of psychomotor response stimuli. The first full-duration test of the capsule containing a live primate was completed on February 12. This 55-hour test simulating a complete flight was initiated at Vandenberg AFB with the primate sealed in the capsule. A countdown was performed, and after 22 hours the capsule was flown to the Sunnyvale Development Center (with passenger). It was placed in the High Altitude Temperature Simulator for the simulated orbital phase, then sequenced through simulated re-entry-recovery phases. It was then placed in temperature-regulated water for five hours to simulate the final five-hour recovery phase. During these tests the primate responded to stimuli properly and was able to perform all programmed tasks. A new feeder, designed by the School of Aviation Medicine, proved excellent. Electrocardiogram readouts were excellent and all components of the air regeneration system functioned well.

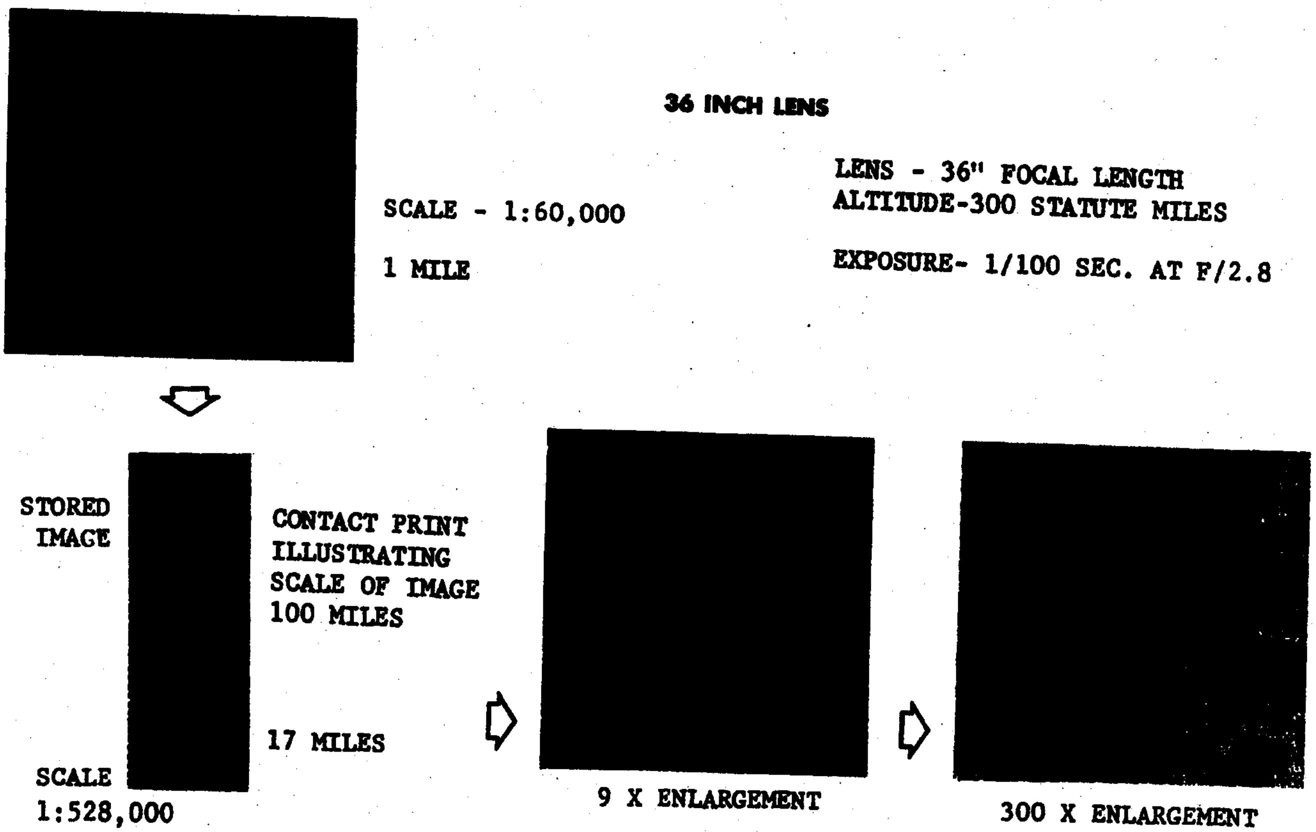


Figure 7. Simulated photography from satellite vehicle.

MONTHLY PROGRESS—SAMOS Program

Program Administration

● As a result of program reorientation announced during December 1959 and made necessary by restricted funding levels, the flight test plan for ferret payloads has been revised as follows:

Ferret Payload	*Number of Flights*	
	Old Schedule	*New Schedule*
F-1	2	3
F-2	2(1—F-2A) (1—F-2B)	4
F-3	4(2—F-3A) (2—F-3B)	1

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

Technical Progress

Second Stage Vehicles

● Work on the second stage (AGENA) vehicle for the first SAMOS flight is 70 percent complete in the Modification and Checkout Center. This vehicle will be the first of three to carry a combination visual and ferret (E-1 and F-1) payload. Assembly of the other two vehicles is proceeding on schedule. Interior design of the AGENA vehicles for flights 4 and subsequent is proceeding on schedule. A common airframe design from the forward equipment compartment aft is being used for these vehicles and for MIDAS vehicles (flights 3 and subsequent). Equipment installations need not be interchangeable. Substantial progress has been made on the design of the AGENA vehicle to be used for E-5 (recoverable) SAMOS payloads.

Visual Reconnaissance System

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

Readout:

E-1 — Component Test Payloads

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

Recovery:

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

Payloads

● **E-1 Payloads**—The first E-1 flight article payload was delivered to LMSD on 8 February. Functional tests were performed on all components. During a preliminary functional test, with the payload mounted in the collimator, a system resolution of greater than 94 lines per millimeter was obtained. The payload was subjected to a series of three 19-hour tests under simulated orbital conditions, with satisfactory results being obtained. The second E-1 payload is undergoing quality evaluation testing at Eastman Kodak. This is a spare payload for component replacement only and will be delivered to LMSD unassembled before 15 March.

● **E-2 Payloads**—Delivery of the first E-2 payload is scheduled for July. Environmental tests of the thermal model E-2 payload were completed on 28 January in the high altitude temperature simulation chamber. Test objectives were achieved. Changes in the payload housing surface and heater power requirements are being made as a result of testing data obtained.

● **E-5 Payloads**—Design of the high acuity panoramic camera system is proceeding satisfactorily. The special optical glass for the lens elements, which has been ordered from West Germany, will be deliverd to the Itek Corporation in mid-April. The Development Test Plan for the recovery capsule has been published, including payload test requirements from checkout through post-launch operations. Avco Corporation is conducting wind tunnel tests on various capsule configurations as a parallel effort with LMSD aerodynamics studies.

Ground Support Equipment

● The complete visual reconnaissance system ground support equipment complex was operated with the E-1 payload during February. All equipment operated satisfactorily.

Ferret Reconnaissance System

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

F-1 — R&D Test Payloads

F-2 — Digital General Coverage Payloads

F-3 — Specific Mission Payloads

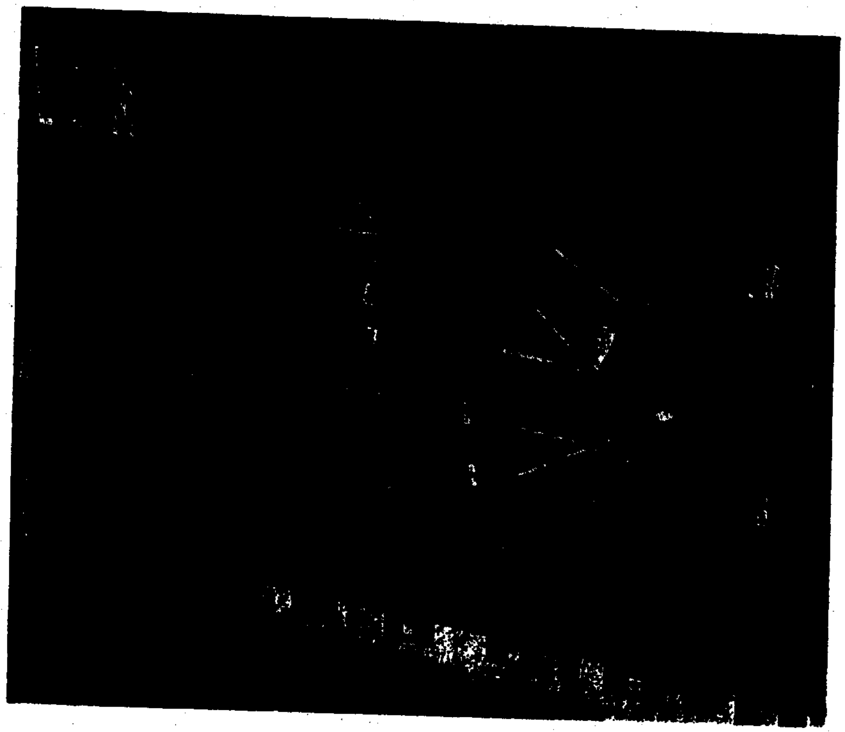


Figure 8. F-1 payload separation test set-up. Satisfactory payload separation was demonstrated in tests conducted by LMSD in February. Payload-vehicle attachments were simulated in test set-up. The zero gravity condition of the payload in orbit was effected by suspending it from a 60-foot cable (center of photo).

Payloads

● **F-1 Payloads** — The first two F-1 payloads are being prepared for installation in their respective AGENA vehicles at the Modification and Checkout Center. During payload evalution tests conducted in January a discrepancy was indicated in the pulse width measurement circuits. The circuit design is being studied in an effort to solve this problem. Efforts to solve the intermittent time counter errors encountered during systems testing of the third F-1 payload are progressing satisfactorily. Desensitizing the counter stages appears to be the most feasible solution. A breadboard of the desensitized time counter has been installed in an F-1 service test model payload and has been operated satisfactorily for 48 cycles of life testing (equip to approximately three days of orbital operation). The use of line filters is being studied as an additional effort. Separation tests of the vehicle nose cone were completed satisfactorily during January. Separation tests simulating vehicle-payload attachments were completed satisfactorily during February.

● **F-2 and F-3 Payloads** — In accordance with the program reorientation reported in paragraph B.1, the concepts and basic characteristics for the new F-2 and F-3 payloads were defined in an LMSD Technical Letter Report for January. Work statements in accordance with the new requirements are being prepared for Airborne Instruments Laboratory. Design and modification of some of the payload components affected by the change (i.e. payload structure and antenna assemblies) have been initiated.

Ground Support Equipment

● Delivery of the F-1 data conversion equipment to the Satellite Test Center is scheduled for 25 March. Negotiations are underway for the changes to the F-2 and F-3 ground data handling equipment resulting from program reorientation.

Program Communications and Control Equipment

● Design of the exit VHF antenna for the satellite vehicle has been refined, using a honeycomb dielectric to support the cavity. A weight reduction of 60 percent was realized and laboratory tests indicate satisfactory performance.

● Systems and acceptance tests are being conducted on the UHF ground equipment for the Vandenberg AFB tracking and data acquisition station.

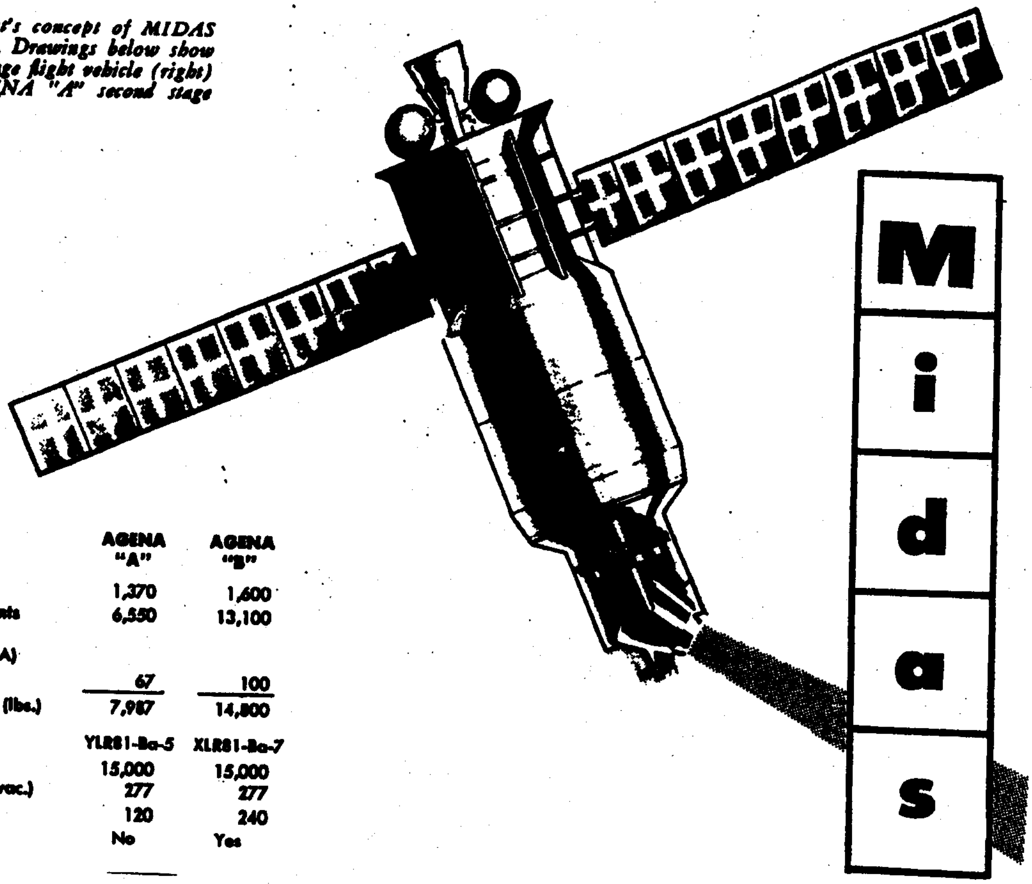
Ground Support Program

● **Ground Handling and Service Equipment** — Equipment for Point Arguello launch pad #1 has been delivered and is scheduled to be completely installed and checked out by the middle of May.

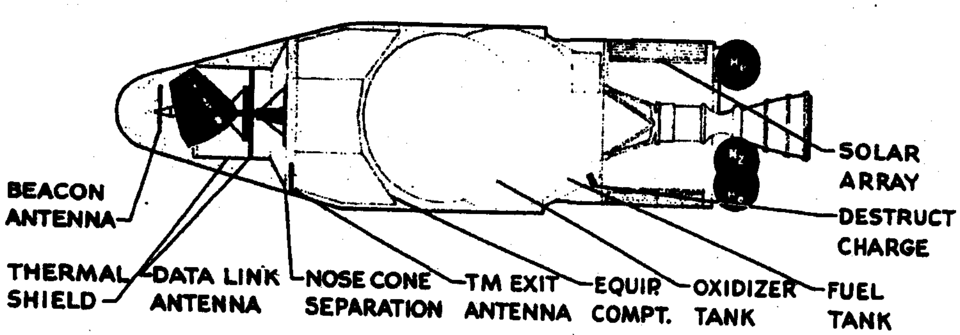
● **Launch Control Equipment** — Manufacturing of launch control systems equipment for Point Arguello launch pad 2 is 80 percent complete. The equipment for launch pad 1 was shipped to Vandenberg AFB on 18 February.

[redacted]

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



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



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

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

[redacted]

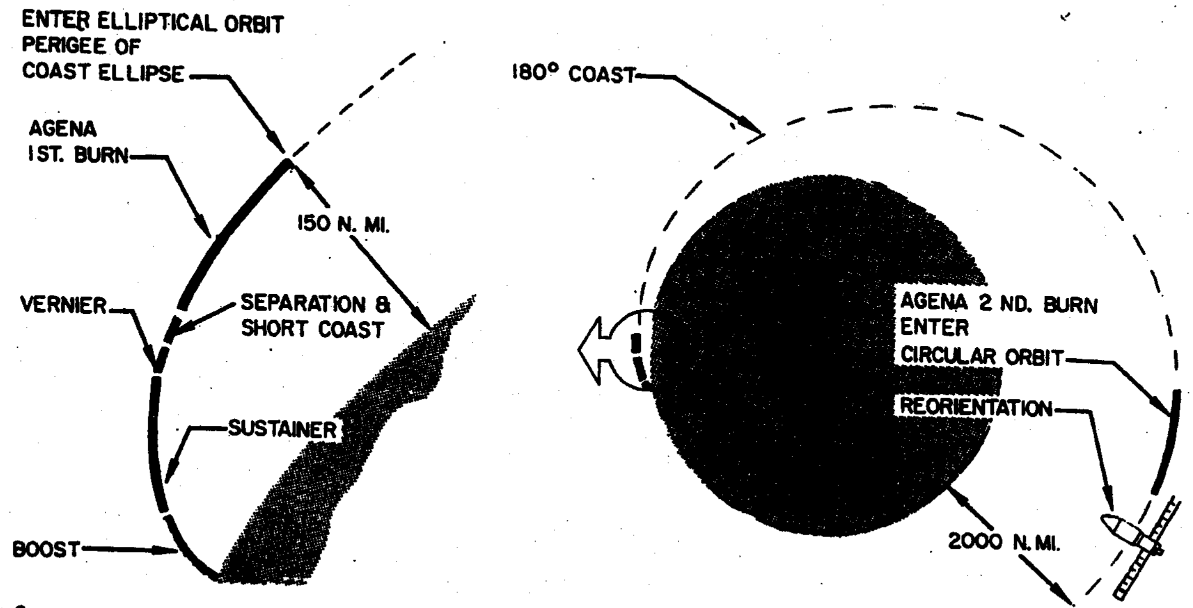


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. Optimum ATLAS boost, guided by radio-inertial system. AGENA ascent (coast, burn, coast, second burn) provides attitude reference. Also governs velocity magnitude and direction by inertial guidance system monitored by horizon scanner.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

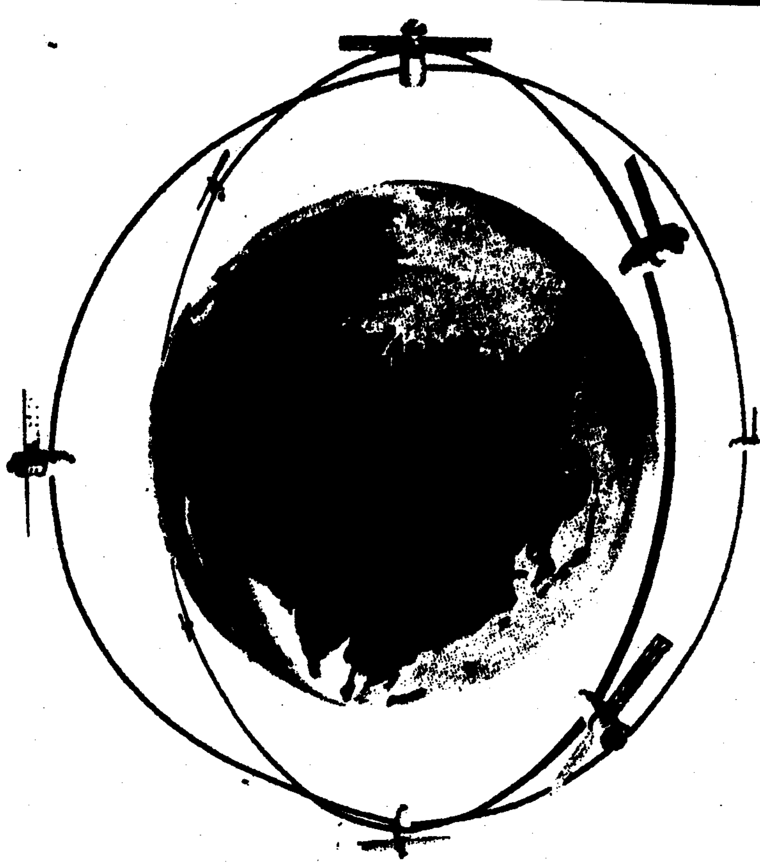


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

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

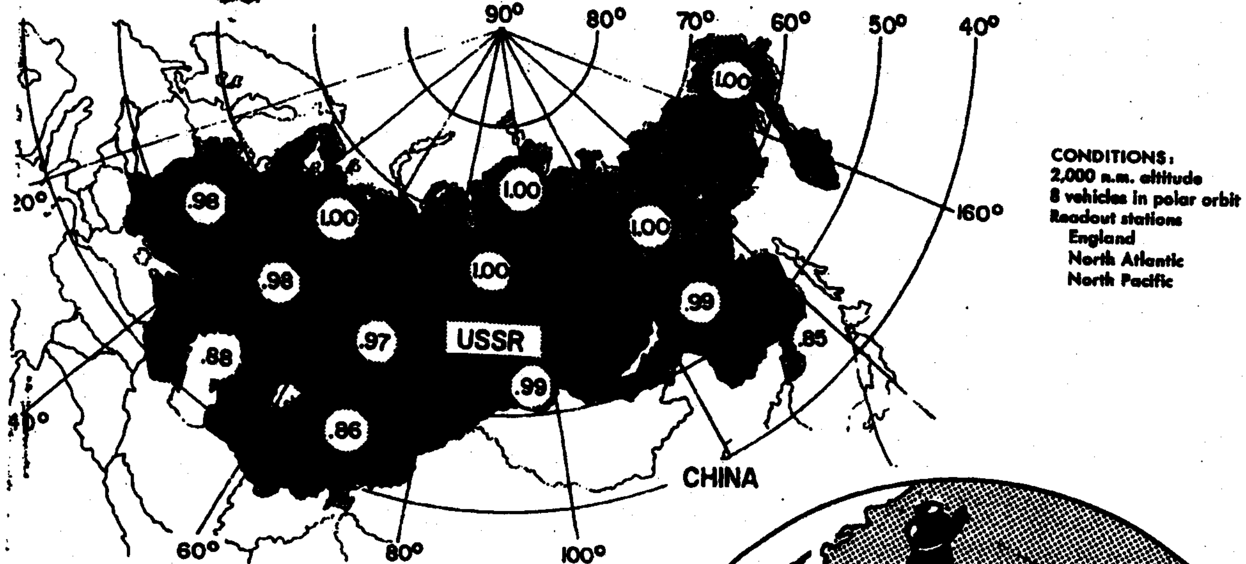
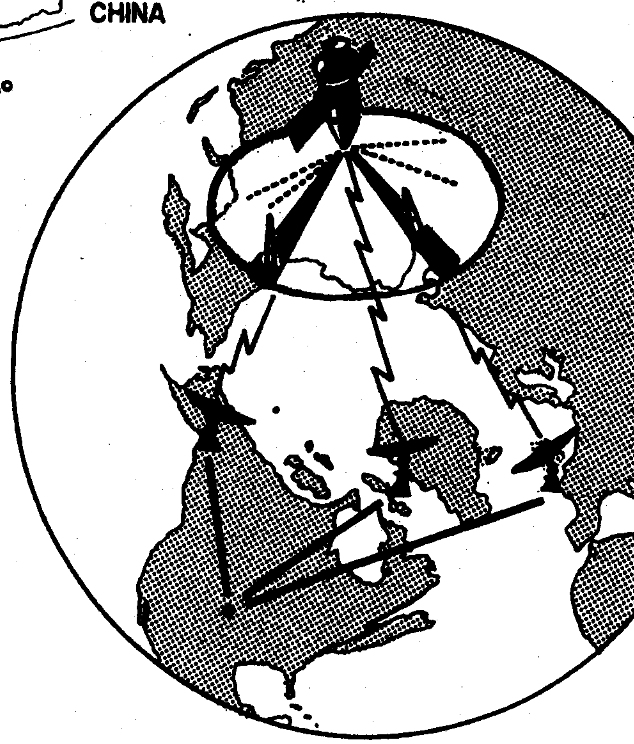


Figure 4.
Orbiting satellites detect infrared radiations emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveals approximately the number of missiles launched and launch location, direction of travel and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



TECHNICAL HISTORY

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

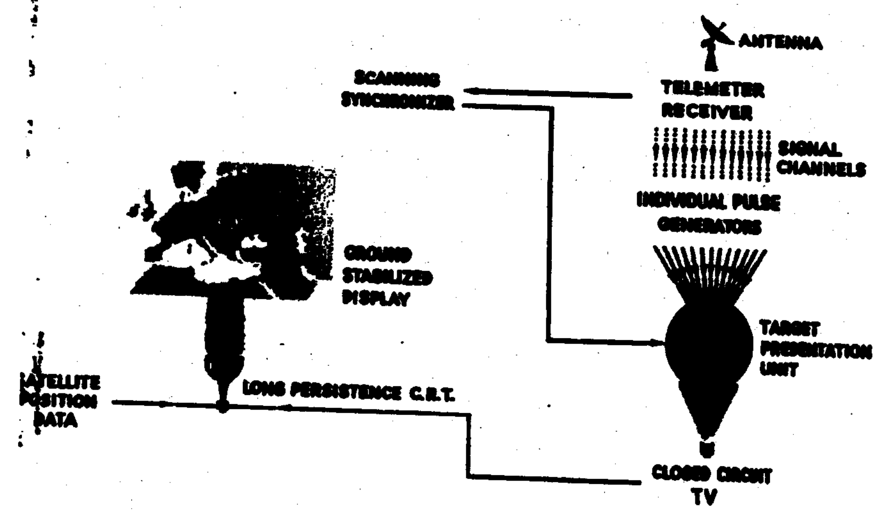
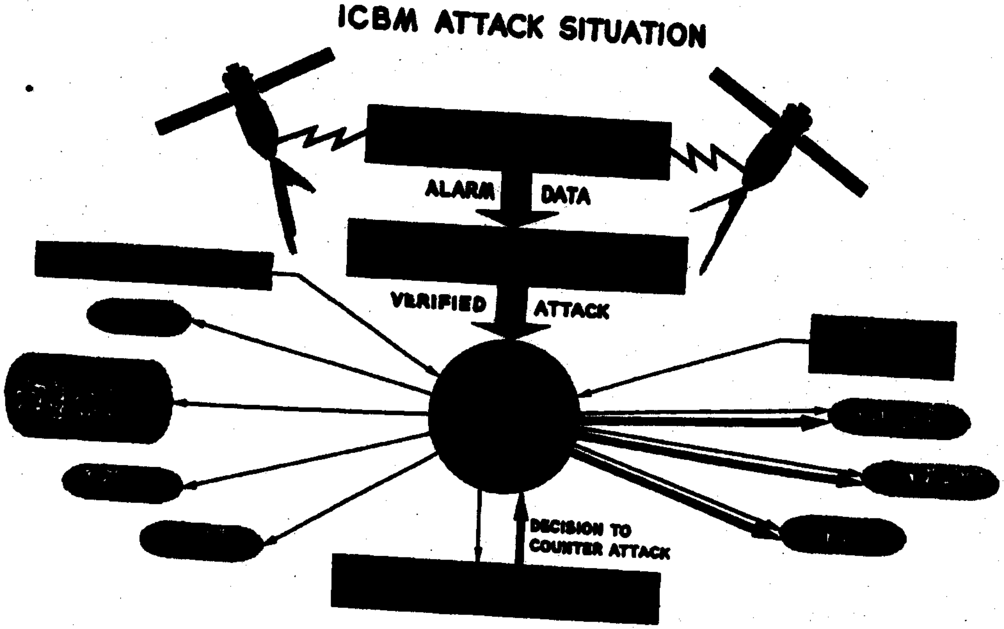


Figure 5.
Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies 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.



CONCEPT

The MIDAS system is designed to provide continuous infrared reconnaissance of the Soviet Union. Surveillance will be conducted by eight satellite vehicles in accurately positioned orbits (Figure 3). The area under surveillance must be in line-of-sight view of the scanning satellite. 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 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.

MONTHLY PROGRESS—MIDAS Program

Flight Test Progress

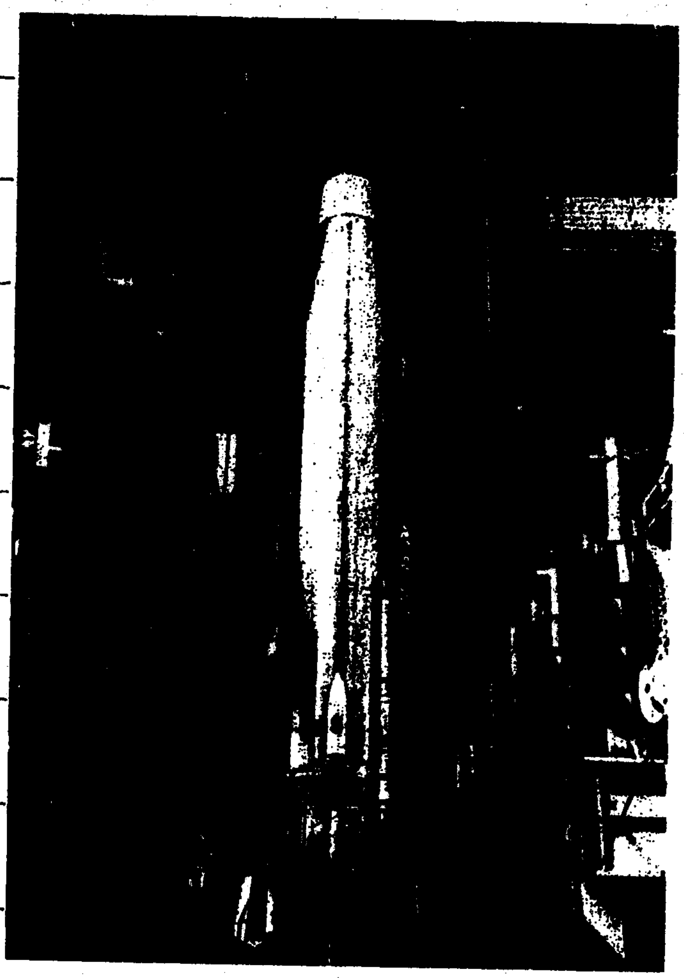
● The first MIDAS flight test vehicle was launched from Atlantic Missile Range launch pad 14 on 25 February. Satellite orbit was not attained. A detailed analysis of the flight and of the problems encountered will be included in next month's report.

Flight Parameters

● The first MIDAS flight test was programmed to place the satellite vehicle into a 261 nautical mile circular orbit, with a maximum eccentricity of 0.007 and an inclination angle (to the equator) of 32.5 degrees. A useful orbital lifetime of 29 days was anticipated. A launch azimuth of 107 degrees was used, with orbital injection planned to occur at T plus 655 seconds at a velocity of 25,024 feet per second.

Launch Preparations

● The electrical rewiring of launch pad 14 required for the MIDAS vehicle, and launch pad umbilical drop tests, were completed on schedule. Additional redundant electrical circuits were installed in the umbilical mast to provide increased launch reliability.



● Systems checkout of the ground support equipment was conducted successfully with no problems becoming apparaent. Checkout of the ATLAS booster also was conducted with completely satisfactory results.

● MIDAS vehicle simulators were delivered to AMR, Kaena Point (Hawaii) and Vandenberg AFB early in February. These units were used to train and familiarize operating personnel in vehicle handling, checkout, tracking and readout; and for electrical checkout of associated ground equipment. Each unit consists of two equipment racks. The simulators are capable of receiving telemetry, transmitting commands, and simulating the characteristics of the infrared payload and communications subsystem of the orbiting MIDAS satellite.

Satellite Readout Plans

● AMR, Kaena Point and Vandenberg AFB were scheduled to perform payload-to-ground data link readout. All three stations were to have tape recorded the satellite system-time data for analysis and processing for presentation on the command console of the ground presentation unit at the Satellite Test Center, Sunnyvale, California. In addition, real-time readout was to have been performed on the ground presentation unit at Vandenberg AFB. Motion pictures were to have been made of the real-time ground presentation, with comparable system-time indicated on each frame.

● A series of targets had been planned to test the infrared readout capability of the orbiting MIDAS satellite. These included the launchings of an ATLAS and a TITAN missile from the Atlantic Missile Range, and the SAC launch of an ATLAS missile from Vandenberg AFB. All launches were to have been timed to coordinate with passes of the MIDAS satellite. In addition, ten pyrotechnic targets were to have been ignited at Vandenberg AFB and Edwards AFB during night time orbital passes.

Technical Progress

Second Stage Vehicles

● Preparation of AGENA vehicle 1007 for installation on the second MIDAS flight vehicle is proceeding on schedule in AMR Hangar E. X-ray exam-

Figure 6. View of ATLAS booster for first MIDAS flight, as seen from gantry. ATLAS is installed in transporter prior to erection.

Figure 7. View of launch pad 14 gantry and umbilical tower during erection of ATLAS booster for first MIDAS flight.

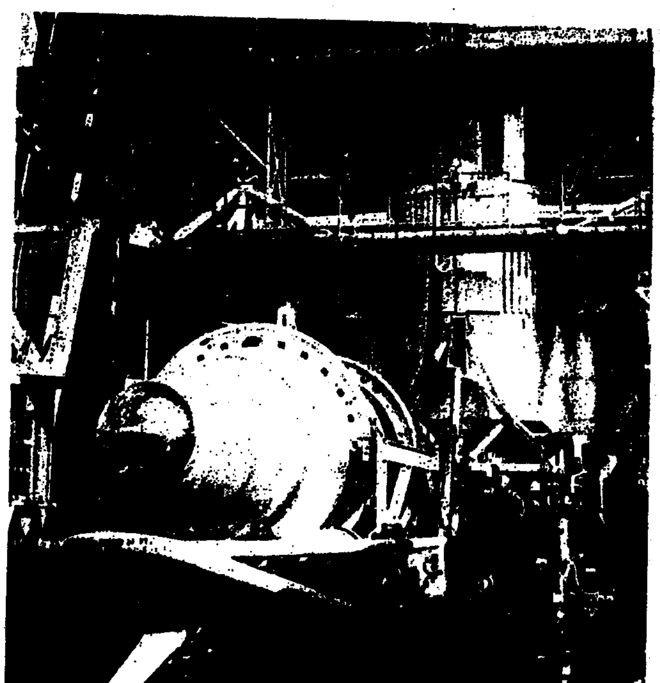


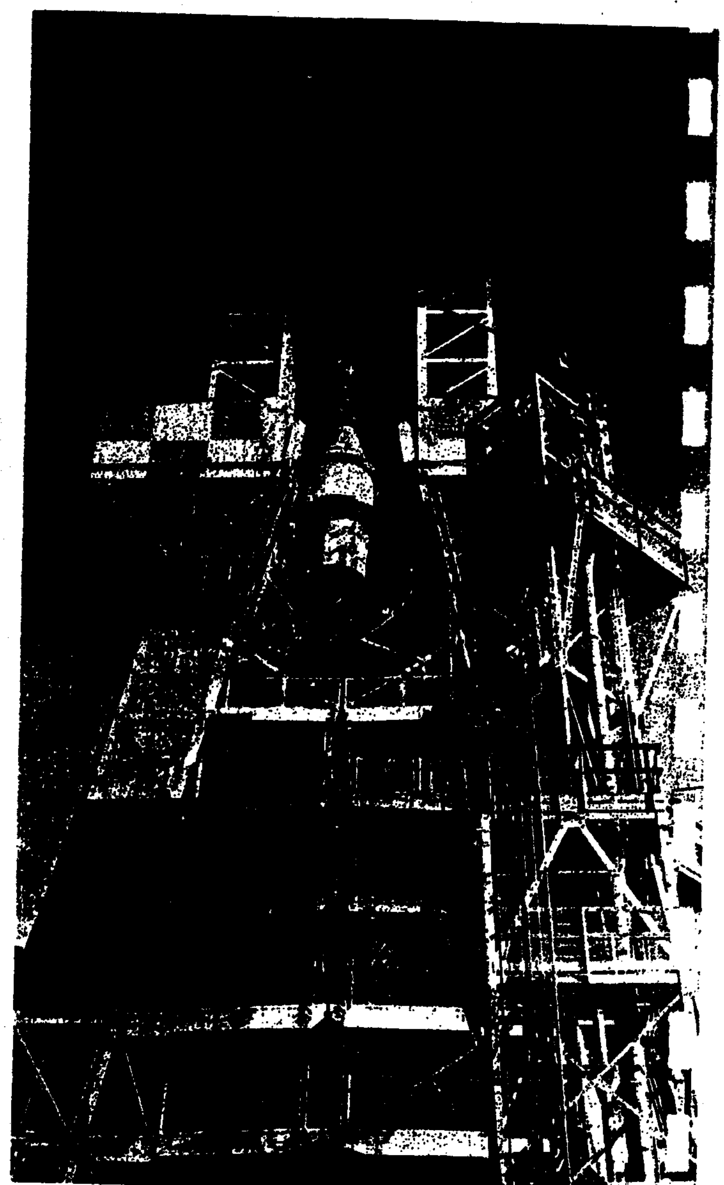
Figure 8. AGENA vehicle (above) mounted in transporter shown at base of gantry and (right) being lifted into gantry for mating with ATLAS booster.

ination of the thrust chamber revealed the presence of a foreign particle in the oxidizer inlet manifold. A new thrust chamber was installed on 8 February.

- Design of the AGENA vehicle for the third MIDAS flight test is proceeding on schedule. Structures are being fabricated and release of equipment and installation bracketry designs to manufacturing is anticipated early in April.

Infrared Scanner Units

- Three of the infrared scanner units for the first two MIDAS flights were shipped to AMR during February, and the fourth is in the Modification and Checkout Center. One of the units at AMR is the flight article for the second MIDAS flight.



Infrared Payload Tracking Tests

● An operational test of the complete MIDAS system was conducted successfully on 29 January. The test target was an ATLAS missile launched from Vandenberg AFB. The infrared payload and satellite data link were mounted outside the telemetry building to permit missile tracking during ascent. The ground data link system transmitted the data to the tracking station where it was tape recorded. Analysis of the tapes on which the tracking information was recorded revealed that the target information obtained was highly satisfactory. The capability of the space and ground presentation equipment, as installed at Vandenberg AFB, was established. The test also provided a valuable personnel training function. On 4 February, the launch and flight of the DISCOVERER IX vehicle was tracked in a similar manner for 110 seconds.

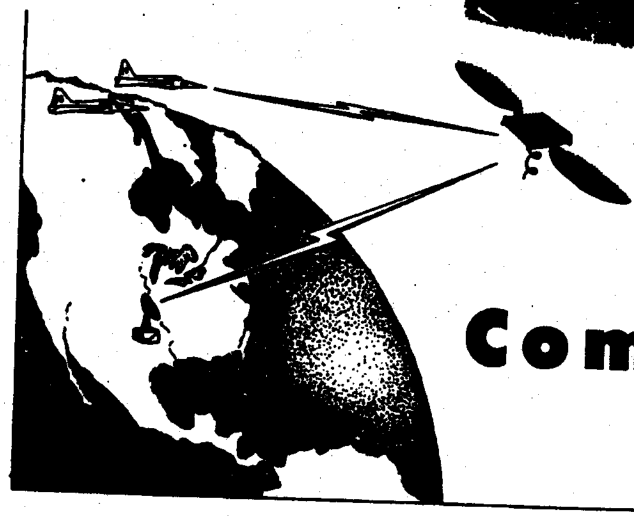
● **Advanced Presentation Unit** — Negotiations between LMSD and General Electric Co. on the contract for this unit are essentially complete.

● **Solar Auxiliary Power** — Fabrication of the solar array panels was started on 8 February. The mockup of the entire array is nearly complete. A functioning 1/10 scale model of the array mechanism was completed during February.

● **Reliability Negotiations** — LMSD and Bell Aircraft have completed a work statement for an AGENA engine reliability program.

Figure 9. Infrared scanner unit and associated equipment shown in test set-up at Vandenberg AFB. Infrared tracking of ATLAS and DISCOVERER flights were performed with highly successful results. Note the filter-out position of the scanner. Satellite borne communications system circuitry is shown at right side of photographs.

[redacted] ~~CONFIDENTIAL~~



Communications Satellite

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

STEER (Figure 1)

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

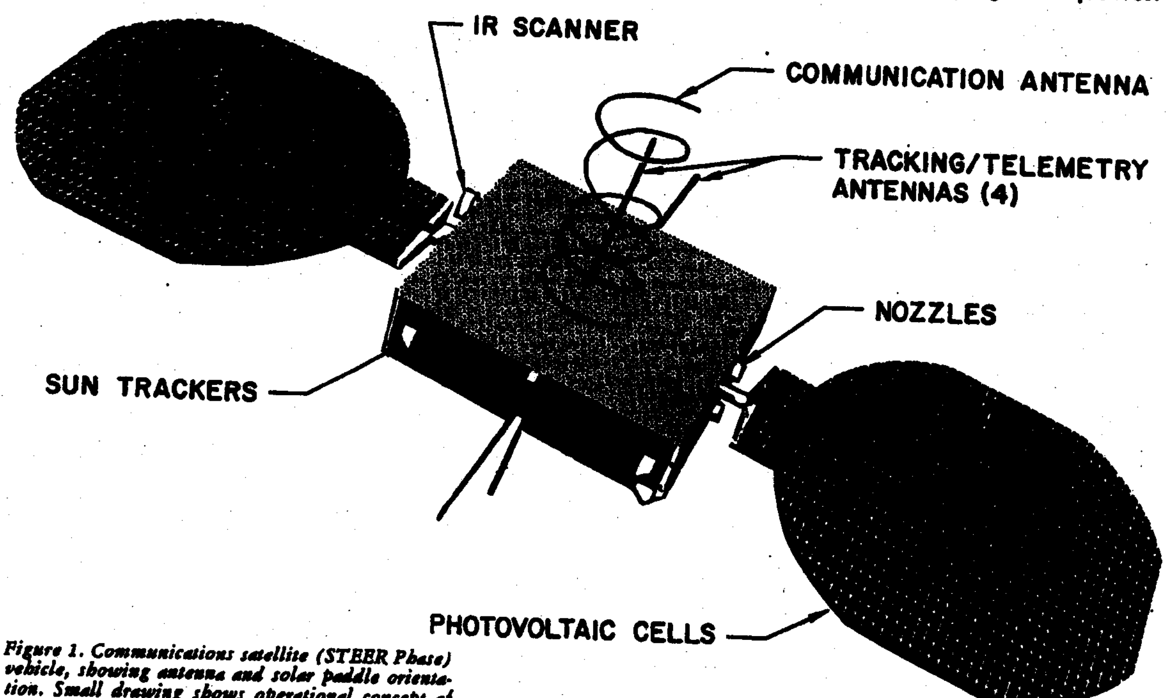
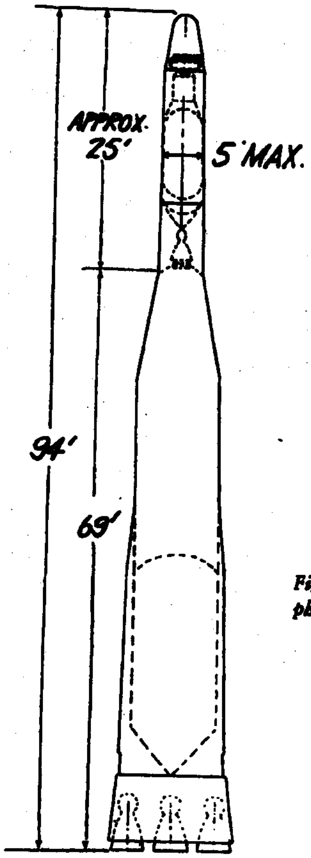


Figure 1. Communications satellite (STEER Phase) vehicle, showing antenna and solar paddle orientation. Small drawing shows operational concept of STEER phase.

~~CONFIDENTIAL~~

[redacted]

~~CONFIDENTIAL~~



AGENA SECOND STAGE

XLR-Ba81-7 engine

ATLAS-D BOOSTER

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

Figure 2. Flight vehicle for STEER and TACKLE phases.

STEER objectives include:

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

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

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

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

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

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

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

[redacted]

~~CONFIDENTIAL~~

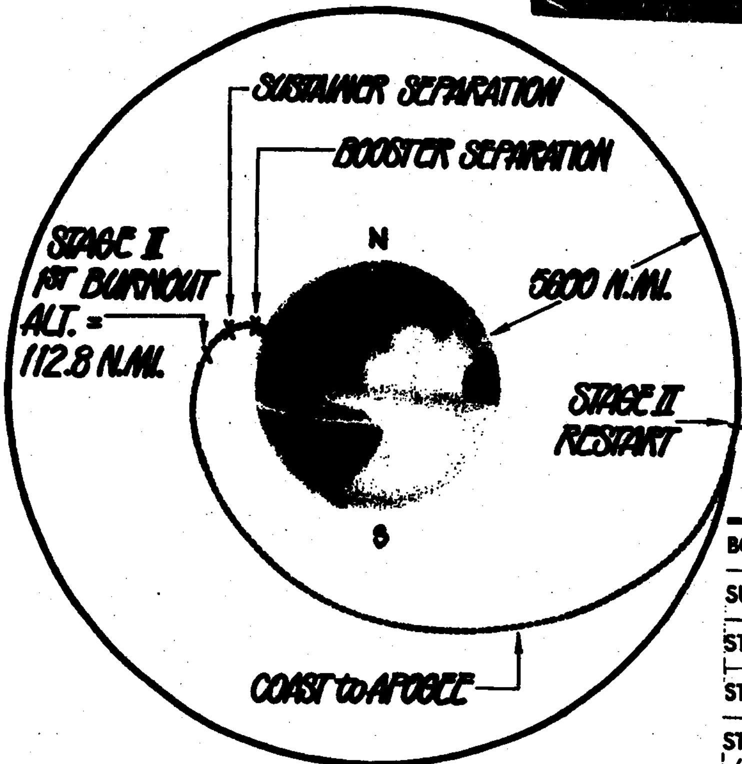


Figure 3. Schematic of STEER phase flight trajectory and orbits showing sequence of operational events.

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

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

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

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

DECREE

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

MONTHLY PROGRESS—COMMUNICATIONS

SATELLITE Program

Program Administration

● AFBMD has been advised by OSD teletype that Amendment 4 to ARPA Order No. 54, dated 29 February 1960, has directed that efforts defined under Projects STEER and DECREE be reoriented into a single integrated project under the code name ADVENT.

● AFBMD is preparing a development plan which reorients the program in keeping with the spirit and intent of Amendment 4. The new plan will be submitted to ARPA in March.

● Because FY 1960 funds have not been released, current launch schedules for Projects STEER and DECREE are not valid. As a result, the efforts of Project STEER contractors were reoriented during February to preserve the integrity of the engineering team as long as possible.

Technical Progress

● Preliminary configuration studies of the final stage vehicle have been completed. These include detailed weight, power, thermal analysis and volume estimates. Parts counts were made on system block diagrams to provide realistic weight and power estimates. Super insulation is used on surfaces exposed to solar radiation, and variable temperature control radiators on surfaces not so exposed. These studies were conducted by Space Technology Laboratories.

● Laboratory tests of components and mock-up models have been performed by the General Electric Company, emphasizing the following areas:

a. Tests of silver-zinc batteries for possible use as a primary power source during periods of eclipse. Test failures have justified a decision to use nickel-cadmium batteries.

b. Radiation testing of solar cells.

c. Communications antenna pattern tests on full-scale model.

d. Telemetry antenna patern tests on quarter-scale model.

e. Bearing tests under vacuum with various combinations of teflon and silver-plated steel balls.

f. Emissivity evaluation tests on several materials as part of the temperature control method.

● Extensive analyses relating to the development of a communications satellite have been formalized by Space Technology Laboratories and transmitted to General Electric. Areas covered include:

a. Station keeping accuracies.

b. Visibility time.

c. Use of elliptical orbits for polar coverage.

d. Trajectory error budgets.

e. Satellite space radiation environment.

f. Vacuum bearing data.

g. Electrical power and weight trade-offs.

h. Various satellite attitude control systems and control laws.

i. Separable versus non-separable final stage vehicles.

j. All available ABLE Program antenna design data.

● Studies currently in progress which affect the design of the final stage vehicle include:

a. Analysis of problems associated with orbit station keeping to determine the required accuracies for command and mechanization.

b. Analog and digital simulations to evaluate the effects of lunar and solar gravitational perturbations, gravity gradient and solar radiation pressure.

c. Basic battery studies, i.e., reliability versus cyclic life and depth of discharge on voltage regulation.

d. Effects of radiation and micrometeorite impact on solar cell efficiency.

e. Several propulsion methods for the final stage vehicle, including the use of bi-propellants and mono-propellants.

Communications Equipment Development

UHF

● Bendix has conducted an experimental evaluation of hard limiters for use in the satellite repeater equipment. Their evaluation exactly confirms theoretical predictions and has shown the following effects of hard limiting upon frequency modulated or phase modulated signals. For positive or negative signal-to-noise or signal-to-jamming ratios of greater magnitude than about 10 decibels, hard limiting increases the magnitude of the ratio by six decibels. Thus, in the absence of jamming the hard limiter would act as a noise filter; however, in the presence of overpowering jamming (negatives S/J ratios) the hard limiting would enhance the jamming signal and reduce the intelligence-carrying signal.

● Site selection criteria for the communications subsystems ground station have been prepared. No action has been taken because of a lack of funding.

Microwave

● Preparation of specifications for satellite borne and ground station communications equipment is nearing completion. Consideration has been given to the terminal equipment for two ground stations. The terminal equipment will consist of: 8 AN/FGC-25X teletypewriter sets, 4 AN/TCC-41 PCM multiplex units, 4 AN/GXC-4 facsimile units, 8 AN/TCC-30 terminal units and 4 analog-to-digital converters.

● Army Signal Research and Development Laboratory has requested the following specific frequency allocations for the communications subsystem:

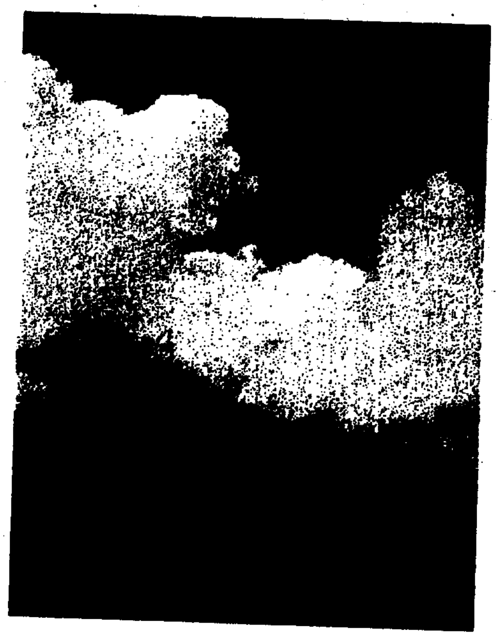
Ground station-to-satellite—7140 mc, 7580 mc, 8020 mc, 8460 mc.

Satellite-to-ground station—1830 mc, 1940 mc, 2050 mc, 2160 mc.

Beacon tracking of satellite—1770 mc, 1880 mc, 1990 mc, 2100 mc.

● A contract was awarded Varian Associates for the purchase of one high power, 8000 mc klystron tube and the performance data to indicate the system suitability of this tube.

SPACE



projects

- ABLE
- TRANSIT
- COURIER
- TIROS
- AGENA
- ABLE-STAR
- MERCURY
- 609A

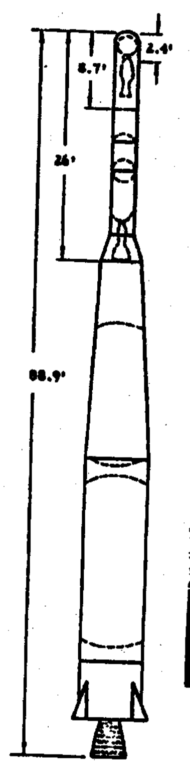


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.

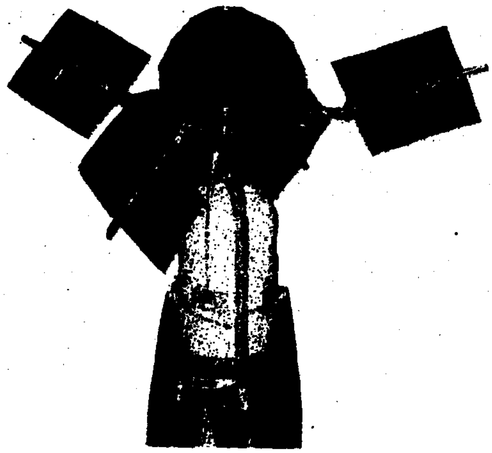


Figure 2. ABLE-3 third stage and payload with solar paddles in fully extended position.

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

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

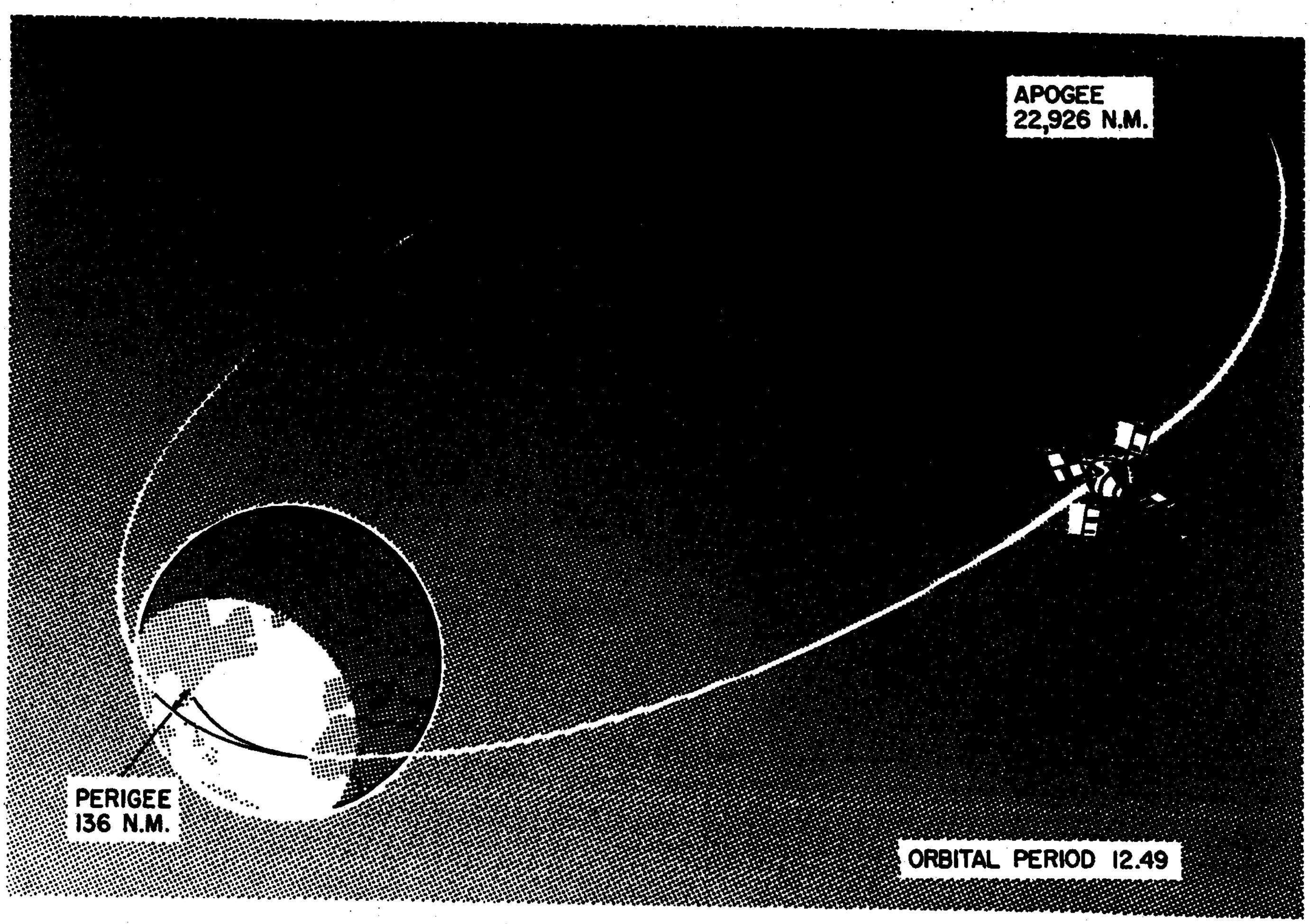
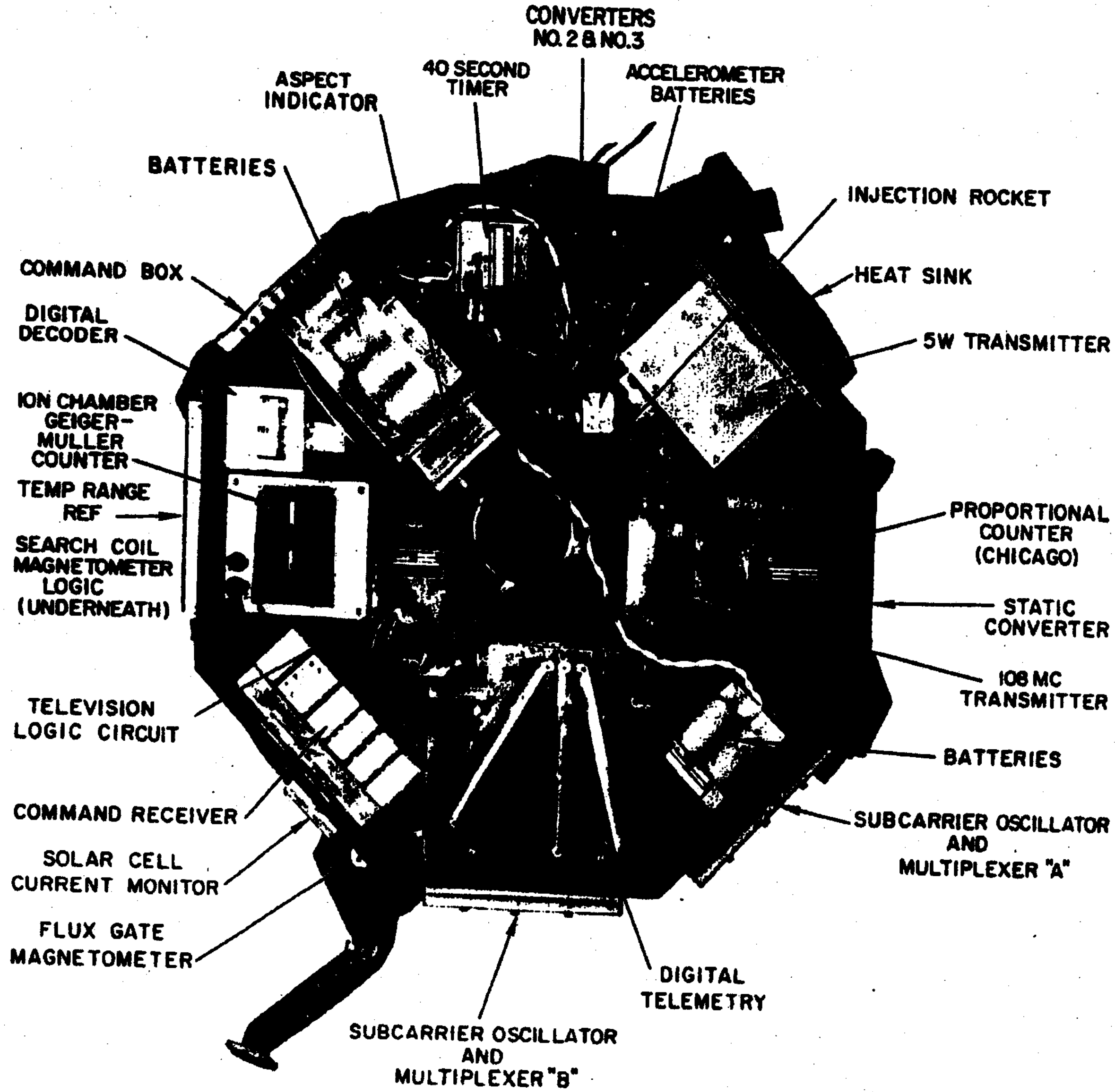


Figure 3. Drawing of extremely elliptical ABLE-3 orbit.



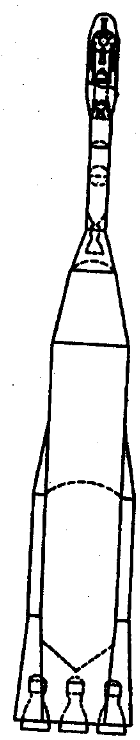
THOR-ABLE III PAYLOAD (TOP VIEW)

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

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

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

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



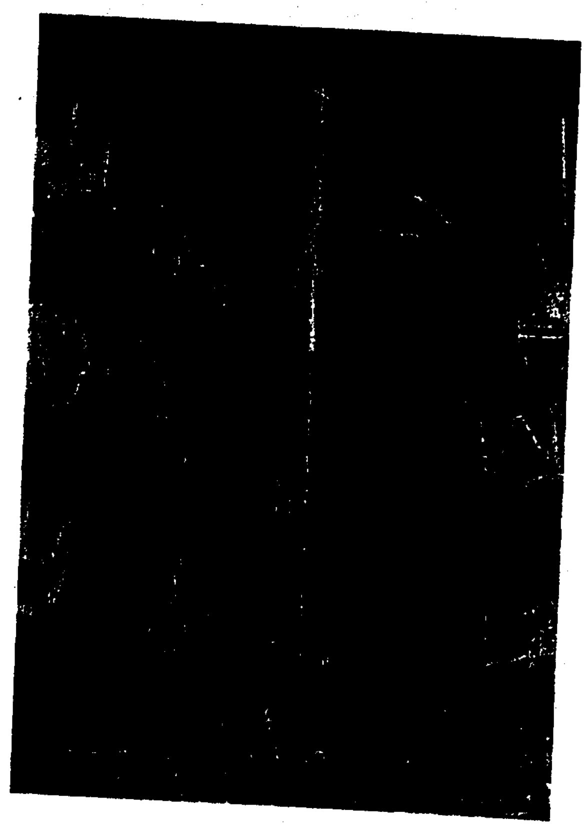


Figure 5. Line drawing of ABLE-4 ATLAS flight test vehicle. Photos show vehicle on launch pad. Vehicle booster and second-stage were subsequently destroyed during flight firing readiness.

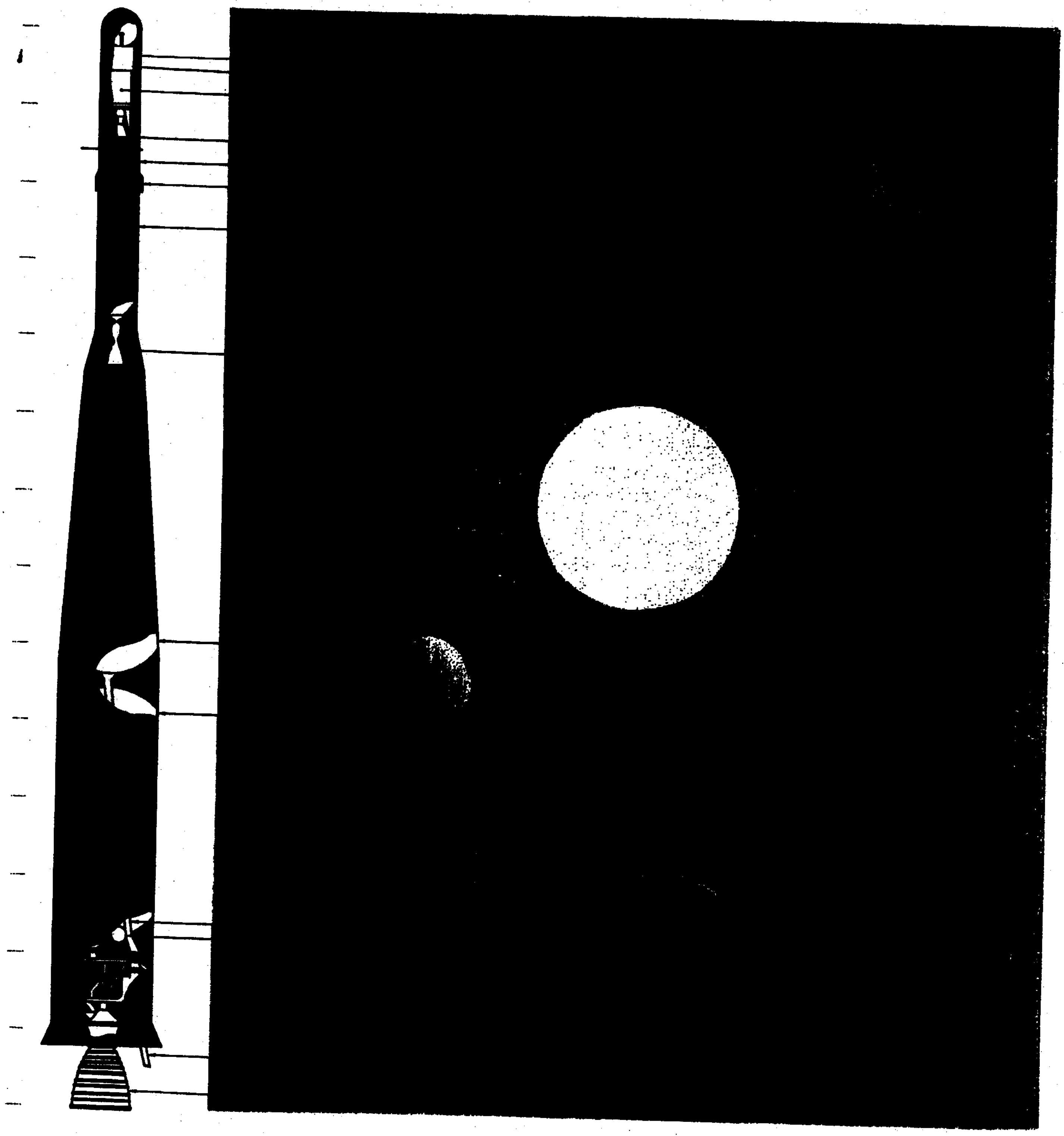


Figure 6. Cutaway view of ABLE-4 THOR flight test vehicle (left). Drawing (right) shows artist's conception of ABLE-4 THOR payload in orbit about the sun.

MONTHLY PROGRESS—ABLE Projects

ABLE-4 THOR

Flight Schedule

● Welding repairs made necessary by a leak in the oxidizer tank outlet caused a delay of several days in the ABLE-4 THOR launch date.

Note

The ABLE-4 THOR was launched successfully from the Atlantic Missile Range on 11 March. All three stages performed excellently and the payload continued to be tracked along the programmed trajectory. A detailed report of the launch and orbital performance of the payload will be given in next month's report.

Pre-launch Operations

● An extensive testing and checkout program for ABLE-4 THOR systems and components was culminated during February. Forty environmental tests, 25 acceptance tests, 2 type tests, and 12 R&D tests were completed during the month. Three of the most significant tests performed were:

a. Indications of high level third stage engine vibrations in the 600 csp range required testing to determine the effective mass measurements in this area. Test results were coordinated with NASA, resulting in revision of the specifications. On a basis of the revised specifications, the back-up flight payload was redefined as the type test payload and vibration tested ten times in each direction at high level, and at very high level at 600 cps.

b. The flight payload also was subjected to vibration acceptance testing and to additional temperature tests.

c. Altitude soak tests were performed on the payload at a simulated 600,000 feet and at high temperatures. Only minor difficulties were encountered in two of the experiments, both of which were traced to test instrumentation and were corrected.

● Following high altitude soak testing, the flight payload was shipped to AMR on 24 February. All recommendations of the Space Technology Laboratories Design Review Board had been accomplished and all tests required by NASA had been completed.

Payload Batteries

● Prolonged overcharge tests of the payload batteries revealed a pronounced unbalance of charge current into the two parallel sections of the battery pack. The following approaches were used in an effort to alleviate this problem:

a. The balance of current on charge was added to the battery selection criteria.

b. Two temperature sensing thermal switches were added to each battery section and set to operate at 120 degrees F. The two switches for each section are wired in parallel and connected in series with the two switches for the opposite section.

Extensive environmental, vibration and reliability tests were conducted on the thermal switches, using the standard solar cell source and battery set-up.

● The battery manufacturer indicated at this time that the maximum operating temperature for obtaining satisfactory battery life should be revised from 150 down to 107 degrees F. As a result, efforts were initiated by STL to improve the battery cooling methods. Control of battery temperatures within the revised limits was subsequently realized by replacing the standard melamime sheet battery enclosure with a thin (2-3 mils) coating of epoxy, baked for 17 hours at 95 degrees F.

● Additional battery tests were then performed, simulating frequency of load applications and charge rate under estimated flight conditions. The test was conducted for 6 hours under the following conditions:

a. Melamime sheet battery enclosure.

b. No thermal switches included.

c. Approximately 80 degrees F. ambient and vacuum temperatures.

Under these conditions, the severity of the test was increased considerably. Test results were highly satisfactory.

Payload Experiments

● An electronic system was constructed for supplying various types of currents to the Helmholtz coils used for magnetic checkout of payloads at AMR (Atlantic Missile Range). This equipment will be used for mapping the magnetic induction vector on ABLE-4 THOR payload. Recalibration of ABLE-4 THOR magnetometer has been completed. The tests were also run to measure the ripple pickup by the search coil from the power mains. These tests were necessitated because of the rewiring of the payload harness.

Computer and Guidance

● All guidance constants were computed for the launch period and verified by making a series of flight simulations on an IBM 709 computer, using a closed loop guidance computer program. A new wiring list and answer tapes and plots were generated on the IBM 709 for use with the Burroughs (J-1) Guidance Computer at AMR. Flight simulations on the J-1 computer produced output tapes and plots which were in complete agreement with those generated on the IBM 709.

Antennas

● Life tests were conducted on the Transco Coaxial Relay at pressures simulating altitudes of 385,000 to 415,000 feet. With 15 volts applied to the solenoid, the switch was cycled 4,500 times with no malfunctions. Centrifuge and vibration tests also were completed successfully with 10 volts applied to the solenoid.

Ground Support Stations

● At the end of February, all ground stations were ready to support the ABLE-4 THOR launch. These include: AMR, Manchester (England), Hawaii, and Singapore.

ABLE-3

Phase Comparison Data

● Reduction analysis of satellite phase comparison data commenced in February. The reduction had been awaiting computer runs of the expected values of the angle formed by the planes containing (a) the vehicle spin axis and sun vector and (b) the spin axis of magnetic field vector. This data will be used to test for primary winds in the outer atmosphere. Primary winds would be expected to produce a current which would result in a magnetic field perturbation.

Magnetic Radiation

● Two scientific papers (originated in Space Technology Laboratories) were presented at the New York meeting of the American Physical Society. The most significant and scientifically rewarding result described in these papers is the observation of the behavior of the second Van Allen radiation zone when large flares occurred on the sun. A sudden magnetic storm, presumably of solar origin, was observed on the earth between 15-16 August 1959. Fluctuations in intensity, sometimes rising to 5,000 times the normal base value in a matter of a few seconds, were observed in the outer Van Allen zone on 16-17 August. Simultaneously, the boundary of the outer zone moved in towards the earth by almost 4,500 miles. The approximate boundaries of the radiation fields were determined from data the satellites had been sending for over a week. Between 20-29 August, the boundaries moved out to a distance even further from earth than their ante-storm position.

● These results show that during magnetic storms particles are thrown off from the second radiation zone, presumably by a fluctuating magnetic field. Earlier evidence of a fluctuating magnetic field had been obtained from a magnetometer carried aboard Pioneer I and Explorer IV, and also from the intensity fluctuations observed by Explorer VI's scintillation counter.

● After the storm, particles began to fill the second radiation zone; intensity increased and the boundaries moved further from the earth.

Electron Flux

● Other results from Explorer VI include observation of flux of particles thought to be electrons on the order of 100,000,000 electrons/cm^2 sec, and the first detailed mapping of the isointensity contours in the outer radiation zone. The latter revealed a pronounced concentration of particles around the geometric equator at high altitudes.

Transit

A. 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

B. 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

C. 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

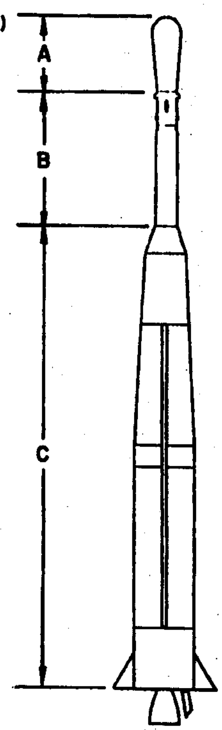


Figure 1. TRANSIT 1A three stage flight vehicle.

TRANSIT 1A launched from Atlantic Missile Range

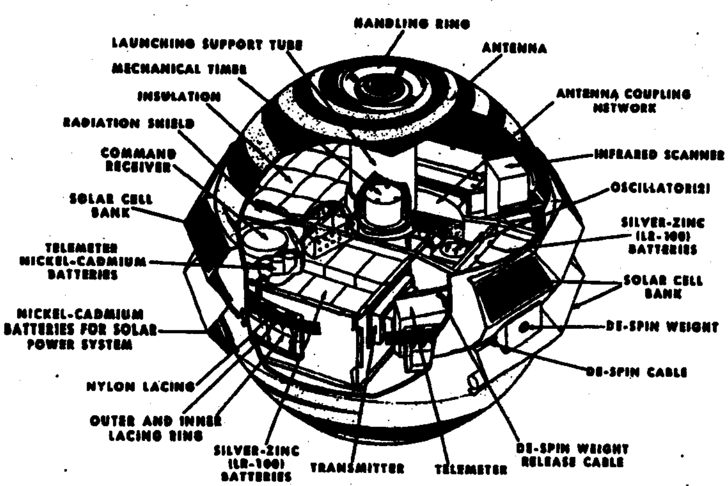
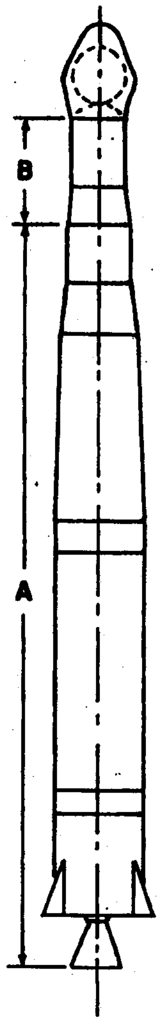


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV 1).

The TRANSIT Program consists of the flight testing of four vehicles to place 200-270-pound satellite payloads into circular orbits of 400 to 500 nautical miles. The program is designed to provide extremely accurate, world-wide, all-weather navigational information for use by aircraft, surface and subsurface vessels, particularly in relation to POLARIS missile firings. The ARPA Order for TRANSIT 1A was initiated in September 1958 and amended in April 1959 to add TRANSIT 1B, 2A and 2B flights. The program is currently authorized by ARPA Order No. 97, which assigns AFBMD responsibility for providing the booster vehicles, integrating payloads to the vehicles, and flight operations from launch through attainment of orbit, including communications to the tracking and data handling facilities. Payload and tracking responsibility has been assigned to the USN Bureau of Ordnance. Applied Physics Laboratory is the payload contractor.

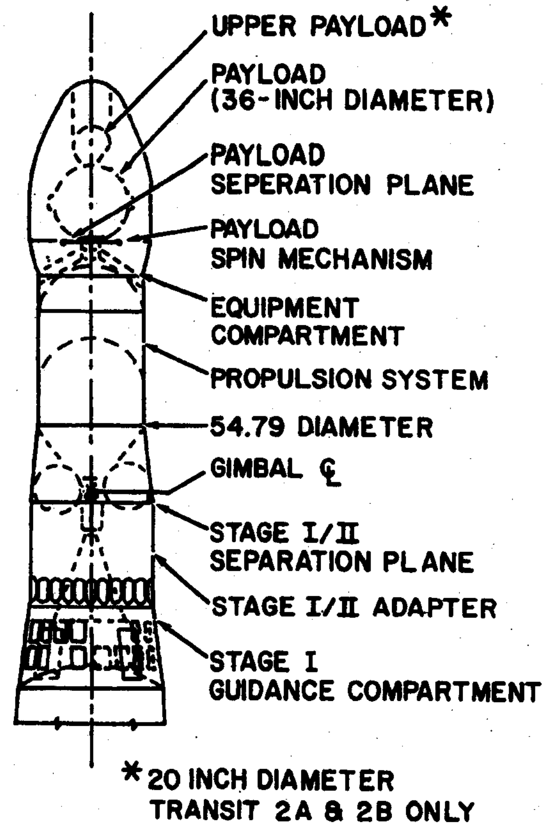


SECOND STAGE—AJ10-42 (Aerojet-General)

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



—TRANSIT 1B, 2A and 2B

Program Objectives

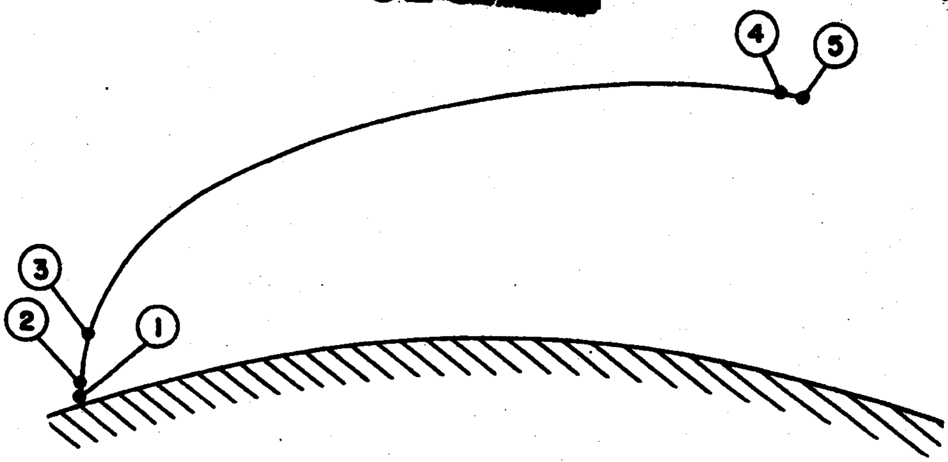
1. Provide accurate navigational reference information for POLARIS launches.
2. Precise determination of satellite position by measuring the doppler shift of satellite transmitted radio signals.
3. Investigate the refractive effect of the ionosphere on radio transmissions.
4. Acquire additional geodetic and geographical data by precision tracking of the orbiting satellite.

Flight Vehicles TRANSIT 1A consisted of three stages as shown in Figure . TRANSIT 1B, 2A and 2B are two-stge vehicles as shown in Figure .

Launch Plans All vehicles will be launched from Atlantic Missile Range pad 17A or 17B. Launch azimuth for TRANSITS 1A and 1B is 44.5 degrees and for TRANSITS 2A and 2B, 140 degrees.

Powered Flight Trajectory The powered flight trajectory for TRANSITS 1B, 2A and 2B is shown and described in Figure . The sequence of events from launch through payload separation for TRANSIT 1B is given in Table 1.

Payload Description The spherical 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. The TRANSIT 1B payload will also contain an infrared scanner which will operate for the first four days of orbit. On TRANSITS 2A and 2B a 20-inch sphere, mounted on top of the 36-inch sphere, will contain instrumentation for studying solar emissions. The payloads will be spin-stabilized in orbit.



Point	Flight Time (seconds)		Comments	Inertial Speed (ft/sec)		Downrange Distance (n.m.)		Altitude (n.m.)	
	1-B	2-A 2-B	Transit vehicles	1-B	2-A 2-B	1-B	2-A 2-B	1-A	2-A 2-B
1	10	10	End of vertical rise	1,346	1,346	0	0	0.077	0.077
2	167	167	First stage burnout	13,611	12,929	75.2	79.7	41.2	48.3
3	442	448	End of second stage first burning period	24,539	24,376	785.6	778.0	200.1	203.0
4	1,489	1,447	Restart second stage engine	22,486	22,339	4,233.2	4,080.0	500.0	500.0
5	1,504	1,462	Injection into orbit	24,258	24,259	4,416.3	4,130.0	500.0	500.0

FLIGHT TRAJECTORY—TRANSIT 1B, 2A and 2B

Orbital Performance Achievement of program objectives is based primarily on measuring the doppler shift of satellite transmitted radio signals. During the first three months of flight, the four transmitters will be operated to obtain experimental confirmation of the theoretical mathematical relationship between the frequency and the refractive index of the ionosphere. Studies have shown that refraction effects on the doppler shift can be eliminated by using the transmission from two satellites. After four months of tracking the satellite by measuring the doppler shift of the satellite radio signal, the exact position of the satellite at any point in the orbit should be known. Using known orbital positions, ships and aircraft can then use satellite signals to make analogous computations to establish accurate position. Navigational fixes of 0.1 mile accuracy are expected to be obtained.

Ground Support Stations Tracking stations will be operated in Maryland, Texas, New Mexico, Washington and Newfoundland. First and second stage tracking and telemetry and second stage guidance will be provided by the Atlantic Missile Range. A mobile tracking and telemetry van will be located in Germany for TRANSIT 1B and South America for TRANSITS 2A and 2B. These locations were selected as the closest sites possible to the orbit injection point.

Time (sec)	Stage	Event	
X + 0.1	I	Liftoff switch activates	
		Programmer starts	
		Gyros uncaged	
	II	Umbilicals eject	
		Arm destruct initiator	
X + 2	I	Roll program initiated	
X + 9	I	Roll program complete	
X + 10	I	Pitch program initiated	
		1st step pitch rate	As required
X + 25	I	2nd step pitch rate	for trajectory
X + 70	I	3rd step pitch rate	and detailed in
X + 90	I	4th step pitch rate	DTO
		Autopilot gain change	
	II	Programmer armed	
X + 130	I	Pitch program complete	
X + 152	I	Main engine cut-off (MECO)	
		Circuitry armed	
X + 163.5	I	MECO back-up armed	
X + 167.0	I	MECO	
X + 167.0	II	Start programmer	
X + 170.0	II	Engine fire signal	
		Uncage thrust chamber in pitch and yaw	
		Uncage high thrust roll jets	
		Uncage gyros	
X + 170.85	II	Blow separation bolts	
X + 176.0	II	Start pitch program	

Time (sec)	Stage	Event
X + 230.0	II	Jettison nose fairing
Times vary in accord. with trajectory.	II	Stop pitch program
		Pitch command
		Yaw command
X – 429.0	II	Stop pitch program
X – 441.5	II	Engine cut-off signal
		Switch pneumatic coast control system on pitch, yaw and roll
X – 471.0	II	Turn off hydraulic power
X – 480.0	II	Initiate coast phase pitch program
X – 1036.8	II	Stop coast phase pitch program
X – 1458.6	II	Start hydraulic power
X – 1488.6	II	Engine restart fire signal
		Uncage accelerometer
X – 1491.6	II	Cage coast pneumatic control system
X – 1500	II	Arm TPS cut-off probe (back-up)
		Arm oxidizer probe (back-up)
		Arm spin and separation mechanism
X – 1504.0	II	Engine cut-off signal
		Uncage coast pneumatic control system
		Start spin table
		Start timer on spin table
X – 1506.0	II	Engine cut-off (back-up)
		Start spin table (back-up)
X – 1507.0	II	Remove spin table bolt power
X – 1526.0	II	Blow separation bolts
		Activate separation actuators
		Payload separation occurs

Sequence of Events—TRANSIT 1B, 2A and 2B

MONTHLY PROGRESS—TRANSIT Program

TRANSIT 1B

● The second stage vehicle is scheduled for shipment to AMR on 12 March following completion of various assembly and checkout procedures.

Launch Schedule

● Launch date has been rescheduled from 5 April to 12 April because of the following work requirements:

a. Replacement of helium bottles and engine anti-rotation bolts found to be defective on the second stage propulsion system.
b. Rework of the second stage nitrogen attitude control system manifold to eliminate undesireable design characteristics.
c. Increasing the size of the explosive bolt holes (Stages I/II).
d. Rerouting of an oxidizer line.
e. Relocating the Stages I/II electrical connectors.
f. Providing a mounting bracket for the propulsion electrical sequence unit.

Testing and Checkout

● Altitude tests have been completed which investigated the possibility of the payload surface becoming contaminated from fuel vapors which might be present in the helium gas used to actuate the payload spin and separation mechanism. Test results indicate that no contamination problem exists.

● The Stages I/II structural tests were completed during February.

● Second stage systems checkout van #3 was validated at Los Angeles and is to be returned to AMR. The second stage launch control consoles also have been validated and are being used in hangar operational tests of the vehicle in Los Angeles. The consoles will be shipped to AMR for installation.

TRANSIT 2A

Launch Schedule

● Launch date has been delayed to 18 May because of the delay in the TRANSIT 1B schedule. This date permits a five week interval to be maintained between the two flights.

Technical Progress

● The defective helium bottles and engine anti-rotation bolts reported for TRANSIT 1B were also encountered on the TRANSIT 2A second stage. These units are being replaced.

● The second stage flight propulsion unit (AJ10-104) was delivered during February. The equipment compartment has been installed and aligned and the forward and aft electrical cables installed. Also, the thrust chamber assembly and attitude control jets have been checked and aligned.

TRANSIT 2B

● Launch date has been set tentatively for October or November, depending upon the availability of the ground support equipment for the second stage advanced guidance system.

● Manufacturing and delivery problems reported last month for the Minneapolis-Honeywell gyro have been resolved. "Stop Work" orders issued to the contractor in January have been cancelled.

● The initial release of all drawings and specifications to Aerojet-General Corporation and Space Electronics Corporation was completed during February. Fabrication of subsystems has been started by these contractors.

[redacted] ~~CONFIDENTIAL~~

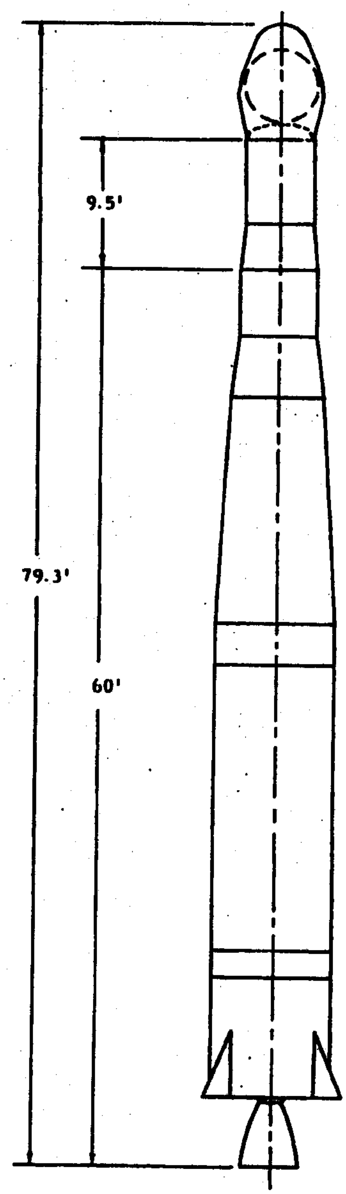
The ARPA COURIER Program consists of two flight vehicles to be launched from the Atlantic Missile Range. The program objective is to test delayed repeater communications between a satellite and ground stations. The program also will be used to determine the operating characteristics and capabilities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

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

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

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

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



C o u r i e r

SECOND STAGE—ABLE-STAR (AJ10-104)

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

FIRST STAGE—THOR IRBM

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

MONTHLY PROGRESS—COURIER Program

Launch Schedule

- The launch of COURIER 1A has been delayed from June to 15 July because of payload availability. At the request of ARPA, the launch of COURIER 1B also has been delayed and is scheduled for 1 September. Modifications to AMR launch pad 17B for COURIER vehicles is proceeding on schedule.

Technical Progress

COURIER 1A

- Delivery of the second stage propulsion system (AJ10-104) to the Space Technology Laboratories Hangar in Los Angeles is scheduled for 25 March.

COURIER 1B

- Manufacturing and delivery problems relating to the Minneapolis-Honeywell gyro have been resolved. "Stop Work" orders issued to the contractor during January have been cancelled.

- The initial release of all drawings and specifications to Aerojet-General Corporation and Space Electronics Corporation was completed during February. Fabrication of subsystems has been started by these contractors.

- Space Technology Laboratories will provide Aerojet-General Corporation with systems checkout van #2 and associated hangar checkout equipment for use during the Azusa hangar checkout of the ABLE-STAR systems. A complete list of all special test and test support equipment that will be provided to Aerojet-General Corporation and Space Electronics Corporation by STL was issued during February.

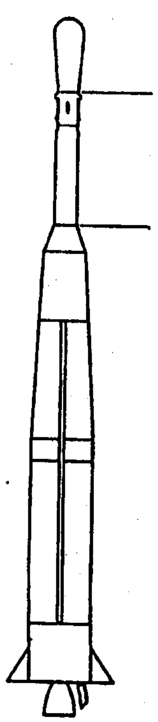
CON

TIROS

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

VEHICLE DESCRIPTION

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



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

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

SECOND STAGE—AJ10-42 (Aerojet-General)

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

FIRST STAGE—THOR IRBM

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

FLIGHT DESCRIPTION

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

PAYLOAD OBJECTIVES

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

GROUND SUPPORT STATIONS

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

TABLE I. TIROS POWERED TRAJECTORY FLIGHT PLAN

1.	Vertical lift-off	
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 begins Stage II closed-loop steering	172.8 sec.
10.	Jettison nose fairing	182.8 sec.
11.	BTL guidance ends Stage II closed-loop steering	253 sec.
12.	BTL discrete ends Stage II pitch program	255 sec.
13.	BTL discrete spins up third stage and payload—120 rpm	265 sec.
14.	Stage II cutoff—SECO; begin coast period	SECO (Approximately 267 sec.)
15.	Stage II-III separation	268.5 sec. SECO—2 sec.
16.	Fire Stage III rocket	811 sec to 848 sec.
17.	Separate payload from Stage III	864 sec.
18.	De-spin payload—12 rpm	In orbit

MONTHLY PROGRESS—TIROS Program

Program Administration

- The revised powered flight trajectory was approved by NASA and a revised Detailed Test Objectives document issued. All vehicle design changes and modifications required by the new trajectory have been completed and no delay in the launch schedule is anticipated.

- Trajectory and Initial Impact Point data have been submitted to range safety for approval and no changes in range safety requirements or the Millstone (Massachusetts) beacon antenna locations or patterns are anticipated at this time.

Flight Schedule

- A launch date of 31 March was established during February, keyed to the following prelaunch schedule:

First stage on stand	11 March
Second stage on stand	14 March
Third stage on stand	18 March
T-6 days test	24 March
T-1 day test	30 March
Launch	31 March

Technical Progress

- System design and qualification tests were completed successfully during February.

[redacted]

AGENA

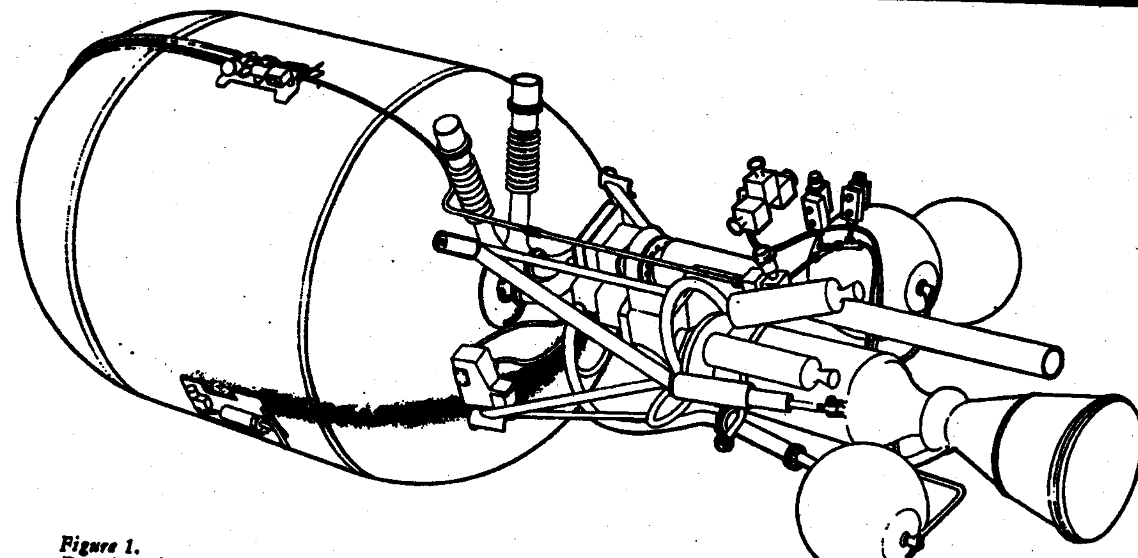


Figure 1.
Drawing of AGENA "B" propulsion system.

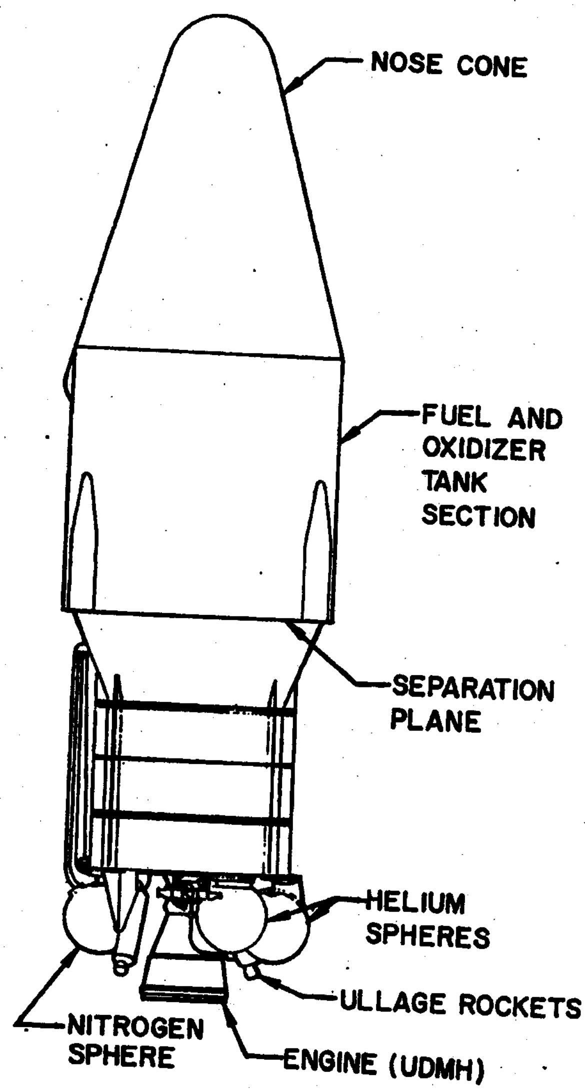
The AGENA vehicle was originally designed by the Air Force for use as the basic satellite vehicle for the Advanced Military Reconnaissance Satellite Program (Weapon System 117L). The vehicle was designed to be boosted by an ATLAS ICBM and basic dimensions were derived from this booster selection. The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

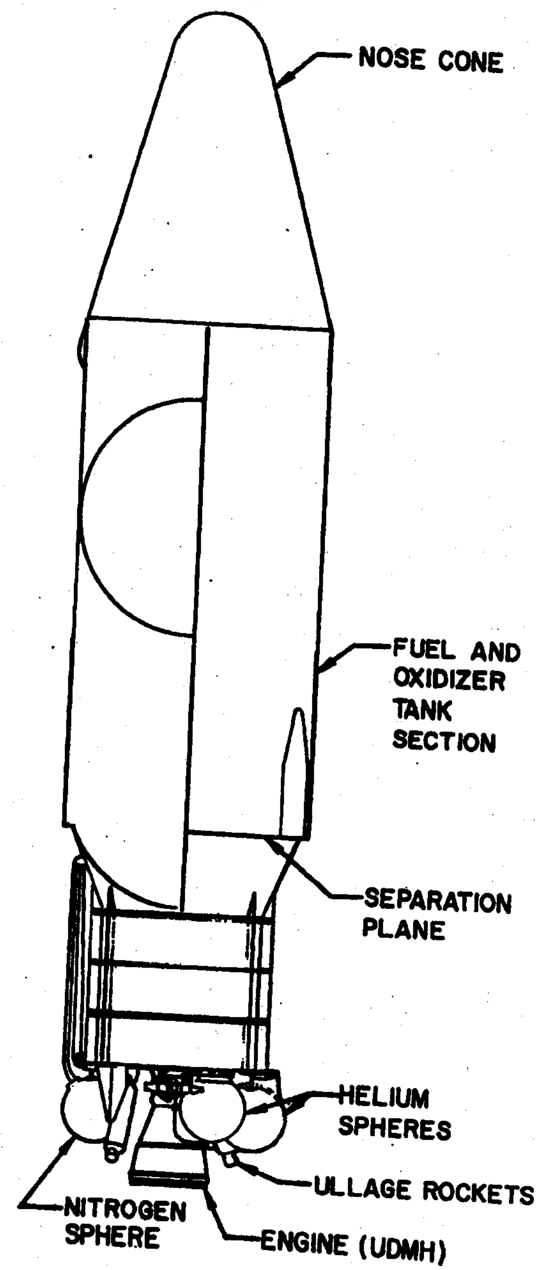
Progress in the design of payloads for the MIDAS program created an urgent need for the attainment of higher altitude orbits. As a result a modification program was initiated to develop the AGENA "B" configuration. This work was authorized by ARPA Order No. 48 and continued under ARPA Order No. 96. On 17 November 1959 program responsibility was assigned to the Air Force by the Secretary of Defense. The AGENA "B" configuration includes the addition of a single restart and extended burn capability to the engine and propellant tankage of twice the AGENA "A" capacity. The engine (Bell Aircraft Model 8081), for use on this vehicle, is officially designated USAF Model XLR81-Ba-7. A subsequent version, XLR81-Ba-9 (Bell Aircraft Model 8096), with a nozzle expansion ratio of approximately 45:1 will further increase performance capa-

[redacted]

bility. The AGENA "B" configuration has increased the effectiveness of the payload weight/orbital altitude relationship for this vehicle. This reduction of payload restrictions has increased greatly the potentialities of using the extremely reliable THOR as an AGENA booster. In order to obtain maximum efficiency from the use of ATLAS as an AGENA booster, modifications to the ATLAS are being made to reduce limitations imposed by trajectory requirements and static load capabilities.

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





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

MONTHLY PROGRESS—AGENA Program

● All of the development efforts related to the AGENA "B" double capacity integral propellant tanks have been completed successfully.

AGENA "B"

XLR81-Ba-7 Engine

● Preliminary Flight Rating tests were completed on 18 February and a formal review of the test results has been started. Both of the engines being tested experienced thrust chamber burnout problems during continuous 240 second firings under certain conditions of coolant ambient temperatures and IRFNA solids content. Development efforts are being continued by the engine manufacturer to alleviate these problems. In the meantime, however, satisfactory chamber cooling can be assured by closely controlling the solids content and the ambient temperature (70 degrees maximum) of the oxidizer used.

● Testing of the XLR81-Ba-7 engine installed in the Propulsion Vehicle Test Assembly was completed at Santa Cruz Test Base. The total testing program consisted of seven firings, three of which were conducted during February. Two Engine restart operations were performed successfully in this test series. Testing was accomplished on a propulsion test vehicle assembly having aluminum tanks and a test installation of the fuel pressure driven hydraulic control system (See DISCOVERER Monthly Progress section). On 8 February a full duration run of 244 seconds was made. On 9 February, the engine was run for 220 seconds, shut down for five minutes, and restarted for a 28 second firing to oxidizer exhaustion. On 12 February, the engine was operated for 220 seconds, shut down for five minutes, and reignited for a 27 second firing.

AGENA "B"

XLR81-Ba-9 Engine

● A test run of the XLR81-Ba-9 engine installed in the propulsion test vehicle assembly was made on 19 Febraury at the Santa Cruz Test Base. The engine was operated initially for 120 seconds, shut down for five minutes, and reignited for a 122 second operation. The first successful gimballing program was achieved on this run. Six additional test firings are scheduled for this engine.

● Testing of the engine nozzle extension program (to achieve a 45:1 area ratio) was continued during the month at Bell Aircraft Co. An extension constructed of titanium was tested successfully for 240 seconds, followed by a 10 second restart firing. Another successful 240 second firing was accomplished on the same extension following a recoating of the interior surface with aluminum oxide.

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.

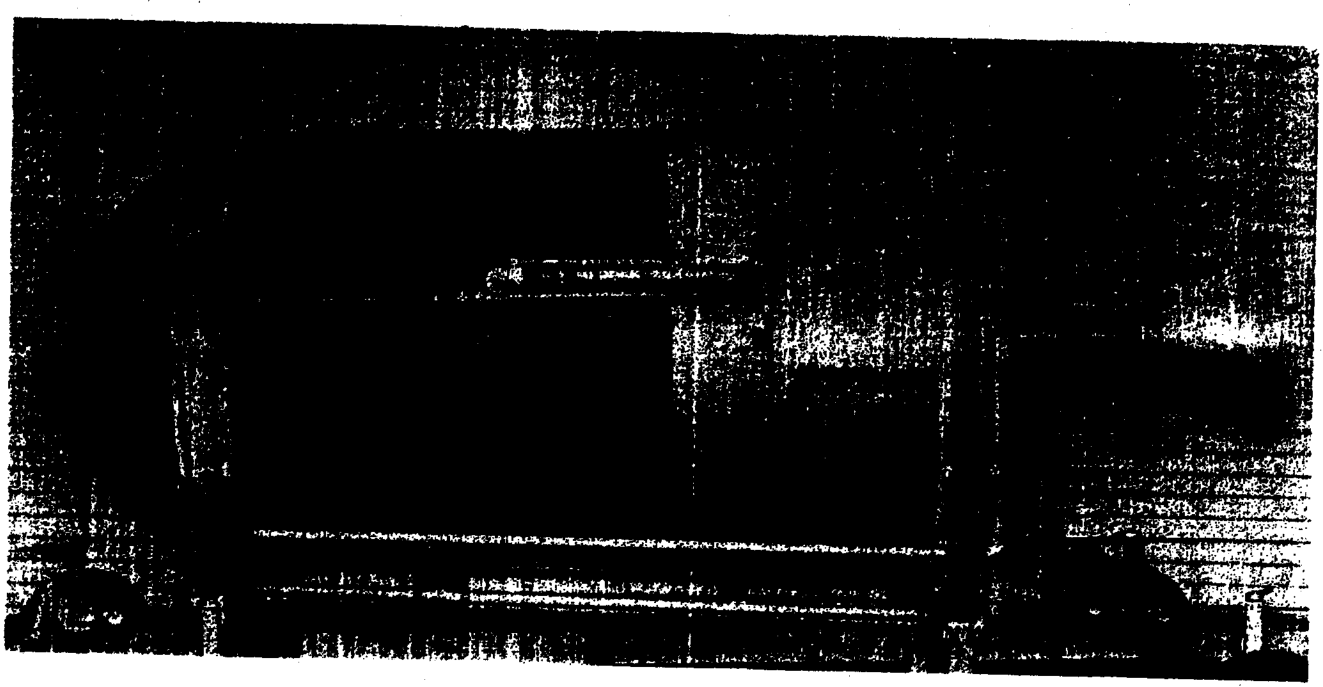
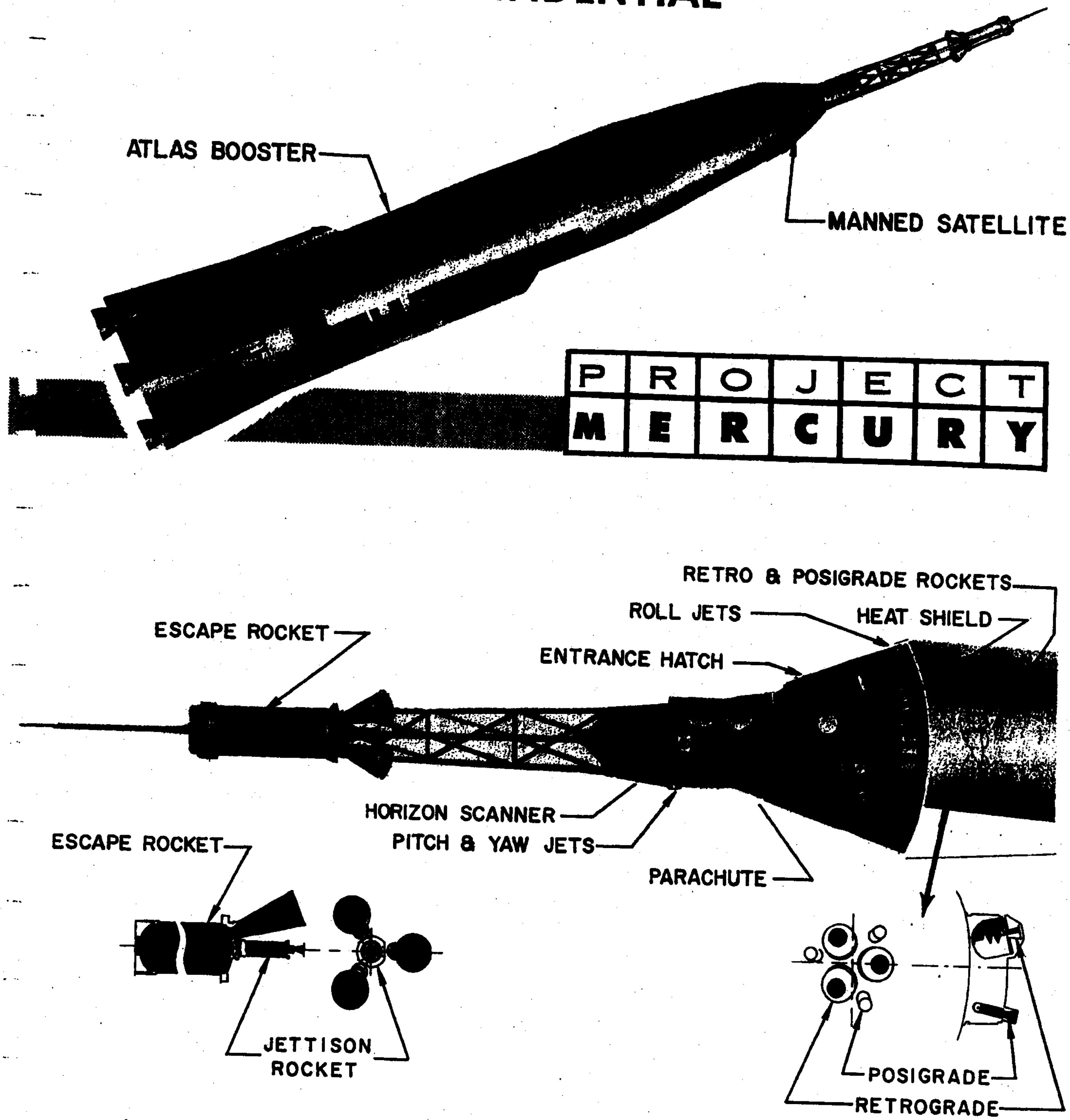


Figure 1. Side view of ABLE-STAR vehicle mounted in handling dolly.



WEIGHT AT SEPARATION	APPROX 25 LBS	ORBIT INCLINATION	33 DEGREES
ORBITAL ALTITUDE	105-115 MILES (n)	HEAT SHIELD	ABLATIVE
ORBITAL CYCLES	3-18	RECOVERY	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 threshold 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.

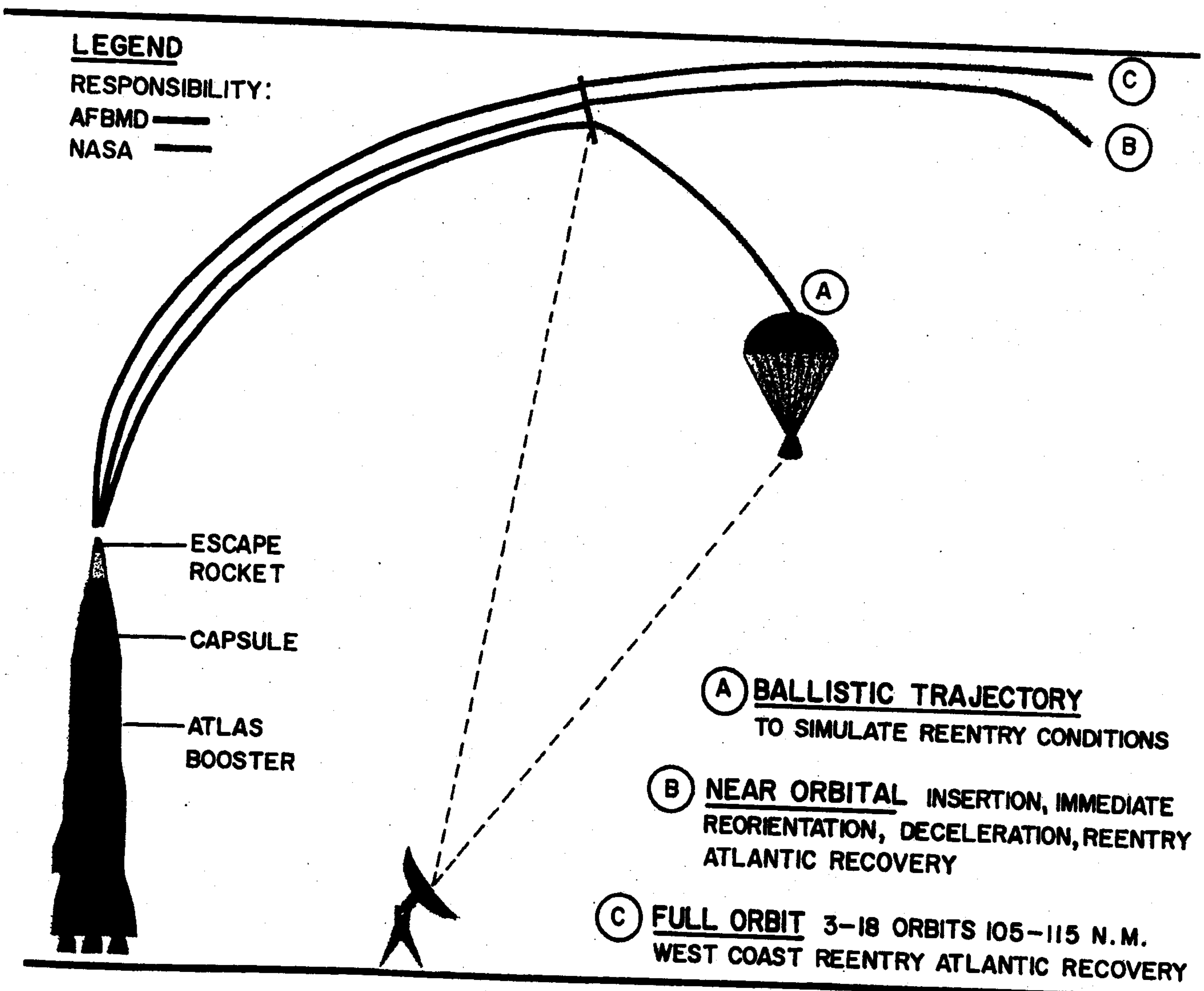


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.

PROJECT MERCURY

NASA Responsibility

Booster-Capsule integration
Capsule
Ground support
Recovery

Flight 1

NASA
Laboratory

Re-entry
heating,
dynamics,
recovery

Flights 2–9

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, fuel injector pressure, electrical power, attitude and sustainer hydraulic pressure. Can initiate escape sequence

Launch

Integrated countdown—including pilot insertion and capsule countdown. AMR launch Stand 14—adapted for pilot and capsule.
GE ground guidance equipment modified to provide: (a) real time data, (b) additional discrete command signals during powered flight.
Approximate 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 Equipment modification Hardware fabrication	Flight scheduling	Launch support Trajectory data Missile allocation
Provide ten (10) ATLAS boosters.	Modify boosters for NASA preliminary research and manned orbital flight and safety objectives.	Launch, control and define trajectories of booster-capsule vehicle up to, and including, injection into orbit.

Table 2. AFBMD responsibilities in support of PROJECT MERCURY.

MONTHLY PROGRESS—Project MERCURY

Flight Test Progress

● The second launch in ATLAS/MERCURY flight test program, designated MA-1, is scheduled for late May or early June from Atlantic Missile Range launch complex 14. MA-1 launch plans have been revised by NASA and were presented to AFBMD during February. The revised flight plan includes the following characteristics:

Booster — ATLAS 50D

Capsule — McDonnell structural shell with external shingles and adapter. Internal equipment will be furnished by NASA.

Trajectory — A near orbital trajectory will be used, similar to that shown on Figure 2, item B. Capsule abort from an orbital launch will be simulated at approximately 20,000 feet per second.

Abort Sensing System — The abort sensing system will be carried on the ATLAS vehicle and will be open loop tested on this flight. The escape system, designed as part of the basic capsule configuration, will not be carried on this flight. However, a stub escape tower will be carried for ballast effect. Separation of the capsule from the ATLAS booster will be effected by posigrade rockets attached to the capsule.

Primary Test Objective — To demonstrate the structural integrity of the capsule airframe, particularly the shingles on the conical afterbody (see Figure 3). The shingles are designed to provide structural support and capsule insulation functions.

Ground Support Progress

● A meeting was held between the AFMBD ATLAS guidance contractors (General Electric Co. and Burroughs) and the NASA ground communications and data link contractors (IBM, Western Electric Co, Bendix, and Milgo) on 11-12 February. The purpose of the meeting was to reach agreement on the Burroughs-IBM interconnection specification for providing NASA with ATLAS/MERCURY guidance data. This data will be used by the NASA Control Center and computing facilities at Beltsville, Maryland.

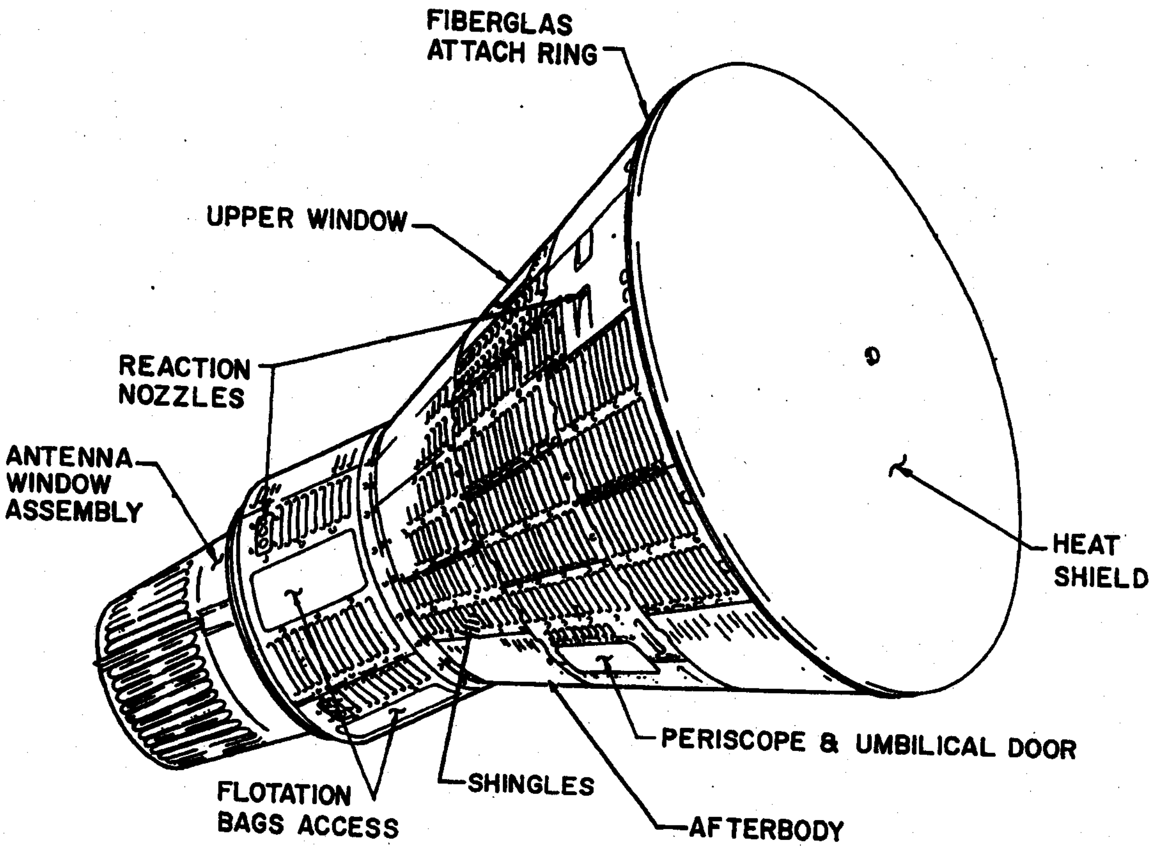


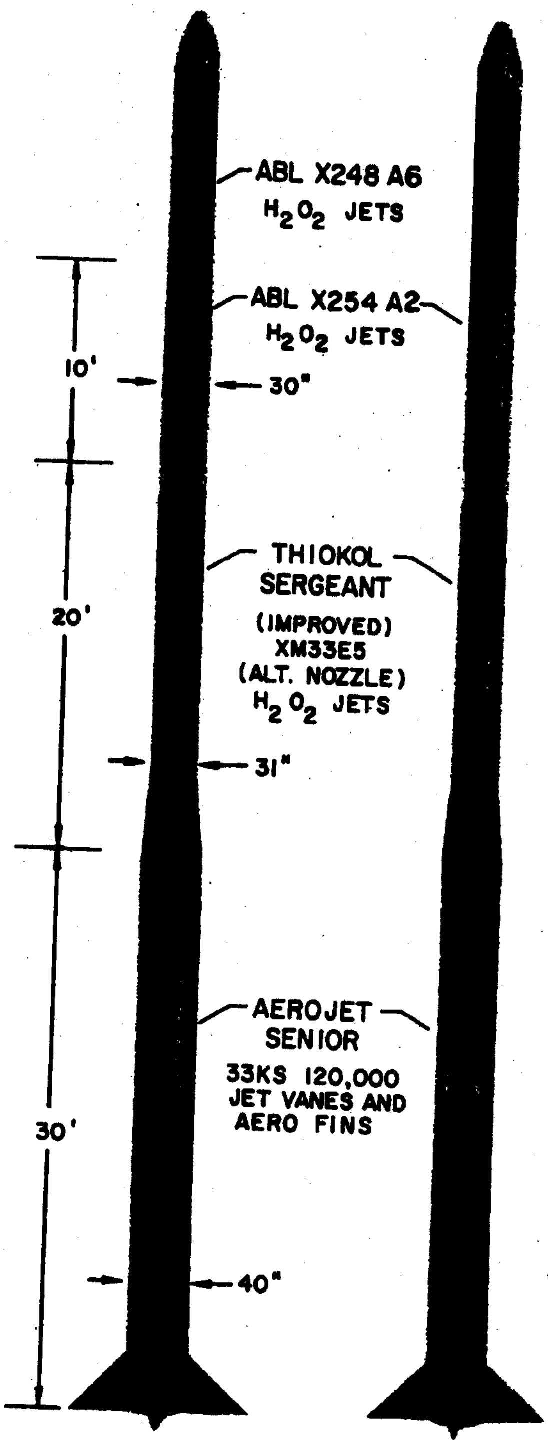
Figure 3. McDonnell shell to be carried on second ATLAS/MERCURY flight test.

PROJECT 609A

Hyper-Environment Test System

PROGRAM DESCRIPTION—The Hyper-Environment Test 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



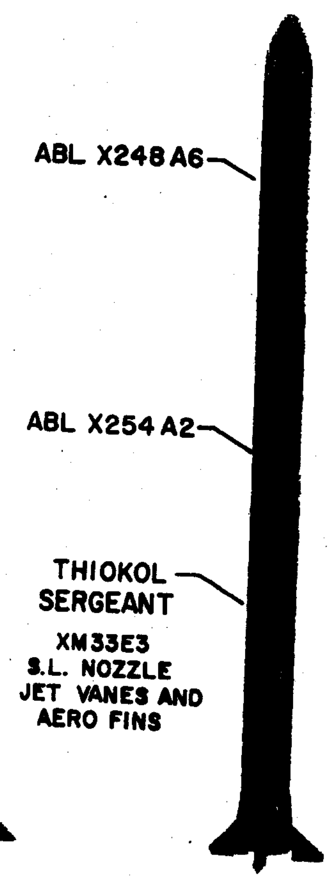


Figure 1. Three variations of Project 609A vehicle demonstrate the mission-versatility of the program.

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 AFMBD, 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 complex 18 will be made available to the Air Force for this program. A Project 609A division has been established within the 6555th Test Wing (Development) 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.

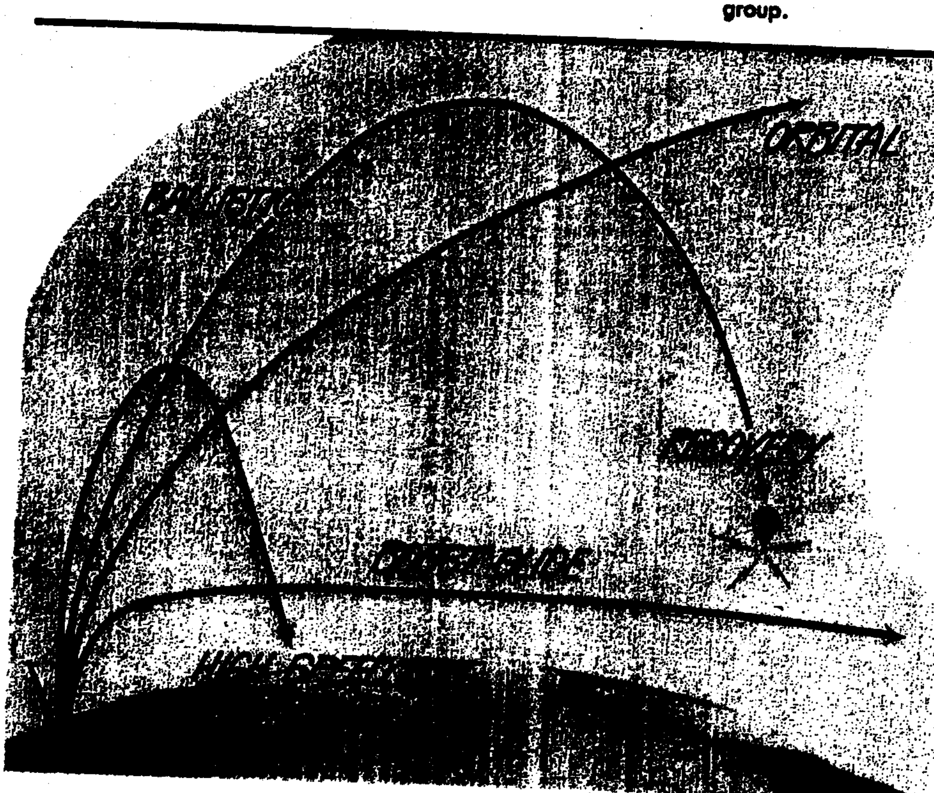


Figure 2. Four different trajectories possible using different arrangements of Project 609A stages.

MONTHLY PROGRESS—Project 609A

Program Administration

● **Launch Schedule** — The launch date for the first NASA SCOUT flight test is now scheduled for "not earlier than June." This date reflects the most current of several delays from the original October 1959 launch date. Previous NASA delays of long duration have resulted in a lesser slippage of the 609A schedules. However, it is intended that the present launch date of 11 May 1960 will be maintained for the first Project 609A flight test vehicle. An investigation is being conducted of methods of preserving 609A schedules in the face of continuing NASA slippages.

● **Funding** — NASA has stated that additional funds are required immediately to complete the work currently under contract for Air Force Project 609A. This situation has been caused by the steadily increasing costs of hardware being procured by NASA in accordance with the requirements of Air Force Delivery Orders. The increased costs have been particularly significant in the guidance and control areas. The funds requested by NASA would have exceeded the funds available, not only for FY 1960, but the total funds programmed for the development phase through FY 1961. In order to remain within present funding limits, the quantities of items on order have been reduced. The total program has been reduced also, to nine flight tests, including two less expensive unguided vehicles instead of the previously scheduled one.

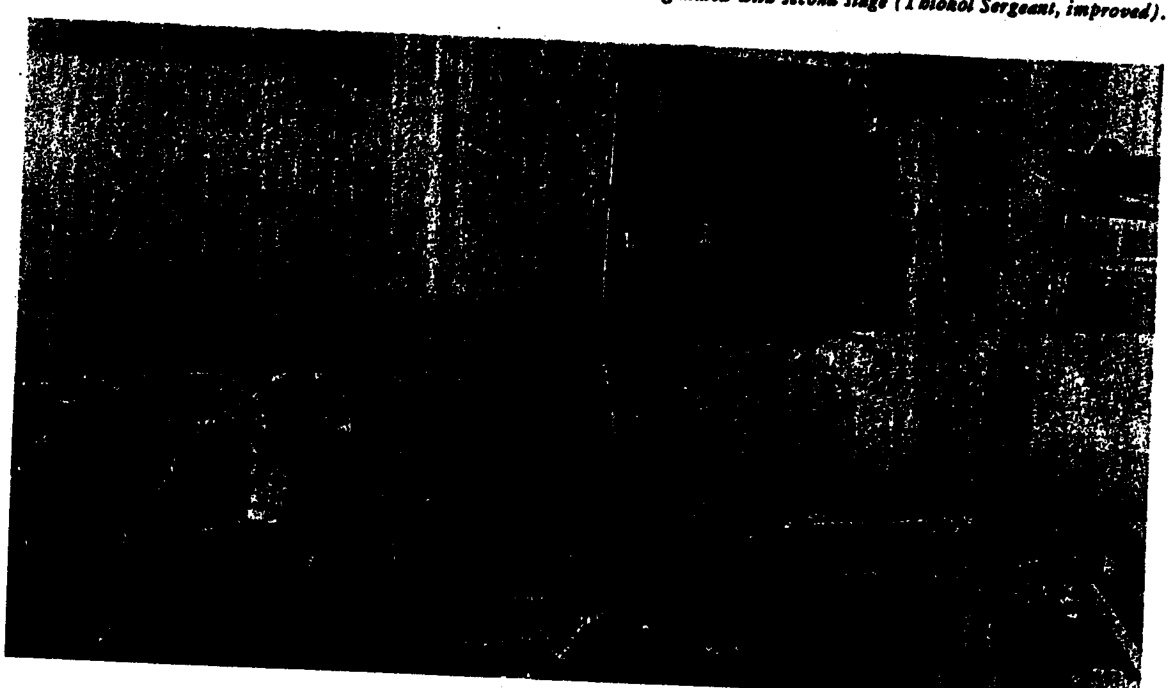
609A Booster Support Requested by Navy

● The Department of the Navy (BuWeps) has requested Air Force Project 609A booster vehicle support for the downstream prototype and operational test phases of the Navy TRANSIT Program. AFBMD has furnished support capability information to AFDAT. In accordance with the 18 September 1959 Secretary of Defense memorandum assigning booster support responsibility for space programs to the Air Force, Hq USAF (AFDAT) has coordinated a "Navy Plan for TRANSIT" and committed the Air Force to support the program. The Air Force commitment imposes a significant emphasis on the need for maintaining present Project 609A schedules regardless of further NASA slippages to make a reliable vehicle available in time for the TRANSIT launches. The Navy is anticipating the imminent transfer of this program from ARPA. Approximately 18 Atlantic Missile Range launches will be required, using 609A vehicles to place 50- to 100-pound payloads into 500-mile circular orbits. The first launch is required about May 1961 with following launches on a one a month schedule.

Technical Progress

● Six static test firings of the modified ABL X254 (third stage) engine have been conducted success-

Figure 3. Project 609A first stage vehicle (Aerojet Senior) being mated with second stage (Thiokol Sergeant, improved).



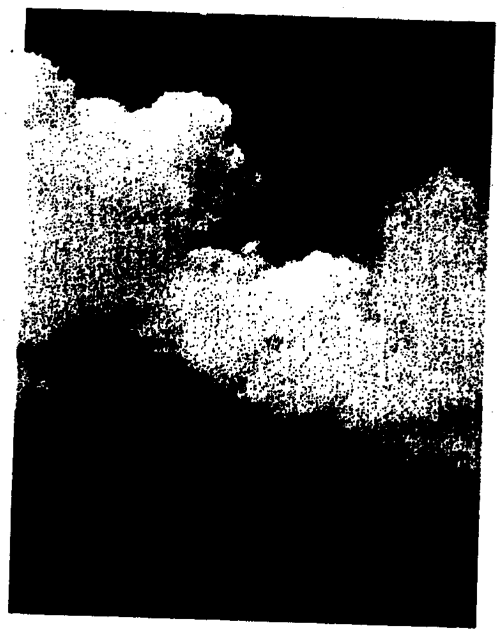
fully. Test results indicate that the propellant bonding "fix" has solved the burn-through problem and provide high confidence in the success of two simulated altitude firings scheduled for March at the Arnold Engineering Development Center. A flight engine is expected to be available for delivery in April.

- A NASA Sergeant type launcher was procured from Vought Astronautics for launch of Project 609A unguided vehicles.

Payload Priorities Committee Formed

- A committee has been formed to review, validate, and assign priorities to payload experiments proposed by ARDC Centers for Project 609A and other test support programs, such as ATLAS Piggyback. The committee includes representatives from various AFBMD directorates of WDZ and WDTV. A charter and set of operating rules are being prepared.

SPACE



studies

SPACE STUDIES

ADVANCED SYSTEMS STUDIES

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

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

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

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

CONFIDENTIAL

DISTRIBUTION

Headquarters, United States Air Force	26
Headquarters, Air Research and Development Command	10
Strategic Air Command	1
Air Force Cambridge Research Center	1
Air Force Flight Test Center	1
Rome Air Development Command	1
Air Force Missile Defense Command	1
Wright Air Development Division	1
Air Force Special Weapons Center	1
Air University	4
Arnold Engineering Development Center	2
Air Proving Ground Center	6
Air Defense Command	1
Air Training Command	1
Air Photo and Charting Service	1
Air Force Missile Test Center	1
United States Air Force Academy	4
Air Technical Intelligence Center	1
6555th Test Wing (Development)	2
Air Force Ballistic Missile Division (ARDC)	67
Ballistic Missiles Center (AMC)	11
Assistant CINCSAC (SAC MIKE)	3
Aeronautical Chart and Information Center	1
Rand Corporation	1
San Bernardino Air Materiel Area	3
6594 Test Wing (Satellite)	1
1002 Insp. Gen. Group	1