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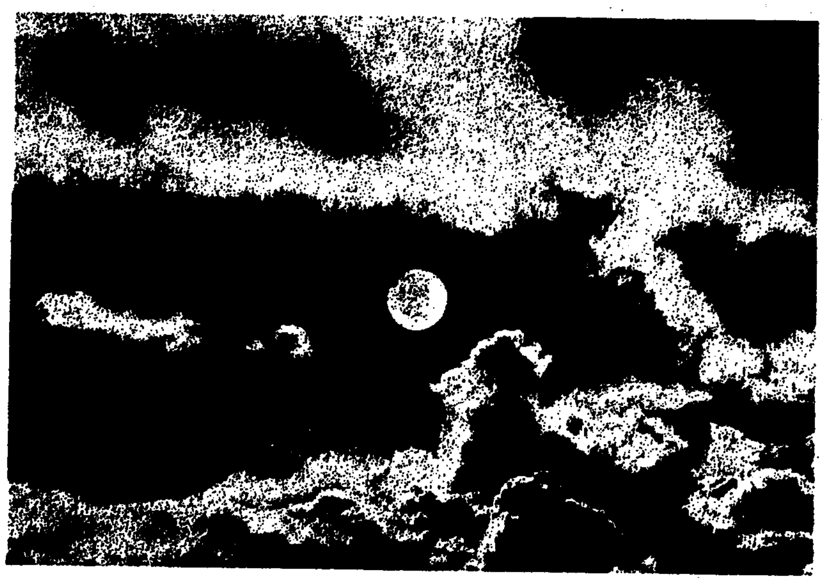

SPACE

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

WDLPM-4

21 September 1960

FOREWORD

Activities summarized in the report include the major space systems, support programs and defense programs for which the Air Force Ballistic Missile Division is wholly or partially responsible. Each space system and program is introduced by a concise history of the administration, concept and objectives, making possible a more meaningful evaluation of the monthly progress information. The program description information is revised monthly as necessary 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.

During this report period two DISCOVERER capsules were recovered after extended exposure to the space environment. Recovery of the capsule of DISCOVERER XIII marked the first recovery of an object from extended space flight. Subsequent recovery of the capsule from DISCOVERER XIV was the first aerial recovery of an object from space.

O. J. RITLAND
Major General, USAF
Commander

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SATELLITE
systems

DISCOVERER
SAMOS
MIDAS
COMMUNICATIONS SATELLITE

The DISCOVERER Program consists of the design, development and flight testing of 37 two-stage vehicles, using the THOR IRBM as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Project's 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 perform space research in support of the advanced military reconnaissance satellite programs.

PROGRAM OBJECTIVES

(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.

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

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

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

PROGRAM SUMMARY

Early launches confirmed vehicle flight and satellite orbit capabilities, developed system reliability, and established ground support, tracking and data acquisition requirements. Later in the program, biomedical and advanced engineering payloads will be flight tested to obtain support data for more advanced space systems programs. DISCOVERER vehicles are launched from Vandenberg Air Force Base, with overall operational control exercised by the Satellite Test Center, Palo Alto, California.

Tracking and command functions are performed by the stations listed in the Table on page A-4. A history of DISCOVERER flight to date is given on page A-5.

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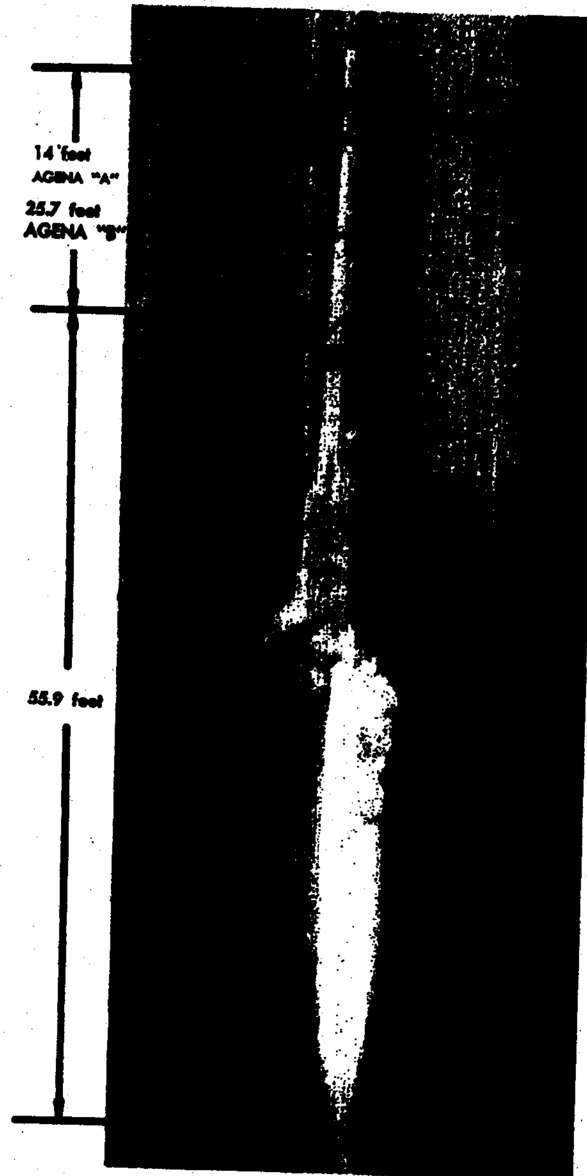


SECOND STAGE	AGENA "A"	AGENA "B"	
Weight—			
Inert	1,262	1,328	1,346
Payload equipment	497	887	915
Orbital	1,759	2,215	2,216
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
TOTAL WEIGHT	8,662	15,676	15,722
Engine Model	YLR81-Ba-5	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn time-sec.	120	240	240

THOR BOOSTER	DM-18	DM-21
Weight—Dry	6,950	6,500
Fuel	33,700	33,700
Oxidizer (LOX)	68,200	68,200
GROSS WEIGHT (lbs.)	108,850	108,400
Engine	MB-3 Block 1	MB-3 Block 2
Thrust, lbs. (S.L.)	152,000	167,000
Spec. Imp., sec. (S.L.)	247.8	248.3
Burn Time, sec.	163	148

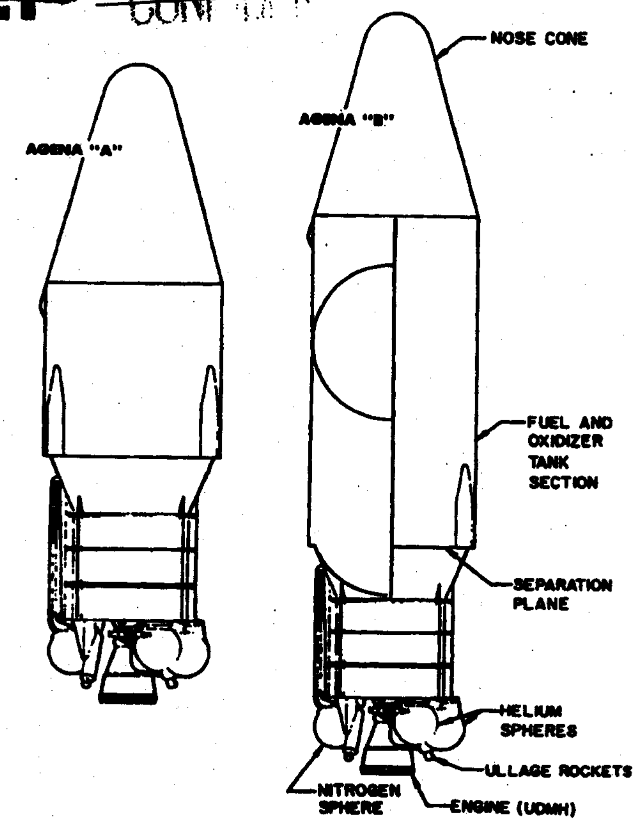
Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and 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.

FLIGHT VEHICLE

The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page A-5. Specifications for the two THOR configurations and three AGENA configurations used are given on page A-1.

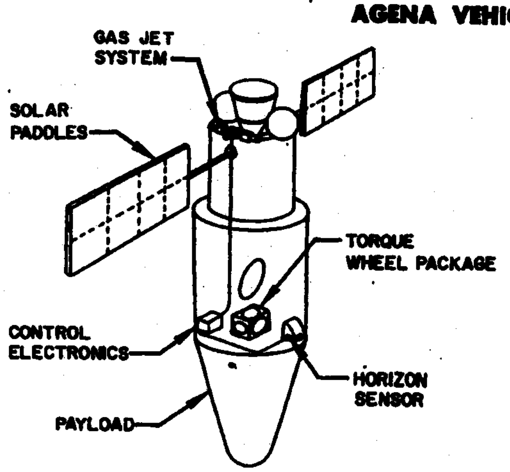
AGENA VEHICLE DEVELOPMENT

The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. Basic design was based on use of the ATLAS ICBM as the first stage. ATLAS trajectory characteristics and the stringent eccentricity requirements of the advanced programs led to the selection of a guidance system suited to achieving orbital injection in a horizontal attitude. As a result, an optical inertial system was developed for vehicle guidance and a gas jet system for orbital attitude control. An urgent need for attaining higher altitude orbits resulted in development of the AGENA "B" versions. The YLR81 Ba-5 version of the LR81-Ba-3 engine (Bell Hustler engine developed for B-58 aircraft) is used on AGENA "A" vehicles. 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.

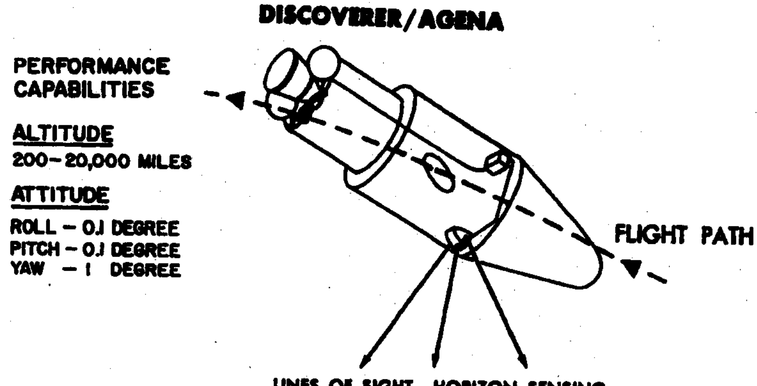


Early AGENA "B" vehicles will use the YLR81-Ba-7 version of this engine. The majority of AGENA "B" vehicles will use the XLR81-Ba-9 engine incorporating a nozzle expansion ratio of 45:1, and providing a further increase in performance capability including engine restart and extended burn-capability.

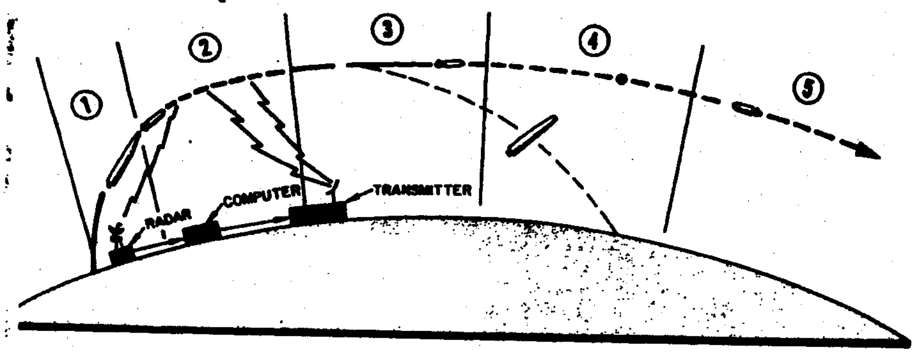
SAMOS and MIDAS AGENA VEHICLE



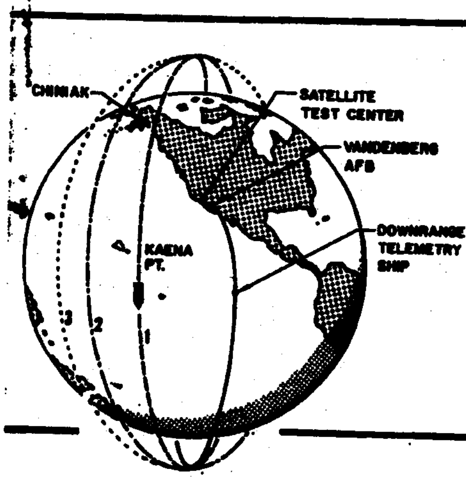
DISCOVERER/AGENA



Powered Flight Trajectory

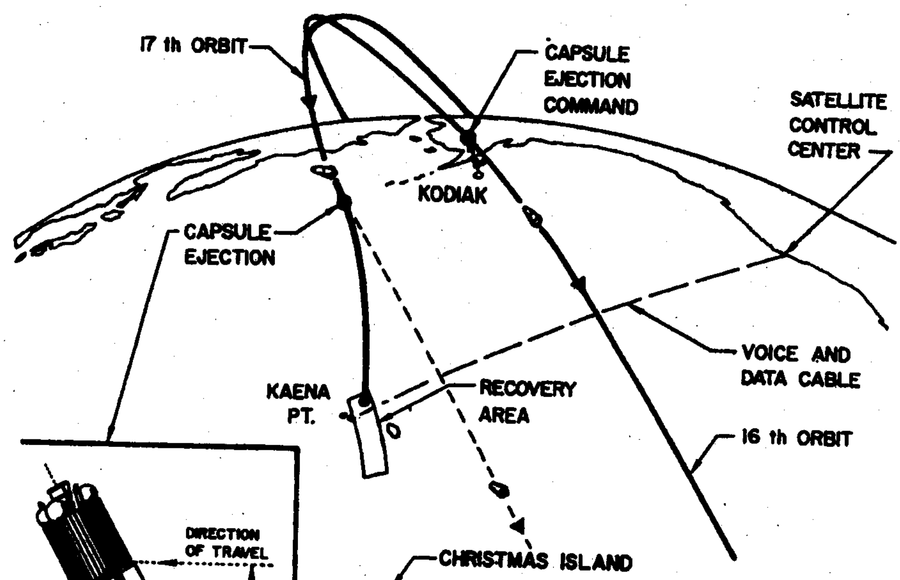


1. **First Stage Powered Flight**—2.5 minutes duration, 78 n.m. downrange, guided by programmed auto pilot.
2. **Coast Period**—2.4 minutes duration, to 380 n.m. downrange; altitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity to be gained commands.
3. **Second Stage Powered Flight**—2 minutes duration, to 770 n.m. downrange. Guided and controlled by inertial reference package, horizon scanner, gas reaction jets (roll) gimballing engine, yaw and pitch accelerometer—integrated.
4. **Vehicle Reorients to Nose Aft**—2 minutes duration, to 2,000 n.m. downrange. Guided and attitude controlled by inertial reference package, horizon scanner and gas reaction jets.
5. **In-Orbit**—Controlled (same as 4).



Orbital Trajectory

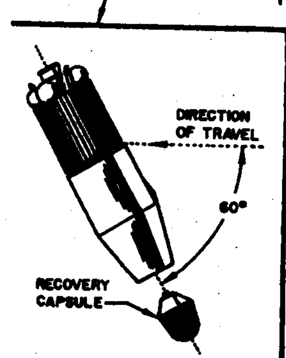
Schematic presentation of orbital trajectory following launch from Vandenberg Air Force Base. Functions performed by each station and a listing of equipment used by each station, is given on page A-4.



CAPSULE RECOVERY SEQUENCE

RECOVERY CAPABILITY

This objective was added to the program after the first launch achieved vehicle flight and orbit objectives successfully. It includes the orientation of the satellite vehicle to permit a recoverable capsule to be ejected from the nose section of the AGENA vehicle. Ejection is programmed to occur on command on the 17th orbit, for capsule impact within the predetermined recovery area south of Hawaii. Aircraft and surface vessels are deployed within the area as a recovery force.



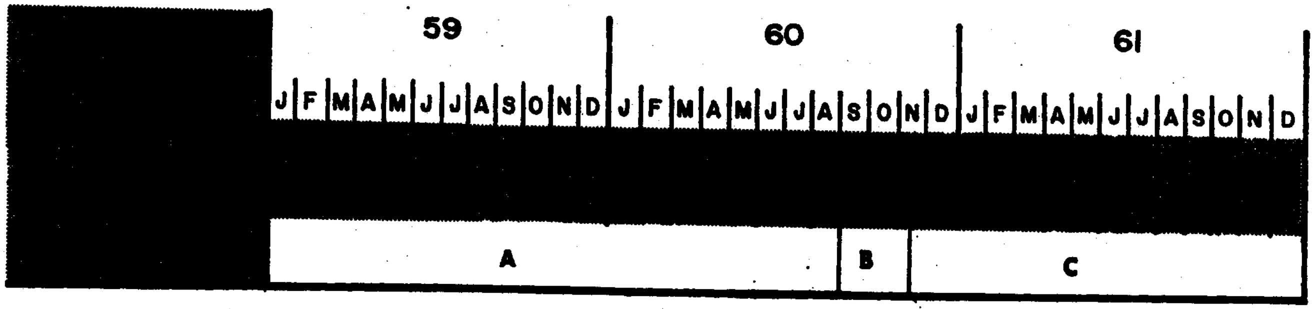
Capsule ejection command is sent to the satellite by the Chiniak, Alaska station on the 16th orbit. The vehicle reorients its position (see inset) to permit ejection to occur on a re-entry trajectory on the 17th orbit. The recovery capsule parachute is activated at about 50,000 feet, and the capsule beacon transmits a radio signal for tracking purposes. The recovery force is deployed in the recovery (impact) area.

Facility	Equipment*	Flight Function
Satellite Test Center	A	Over-all control, convert tracking stations data to obtain a predicted orbit and generate subsequent ephemerides issue acquisition data to tracking stations for subsequent passes, predict recovery area.
Vandenberg AFB	BCDEFGHIJK	Launch, ascent and orbital tracking, telemetry reception, trajectory measurements including time to ignite second stage.
Point Mugu	BCDEFGHIJKL	Ascent tracking and telemetry data reception, transmits command to ignite and shut down AGENA (via guidance computer).
Telemetry Ship (Pvt. Joe E. Mann)	DF	Final stage ascent tracking and telemetry data reception.
Kodiak, Alaska (tracking station)	BDEFGHIJK	Orbital tracking and telemetry data reception, including first pass acquisition, recovery capsule ejection and impact prediction.
Kaena Point, Oahu, Hawaii (tracking station)	BCDEFGHIJK	Orbital tracking and telemetry data reception.
Hickam AFB Oahu, Hawaii		Over-all direction of capsule recovery operations.

Equipment

A. 2 UNIVAC 1103-A digital computers
B. VERLORT (Modified Mod II) radar
C. TLM-18 self-tracking telemetering antenna
D. Tri-helix antenna
E. Doppler range detection equipment
F. Telemetry tape recording equipment
G. Telemetry decommutators for real time data presentation
H. Plot boards for radar and TLM-18 tracking data
I. Conversion equipment for teletype transmission of radar, TLM-18 and doppler tracking data in binary format
J. Acquisition programmer for pre-acquisition direction of antennas
K. Ground command to satellite transmission equipment
L. Guidance computer

GROUND SUPPORT FACILITIES



A. THOR—DM-18 / AGENA "A"

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

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

● Attained orbit successfully. △ Failed to attain orbit.

Flight History

DISCOVERER No.	AGENA No.	THOR No.	Flight Date	Remarks
0	1019	160	21 January 1959	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	1022	163	28 February	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	1018	170	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	1020	174	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	1023	179	25 June	*Same as DISCOVERER III.*
V	1029	192	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	1028	200	19 August	*Same as DISCOVERER V.*
VII	1051	206	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	1050	212	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	1052	218	4 February 1960	*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.*
XI	1055	234	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
XII	1053	160	29 June	*Launch, ascent, separation, coast and orbital stage ignition were successful. Failed to achieve orbit because of AGENA attitude during orbital stage boost.*
XIII	1057	231	10 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit. Capsule was recovered after a water impact with negligible damage All objectives except the airborne recovery were successfully achieved.*
XIV	1056	237	18 August	*Attained orbit successfully. Recovery capsule ejected on the 17th orbit and was successfully recovered by the airborne force. All objectives successfully achieved.*

MONTHLY PROGRESS—DISCOVERER Program

Progress

● During August a significant milestone was achieved in the DISCOVERER program when the data capsules of DISCOVERER XIII and XIV were ejected from the orbiting satellite, re-entered the earth's atmosphere and were recovered successfully within the programmed area north of the Hawaiian Islands. These two capsules represent the first objects to have been successfully recovered from an orbit in space. As such, they take their place among four other "firsts" achieved by the DISCOVERER program (see Table III).

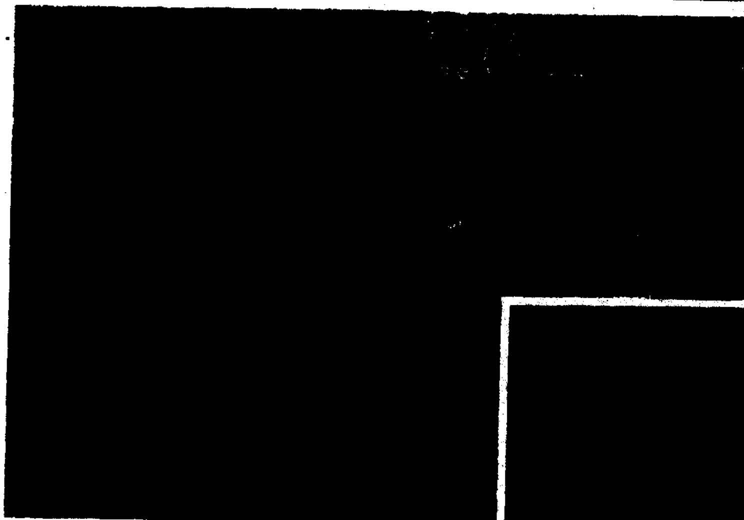
DISCOVERER XIII

● DISCOVERER XIII was launched from Vandenberg Air Force Base at 13:38, PDT, on 10 August and was successfully injected into polar orbit. THOR booster trajectory was slightly high and west but was well within tolerance. Second stage separation was successfully accomplished as was transmission of Commands 5 (time-to-fire correction) and 6 (velocity-to-be-gained correction). AGENA performance was very close to nominal. Re-orientation of the satellite into a nose aft attitude was accomplished after burnout. Table I lists nominal and actual orbital parameters.

PARAMETER	NOMINAL	ACTUAL
Apogee, Statute Miles	408	429
Perigee, Statute Miles	140	155
Eccentricity	0.0323	0.0326
Period, Minimum	93.5	94.1
Inclination Angle, Degree	81.69	82.67
Injection, Altitude, Statute Miles	140	156
Injection Angle, Minimum	0	+0.08
Injection Velocity, ft/sec		25,852

TABLE I. DISCOVERER XIII Orbital Parameters

● The recovery sequence was automatically initiated by the satellite programmer 26 hours, 37 minutes after launch. This event occurred within range of the Kodiak, Alaska, tracking station as DISCOVERER XIII passed southward toward Hawaii on its



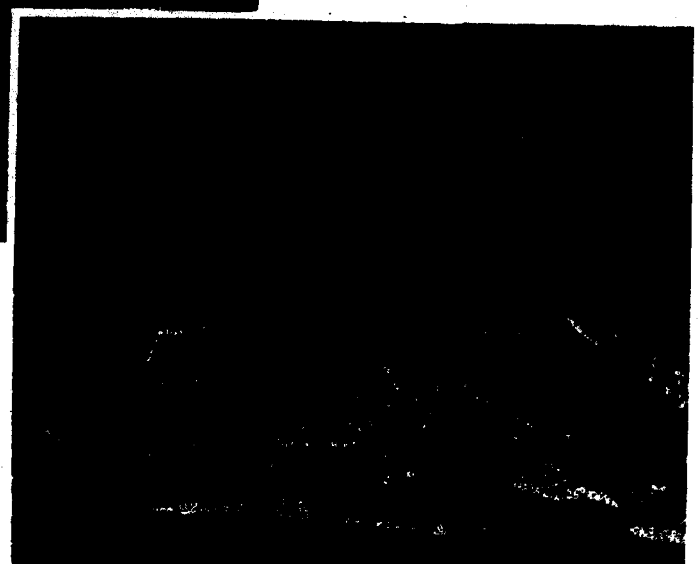


Figure 1. Second stage AGENA vehicle for DISCOVERER XIII during systems checkout (above) and mating with THOR first stage (right). The helium and nitrogen spheres visible in both photos are used for propellant tank pressurization and the satellite orbital attitude control system respectively.

17th orbit. Telemetry received by Kodiak from the satellite and the capsule confirmed that satellite pitchdown, capsule ejection, spin, retro rocket firing, capsule de-spin and thrust cone ejection were accomplished. Minutes later the Hawaiian tracking station acquired the telemetry signal and determined that ablative shield ejection and parachute deployment had occurred.

● All aircraft and ships of the recovery force within range acquired the capsule's RF beacon and began homing on the signal. No aircraft was able to attempt recovery, but one plane did observe the capsule impacting in the sea. A helicopter from the "Haiti Victory," one of the recovery ships, was sent to retrieve the capsule. The capsule was flown to Hawaii by helicopter, transferred to an Air Force plane, and delivered to Washington DC. After being viewed by President Eisenhower, the capsule was placed on public display by the Air Force. This historic object, the first man-made object recovered after a sustained period of orbit, will become part of the Smithsonian Institute's collection of space vehicles.

● DISCOVERER XIII carried a diagnostic payload in addition to the normal recovery equipment. The payload contained instrumentation to determine capsule environment and the functioning of separation and recovery sequence events. A five channel telemetry system was installed to transmit the data obtained to the ground stations. To assure receipt of all data, a tape recorder was provided to record the real time events and capsule performance during the telemetry "blackout" period which occurs when the capsule re-enters the atmosphere. After a two-minute time delay, these stored data were transmitted to the ground stations. The high speed of re-entry induces ionization over the skin of the capsule which effectively blocks telemetry transmission. An S-band transponder was also provided to aid in tracking the capsule from ejection through recovery.

DISCOVERER XIV

● DISCOVERER XIV was launched at 1257, PDT, on 18 August into a polar orbit from Vandenberg Air Force Base. The launch was delayed approximately 15 minutes because the still orbiting DISCOVERER XIII satellite was passing through the projected flight area. THOR booster performance was near nominal. Separation, transmission of Commands 5 and 6, and orbital boost were accomplished as planned. Nominal and actual orbital parameters are given in Table II.

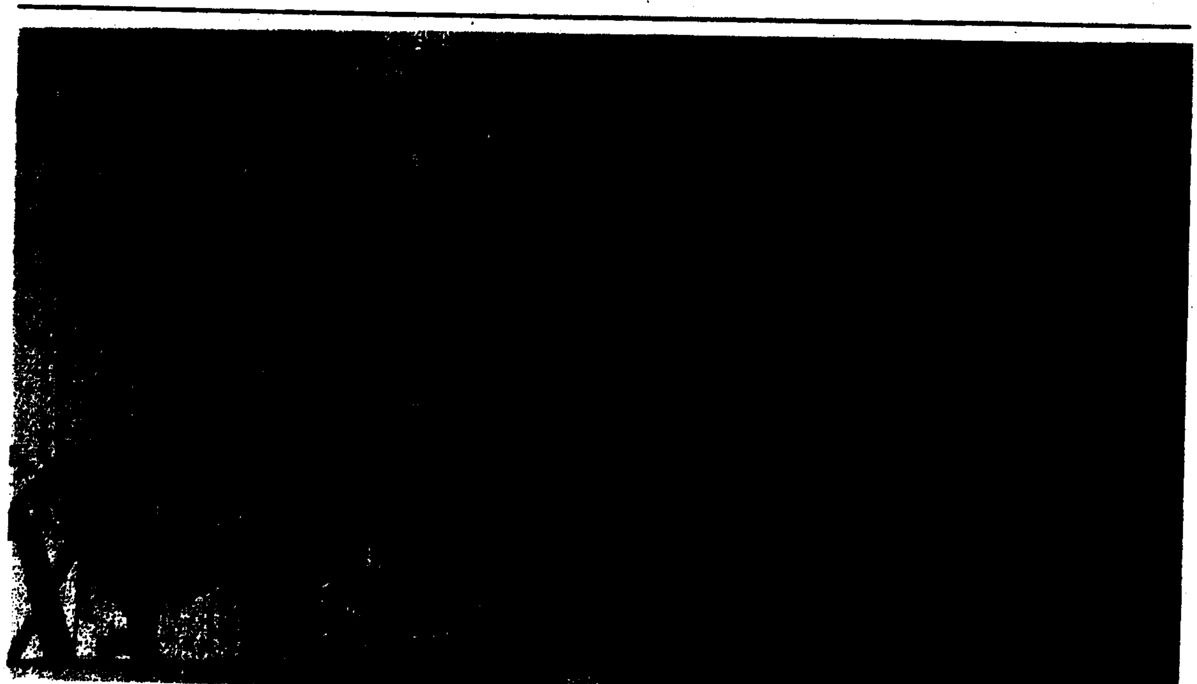
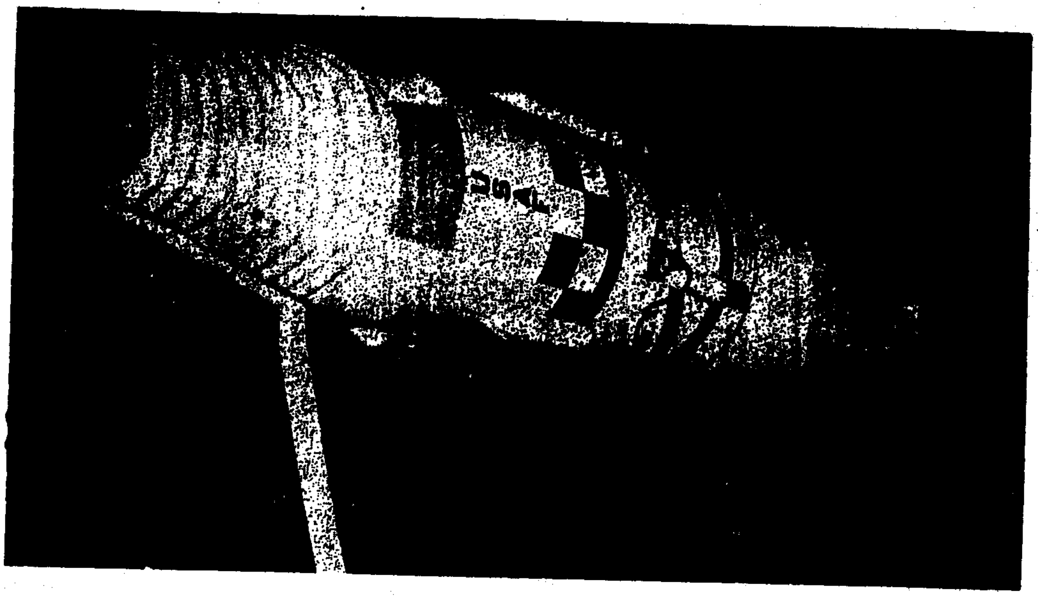


Figure 2. Close-up of AGENA vehicle forward equipment compartment prior to mating with THOR booster.



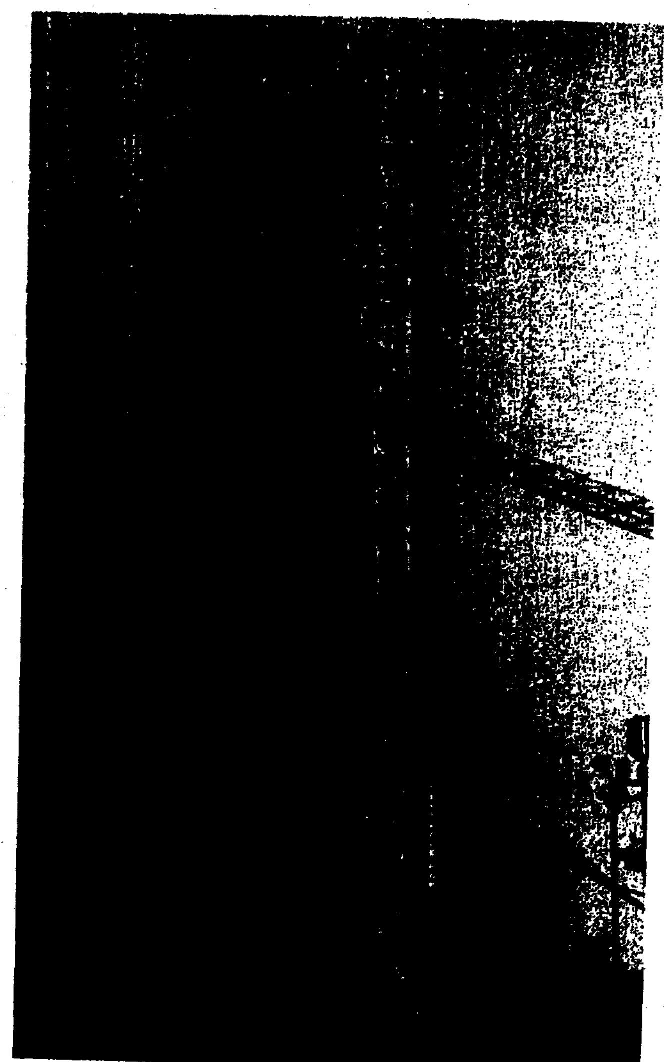
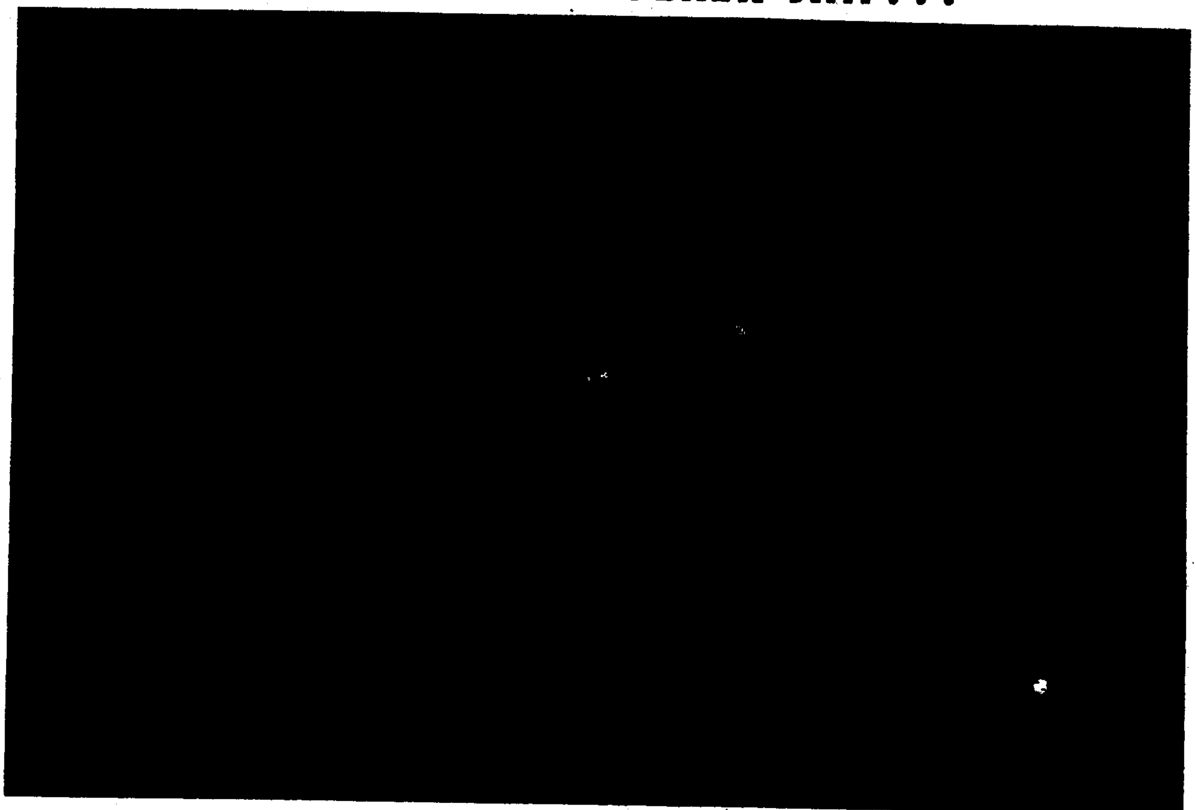


Figure 3. DISCOVERER XIII during pre-dawn countdown on 10 August, prior to erection (above) and during servicing operations following erection on launch pad (right). In top view, the blanket surrounding the nose cone provides air conditioning for capsule electronics during countdown to prevent overheating. The black dome protruding from the blanket is part of the ablative shield which surrounds and protects the capsule during re-entry.

Figure 4. DISCOVERER XIII during lift-off from Vandenberg Air Force Base launch complex on 10 August.

DISCOVERER XIII . . .



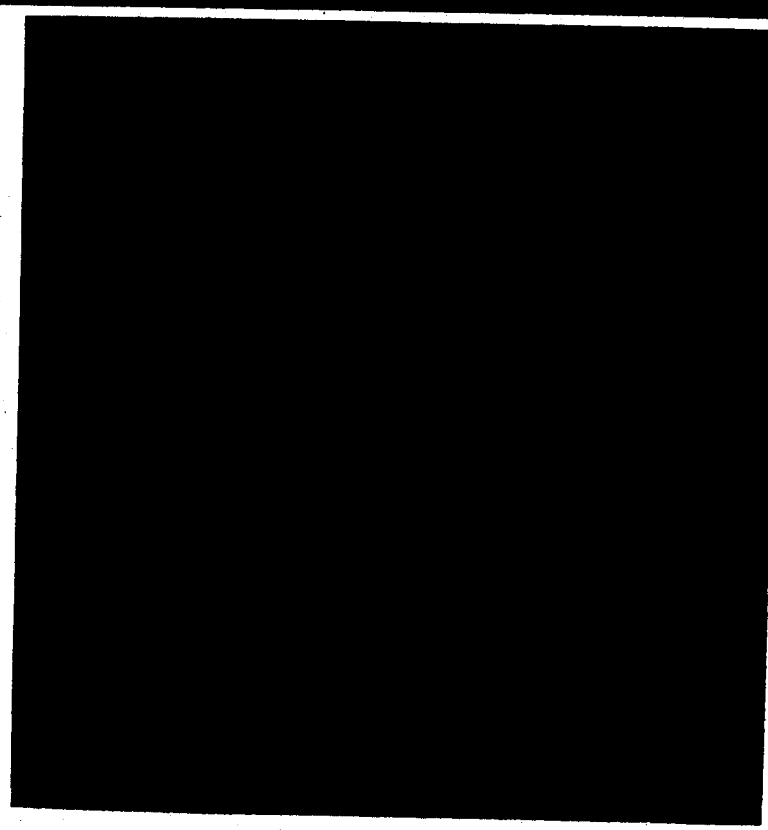
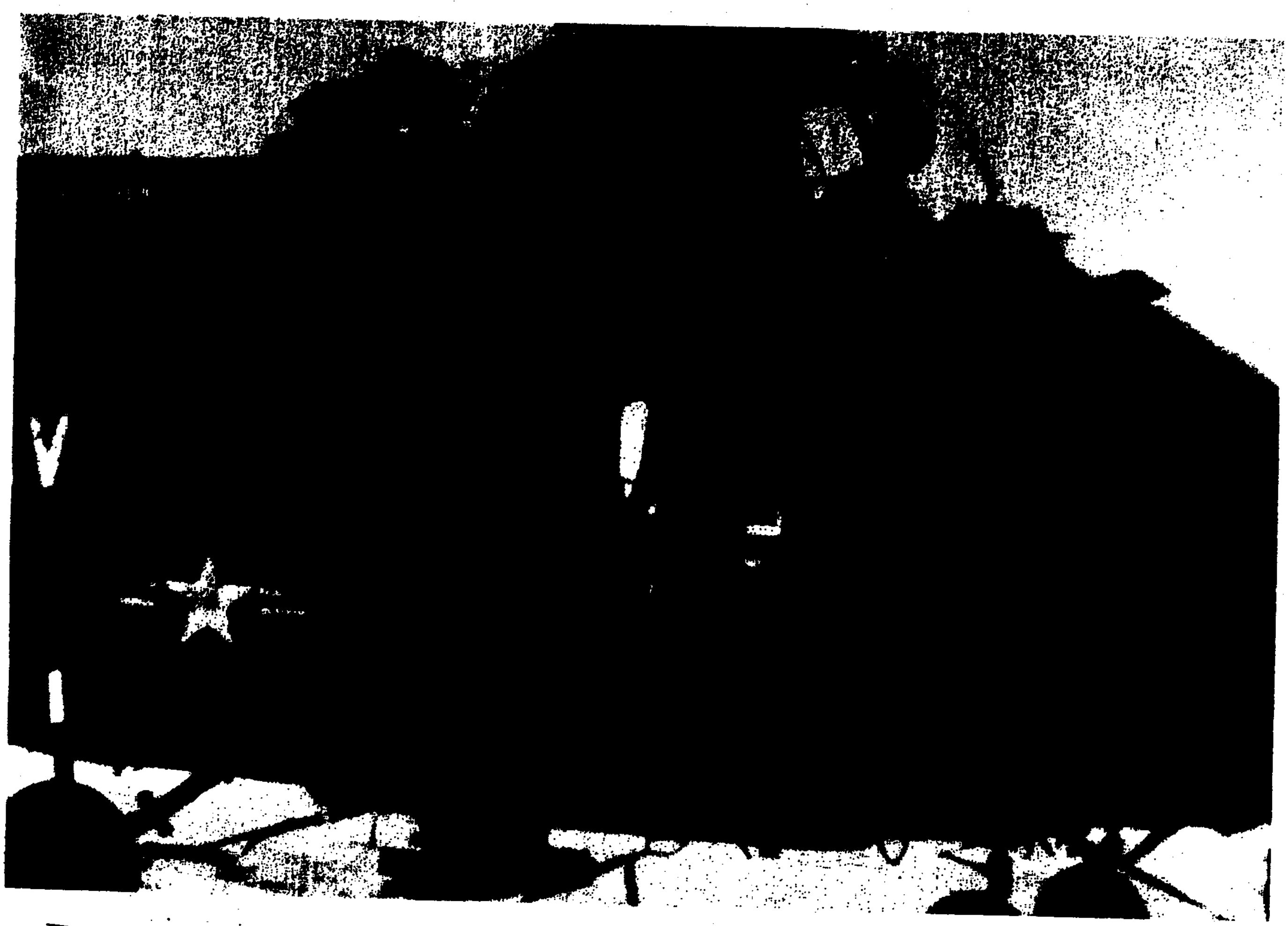


Figure 5. Helicopter recovers DISCOVERER XIII capsule from sea north of Hawaii. Frogman jumps into sea (above) to secure recovery gear to capsule. The capsule is reeled in by the helicopter winch (right) and the frogman is returned to the helicopter (top photo, opposite page). The capsule is shown prior to removal from the helicopter (bottom photo, opposite page), following its return to the recovery force ship "Haiti Victory."

. . . SEA RECOVERY OF CAPSULE



DISCOVERER XIV...

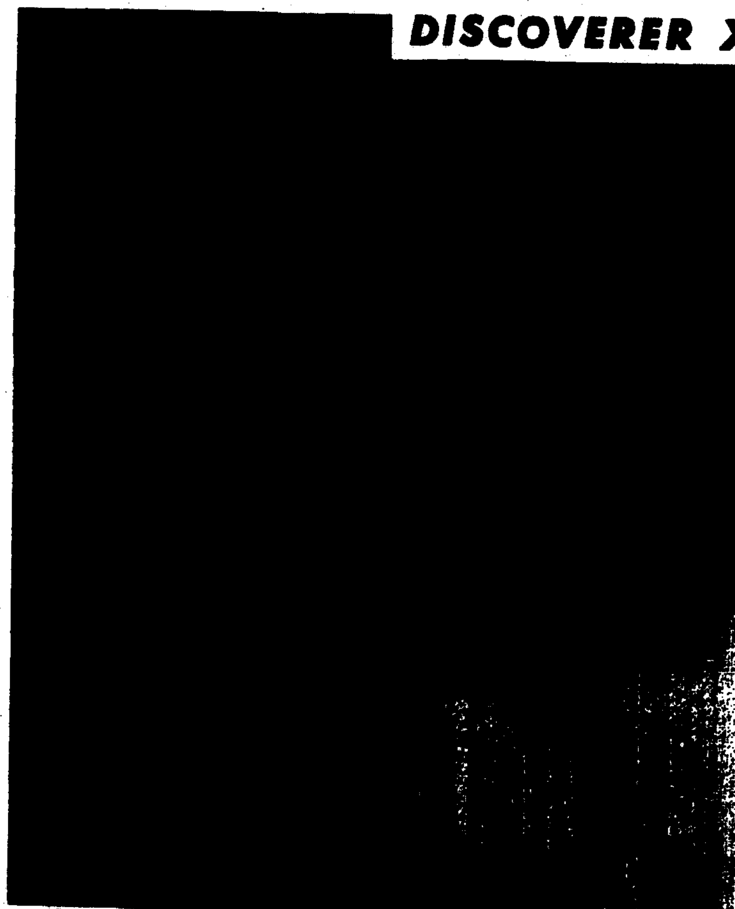
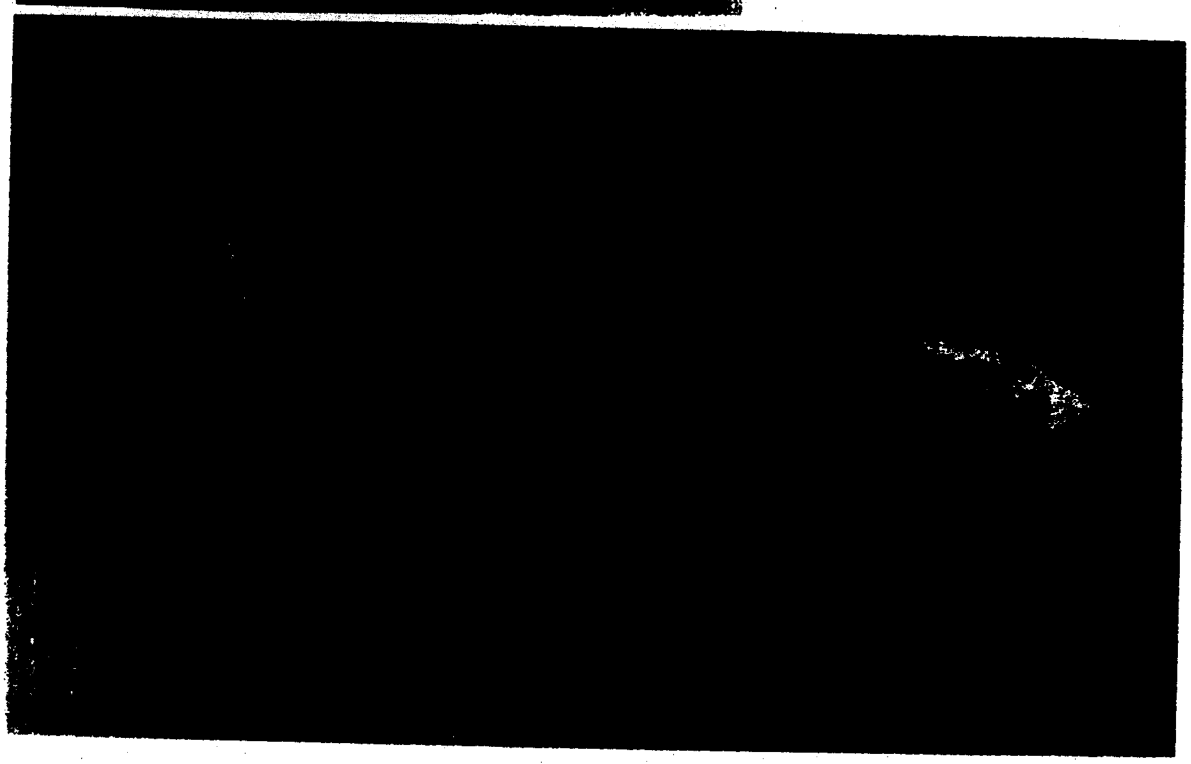


Figure 6. Crewmen aboard recovery aircraft check hook on recovery harness prior to harness deployment.

Air Force C-119 patrolling in recovery area north of Hawaii with capsule recovery harness extended.



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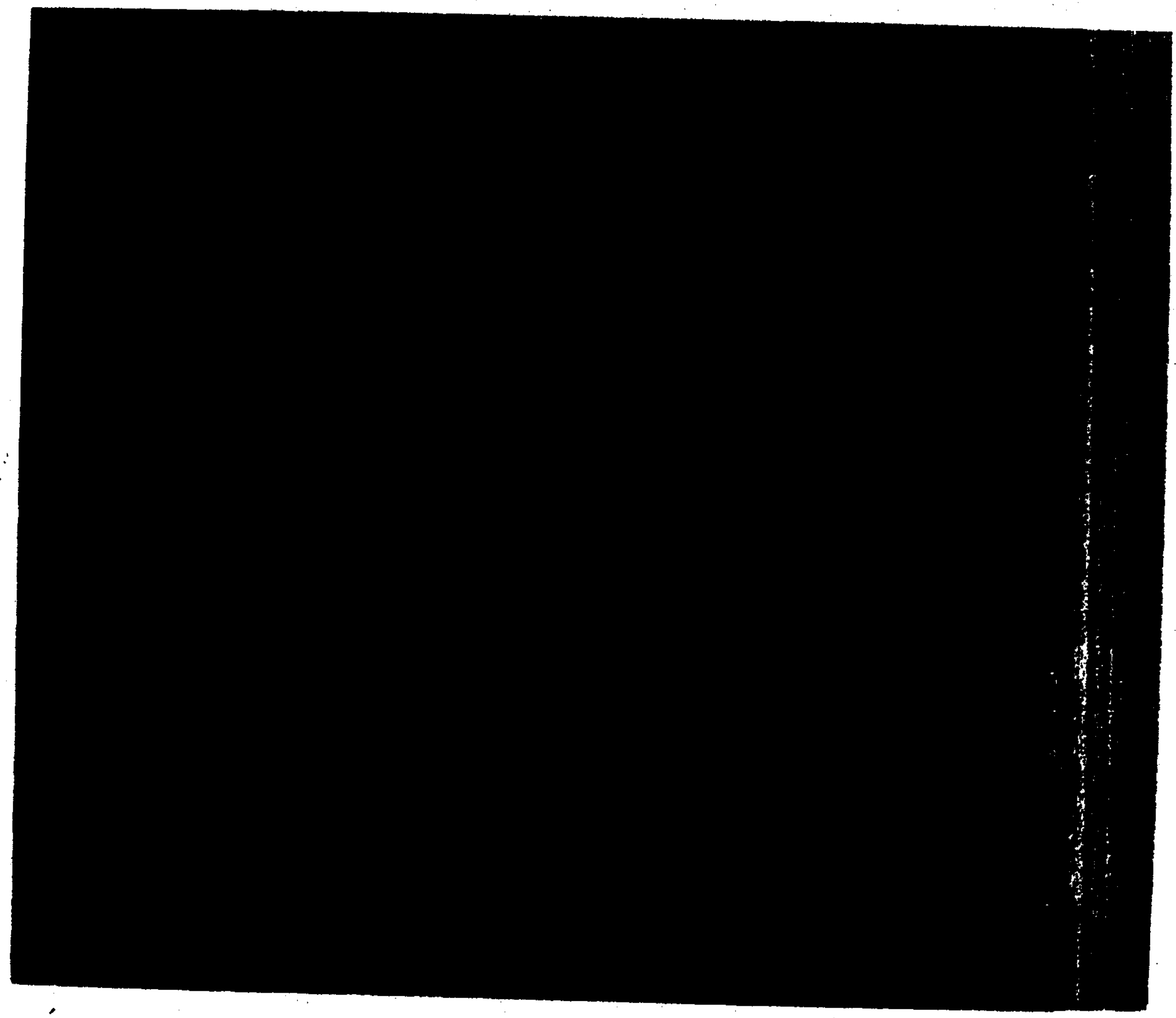
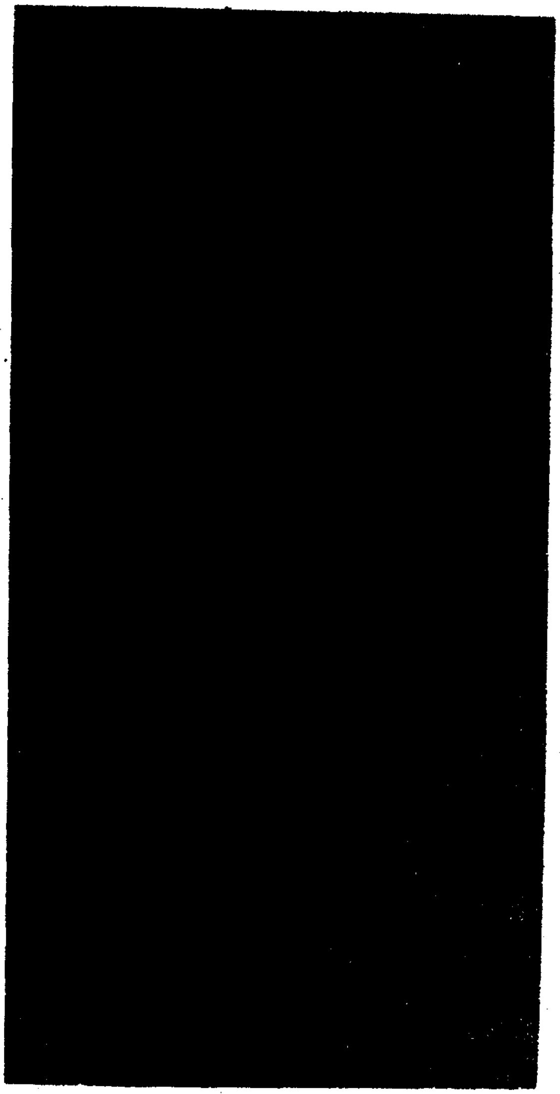
. . . AERIAL RECOVERY OF CAPSULE

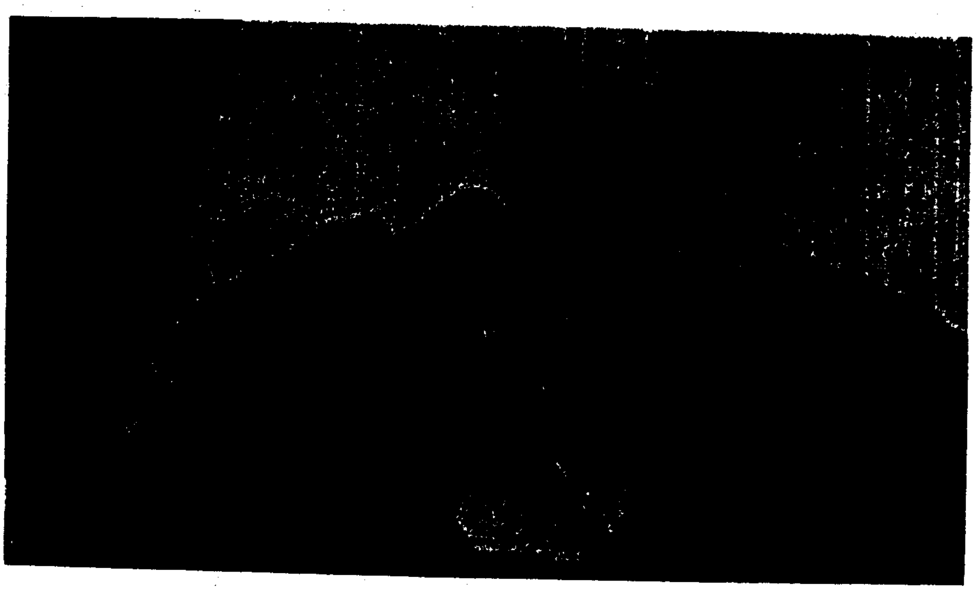


Photograph of capsule and parachute taken from within C-119 fuselage on second of two unsuccessful attempts at aerial recovery of DISCOVERER XIV.

Capsule being re[…] fuselage by memb[…] ery crew.



Photograph of recovery harness engaging capsule and parachute, taken from within C-119 fuselage on the third recovery attempt.



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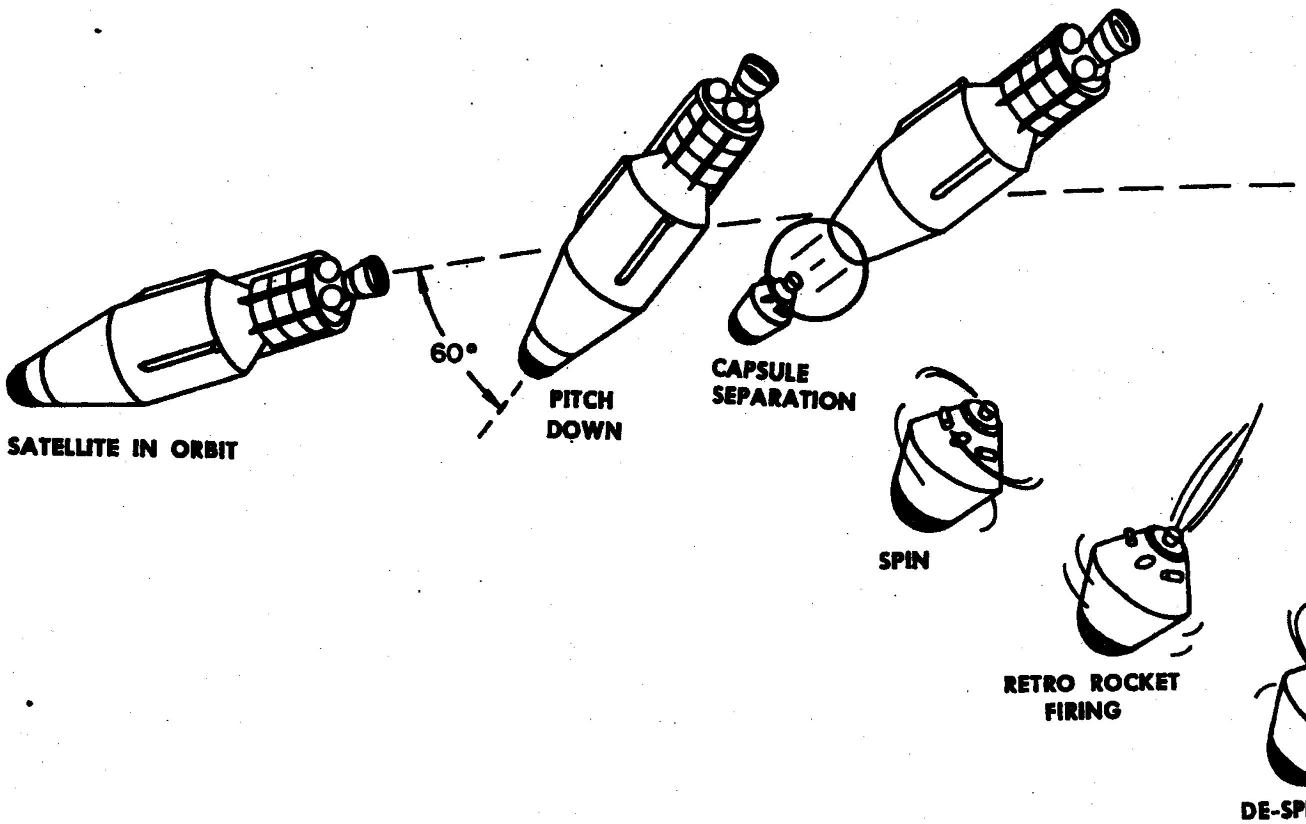
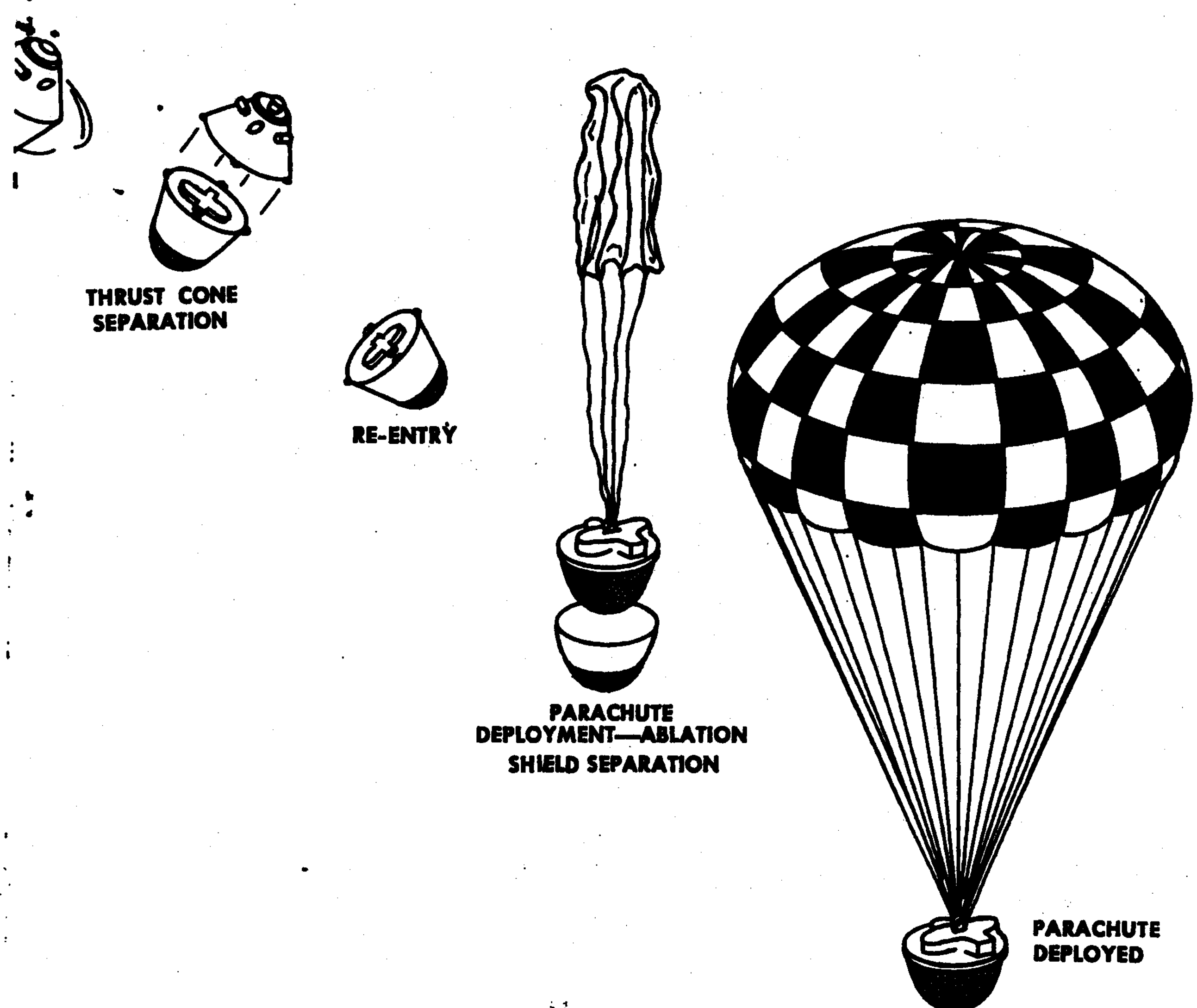
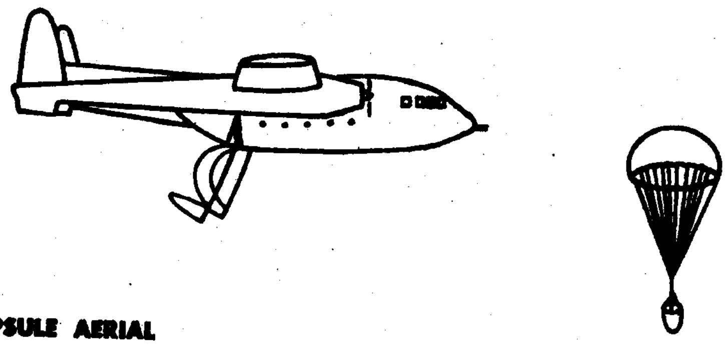


During its seventeenth orbit (approximately 26 and three-quarter hours after launch) the AGENA vehicle pitches nose down and capsule separation occurs. These operations require about a minute and one half. From launch to capsule ejection the satellite has traveled about 444,000 miles in its elliptical orbit around the earth. The "cold gas" spin system operates, the retro rocket fires and the "cold gas" de-spin system operates. Next the thrust cone separates. The thrust cone contains the spin/de-spin system gas spheres, squib operated valves, manifolds, and exhaust jets; the retro-rocket; the rocket programmer; and the S-band beacon transmitter. The capsule then free falls in much the same position as when it was ejected. Upon re-entry the capsule re-orients itself so that the ablation shield absorbs the intense heat of re-entry. After the two and one-half minute period of re-entry the parachute compartment cover is ejected and the chute unfolds. At this time the ablation shield, having served its purpose, is separated from the capsule. The parachute is deployed at approximately 55,000 feet and the capsule, sending out a signal on which the recovery aircraft "home," descends toward the earth it left only the day before. On recovery, the weight of the capsule is approximately one-third what it was at the time of separation. Items that are no longer needed are ejected to reduce the capsule weight and permit recovery.

DISCOVERER CAPSULE EJECTION, RE-ENTRY, AND PARACHUTE DEPLOYMENT



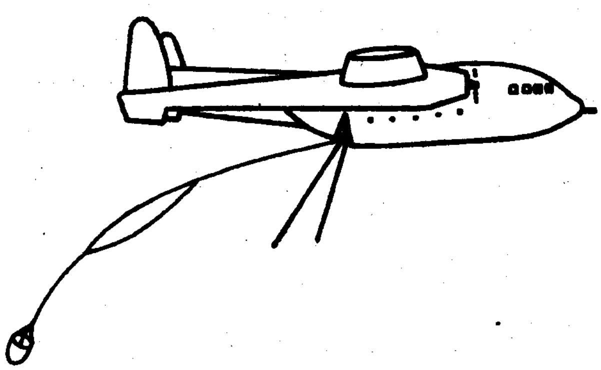


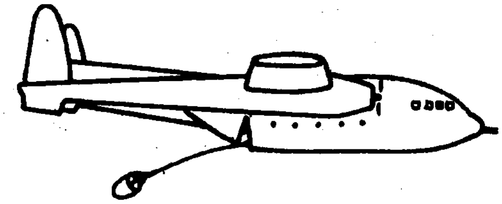
DISCOVERER CAPSULE AERIAL RECOVERY

After capsule ejection from the satellite and re-entry into the earth's atmosphere, the parachute deploys. Parachute deployment occurs at an altitude of approximately 55,000 feet. The crews of C-119 aircraft in the recovery zone "home" in on the signals transmitted by the capsule's beacon and determine their intercept course. They have between 20 and 30 minutes from the time of parachute opening until it impacts into the sea to effect recovery.

The sequence on this page shows contact being made (top center), the aircraft making a pass on the falling capsule (above), the hook of the recovery gear snagging the nylon canopy (above right), and the capsule being hauled into the recovery aircraft. From the time the chute is snagged until it is safely aboard requires from 15 to 20 minutes. If the aircraft cannot effect recovery, surface vessels in the impact area attempt to recover the capsule from the sea. A flashing lite, dye markers, and the transmitter aid them in their search.

Recovery of the DISCOVERER XIV capsule by the Hawaiian based recovery force was the first time in history a man-made object returning from a sustained period in space was recovered by an aircraft.





PARAMETER	NOMINAL	ACTUAL
Apogee, Statute Miles	428	500
Perigee, Statute Miles	118	111
Eccentricity	0.037	0.046
Period, Minimum	93.4	94.5
Inclination Angle, Degree	79.6	19.6
Injection Altitude, Statute Miles	118	118
Injection Angle, Minimum	0	−0.22
Injection Velocity, ft/sec		26,150

TABLE II. DISCOVERER XIV Orbital Parameters

- On the first pass over Kodiak, telemetry data indicated an abnormal satellite attitude, stop indications by the horizon scanner and excessive control gas consumption. The satellite stabilized in its proper attitude on subsequent passes and orbited as planned.

- While on its 17th orbit, the satellite programmer automatically initiated the recovery sequence. The capsule re-entered the atmosphere and its parachute was deployed. A C-119, one of the airborne recovery force, homed on the CW beacon signal and visually sighted the capsule. On the third pass, 1609 PDT, the hooks on the special air-recovery gear snagged the nylon canopy. The chute and capsule were carefully reeled in and at 1623 PST were safely aboard the aircraft. The capsule is presently being analyzed at the contractor's facility.

Technical Progress

Second Stage Vehicles

- Only two DISCOVERER AGENA "A" vehicles remain to be flown. DISCOVERER XV is at Vandenberg Air Force Base in preparation for a September launch. The remaining vehicle is at Sunnyvale for modifications incorporating the improvements from the latest flight tests.

- Two AGENA "B" satellites were delivered to Vandenberg Air Force Base during August and are currently undergoing subsystem checks in the missile assembly building. An additional AGENA "B" has been accepted by the Air Force and is awaiting shipment to Vandenberg Air Force Base. Three vehicles have completed their test firings at Santa Cruz Test Base and are being readied for Air Force acceptance inspections.

- Phase 2 of the Preliminary Flight Rating Tests (PFRT) on the XLR-81Ba-9 engine (serial number 306) were initiated during August. After being retrofitted with flight configuration components the engine was installed on the Bell Test Center vertical test stand for initiation of start-stop and malfunction tests. A 30-second restart firing was accomplished, but test

TABLE III. Space FIRSTS achieved in DISCOVERER Program.

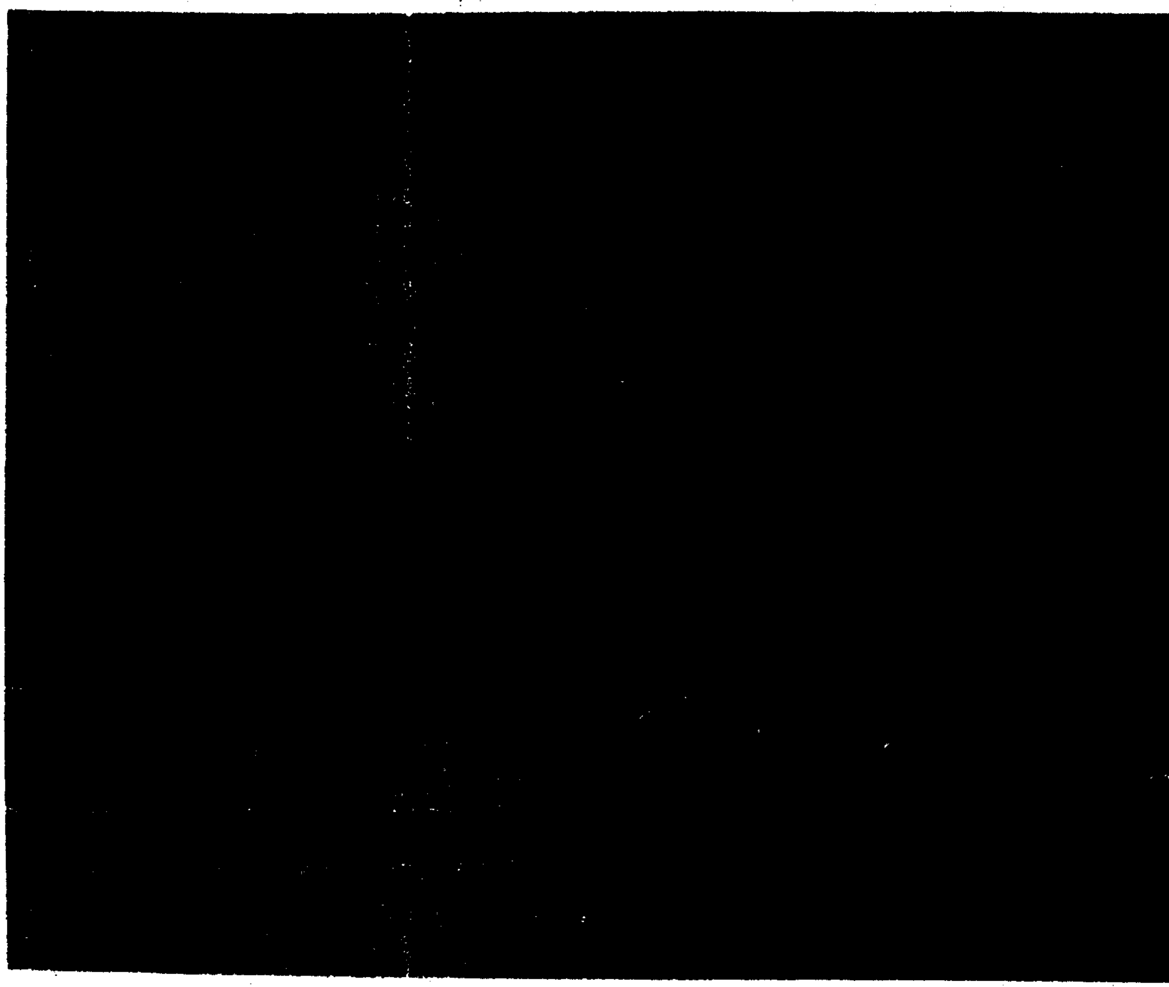
- *The DISCOVERER is the first satellite of major size (above 1,000 pounds) orbited by the United States.*

- *The DISCOVERER is the first satellite to be placed in orbit over the north and south pole.*

- *The DISCOVERER was the first satellite to be reoriented on orbit into a programmed attitude.*

- *The DISCOVERER was the first satellite to be maintained in a stable earth-referenced attitude while on orbit.*

- *The first man-made object ever recovered after a sustained period in space was the capsule ejected from a DISCOVERER satellite.*



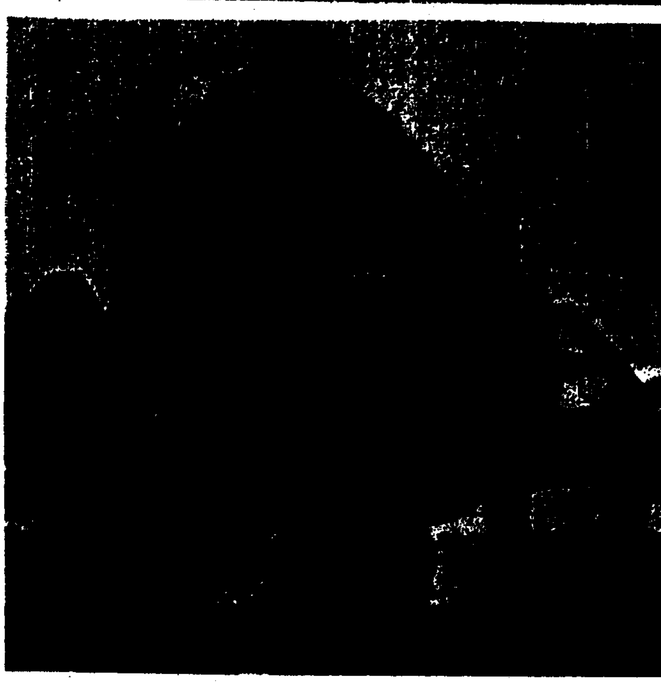


Figure 7. Loading one of the telemetry vans into a C-124 aircraft for airlift to the new DISCOVERER ground station at New Boston, New Hampshire.

data indicated a 2.75 percent shift in the power level. The engine was torn down for examination. Tests of this engine are expected to resume early in September.

● The first XLR-81Ba-9 engine (serial number 316) delivered with flight configuration hardware, has successfully completed acceptance testing. One engine (serial number 317) has been hot fired but operation was unstable and the power level dropped. Analysis disclosed that the gas generator venturies required resizing and that the oxidizer filter was improperly installed. This engine is now being prepared for final acceptance testing.

Balloon Drop Test Program

● The drop test program continued at Holloman Air Force Base with two test attempts on 4 August. The first balloon burst at 30,000 feet, before the planned drop of the Mark IV capsule, however, the equipment was recovered successfully. On the second the capsule was dropped and parachute deployment was satisfactory. The purpose of these tests was to determine if the new parachute cover would release properly during capsule deceleration. The Mark IV capsule is similar to the recently recovered capsules but contains an improved programmer and other modified components.

Facilities

● Acceptance of the air conditioning system modification for the Vandenberg Air Force Base data acquisition and processing building was made following successful completion of an equipment test run.

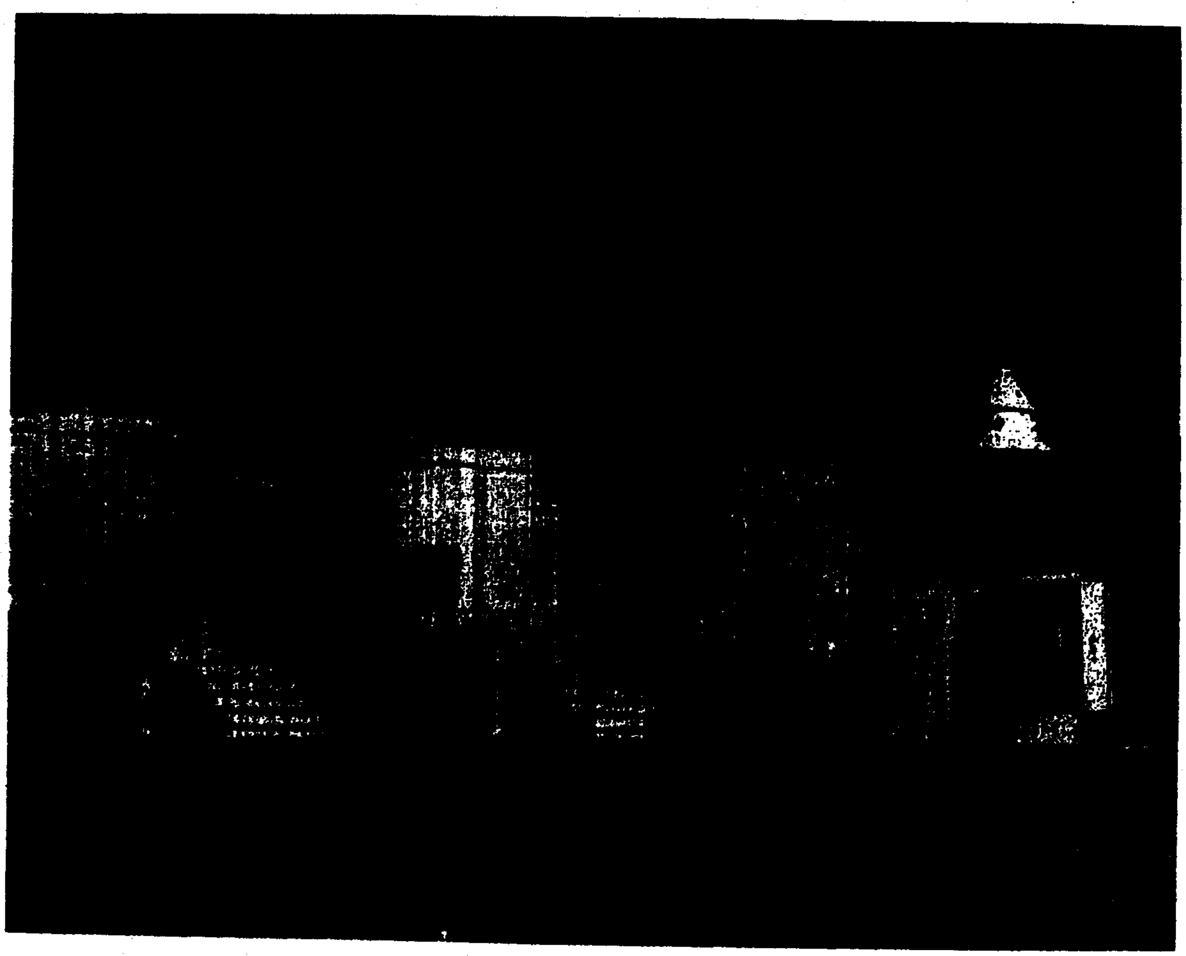
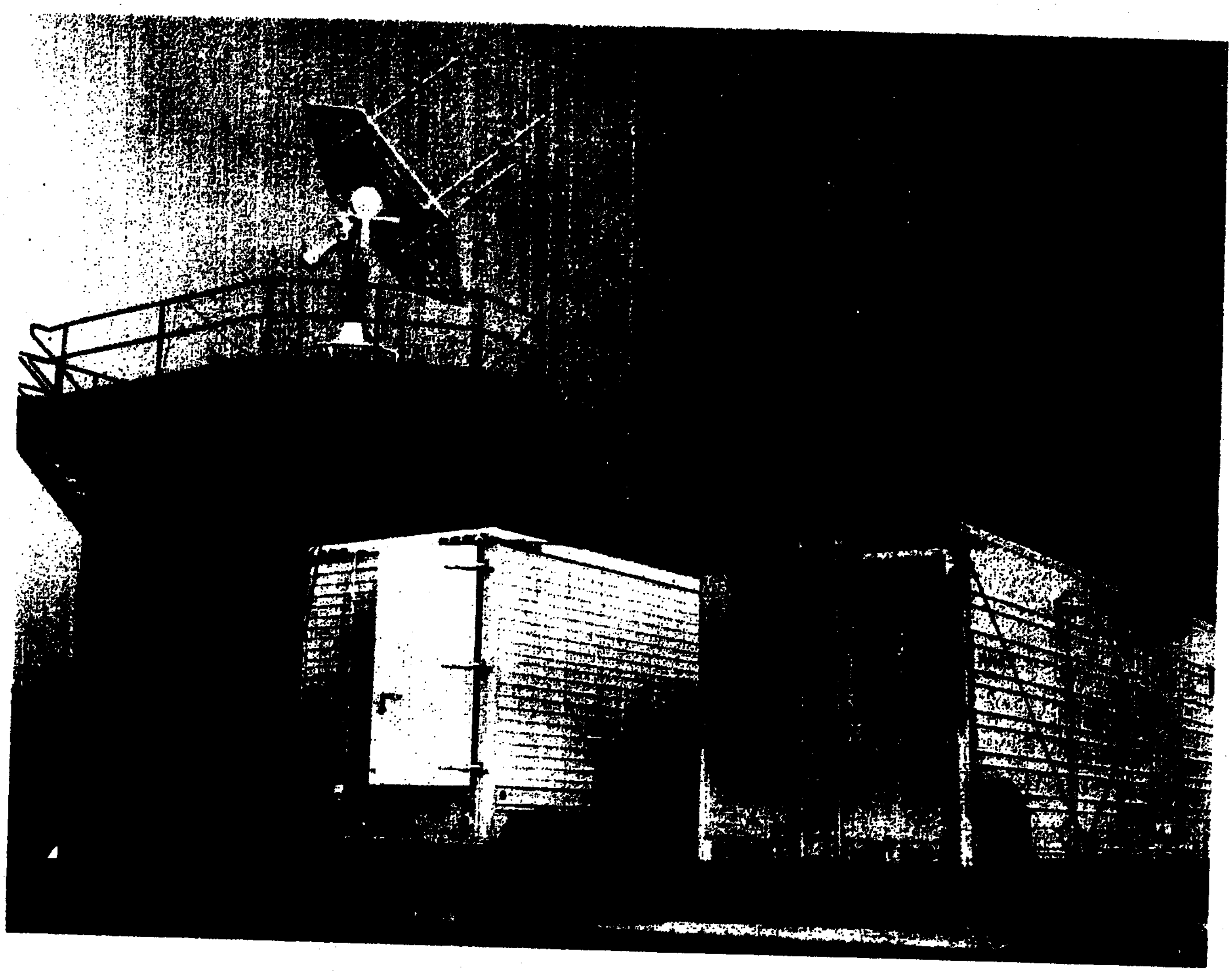


Figure 8. Vans installed alongside facilities buildings at new DISCOVERER ground station at New Boston, New Hampshire.

● Installation of a DISCOVERER ground station at the New Boston, New Hampshire, facility was completed and checked out on 17 August. Installation of equipment was started in July. The station has the capability for Verlort radar tracking, command and telemetry reception. Construction of support facilities is on schedule. The initial increment of support facilities was accepted on 2 August with the remainder scheduled for completion on 7 September.



S a m o s

BOOSTER—ATLAS ICBM

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

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—		
Inert	1,508	1,695
Payload equipment	2,605	3,058
Orbital	4,113	4,753
Impulse Propellants	6,492	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	718
GROSS WEIGHT (lbs.)	11,211	18,421
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240

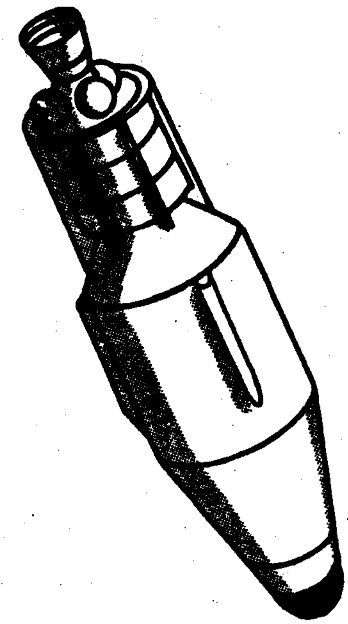
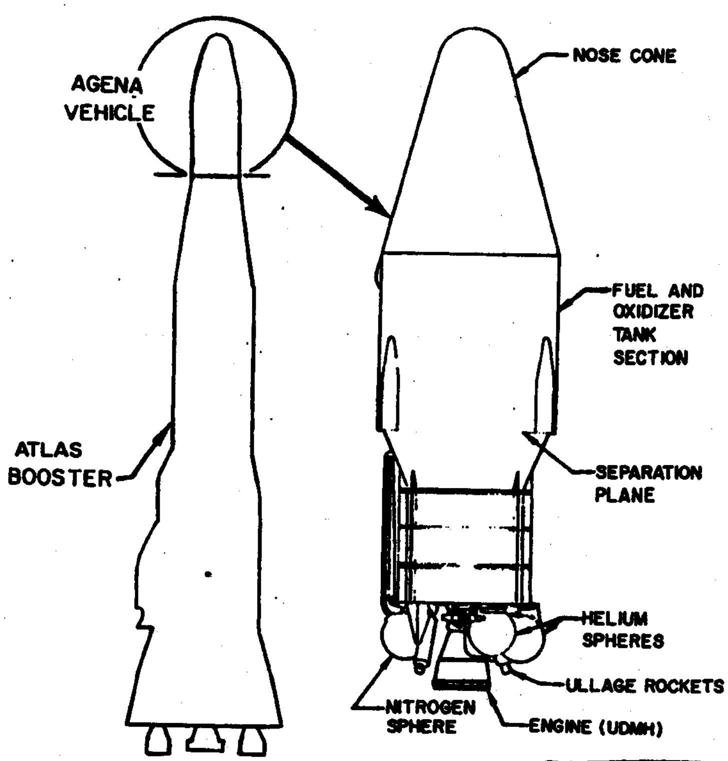


Figure 1.

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



PROGRAM HISTORY

The SAMOS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency early in 1958. ARPA separated WS 117L into the DISCOVERER, SAMOS and MIDAS programs with the SAMOS objectives based on a visual and ferret reconnaissance system. On 17 November 1959 responsibility for this program was transferred from ARPA to the Air Force by the Secretary of Defense. The program was realigned on 11 August 1960 to emphasize visual reconnaissance over ferret and physical recovery of data over electronic readout.

PROGRAM MISSION

The primary mission of the SAMOS advanced reconnaissance system is to provide visual and electronic coverage of the USSR and its allied nations. Efforts include development of hardware to permit:

a. Verification of known targets, detection of unknown targets.

b. Location and evaluation of defenses.

c. Evaluation of military and industrial strength.

d. Assessment of high-yield weapons damage.

e. Reconnoitering of troop movements.

f. Location of naval forces throughout the world.

g. Determination of characteristics of enemy electronic emissions.

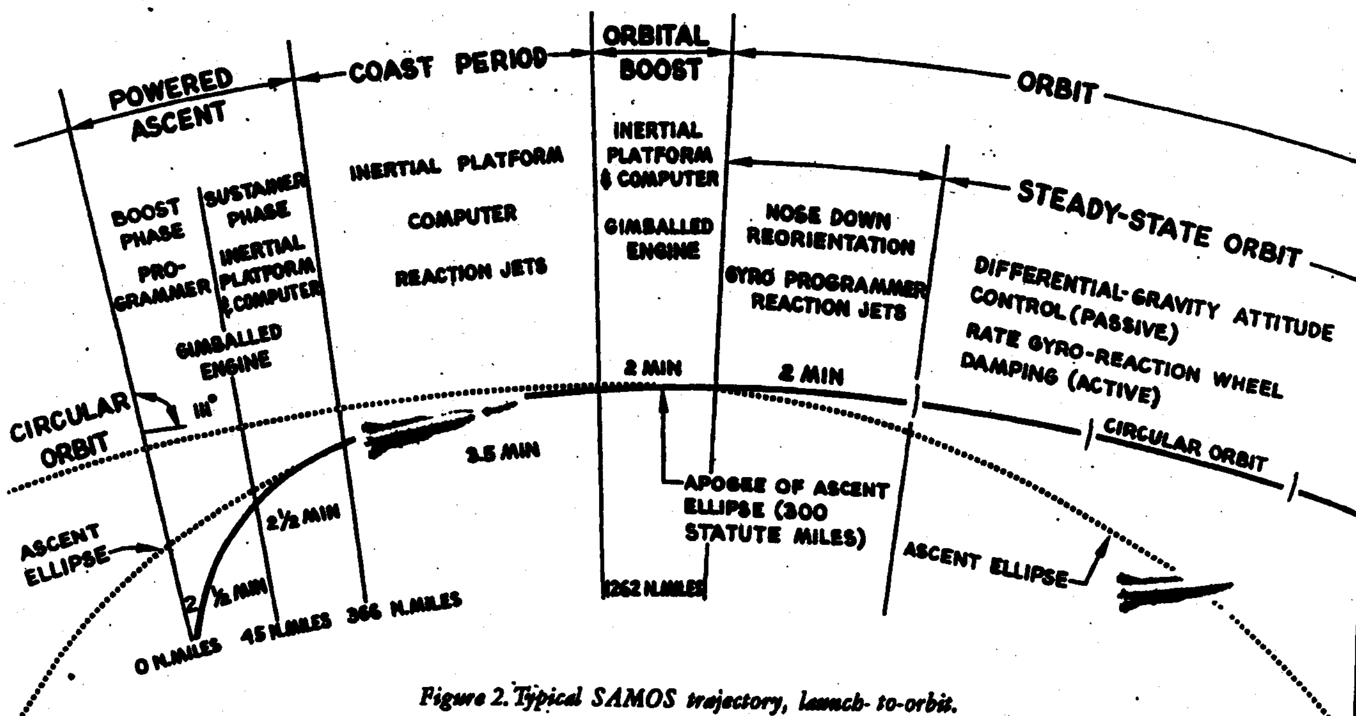


Figure 2. Typical SAMOS trajectory, launch- to-orbit.

Ferret Reconnaissance . . .

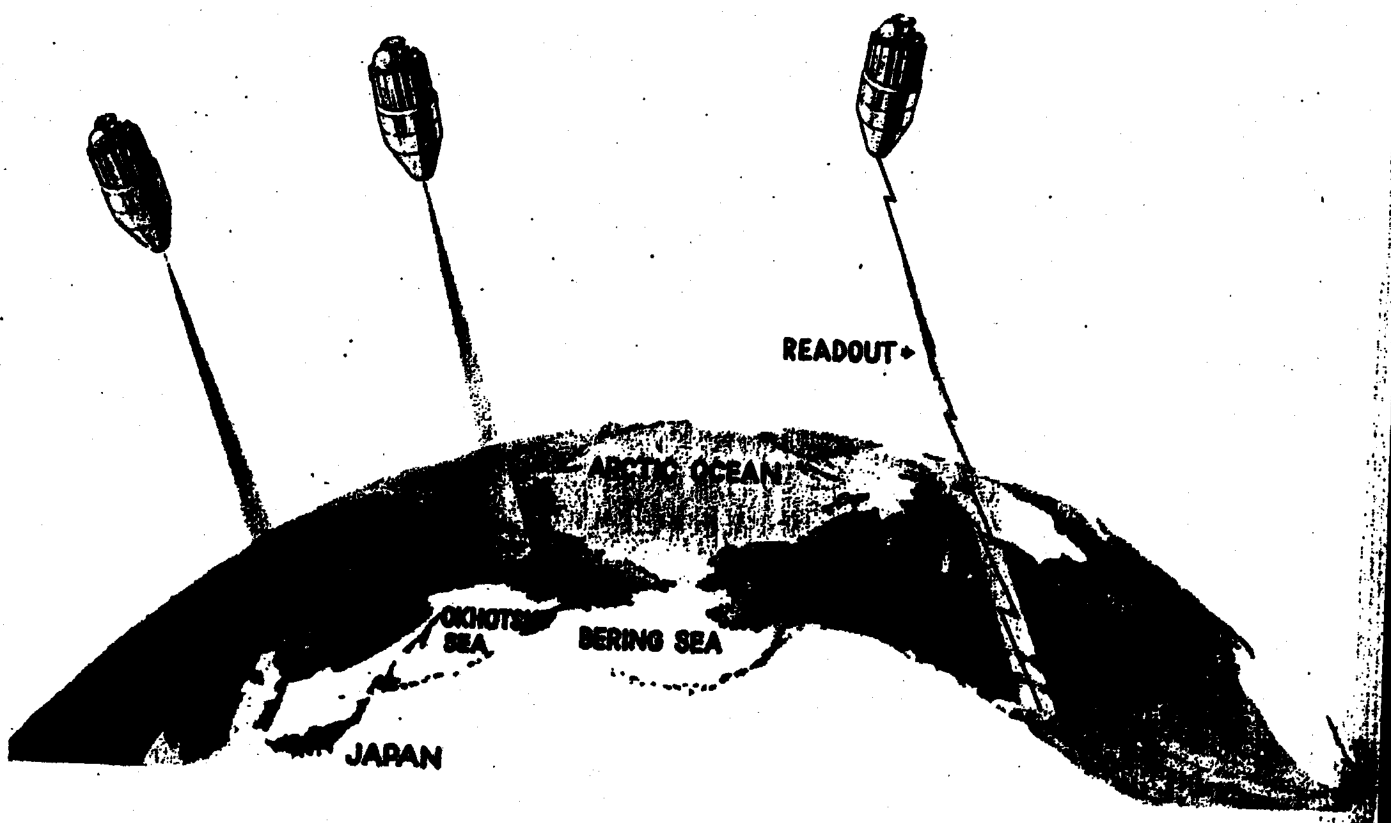


Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over areas of interest.

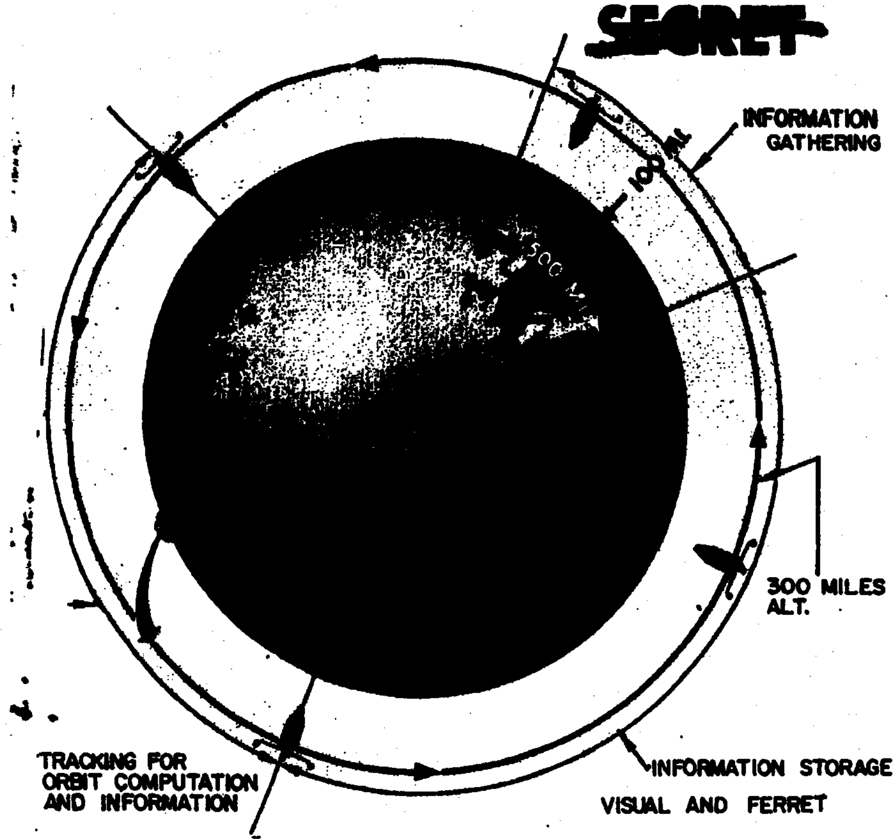


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over the area of interest the sensing equipment is turned on (Information gathering). When it leaves the area of interest the sensing equipment is turned off and the sensing data is processed (Information storage). When the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

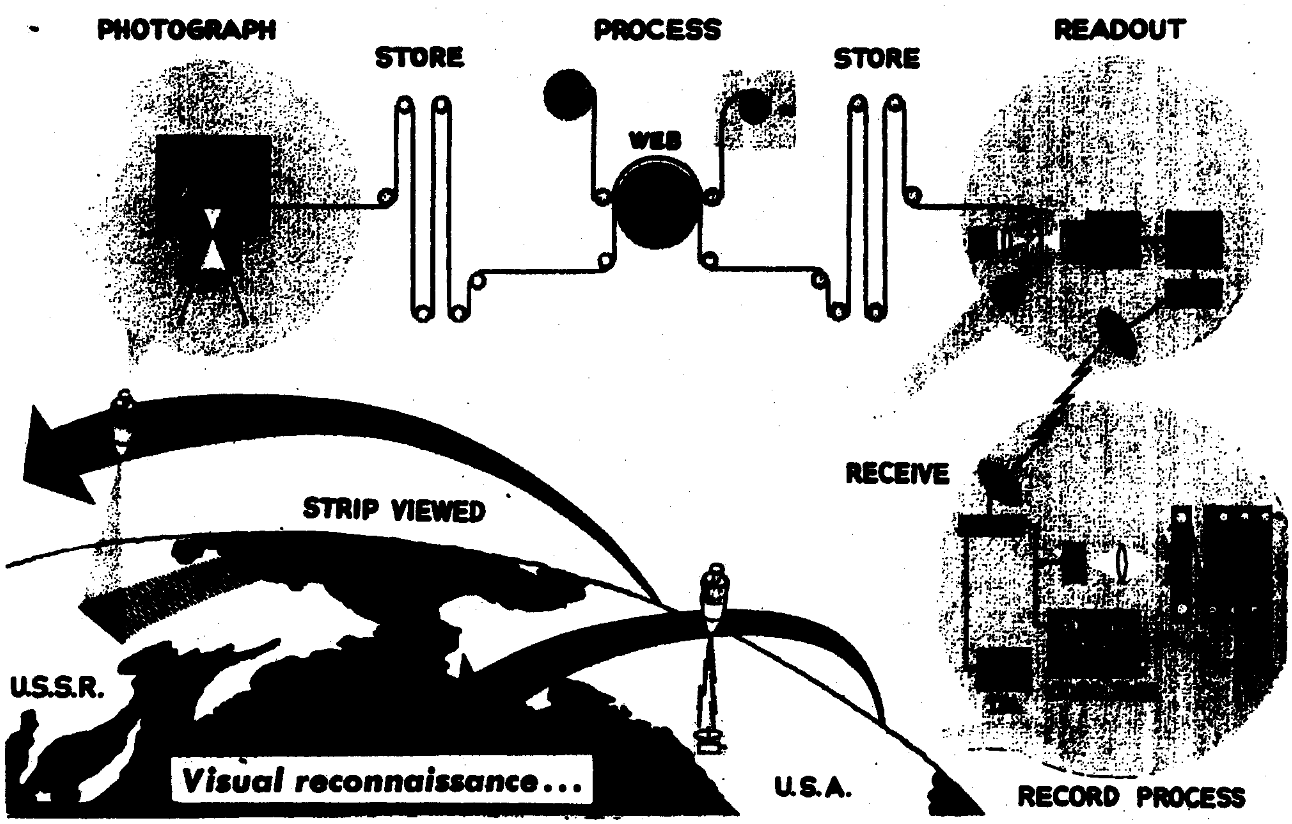


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects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

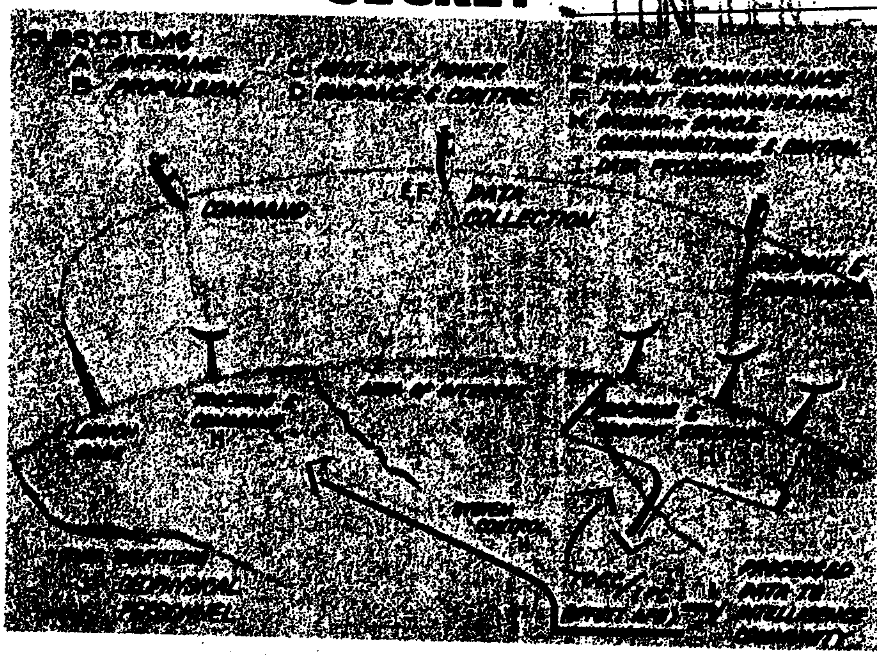


Figure 6. SAMOS concept, showing reception of commands and transmission of data between satellite and ground station; and subsystem functions (schematic).

For economical testing of components a dual-capability visual and ferret payload will be flown on the first 3 flights. On later flights only a visual or ferret system payload will be carried. These payloads will be housed in the AGENA vehicle (Figure 1).

Data collected by the visual payloads will be electronically transmitted in the readout system or physically recovered in the recovery system. Ferret data will be transmitted electronically. These systems are composed of the AGENA vehicle, ATLAS booster, launch facilities, tracking facilities, and a communications and data processing network. The recovery system will include a re-entry capsule and a recovery force.

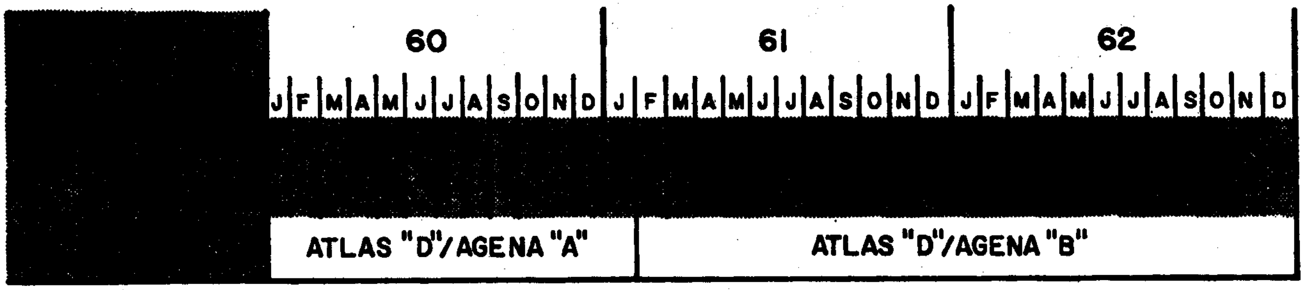
CONCEPT

ATLAS Series D missiles launched from VAFB will boost the AGENA vehicle into polar orbits. Injection into near-circular orbits (Figure 2) will be accomplished by the AGENA vehicle rocket engine. A self-contained guidance system using a horizon reference scanner will provide altitude stabilization. As the satellite travels in an orbit essentially fixed in space the earth rotates inside the orbit (Figure 3). Each successive orbit is displaced laterally approximately 23½ degrees at the equator, permitting one vehicle to observe the entire earth in a time period dependent upon the width of the area under surveillance. Early versions will have a useful life of approximately ten days. The readout systems will have a useful life of four months with a design objective in certain configurations of one year; recovery systems will have a useful life of fifteen to thirty days.

TECHNICAL DESCRIPTION

Visual Program—Four versions (E-1, E-2, E-5 and E-6) of visual payloads are being developed. The E-1 payload is a photo component test payload which is combined with the F-1 ferret payload. The E-2 photographic payload, under development by Eastman Kodak Company, includes a camera, film processor, and electronic readout equipment. The E-5 recoverable system designed by Lockheed will retain the exposed film and the 66-inch focal length camera developed by Itek Corporation. The E-6 payload is a medium resolution, general area coverage, photographic recoverable subsystem being developed as an alternate to the E-5. The E-6 is now in the source selection phase.

Ferret Program—Ferret payloads are being developed on a progressively more advanced basis from R&D (F-1) to advanced systems (F-4). Although only the F-1 and F-2 are included in the flight test schedule. The F-2 all-digital, general coverage payload will use superheterodyne scanning receivers in conjunction with directional antennas, an analog to digital converter and tape recorders (for storage). A programmer will be used to control read-in over areas of interest and readout over tracking stations. The F-3 payload will use similar receivers with stop-scan capability and controllable antennas added. Recording of the actual signal intercepted (rather than the digital representation) will be possible with a bandwidth up to 6mc. A complex programmer will permit satellite search of a given area or frequency range.



SAMOS Launch Schedule

Monthly Progress—SAMOS Program

Technical Progress

Second Stage Vehicles

- The second stage vehicle for the first SAMOS flight has undergone systems tests throughout the report period at Vandenberg Air Force Base. The tests were successfully concluded on 17 August following a simulated launch. Late equipment deliveries and the requirements for full-scale RF interference check (because of the DISCOVERER XII horizon scanner problem) resulted in rescheduling the on-stand date from 19 August to 2 September. This revised on-stand date is compatible with the requirement of not installing the AGENA until after completion of the ATLAS booster flight readiness firing (FRF). The ATLAS FRF was successfully completed on 23 August. Launch of the first SAMOS flight is now scheduled for 4 October. This date will permit the telemetry ship Pvt. Joe E. Mann to return on station, following its support of the DISCOVERER recovery operation.

- The two remaining SAMOS AGENA "A" dual payload satellites are proceeding through modification and checkout in the system test area. These vehicles are approximately six-to-eight weeks behind schedule. This delinquency was caused by late delivery of flight and space airborne communications

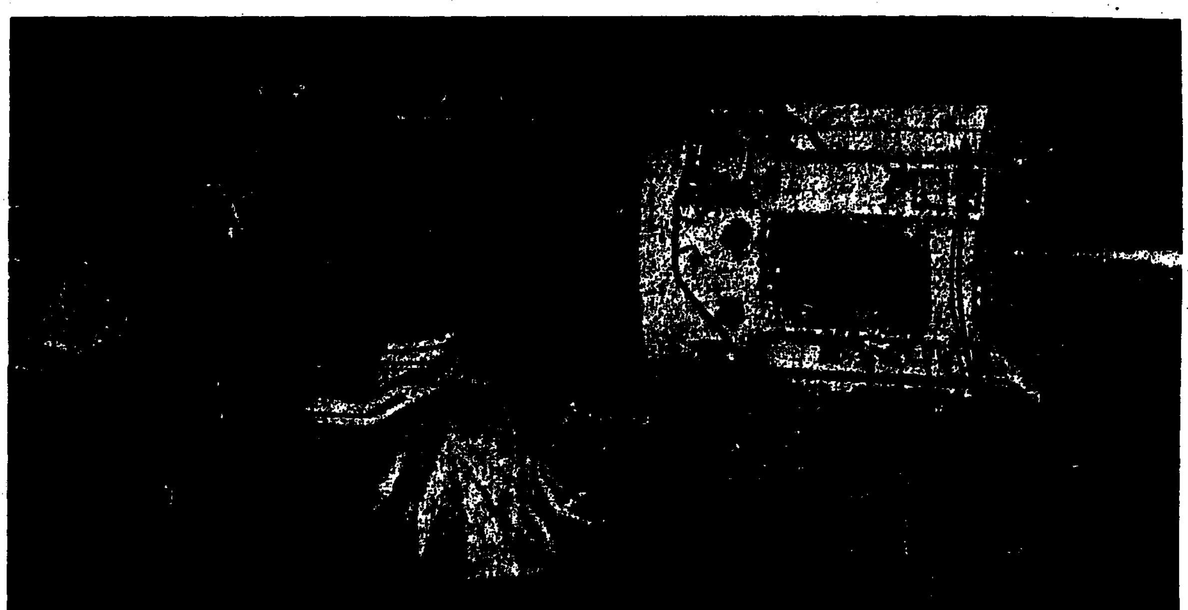


Figure 7. The AGENA "A" vehicle for the first SAMOS flight undergoing auxiliary power subsystem checkout at Vandenberg Air Force Base. The test fixture on the extreme left is used in checking the satellite's inertial reference unit. The inertial reference unit and the horizon scanner provide the attitude reference for the AGENA flight control system.

equipment, the one month duration strike, and the decision to incorporate engineering changes in the systems test area which were formerly programmed for Vandenberg Air Force Base. This change was made in the interest of decreasing the time required for the missile assembly building phase of prelaunch operations. Although there are no airborne communications equipment delinquencies at this time, previous delays have made schedule recovery almost an impossibility.

- The stacking of major components for the first AGENA "B" (single payload) vehicle was completed on 23 August. The vehicle has now entered the final assembly phase of manufacture. The XLR81-Ba-9 engine (45:1 area nozzle ratio) was received in mid-August. Delivery has also been made of the guidance control system inertial reference package and its associated electronic items.

Visual Reconnaissance Systems

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

Readout:

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

Recovery:

- **E-5—High Resolution, Steerable, Recoverable Payload (with 5-foot ground resolution)**
- **E-6—Medium Resolution, General Area Coverage, Recoverable Payload (with at least 10-foot ground resolution)**

Payloads

E-1 Payload—Checkout and testing of the E-1 payload continues to proceed on schedule at Vandenberg Air Force Base.

E-2 Payload—Final assembly of the E-2 payload for the fourth SAMOS flight was completed during the report period. Subsequent functional testing of the completed payload has resulted in modifications to the processor web feed system. Eastman Kodak is expending maximum effort to incorporate these improvements with a minimum delivery schedule slip-

[redacted]

Figure 8. Stacking or premating of the major components of the AGENA "B" vehicle for the fourth SAMOS flight. This vehicle has twice as much propellant capacity as previous vehicles and will be flown carrying an E-2 payload. Following this operation, the AGENA structural assemblies are mounted horizontally in a stand for installation of the engine and other flight components.

page. Delivery of the payload is not expected until mid-September.

E-5 Payload—Design releases for the full-scale test models of the E-5 recovery capsule have been completed and fabrication of the initial test articles is progressing satisfactorily. A thermal model of the E-5 payload, for testing in the high altitude temperature simulator, was completed during the month. Delivery of this thermal model is programmed for early September.

- Wind tunnel tests for the purpose of confirming the E-5 recovery capsule basic aerodynamic configuration are essentially complete. The force oscillation tests at Langley Field, to determine dynamic stability characteristics in the 2.3-5 Mach range, were completed on 10 August. Tests in the transonic range are scheduled to begin in early September.

- Preparations are continuing for the shock tunnel tests at high angles of attack and low Reynolds numbers to be conducted at the Cornell Aeronautical Laboratories. These tests are programmed to begin on 3 October. The aerodynamic/thermodynamic tests of the ablative heat shield, originally scheduled to begin at the Avco Corporation in early August, have been delayed because of technical difficulties with the test facilities.

- Two Recovery Equipment Test Units (RETU) tests have been conducted at Edwards Air Force Base. The purpose of these tests was to determine the E-5 capsule drag and oscillation characteristics during retrieval into the recovery aricraft. Because the RETU was lost during the deployment phase, neither test was completed. Some data were obtained and are currently being evaluated.

- Test results of the stability and rate of descent characteristics of a single main parachute versus a clustered main chute configuration are still being evaluated. Based on visual observation of tests com-

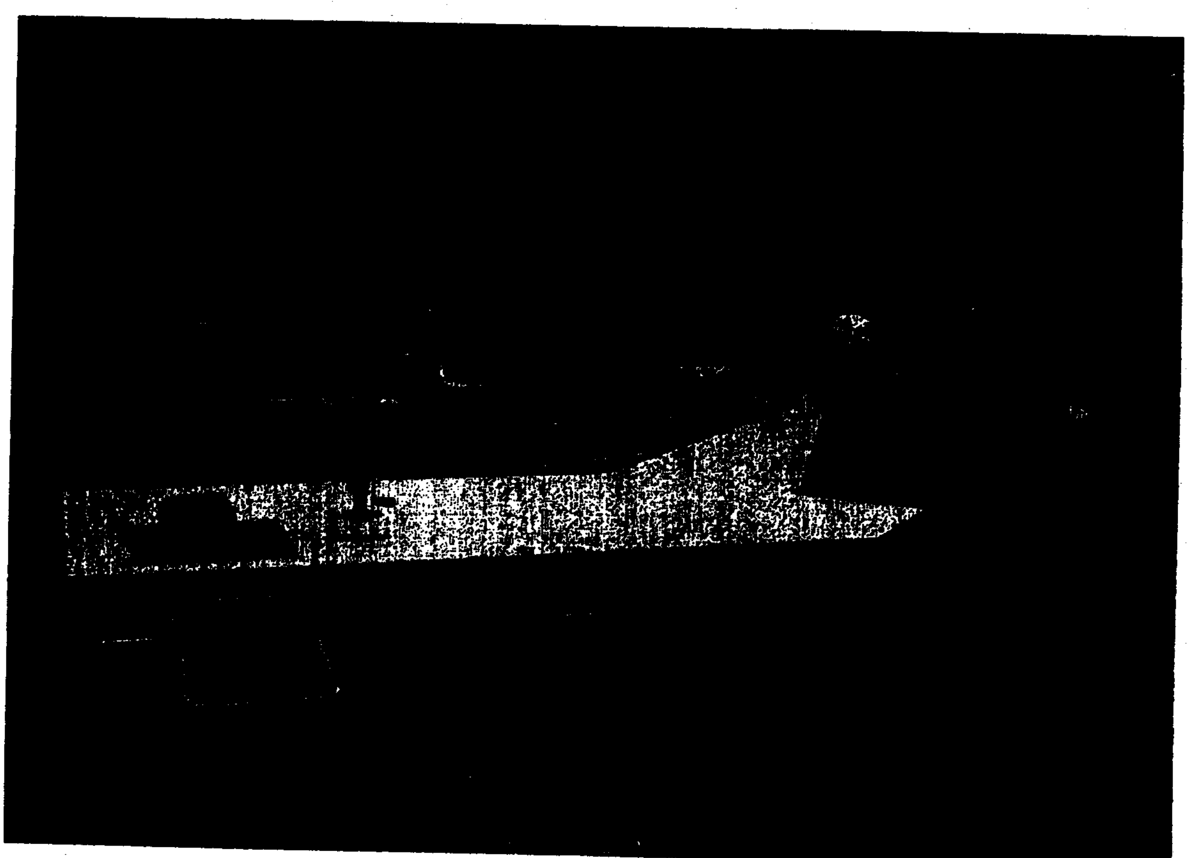


Figure 9. Model 1604 computer installation in the Vandenberg Air Force Base data acquisition and processing building. This high speed computer is especially well adapted to the real time operations required in satellite programs. A similar computer installation is located at the Satellite Test Center.

pleted to date at El Centro, California, the single chute system appears more desirable from the stability standpoint. Structural integrity tests of the E-5 stabilization chute were initiated late in August.

Ferret Reconnaissance System

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

F-1—Component Test Payloads

F-2—Digital General Coverage Payloads

F-3—Specific Mission Payloads—
Analog signal recording

F-3—Specific Mission Payloads—Analog signal recording

Payload

F-1 Payload—Checkout and testing of the F-1 payload is proceeding on schedule at Vandenberg Air Force Base.

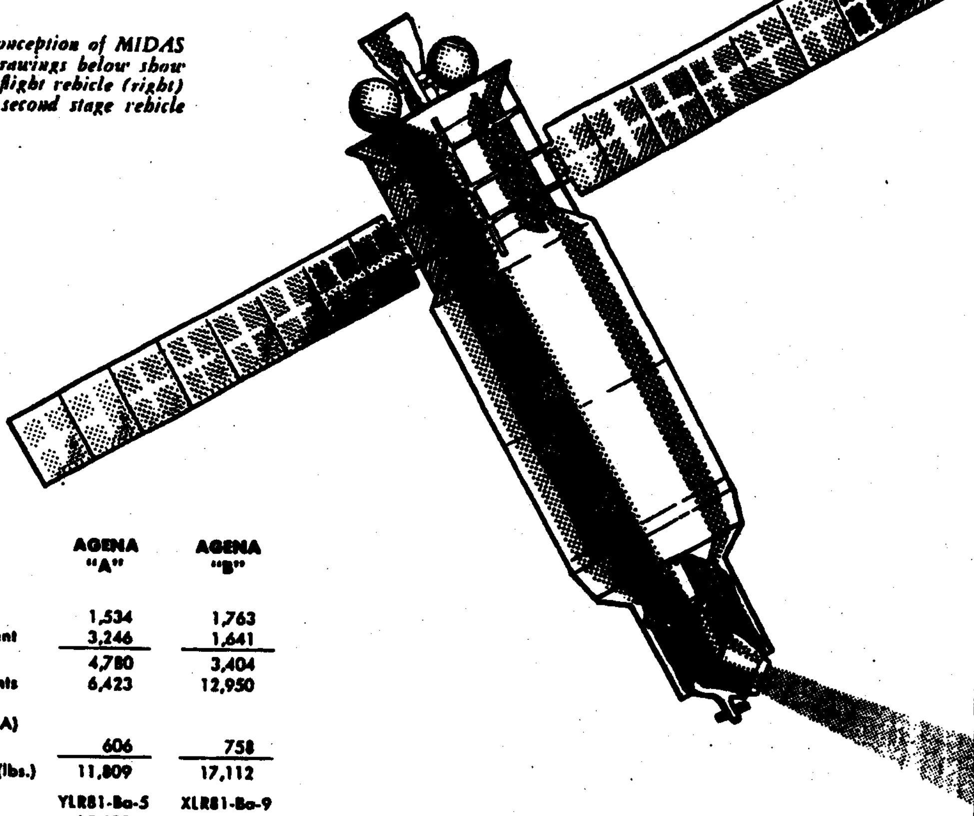
Ground Support Equipment

- The installation and checkout of Point Arguello Pad No. 1 ground support equipment has been completed, with minor exceptions. These will have no effect on the launch schedule. The ATLAS flight readiness firing on 23 August demonstrated the readiness of the ATLAS ground support equipment.

Facilities

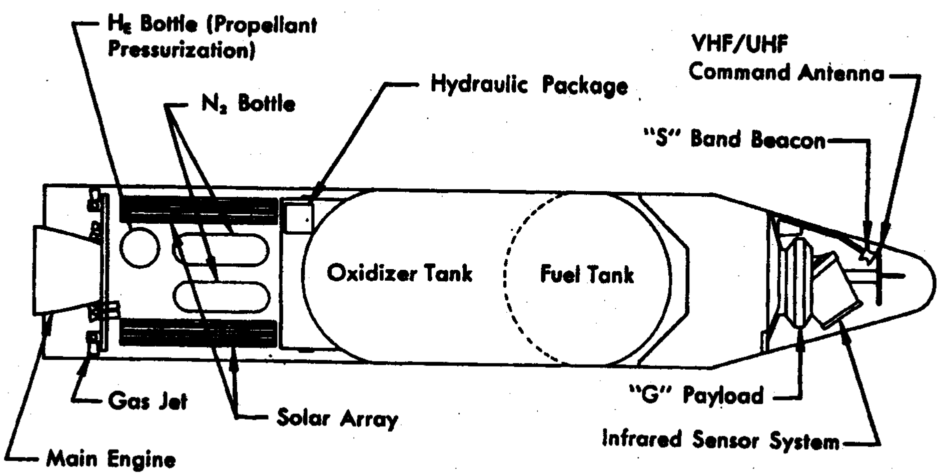
- The architectural and engineering phase of the modifications to accommodate an R&D data processing facility in the satellite test center is complete. Construction of the required changes is scheduled to begin in early September. Approximately 70 percent of the equipment to be installed in the data processing facility is on hand. The over-all effort to have this facility ready by mid-September is progressing satisfactorily.
- The contract for construction of the Point Arguello diesel generator building was awarded on 29 August.
- Design of the Vandenberg Air Force Base helium unloading and storage facility has been initiated with final design review scheduled for 9 September.

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

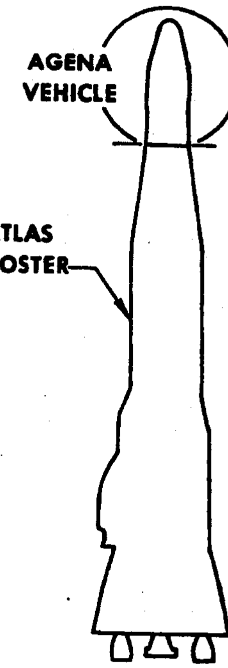


M i d a s

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—		
Inert	1,534	1,763
Payload equipment	3,246	1,641
Orbital	4,780	3,404
Impulse Propellants	6,423	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	758
GROSS WEIGHT (lbs.)	11,809	17,112
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240
Restart Provisions	No	Yes



MIDAS, Configuration II, AGENA "B" Satellite



BOOSTER—ATLAS ICBM

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

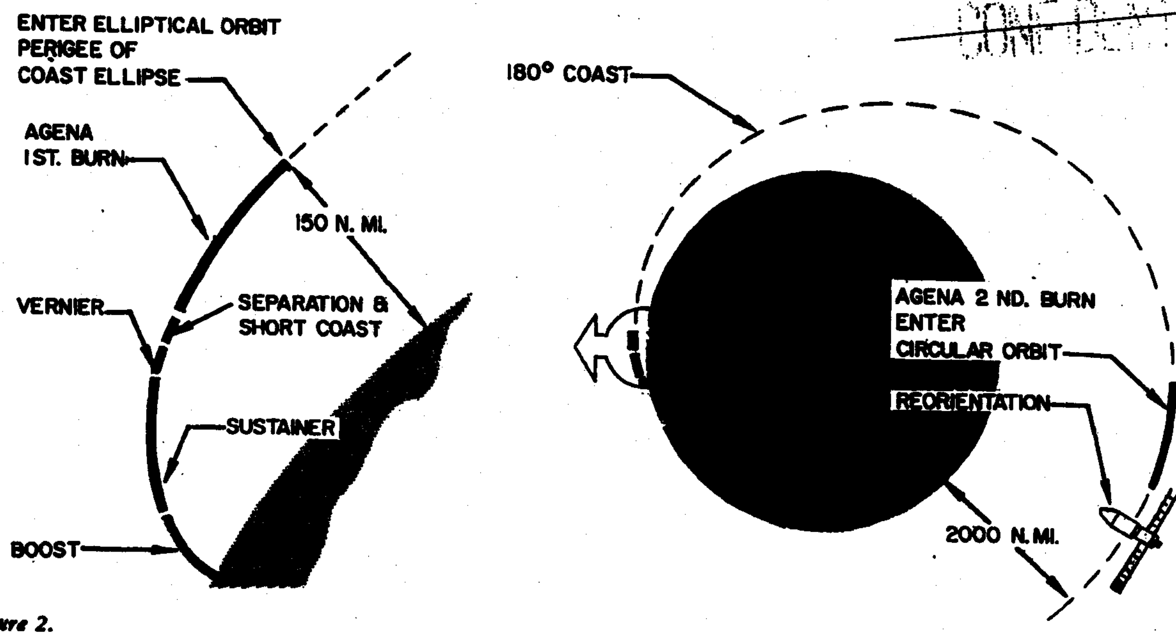


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. From boost through separation guidance and control is provided by the ATLAS radio inertial system. The AGENA inertial guidance system, with horizon scanner, provides attitude, velocity and directional control to establish the orbit and vehicle orientation.

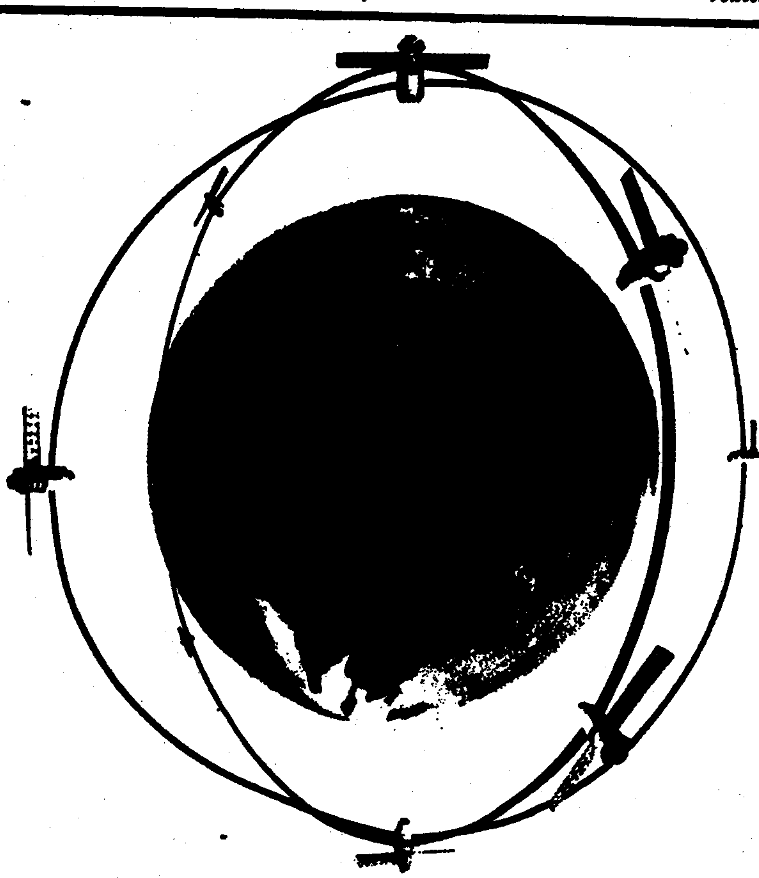
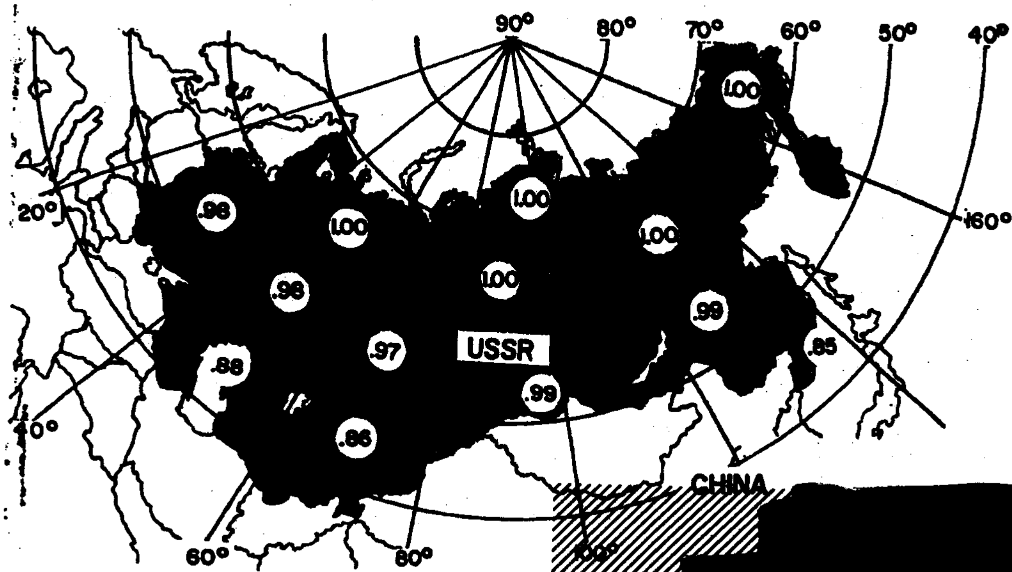


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency. 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. A ten launch development plan for MIDAS (WS-239A) has been approved. Additional authorization has been obtained to utilize two DISCOVERER flights (designated RM-1 and RM-2) to carry background radiometers in support of MIDAS.



CONDITIONS:
2,000 n.m. altitude
Two orthogonal polar orbital planes, four equi-spaced satellites in each plane.

[redacted]

Figure 4. Orbiting satellites detect infrared radiation emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveal approximately the number of missiles launched and launch location, direction of travel and burning characteristics. Probabilities of less than 1.00 on the above map indicate the probability of at least one MIDAS satellite detecting an ICBM launch. Probabilities of 1.00 indicate that more than one MIDAS satellite will always be in position to detect an ICBM launch. These figures are based on geometric considerations of the family of satellites and ground readout station locations.

[redacted]

TECHNICAL HISTORY

The MIDAS infrared reconnaissance payload is engineered to use a standard launch vehicle configuration. This consists of an ATLAS missile as the first stage and the AGENA vehicle, powered by a Bell Aircraft rocket engine as the second, orbiting stage (Figure 1). The final configuration payload weight will be approximately 1,000 pounds.

The first two of the ten R&D flights used the AGENA "A" and ATLAS "D" vehicle programmed to place the payload in a circular 261 nautical mile orbit. Subsequent R&D flights will utilize the ATLAS "D"/AGENA "B" configuration which will be programmed to place the payload in a circular 2,000 nautical mile polar orbit.

MIDAS I, launched in February 1960, did not attain orbit because of a failure during ATLAS/AGENA separation.

MIDAS II, launched in May 1960, was highly successful. Performance with respect to programmed orbital parameters was outstanding. Useful infrared data were observed and recorded.

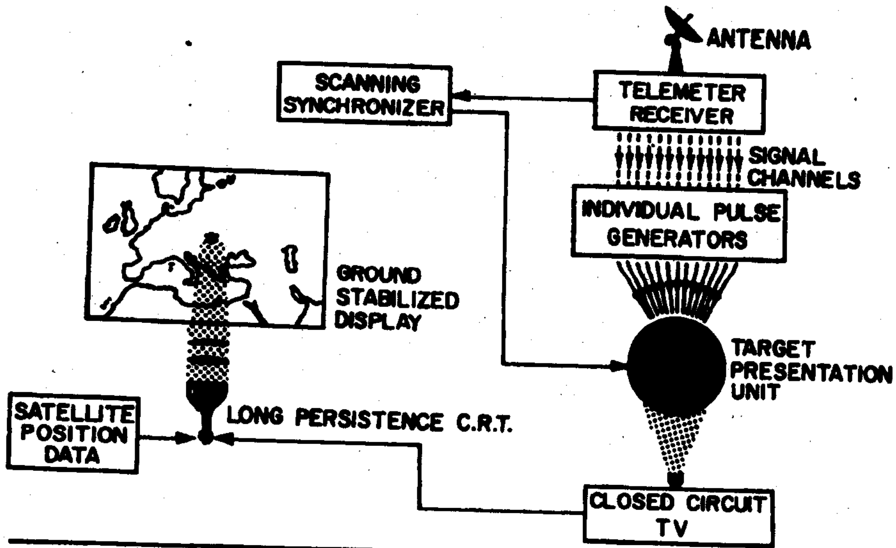
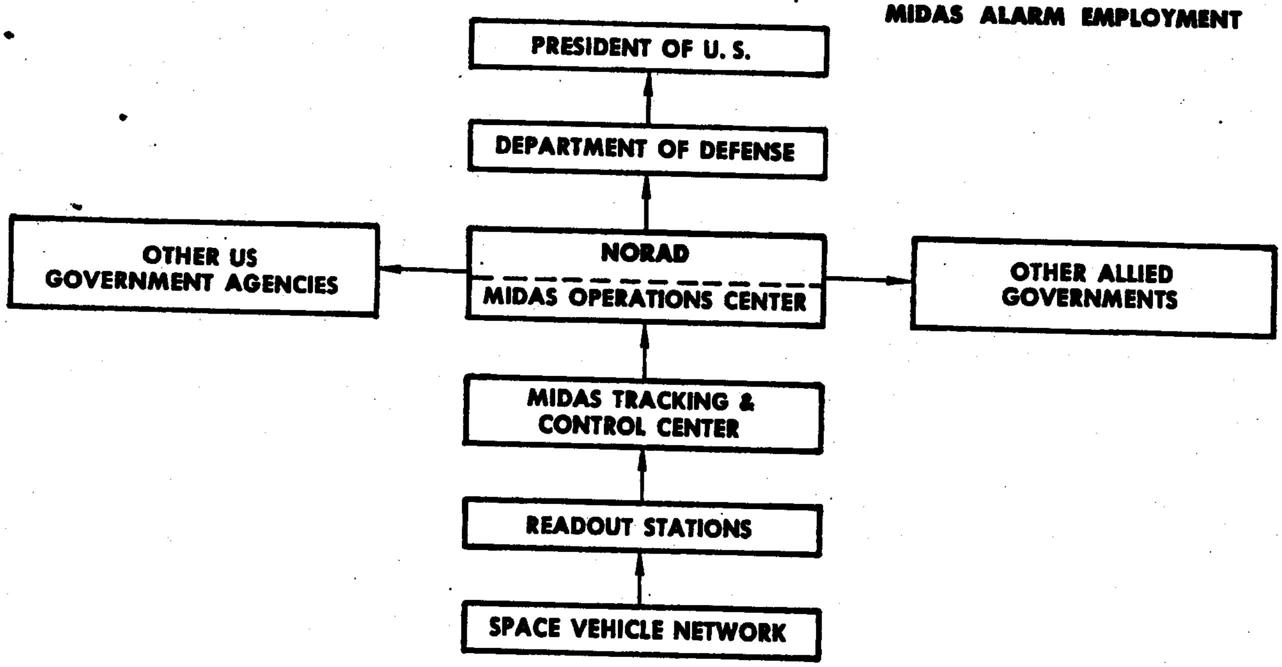


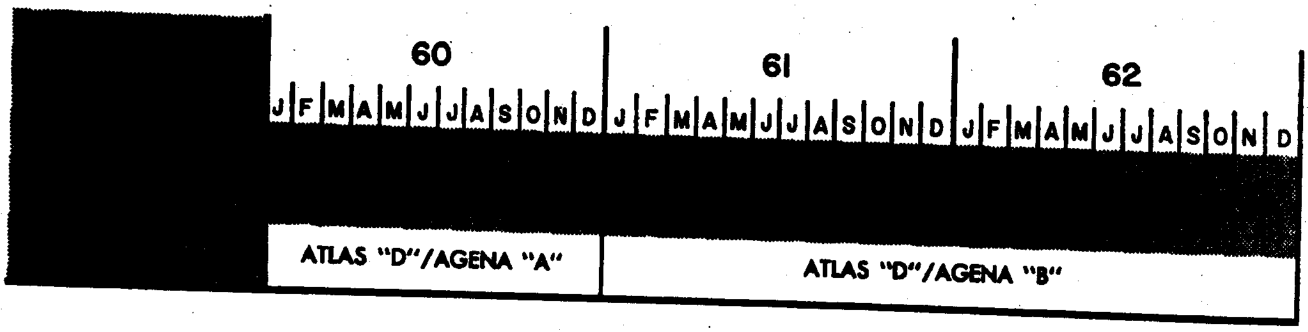
Figure 5. Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies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

MIDAS ALARM EMPLOYMENT



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 Tracking and Control Center where it is processed. It is then displayed and evaluated in the MIDAS Operations Center (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.



MIDAS Launch Schedule

MONTHLY PROGRESS—MIDAS Program

Flight Test Progress

- The payloads for the two MIDAS Radiometric Measurement flights are scheduled for delivery to Vandenberg Air Force Base in late September and October. The DISCOVERER AGENA "B" vehicles for these flights will be available on approximately the same schedule. These satellites will orbit in a horizontal attitude and will have an orbital period of 93 minutes with an operational lifetime of two days.

- These flights, designated RM-1 and RM-2, will carry payloads containing a radiometer, associated hardware and wiring, and a nitrogen-gas cooling system for the sensitive element of the radiometer. The primary function of these flights will be to provide background radiation data for use in future MIDAS flights. The launches are scheduled for November or December. It is proposed that the RM-2 flight include the first operational use of the AGENA vehicles restart capability. Although this would not be a full-scale dual-burn flight, the engine would be reignited following initial shutdown.

Technical Progress

Second Stage Vehicles

- The AGENA "B" vehicle for the third MIDAS flight was transferred to the systems test area on 8 August. This will be the first flight to utilize the full dual-burn capability of the AGENA engine.

- The AGENA vehicle for the fourth MIDAS flight underwent premating checks on 24 August. Vehicle assembly is scheduled for completion on 10 October.

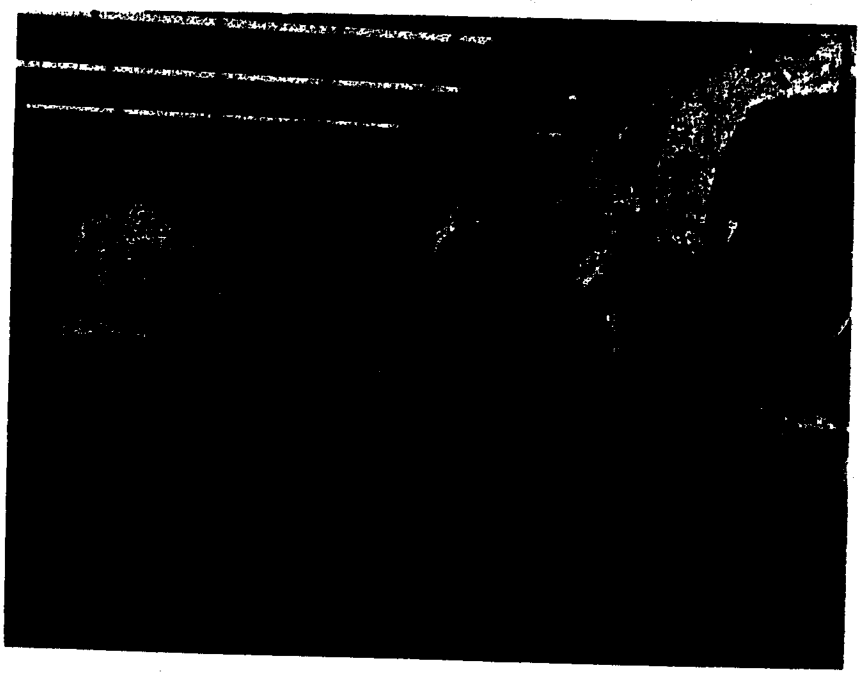


Figure 6. Engine functional checks being performed on the third MIDAS satellite vehicle. The refrasil heat shield, designed to protect the aft equipment rack extension from the hot exhaust gasses, can be seen surrounding the engine nozzle. One arm of the solar auxiliary power array will fold into the well on the left side of the vehicle.

It is anticipated that assembly of this vehicle will be completed on schedule.

Infrared Scanner Units

Infrared scanner units for flights 3, 4, and 5 are being manufactured by Baird-Atomic, Inc., and for flights 6, 7 and 8 by Aerojet-General Corporation.

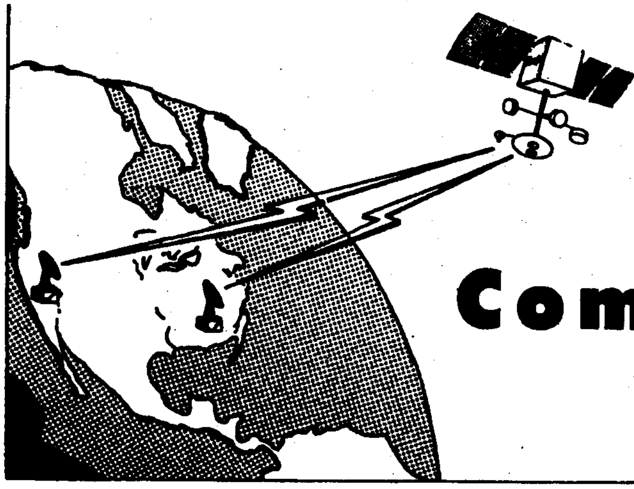
- Delivery of the initial Baird-Atomic, Inc., infrared detector payload has been made. This prototype unit is undergoing tests at the Lockheed facility. The flight payload for the third MIDAS launch is now scheduled for delivery in early September. This represents a two week schedule slippage.

- The delivery dates for the two Baird-Atomic, Inc., ground readout units have been established as 8 and 22 September. These schedule slippages, caused by delays during systems tests, will have no effect on flight schedules.

Facilities

[redacted]

- Initial studies are underway for modification of the New Boston, New Hampshire, data acquisition and processing building to accomodate MIDAS equipment.



Communications Satellite

The Communications Satellite Program will investigate the feasibility of using synchronously spaced satellites as instantaneous repeaters for radio communications. Under ARPA Order No. 54, as amended, AFBMD is responsible for the design, development, and flight testing of the complete system, including launch, satellite tracking and control, and necessary support facilities and ground equipment. The Army Signal Research and Development Laboratory has been delegated development management responsibility for the microwave communications subsystem as directed by ARPA Order 54.

The Communications Satellite Program is currently being conducted in accordance with amendment 5, (dated 11 April 1960) to ARPA Order No. 54. Under this amendment the previous method of accomplishing the program objectives in three progressively

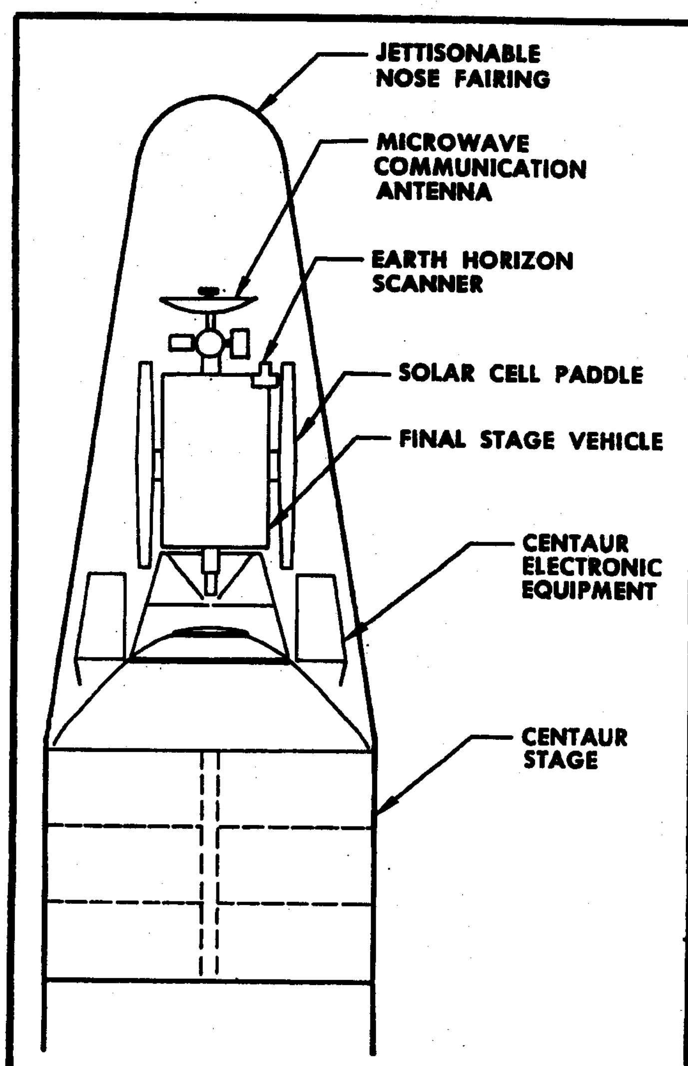


Figure 1. Proposed satellite with jettisonable fairing mounted on CENTAUR second stage.

more advanced phases was replaced by a single integrated effort to which the code name ADVENT was applied. ADVENT calls for an R&D program for a 24-hour global communications satellite system. The feasibility of placing a satellite in a predetermined position in a 19,300 mile equatorial orbit must be demonstrated. The satellite must be capable of providing worldwide communications on a real time basis at microwave frequencies with a high channel wide bandwidth capacity. Amendment 5 also requires the design of a single final stage vehicle for microwave equipment compatible with launching by either AGENA "B" or CENTAUR second stage boosters.

The ADVENT Program, as defined in Amendment No. 9, dated 11 August, will consist of the following flight tests, launched from the Atlantic Missile Range:

a. Three ATLAS/AGENA "B" flights, nominal 5,600 nautical mile orbits, beginning March 1962.

b. Two flight tests, using payload space on NASA ATLAS/CENTAUR R&D flights number 9 and 10, December 1962, and February 1963.

c. Five ATLAS/CENTAUR flights launched into 19,300 nautical mile equatorial orbits, beginning March 1963.

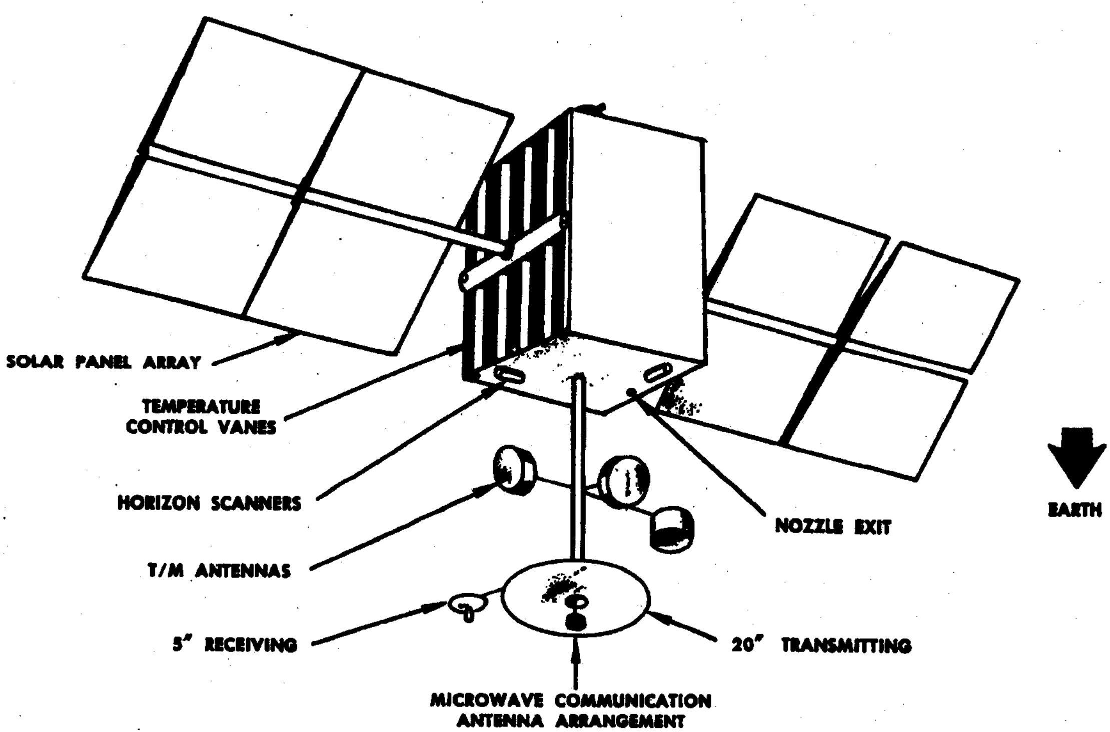
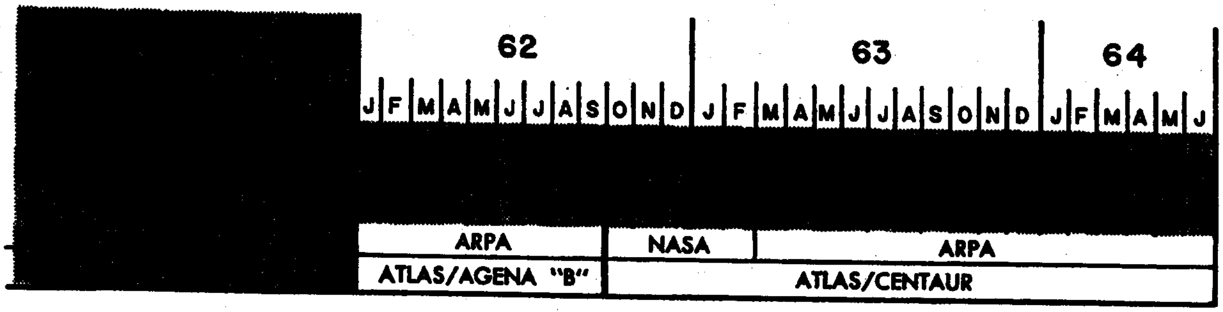


Figure 2. Initial design of final stage vehicle.



ADVENT Launch Schedule

MONTHLY PROGRESS—Communications Satellite Program

Program Administration

- Ten ATLAS boosted launches are programmed from the Atlantic Missile Range in accordance with the following schedule established by ARPA Order No. 54, Amendments No. 8 and 9.

Launch Date		Second Stage	Booster Funded By
March	1962	AGENA "B"	ARPA
June	1962	AGENA "B"	ARPA
September	1962	AGENA "B"	ARPA
December	1962	CENTAUR	NASA
February	1963	CENTAUR	NASA
March	1963	CENTAUR	ARPA
May	1963	CENTAUR	ARPA
July	1963	CENTAUR	ARPA
September	1963	CENTAUR	ARPA
November	1963	CENTAUR	ARPA

Technical Progress

Communications Equipment

- A contract for the development, fabrication and installation of the 60-foot automatic tracking antenna system for the ground station equipment has been awarded Sylvania Electric, Waltham, Massachusetts. The design study is being prepared with completion scheduled for 15 September.

- Bendix Systems Division has been awarded the contract for the development, fabrication and test of the microwave communication equipment for the satellite and the ground stations. The design plan will be completed by 15 October.

Launch Vehicles

- The Stage I and Stage II work statements for the ATLAS/AGENA "B" boosted launches have been forwarded to ARPA for approval.

- Space Technology Laboratories is currently revising the performance specification recommended for use in procurement of ATLAS and CENTAUR vehicle and the CENTAUR engines. The specification was revised to utilize performance figures contained in the latest NASA/ABMA (Army Ballistic Missile Agency) specification for development of the CENTAUR engine.

Final Stage Vehicle

- Amendment No. 9 to ARPA Order No. 54, dated 11 August 1960, approved the Final Stage Vehicle (FSV) work statement, with certain exceptions. The work statement is currently being revised to reflect the provisions of Amendment No. 9. Negotiations are scheduled to being with General Electric's Missile and Space Vehicle Department (MSVD) in late September.

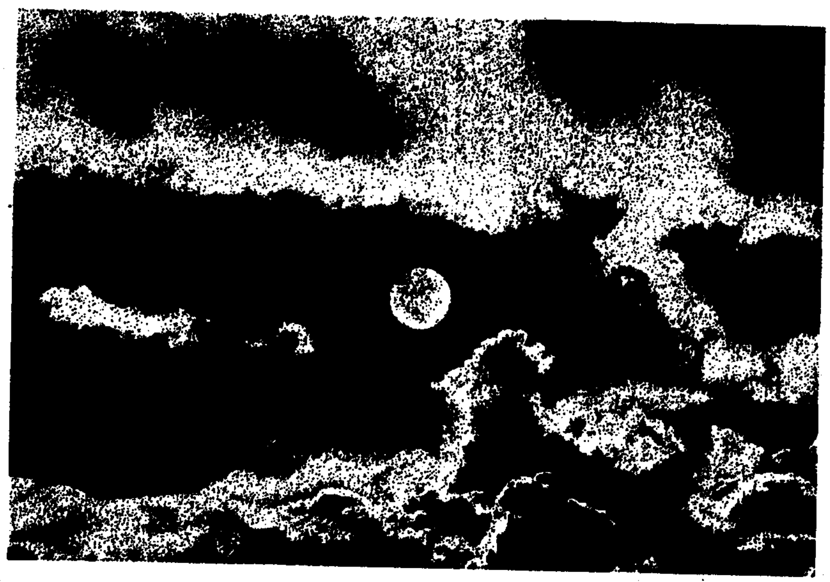
- Investigations of attitude and orbit control requirements of the FSV are continuing. An earth and sun acquisition proposal, utilizing the sun as an initial reference, has been defined. It lowers the required control torques previously specified and in turn reduces the reaction wheel size and the pneumatic thrust levels.

- Problems associated with the FSV high noon and eclipse orbital periods have been investigated. The paddle angle information will be used to start a timer which deactivates the yaw pneumatics and increases the reaction wheel gain during these periods.

- Temperature control requirements (during hot gas firings) prior to injection into a circular orbit have been studied. Numerous design approaches were analyzed and a detailed design of a FSV temperature control system and a super-insulated payload was initiated.

BOOSTER

support programs

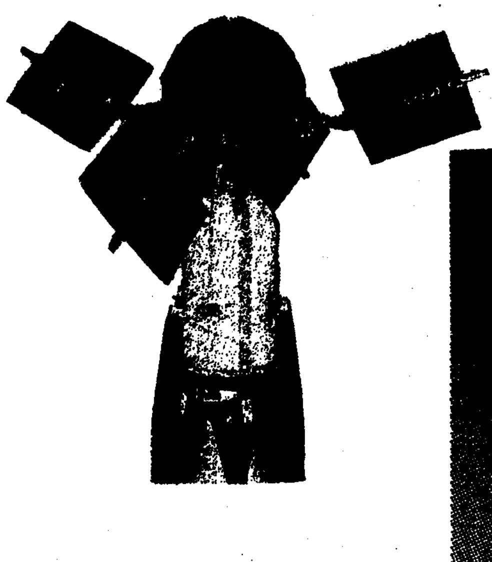


ABLE
TRANSIT
COURIER
MERCURY
609A
DYNA SOAR
NASA AGENA "B"

BOOSTER SUPPORT PROGRAMS

Flight tests of the three ABLE-1 vehicles in 1958 confirmed the feasibility of using this three stage vehicle to launch satellite payloads on interplanetary space probe missions. Objectives of the ABLE program were further defined in AFBMD proposals submitted to NASA and ARPA late in 1958. In October 1958 NASA, given cognizance over the effort, requested AFBMD to proceed with the ABLE-3 and two ABLE-4 projects. In February 1960 NASA authorized the two-flight ABLE-5 (ATLAS boosted) program. The lunar satellites will be launched late in 1960. General objectives included demonstration of vehicle and communications capability and performance of scientific research experiments over interplanetary distances. A four stage vehicle was selected consisting of a THOR or ATLAS first stage, an ABLE second stage, ABL 248 solid propellant third stage and the satellite vehicle fourth stage. A hydrazine engine with multi-start capability was developed for the ATLAS boosted vehicles to permit midcourse vernier control and to provide controlled thrust to inject the vehicle into orbit about another planet. Solar cell auxiliary power equipment was developed with a useful life period in excess of one year. An extensive network of ground support stations was established, the most powerful of which is the 250-foot antenna at the Jodrell Bank Experimental Station, University of Manchester, England. Central control and data computation is accomplished at the Space Navigation Center, Los Angeles, California, with other military and NASA centers assisting in tracking and telemetry according to the specific requirements of each mission. The flight histories of ABLE-1, ABLE-3, ABLE-4 ATLAS and ABLE-4 THOR are summarized in the following paragraphs, followed by a description of the ABLE-5 projects.

ABLE-1—The ABLE-1 program consisted of three flights with the object of placing a payload within the moon's gravitational field. The ABLE-1 four-stage vehicle consisted of three booster stages and a terminal stage composed of eight vernier rockets, an orbit injection rocket (solid propellant TX8-6) and a payload. The booster stages were THOR first stage, Advanced Re-entry Test Vehicle (AJ10-101 engine) second stage, and a third stage utilizing the ABLE X-248-A3 solid propellant rocket engine. The first lunar probe was launched on 17 August 1958. The flight was normal until 73.6 seconds after liftoff when a turbopump bearing failure caused the booster to explode. The second lunar probe was launched on 10 October 1958. Although the payload did not reach the vicinity of the moon, a maximum altitude of 71,700 statute miles was attained and useful scientific data were obtained from the instrumentation. The third lunar probe was launched on 8 November 1958. Because the third stage failed to ignite, the maximum altitude attained was 970 statute miles. The primary program objectives, obtaining scientific data in cislunar space, were achieved by the October flight.



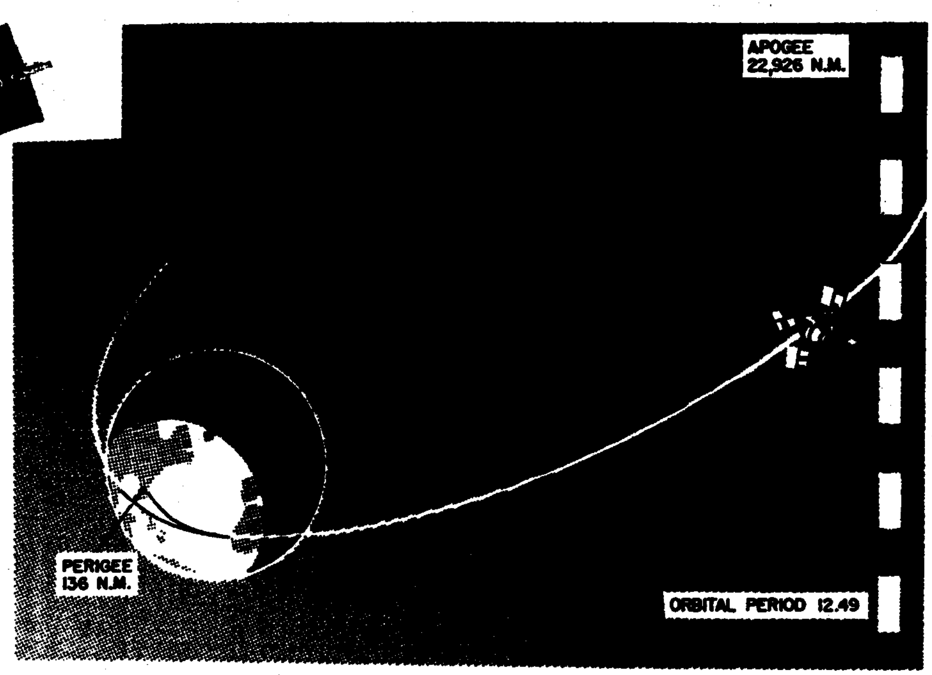


Figure 2. ABLE-3 third stage and payload (above) with solar paddles fully extended. Drawing of extremely elliptical orbit achieved by ABLE-3 (EXPLORER VI).

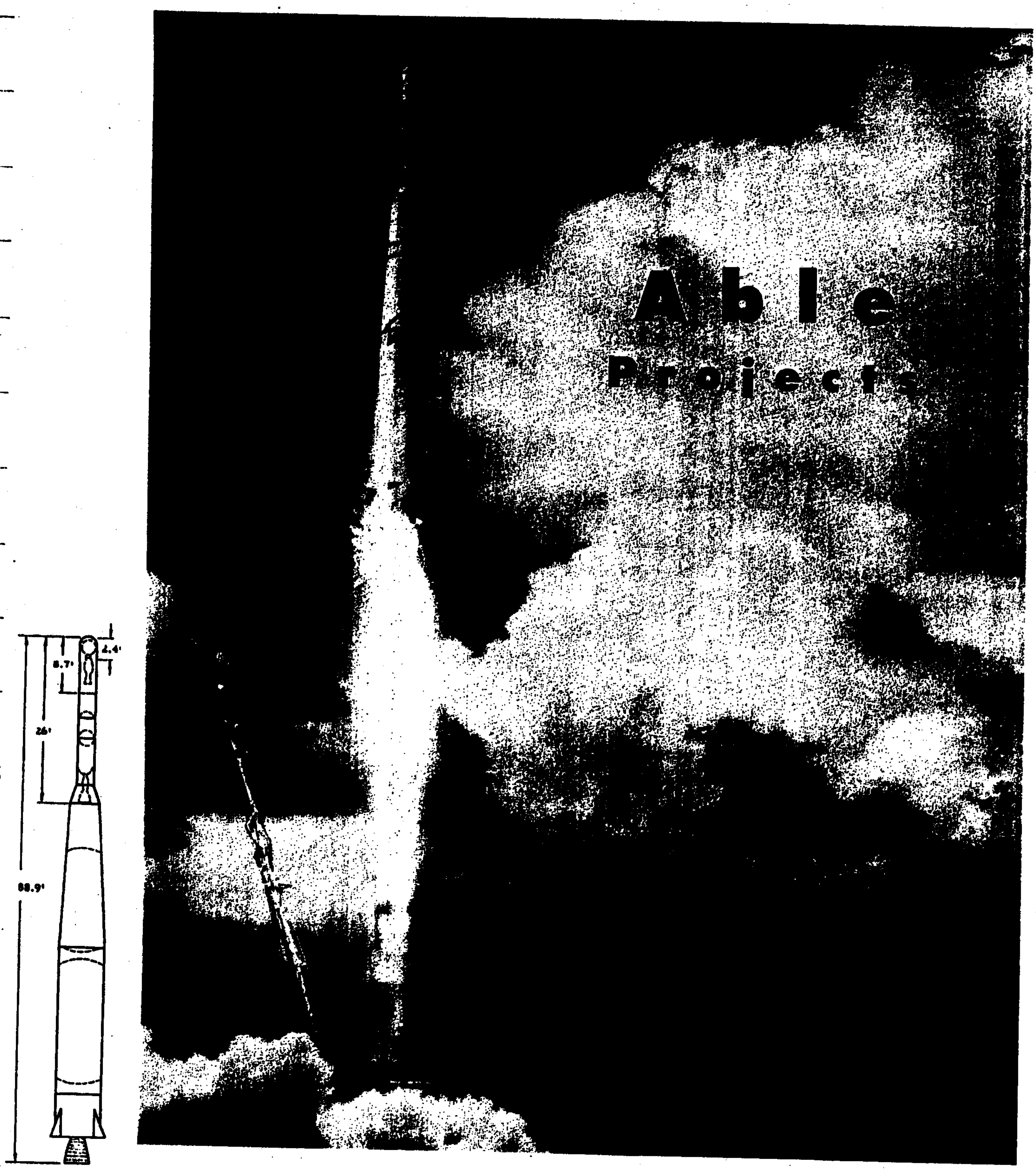
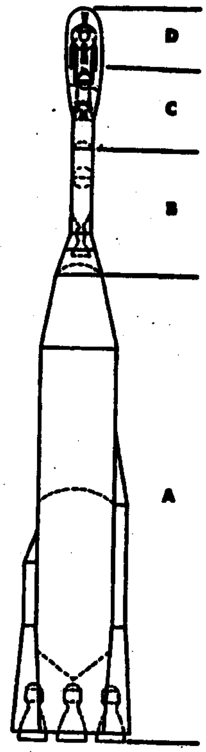


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.



D. Satellite Vehicle	
Gross Weight	380.2 lb
Gross Weight (Burnout)	229.4 lb
Specific Impulse (vac)	230 sec
Thrust (vac)	18.3 lb
C. THIRD STAGE ABL 248-A9	
Gross Weight	903.2 lb
Gross Weight (Burnout)	547.4 lb
Specific Impulse (vac)	250.5 sec
Thrust (vac)	3100 lb
B. SECOND STAGE AJ 10-101	
Gross Weight	5107.3 lb
Gross Weight (Burnout)	1816.1 lb
Specific Impulse (vac)	268 sec
Thrust (vac)	7575 lb
A. FIRST STAGE ATLAS "D"	
Gross Weight	266,390 lb
Gross Weight (Burnout)	11,790 lb
Thrust (S. L.)	316.5 sec
Specific Impulse (vac) Sustainer	81,863 lb
Thrust (vac) Sustainer	290.6 sec
Specific Impulse (vac) Booster	251 sec
Specific Impulse (S. L.) Booster	367,787 lb

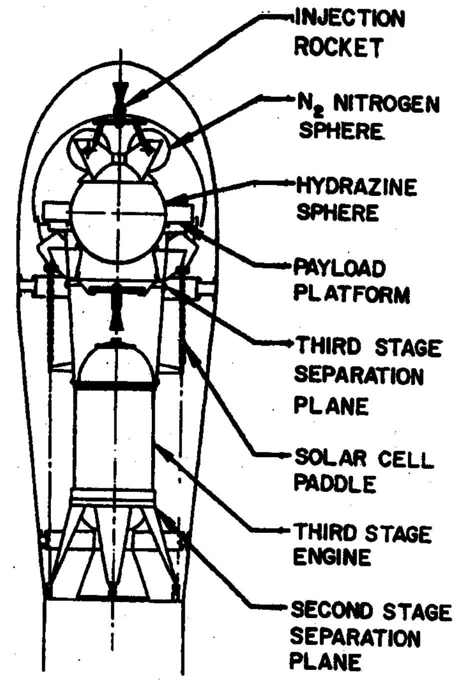
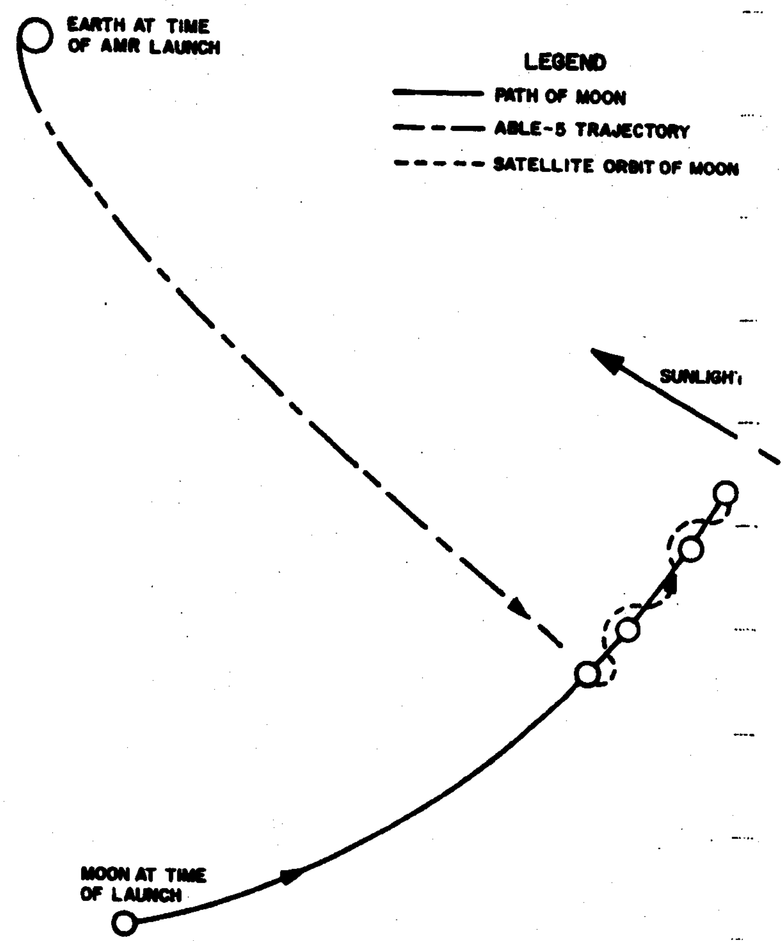
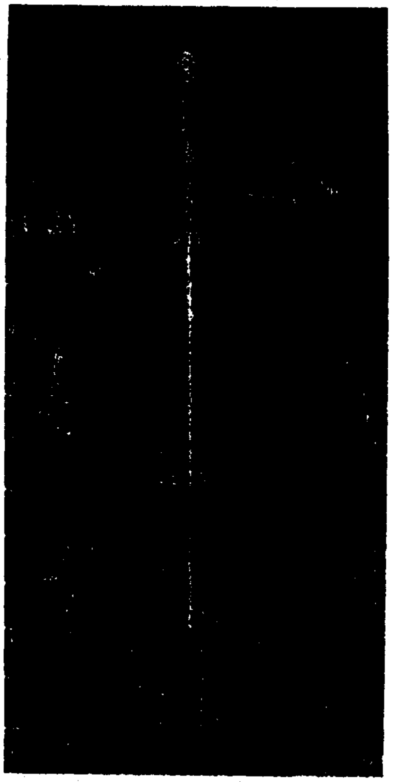


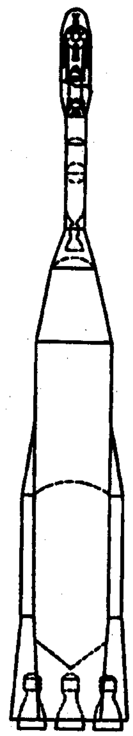
Figure 5. ABLE-5 vehicle configuration drawing and specification list. Third stage and payload configuration (right). Trajectory of ABLE-5 into lunar orbit is shown in drawing (below).

hours EST, on 26 June, the last radio signal was received from PIONEER V. The transmitter has been operated throughout the three and one-half month period and has demonstrated that, except for the batteries, the communications link could have been maintained for a distance significantly greater than the 50 to 60 million miles originally estimated. At the time of the last transmission the vehicle was twenty-two and one-half million miles from earth. Among the firsts accomplished were: the mapping of the interplanetary magnetic field, the quantitative measurement of the interaction of the solar wind and the geomagnetic field, the greatest range over which man has maintained command of an instrumented space vehicle, the measurement of the influence of the solar wind on the Van Allen radiation belts, and the first interplanetary probe to carry its own, self-sustaining auxiliary power supply.

ABLE-5—The ABLE-5 program provides for launch of two ATLAS-ABLE vehicles to place satellites into lunar orbits late in 1960. A proposed ATLAS/ABLE lunar program was submitted to AFBMD by NASA on 4 February 1960, following discussions between AFBMD and the NASA Goddard Space Flight Center in January.



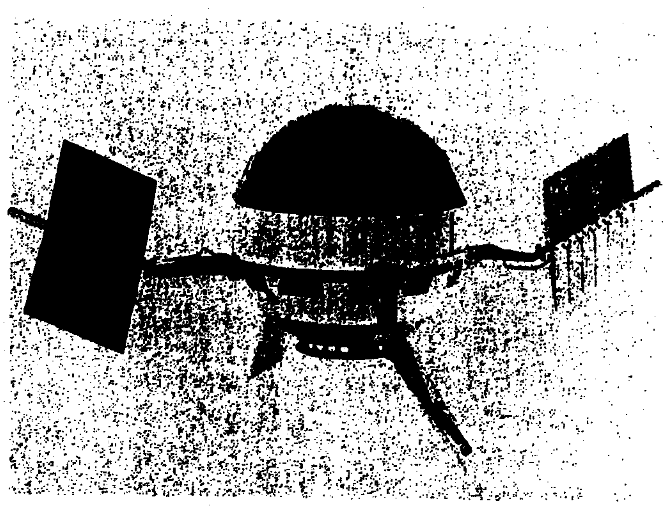




ABLE-3—This four stage flight vehicle was launched from the Atlantic Missile Range on 7 August 1959. The vehicle consisted of a THOR booster, a second stage using the AJ10-101A rocket engine, a third stage powered by the ABL-248 A3 engine, and a fourth stage consisting of the payload and an injection rocket. In addition to carrying a highly sophisticated payload, the ABLE-3 (EXPLORER VI) 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 and orbit were essentially as predicted with deviations in apogee and perigee well within the range of expected values. 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 primarily in that an ATLAS ICBM was used as the first stage instead of a THOR IRBM, permitting installation of a hydrazine engine for midcourse velocity corrections and to accomplish the injection of the satellite into Lunar orbit. 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—This vehicle was launched on 11 March from the Atlantic Missile Range and succeeded in placing the PIONEER V satellite into a solar orbit. At its closest approach to the sun, the satellite will pass near the orbit of Venus, and return to intersect the orbit of earth at its greatest distance from the sun. The vehicle consisted of a THOR first stage, ABLE second stage with AJ10-101 liquid fueled propulsion system and an STL guidance system, and an ABL248A-3, solid fuel third stage. The 95 pound payload contains instrumentation for conducting scientific experiments related to magnetic field and radiation phenomena in deep outer space. At 0733



MONTHLY PROGRESS—ABLE-5

Program Administration

• Negotiations have been initiated with Space Technology Laboratories to procure additional data reduction and analysis for both the Pioneer V and Explorer VI satellite. This concerted effort will be directed toward completing the analysis of data from Pioneer V and toward extraction and analysis of residual data in noisy tapes acquired during the flight of Explorer VI.

Technical Progress

First Stage

• ATLAS 80D was shipped to AMR on 13 August. During inspection, the hydraulic system was found to be contaminated with a large quantity of metal filings. The cleaning and flushing of all affected missile systems was completed on 30 August. It is estimated that the flight acceptance composite test will be completed 9 September as scheduled. Convair is instituting safeguards to prevent repetition of system contamination.

• ATLAS 91D, the booster for the second flight, is proceeding on schedule toward a mid-October delivery date.

• Six flow directors have been added to the Stage I/Stage II interstage area to equalize the pressure inside the transition section with the ambient atmospheric pressure. This installation will improve the structural integrity of the transition section.

Second Stage

• The second stage vehicle for the first flight was delivered to the Atlantic Missile Range on 22 August. On 10 September, following the receiving inspection and system checks, the second stage will be mated on the ATLAS booster.

• Vendor gyro deliveries scheduled for September and three HIG-4 gyros available from the COURIER 1A program have alleviated the ABLE-5 second stage gyro shortage. This shortage has been a serious problem in second stage deliveries.

• The second stage propulsion system for the ABLE 5B flight has successfully completed acceptance testing and was delivered to Space Technology Laboratories airport facility on 18 August.

Third Stage

• The third stage for the first ABLE launch will be delivered on 12 September and attached to the second stage on 18 September.

• Three ABL-X248-A-9 engines were static-tested in a simulated high altitude environment at Arnold Engineering and Development Center to determine internal ballistic performance. The preliminary data indicate that the propellant specific impulse was 0.67 percent lower than expected and that outgassing following propellant burnout was excessive. Both of these items are currently being investigated. The outgassing was of sufficient duration and character to necessitate a change in payload separation equipment and the installation of additional electrical/mechanical measures to prevent the third stage from bumping the satellite vehicle.

• The second flight engine is schedeuled for shipment to AMR in early September.

Satellite Vehicle

• The thermal vacuum environmental test of the type test satellite vehicle was discontinued before completion of the low temperature portion because the test facility was incapable of achieving the test conditions. Both nozzle assemblies of the propulsion system were removed and successfully fired. The oxidizer start tanks were refilled and the nozzle assembly reinstalled prior to completing the environmental tests. At the end of this report period the satellite vehicle was undergoing the temperature storage environmental test and will undergo a re-run of the thermal environmental test next month.

• The first flight satellite vehicle successfully passed the vibration, acceleration, and spin environmental tests. The unit is currently undergoing the thermal environmental test. No malfunction occurred and no out-of-tolerance performance has been noted during these tests. Prior to shipment to AMR on 6 September, the payload will undergo magnetic field background and source checks and be returned to the Malibu facility a third time for search coil circuitry calibration.

• All fabrication has been completed on the second flight satellite vehicle. The wiring harness has been completed and checked out. Electronic testing is scheduled to start early in September.

Figure 6. General arrangement of ABLE-5 A payload experiments and equipment.

Program Objectives

1. Place a satellite into lunar orbit with an apolune of 5,000 nautical miles and a perilune of 3,500 nautical miles.

2. Maintain adequate earth-satellite communications and establish communications parameters for future space probes.

3. Demonstrate effective guidance system performance, particularly for the satellite vehicle.

4. Successful conduct of payload experiments.

Program Vehicle **(see figure 5)**

First Stage**—ATLAS series D missile General Electric/Burroughs Corp. Mod 3 guidance system.**

Second Stage**—ABLE vehicle with Aerojet-General AJ10-101A propulsion system.**

Third Stage**—Allegany Ballistic Laboratory ABL-248 solid propellant rocket, unguided, spin stabilized by spin rockets fired at termination of second stage thrust.**

Fourth Stage **(Satellite Vehicle)—Space Technology laboratories designed, incorporating an injection rocket capable of being restarted four times to increase payload velocity and two times to decrease payload velocity. The satellite also contains a telemetry system (capable of continuous operation), four solar cell paddles, and scientific equipment for conducting the experiments. Satellite vehicle weight is 390 pounds.**

Launch and Powered Flight

These vehicles will be launched from the Atlantic Missile Range on a true azimuth of 93.5 degrees. ATLAS performance parameters have been based on results obtained from series D R&D flight tests. Parameters for all four stages are shown on figure 5. Final burnout is programmed to occur 23,290,000 feet from the center of the earth at an inertial velocity of 34,552 ft./sec.

Orbital Characteristics

Major Axis	0.25211 x 10^8 feet
Eccentricity	0.1899
Orbital period	1,008 minutes
Apolune	4,937 nautical miles
Perilune	3,361 nautical miles
Duration of eclipses.........	less than 90 minutes

Payload Experiments

Scintillation Counter and Pulse Height Analyzer**—measure electron energy (greater than 100 Kev per particle) and proton energy (greater than 2.0 Mev per particle).**

Ion Chamber and Geiger-Muller Tube**—flux and rate data for electron particles (greater than 1.25 Mev per particle) and proton particles (greater than 20 Mev per particle).**

Proportional Counter Experiment**—measure integrated intensity of cosmic ray particles: electrons greater than 12 Mev per particle and protons (greater than 75 Mev per particle).**

Spin Search Coil Magnetometer and Phase Comparator**—map the magnetic field (normal to vehicle spin axis) and investigate very low frequency secular magnetic field variations. Phase comparator circuit uses Spin Search Coil and Flux Gate inputs to determine magnetic field direction relative to inertial space.**

Flux Gate Magnetometer**—measure magnetic field parallel to vehicle spin axis.**

Micrometeorite Flux and Momentum Experiment**—count impacts of micrometeorites and interplanetary dust particles on two differing thresholds.**

Plasma Probe Experiment**—measure the energy and density of streams of protons having energies of the order of a few kilovolts per particle.**

Low Energy Scintillation Counter**—measure the flux intensity of electrons above 50 Kev and protons above 500 Kev.**

Ground Support Program

Atlantic Missile Range**—track vehicle for first 12 hours after launch (except for a three hour period starting a few minutes after liftoff), provide ATLAS guidance, provide first vernier correction for payload stage.**

Manchester, England**—track vehicle for 6 hours, starting 13 minutes after launch, provide second vernier correction for payload stage (and additional corrections as required).**

South Point, Hawaii**—track vehicle for 11 hours starting 6 hours after launch, transmission of commands, including vernier corrections as necessary.**

Other support stations that will track and record data from the vehicle during periods of tracking by the primary stations include Singapore, Goldstone, Millstone Hill and NASA minitrack stations, and the SPAN center at Los Angeles.

Guidance Equations

- Range safety trajectory and aerodynamic data required for these flights have been forwarded to AMR Range Safety. Because of Stage II and satel-

- As a result of closed-loop guidance analyses in both ATLAS and ABLE stages, the following factors have been verified: launch intervals between 25 and 50 minutes are available for the launch dates between 23 and 27 September; satisfactory look-angles are provided for all three stages; three sigma fuel pads are obtained in with the ATLAS and ABLE; the trajectory satisfied all range safety conditions; and errors will be less than 0.1 degree in the velocity vector at third stage burnout. The precise launch intervals will be firmly established based on analysis of look-angle constraints.

- An error analysis for September launches has been completed. The error analysis considers the probability of having enough fuel to correct the trajectory back to the nominal aiming point, and the probability that this correction is made with sufficient accuracy for capture in a lunar orbit. All known sources of error have been examined with satisfactory results.

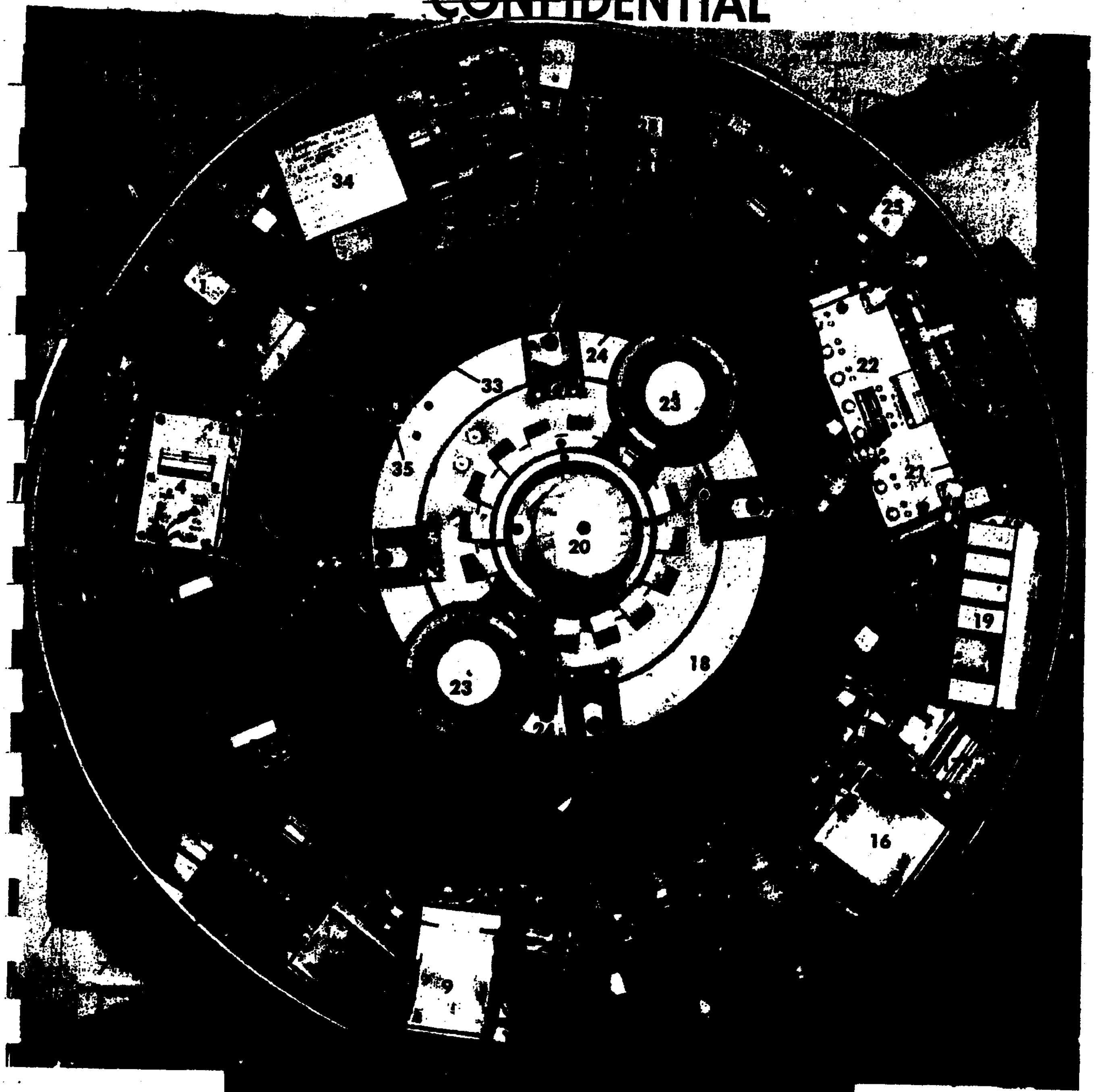
Ground Support Equipment

- The overall design and fabrication of checkout van No. 4 is complete. Van validation using missile simulator equipment was successfully completed. The van was subsequently connected to the Stage II electrical system for the initiation of power, autopilot, telemetry, propulsion, guidance, and igniter circuit subsystem. It is anticipated that the installation of additional guidance transponder evaluation equipment will be completed by the first launch date on a noninterference basis.

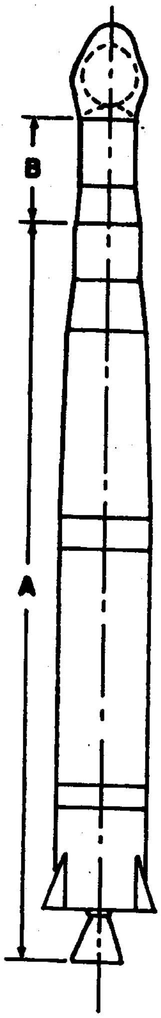
- The ABLE ground stations are being reworked as required to guarantee that they will be in top operating condition for the first ABLE-5 launch. The radio telescope at Jodrell Bank is undergoing major mechanical rework by the University of Manchester. The Rantec switching modifications have been completed at Manchester, and testing is now under way.

Facilities

- The design and fabrication of Complex 12 launch facilities has been completed. The launch facility/missile compatibility test has been prepared and preliminary checks using this procedure have been accomplished using launch facility equipment and missile simulators. Some of the facility electrical cabling has been installed. Strike activity during the month delayed slightly the completion of past modifications. The modifications will be completed early in the next report period.



1. Cosmic Ray Telescope
2. Plasma Probe
3. Telemetry Signal Conditioner
4. Phase Comparison Analyzer & Spin Coil
5. Digital Telemetry Unit
6. Micrometeorite Diaphragm
7. Battery Pack, 1-2
8. Low Energy Scintillation Logic
9. Scintillation Spectrometer Logic
10. Material Coating Probes
11. Angular Accelerometer
12. Micrometeorite Scaler
13. Scintillation Spectrometer Sensor
14. No. 1 Converter (Experiment Supply)
15. Low Energy Scintillation Counter
16. Flux Gate Magnetometer Logic and Amplifier
17. Digital Decoder
18. Micrometeorite Amplifier
19. Receiver
20. Injection Thrust Chamber
21. Power Distribution Box
22. Diplexer
23. Antennas
24. Nitrogen Tanks (Main Pressurizing)
25. Coherent Modulator
26. Solar Cell Paddle Arms
27. Battery Pack, 3-4
28. Non-Coherent Transmitter (Top)
29. Coherent Transmitter (Bottom)
30. Non-Coherent Modulator
31. Coherent and Non-Coherent Converters
32. Sun Scanner
33. Auxiliary Pressurization Nitrogen Tank
34. Ion Chamber, Geiger-Mueller Counter
35. Hydrazine Tank

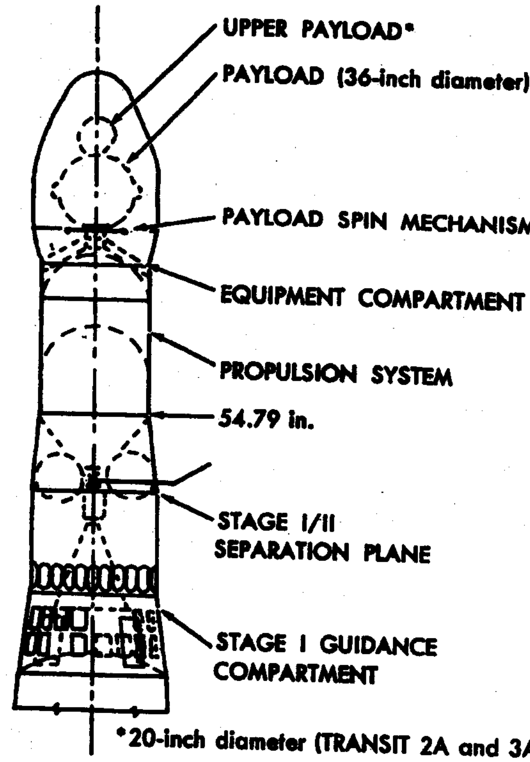


B. SECOND STAGE—ABLE-STAR (AJ10-104)

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

A. 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



*20-inch diameter (TRANSIT 2A and 3A)

—TRANSIT 1B, 2A, 3A and 3B

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 1. TRANSIT 1B, 2A, 3A and 3B are two-stage vehicles as shown above.

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 TRANSIT 2A, 140 degrees.

Powered Flight Trajectory The powered flight trajectory for TRANSITS 1B and 2A is shown and described in the flight trajectory diagram.

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 TRANSIT 2A 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.

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

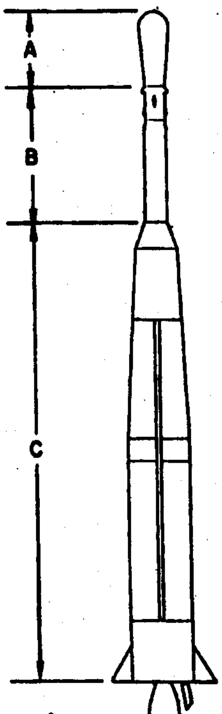
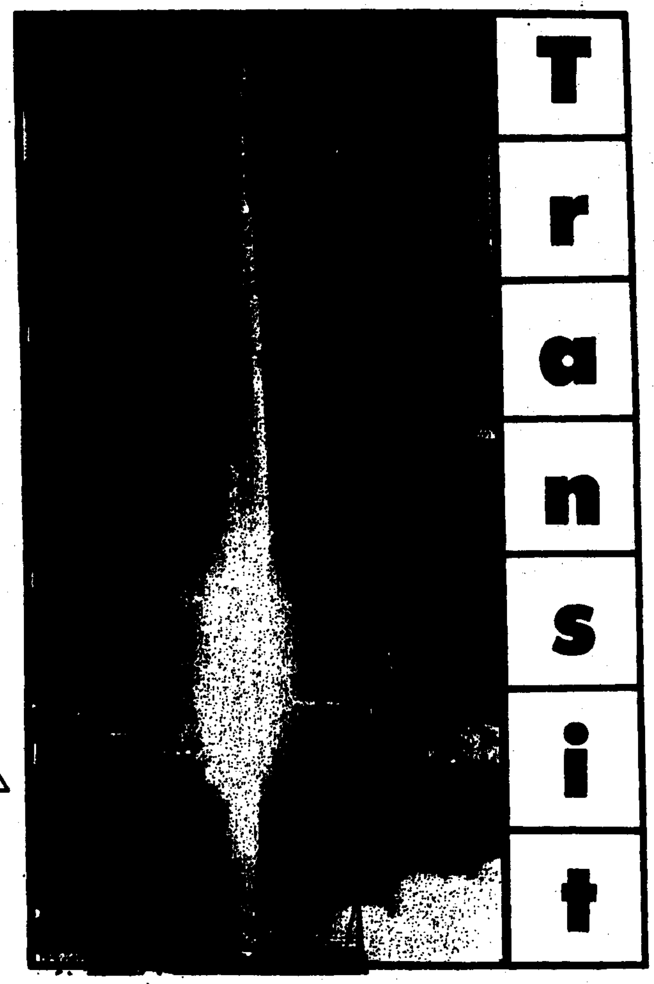


Figure 1. TRANSIT 1A three stage flight vehicle.



TRANSIT 1A launched from Atlantic Missile Range

The TRANSIT Program consists of the flight testing of six 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 TRANSIT 3A and 3B flights were initiated by a Navy MIPR, dated 18 May 1960. Because of the successful TRANSIT 2A launch and excellent payload performance the Navy has elected to launch TRANSIT 3A rather than 2B. TRANSIT 2B was scheduled to carry the same type payload as was carried on the 2A flight.

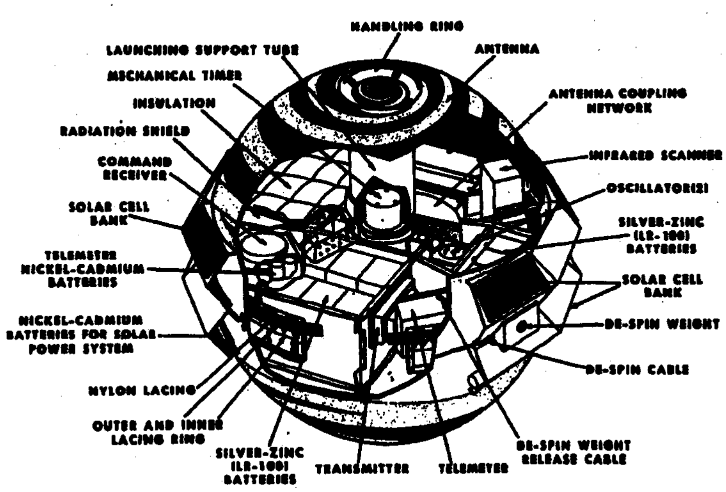


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV 1).

The program was originally authorized by ARPA Order No. 97-60, which assigned 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. The TRANSIT project was transferred to the Navy on 9 May 1960. The Navy has now assumed both the administrative and technical responsibility for the TRANSIT program. Payload and tracking responsibility has been assigned to the USN Bureau of Weapons. Applied Physics Laboratory is the payload contractor.

Monthly Progress—TRANSIT Program

Program Administration

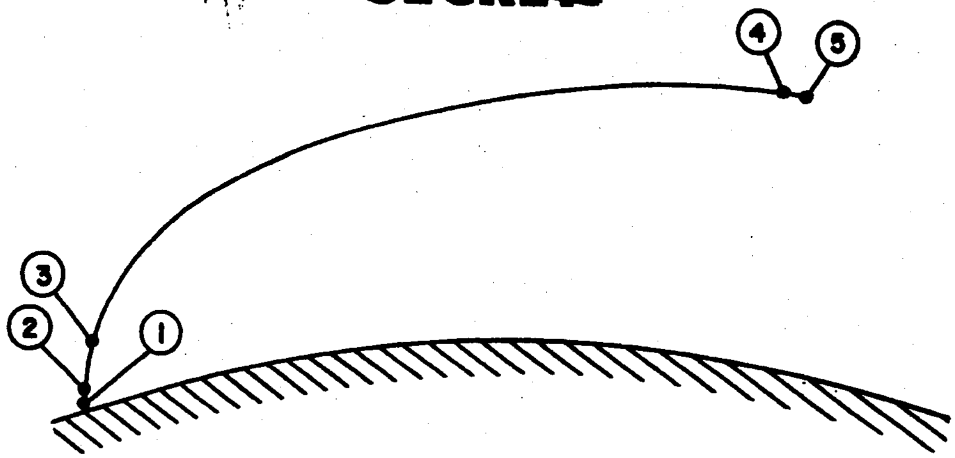
- TRANSIT 2B flight requirement has been cancelled, since it was programmed as a backup to the successful TRANSIT 2A vehicle. A TRANSIT 3A payload will be flown in early November on the THOR ABLE-STAR booster planned for TRANSIT 2B.

- A TRANSIT 3B launch is scheduled for January, 1961. A TRANSIT 4A is scheduled for launch in May 1961.

Flight Test Progress

- TRANSIT 2A flight data revealed erratic directional behavior by the second stage. This behavior was subsequently traced to "coning" of the second stage. "Coning" resembles the swinging motions of a top as velocity decreases, just prior to toppling. The "coning" was found to be caused by sloshing of propellants in the tanks. The sloshing forces became too great to be controlled by the nitrogen gas jet stage roll control system. Wire screen baffles are being incorporated in the fuel tank, which is the most critical, to reduce fuel sloshing. Two additional nitrogen tanks will be added to provide more nitrogen for stage stabilization over a longer period.

- TRANSIT 3A will be launched on an inclination angle of 28.5° to the equator. This course will take the vehicle over Africa during second stage operation at an altitude of 500 nautical miles. This is permissible without clearance for overflying another country.



Point	Flight Time (seconds)		Comments	Inertial Speed (ft/sec)		Downrange Distance (n.m.)		Altitude (n.m.)	
	1-B	2-A	Transit vehicles	1-B	2-A	1-B	2-A	1-A	2-A
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 and 2A

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 was located in Germany for TRANSIT 1B and South America for TRANSIT 2A. The mobile tracking and telemetry van will be located in southeast Africa for TRANSITS 3A and 3B. These locations were selected as the closest sites possible to the orbit injection point.

Monthly Progress—COURIER Program

Flight Test Progress

- COURIER 1A was launched from the Atlantic Missile Range on 18 August. Liftoff was smooth and stable, and flight was normal. However, after 20 seconds of flight missile hydraulic pressure began to drop. By T plus 128 seconds hydraulic pressure was lost completely. The THOR booster control system became inoperative without hydraulic pressure. The missile then began tumbling and broke up, ending the flight. The malfunction in the THOR hydraulic system has been investigated and modifications to the hydraulic systems on the THOR boosters to be used as space boosters have been incorporated.

- The COURIER 1A ABLE-STAR second stage contained modifications to improve second stage stability (See TRANSIT monthly progress). However, due to flight termination prior to second stage ignition, the effectiveness of these modifications was not evaluated.

Technical Progress

- COURIER 1B is being prepared for launch in early October. The first stage is at the Atlantic Missile Range being checked out on the stand. The second stage is at the Atlantic Missile Range undergoing final system and subsystem checkout. The first stage THOR No. 283 was erected on AMR stand 17B on 12 September 1960. The second stage and payload will be installed on the THOR on 19 September 1960.

- Launch will be at an inclination angle of 28.5 degrees to the equator. The 500 pound COURIER payload will be placed in a 650 nautical mile nearly circular orbit. The payload does not differ from the COURIER 1A payload.

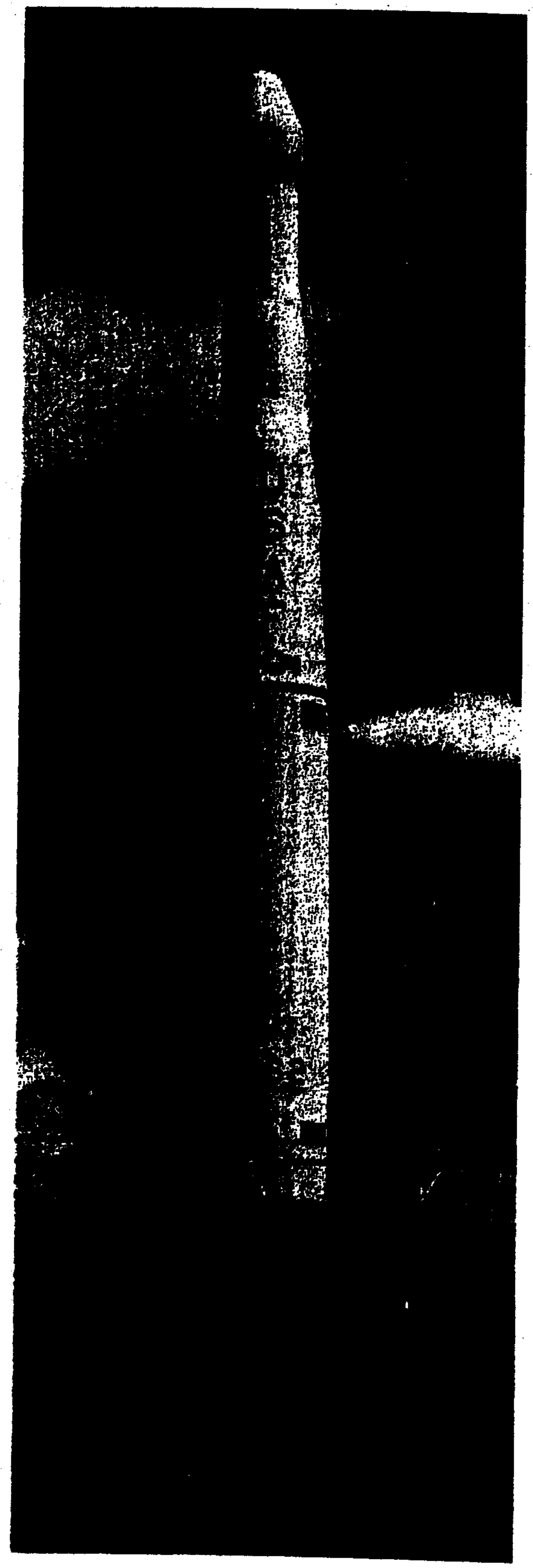


Figure 1. COURIER 1A prior to launch from the Atlantic Missile Range on 18 August. A loss of hydraulic pressure caused the control system to become inoperative and the missile to become unstable resulting in its destruction.

COURIER

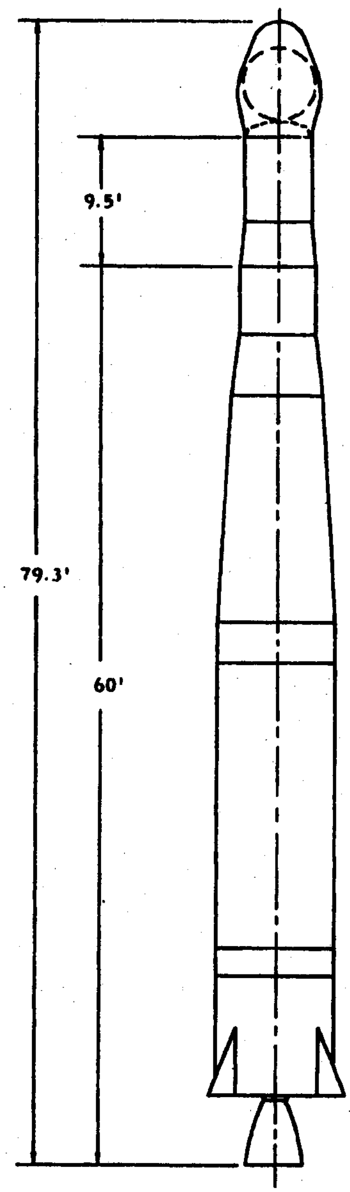
The ARPA COURIER Program consists of two flight vehicles to be launched from the Atlantic Missile Range. The program objective is to test delayed repeater communications between a satellite and ground stations. The program also will be used to determine the operating characteristics and capabilities of the ABLE-STAR (AJ10-104) second stage vehicle. The program is being conducted under ARPA Order No. 98-60 (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 nitric 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 inclination will be 28.5 degrees from the equatorial plane. The orbital period will be 110 minutes.

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

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



SECOND STAGE—ABLE-STAR (AJ10-104)

Thrust at altitude	8030 pounds
Specific impulse (vac)	278 seconds
Total impulse (min)	2.3 X 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

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 14 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.

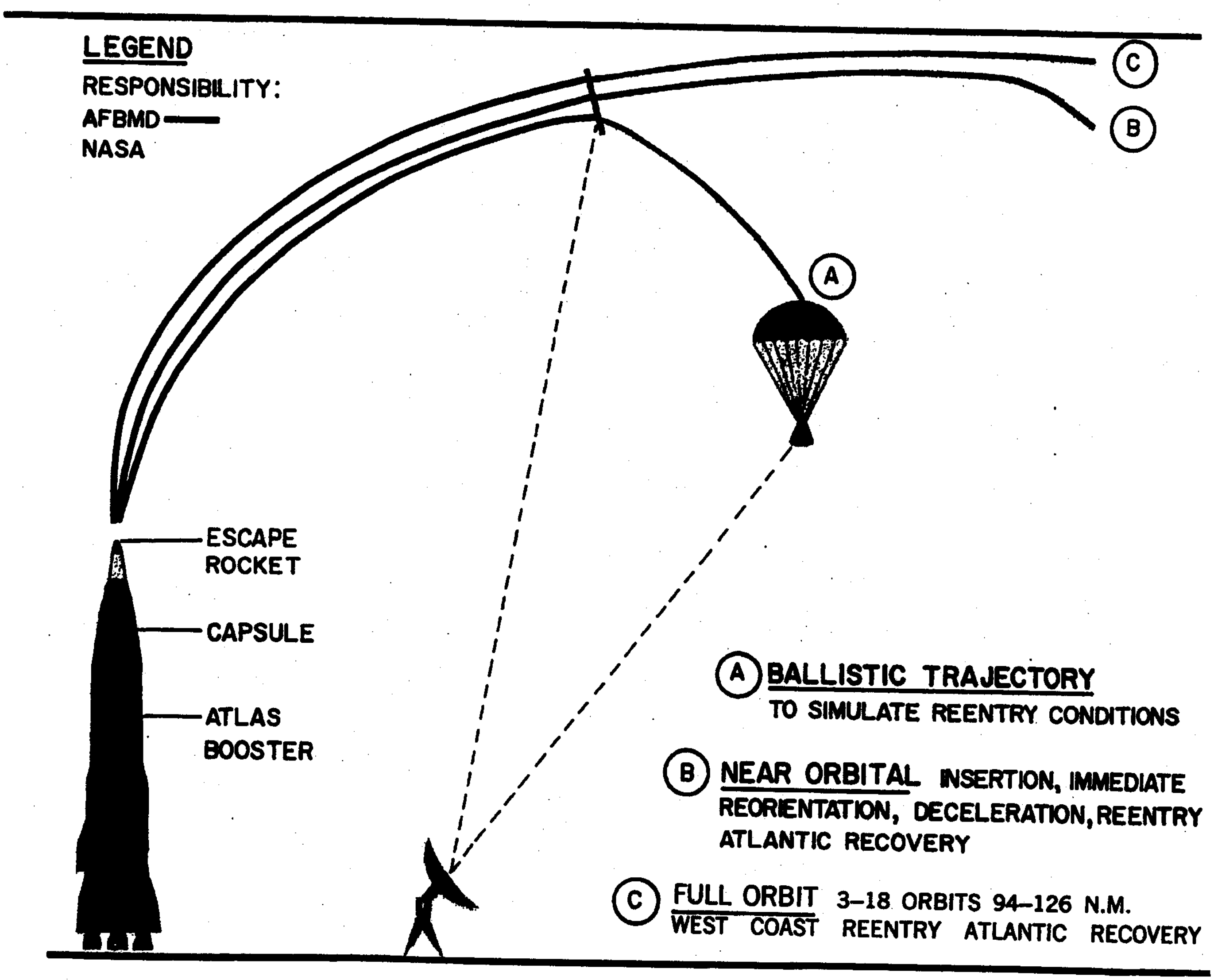
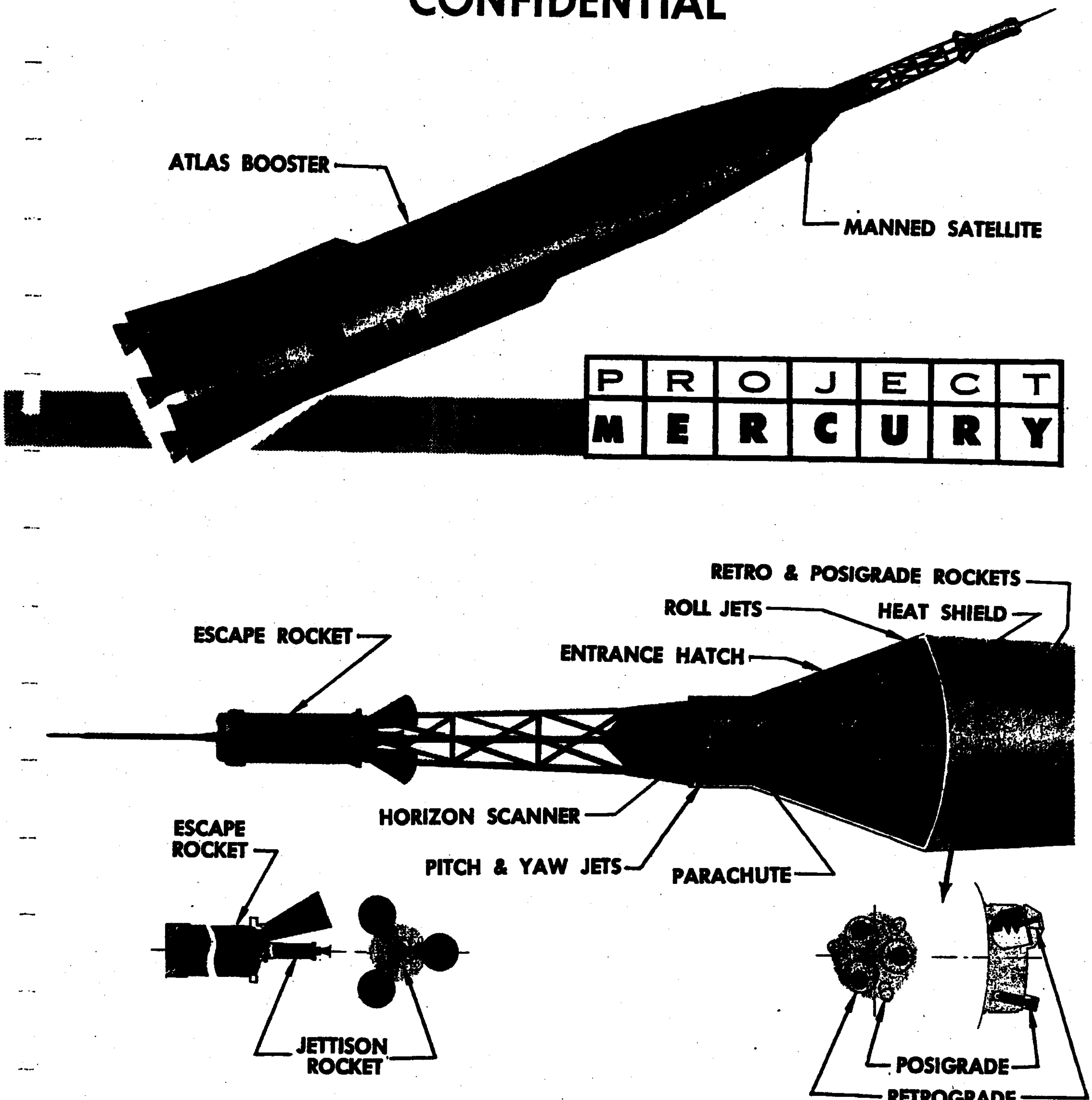


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.



WEIGHT AT SEPARATION	2,500 lbs	ORBITAL CYCLES	3-18
ORBITAL ALTITUDE		ORBIT INCLINATION	33 Degrees
APOGEE	126 N. Miles	HEAT SHIELD	Ablative
PERIGEE	94 N. Miles	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.

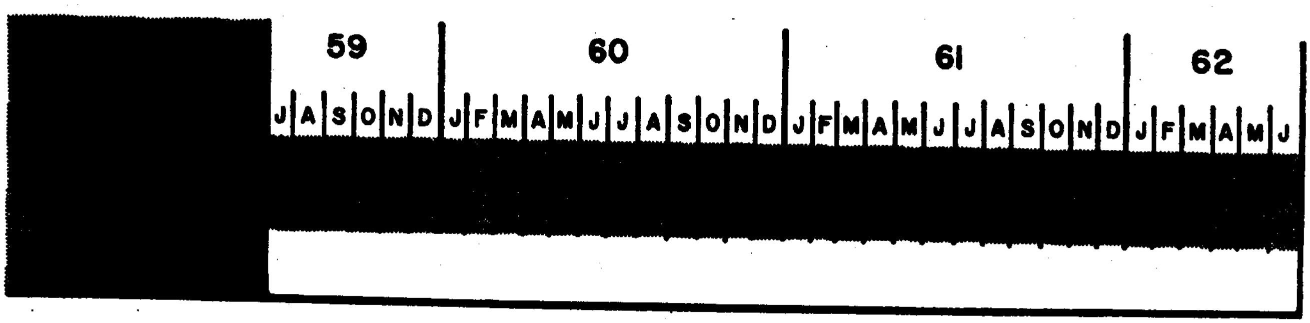
PROJECT MERCURY

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 fourteen (14) ATLAS boosters.	**Modify boosters for NASA preliminary research and manned orbital flight and safety objectives.**	**Launch, control and define trajectories of booster-capsule vehicle up to, and including, injection into orbit.**

Table 2. AFBMD responsibilities in support of PROJECT MERCURY.



Project MERCURY Launch Schedule

PROJECT MERCURY

- **NASA Responsibility**
  - Booster-Capsule integration
    Capsule
    Ground support
    Recovery
    - Flight 1
      - NASA Laboratory Capsule
        - Re-entry heating, dynamics, recovery
    - Flights 2–14
      - 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 altitude:
          Apogee 126 n.m.
          Perigee 94 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.
          (a) Ballistic trajectory—108°
          (b) Orbital trajectory—072°

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

Monthly Progress—PROJECT MERCURY

Flight Test Progress

● Efforts were continued throughout August to determine the specific cause of the MERCURY MA-1 malfunction on 29 July. Although the exact cause of booster destruction has not been determined, it is generally agreed that an unknown malfunction at the forward end of the booster or in the adapter section area led to the destruction of the vehicle approximately 60 seconds after launch. A Malfunction Analysis Panel has been established to monitor and expedite follow-on investigation actions and to insure that precautionary modification action and additional transition section instrumentation are accomplished prior to the next MERCURY launch.

● Because of the destruction of the MA-1 vehicle, the test objectives, trajectory, and general flight plan have been modified for the third MERCURY (MA-2) flight. The flight capsule will be released into a ballistic trajectory, which will result in the highest afterbody temperatures and near maximum re-entry loads anticipated for any MERCURY mission.

● Because of capsule delivery problems and the delays imposed by incorporating modifications indicated as a result of the MA-1 malfunction studies, the launch of the third MERCURY flight test has been rescheduled from 12 September to 1 November. NASA does not anticipate this delay jeopardizing the previously scheduled manned flight launch dates.

● NASA capsule test objectives for the MA-2 flight are:

1. Determine the integrity of the MERCURY capsule structure, ablation shield, and afterbody shingles for a re-entry associated with a critical abort.
2. Evaluate the performance of the operating systems during the entire flight.
3. Determine the flight dynamic characteristics and afterbody heating rates during re-entry from a critical abort.
4. Evaluate the compatibility of the escape system with the MERCURY-ATLAS system.
5. Establish the adequacy of the capsule recovery system, the location of the recovery force and recovery procedures.
6. Evaluate prelaunch, launch and flight monitoring procedures and facilities.

● ATLAS booster test objectives for the MA-2 flight are:

1. Evaluate the closed loop operation of the Abort Sensing and Implementation System.
2. Determine the ability of the ATLAS booster to release the MERCURY capsule at the conditions of position, attitude and velocity defined by the guidance equations.
3. Obtain data on the repeatability of the performance of all ATLAS missile and ground systems.

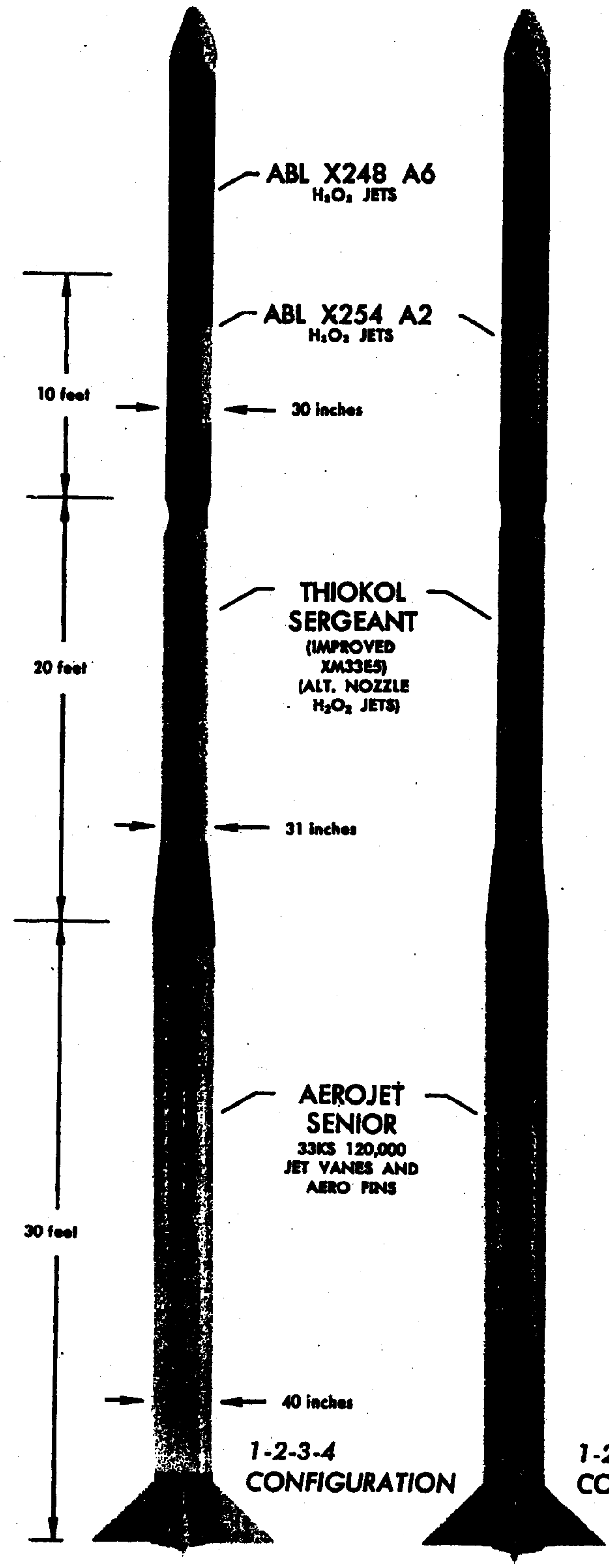
● The Abort Sense and Implementation system will be carried aboard ATLAS booster 67D and will be flown closed loop for the first time. The capsule for this third MERCURY flight will be a full scale McDonnell production model with escape system.

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 25 to 1,000 pound payloads to altitudes of 200 to 50,000 miles. The Operational phase will use these standardized vehicles 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



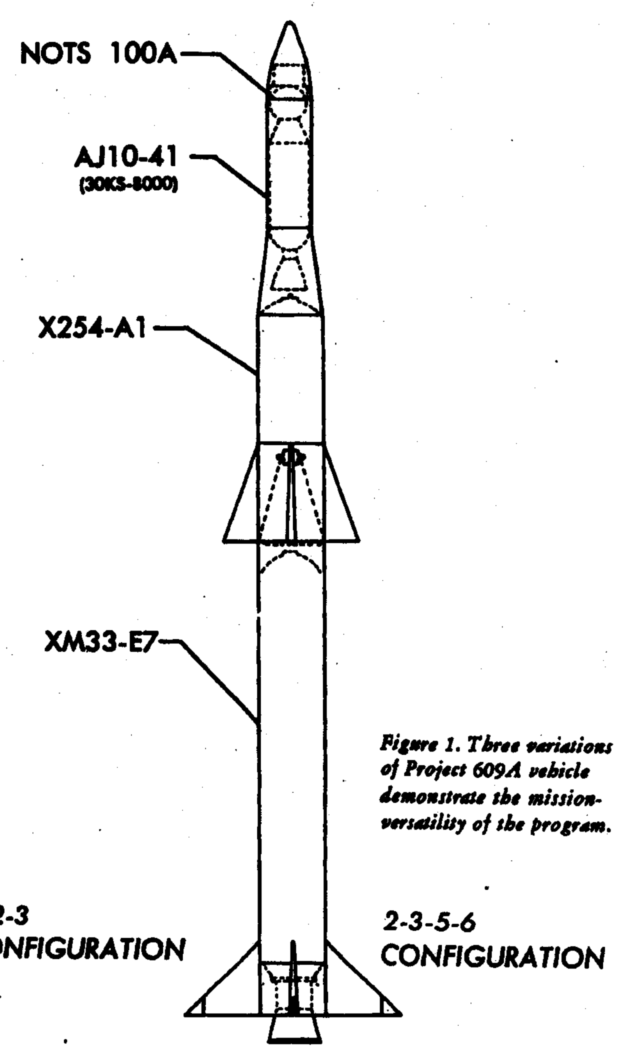


Figure 1. Three variations of Project 609A vehicle demonstrate the mission-versatility of the program.

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 affect 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 twelve 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 $11,500,000 have been made available for this R&D phase 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 (Piggy-back 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.

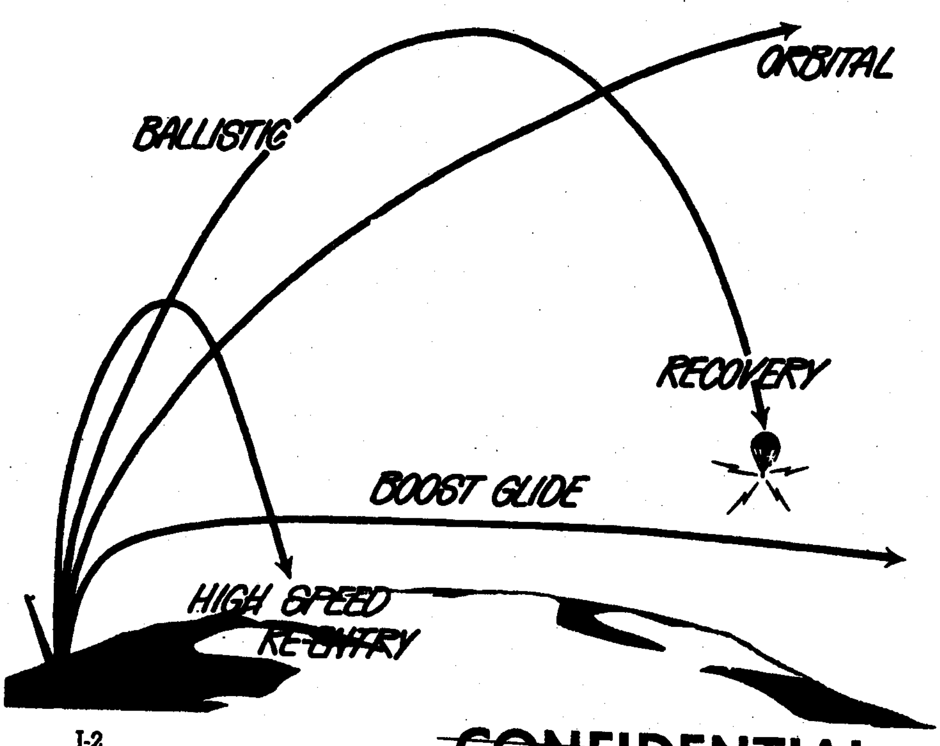
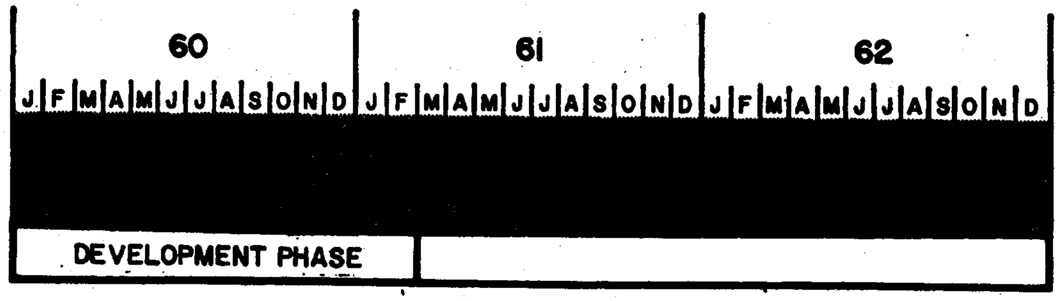


Figure 2. Four different trajectories possible using different arrangements of Project 609A stages.



Project 609A Launch Schedule

MONTHLY PROGRESS—Project 609A

Program Administration

- A review of 6555th Test Wing (Development) manpower was conducted in mid-August at AFBMD. The 6555th presently has a total of 42 officers and men assigned or attached. To meet the requirement for a military launch capability during the program's Operational Phase it was estimated that 135 men will be required.

Technical Progress

- The payload for the first Development Phase orbital launch will be a 12-foot balloon supplied by NASA. This balloon, a Rome Air Development Center experiment, will be placed into a 350-450 nautical mile circular orbit with an expected life of 60 days. AFBMD will be responsible for the launch conducted from the Atlantic Missile Range. The primary objective is the demonstration of orbital capability. The secondary objectives are: obtaining scientific information from the experiment, training 6555th personnel in launch operations and acquiring booster performance data.

- The payload for one of the 609A operational launches will be a DYNA SOAR test model. The requirements for the boost-glide trajectory to be flown have been received from Boeing Aircraft Company and are being studied by Minneapolis-Honeywell engineers to determine how extensive the guidance system modification will have to be. The studies to date have shown that the modifications are feasible.

Figure 3. Artist's conception of the third stage and payload of the first guided flight (1-2-3 configuration) scheduled for launch in October. The vehicle is shown during exit heat shield ejection. The data recovery capsule is in the nose of the vehicle. The experiment packages, guidance and control components, and telemetry system equipment are installed on the shelves of the standard payload carrier. Eleven separate experiments will be carried on this flight.

● Documentation for the revised flight termination system for the 15 September launch has been submitted to the AMR for approval. In accordance with a waiver received from the AMR, the destruct system for this flight is installed only on the first two stages instead of all four stages. No further difficulties are anticipated in obtaining AMR approval of this documentation.

● An ABL-248 linear charge motor destruct test is scheduled at Edwards AFB in early September. This test is needed to demonstrate that the destruction method will meet the AMR safety requirements for the guided vehicles.

● An agreement was reached with the Air Force Special Weapons Center (AFSWC) on the launch of the last three 2-3-5-6 vehicles that have been procured. If the first two 2-3-5-6 vehicle launches from AMR are essentially successful, the third vehicle also will be launched from AMR, and the last two in the Development Phase will be launched from Vandenberg Air Force Base. These last three launches will be made during December 1960 and January 1961. The Vandenberg AFB launches will be controlled by AFBMD, but AFSWC will do much of the task planning and coordinating under their current role of furnishing assistance to the 609A Project Office.

Facilities

● Hq AFBMD has been informed by the 6555th Test Wing that no existing industrial hangar space at AMR can be made available during the Operational Phase. It had been indicated previously that 15,000 square feet of hangar space would be assigned to the program. A new technical support building will have to be constructed if space cannot be obtained. This problem and an estimate of the cost of the new building will be forwarded to Hq ARDC.

● Aeronutronic has provided the criteria for the Operational Phase assembly and combined systems checkout buildings. These criteria are now being developed into detailed plans by an Architect and Engineering firm. These buildings will be placed for bid in October with beneficial occupancy date in March 1961. Criteria are now being prepared for the payload and rocket motor storage buildings.

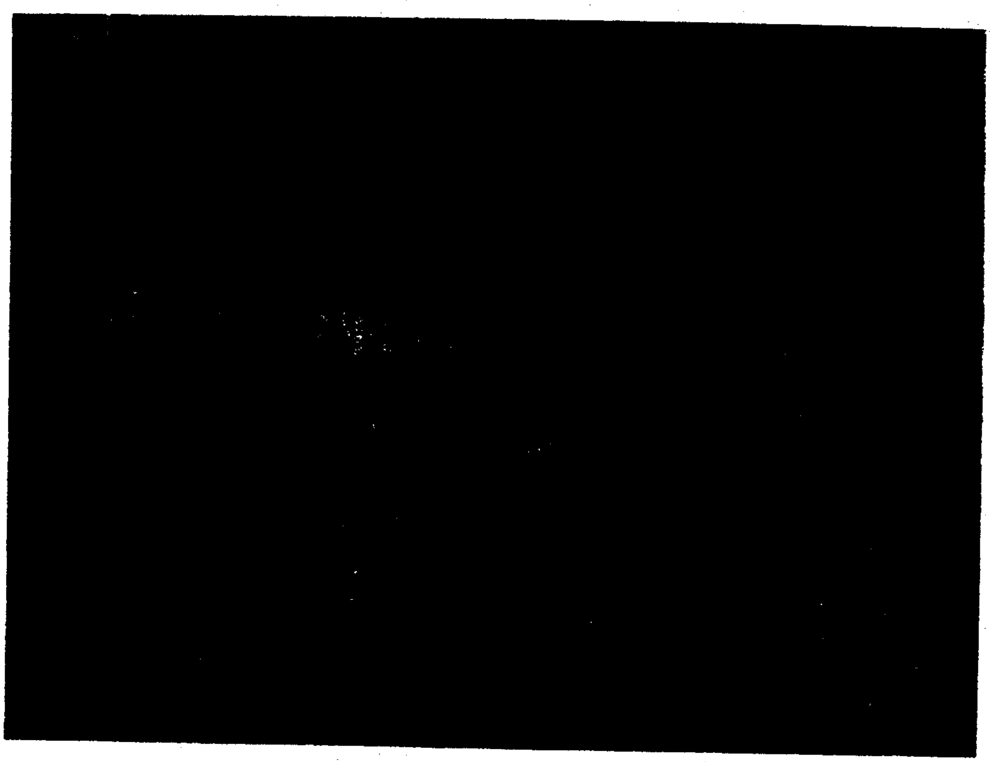


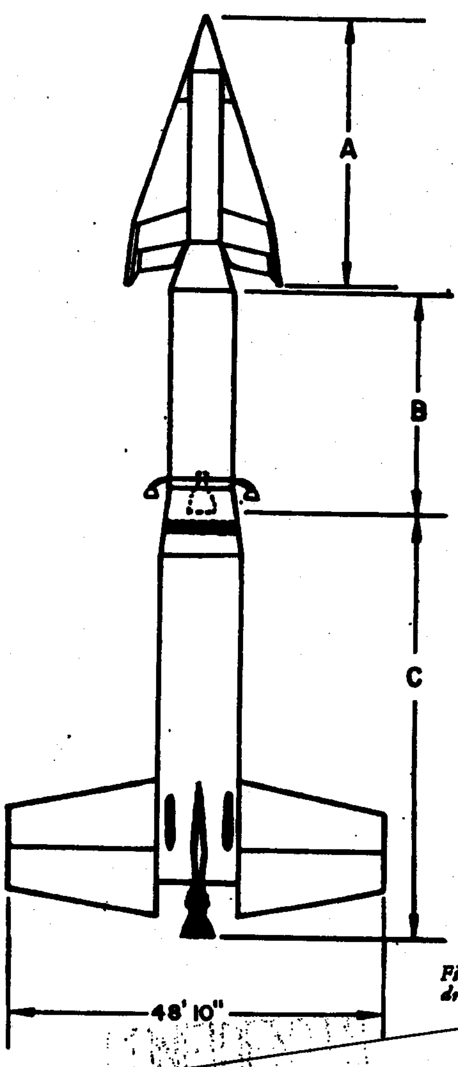
Figure 4. The first stage of the 2-3-5-6 configuration missile (unguided) during launches fit checks at the Atlantic Missile Range. The other stages will be attached and the launches will be raised to a near vertical position for launch. In the background is the gantry at launch complex 18 which will be used in preparing the guided 609A versions for launch.

~~SECRET~~ ~~CONFIDENTIAL~~

DYNA SOAR

Program History—Competition for the DYNA SOAR study contract was initiated in 1958 and resulted in the Boeing Airplane Company and the Martin Company being awarded the follow-on contract to more fully define their proposed approaches. In November 1959, following review and evaluation of the Boeing/Martin detailed studies by a Source Selection Board, it was announced that Boeing had been selected as the glider and system integration prime contractor, with Martin furnishing modified TITAN ICBM's for booster support. The determinations and findings were elaborated on by Dr. Charyk to require a study program, Phase Alpha, with objectives of reaffirming the proposed glider design and indicating any changes required to that design. In April 1960, the Phase Alpha study was completed and the results were presented to the Department of Defense. On 9 May, formal approval of the DYNA SOAR Step I Program was received by AFBMD/BMC from WADD/ASC.

Program Objectives—The DYNA SOAR Program will explore the possibilities of manned flight in the hypersonic and orbital realms. The program will proceed in three major steps from a research and test phase to an operational military system. In Step I, a full scale, minimum sized manned glider will be developed. A modified version of the TITAN ICBM will boost the glider into hypersonic flight at velocities up to 19,000 ft/sec and permit conventional landing at a predetermined site. In Step II the glider will be tested, using a more powerful booster to



A. GLIDER
- Weight .... 9300 lbs.
- Wing Area .... 300 sq. ft.
- L/D Max. at Mach 20 .... 2.2
- L/D Max. Landing 4.5

B. TITAN SECOND STAGE
- Thrust (lbs. vac.) 80,000
- Lift Off Weight ...... 53,853 lbs.
- Propellant Consumed ... 47,274 lbs.
- Burnout Weight .... 6,579 lbs.

C. TITAN FIRST STAGE
- Thrust (lbs-sea level) ...300,000
- Lift-Off Weight ....176,383 lbs.
- Propellant Consumed ...164,243 lbs.
- Burnout Weight .... 12,140 lbs.

D. GROSS WEIGHT ......241,500 lbs. 1st Stage Start of Burn

SECOND STAGE MODIFICATIONS
- Ignition prior to Separation
- Propellant Tanks Capacity Increased
- Intertank Section Strengthened

FIRST STAGE MODIFICATIONS
- Stabilizing Fins Added
- Skirt Section and Intertank Section Modified and Strengthened

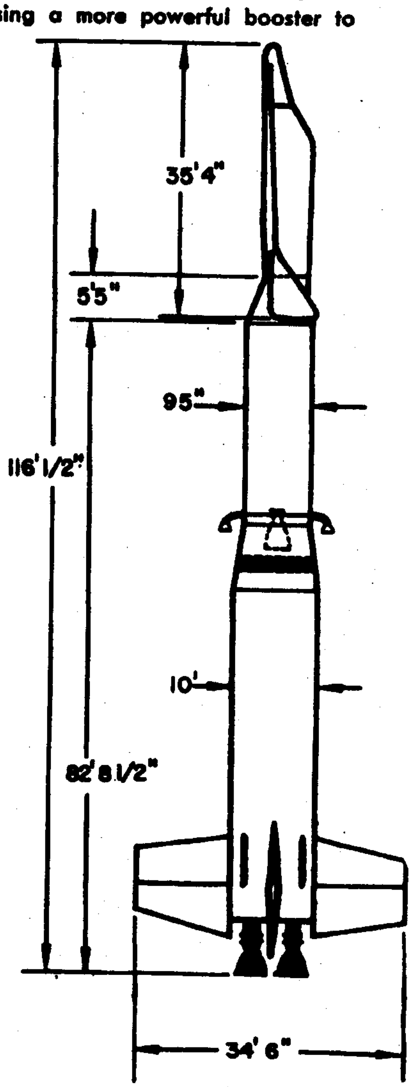


Figure 1. DYNA SOAR vehicle configuration drawing and specification list.

achieve orbital velocities. This phase may be expanded into an interim operational weapon system providing all-weather reconnaissance and satellite interceptor capabilities. The objectives of Step II are to test vehicle performance between 19,000 ft/sec and orbital velocities; and to gather re-entry data from various orbits. Step III will provide an operational weapon system with a vehicle that will operate primarily in a hypersonic glide, be able to maneuver within the atmosphere, and be able to make a conventional landing at a predetermined site. The capability of DYNA SOAR type systems to perform these programmed missions appears attractive as a result of studies made to date. The missions under study are: reconnaissance (manned and unmanned); air and space defense; strategic bombardment and logistics support. Manned and unmanned versions are being considered where applicable.

Flight Program—Step I includes nineteen air-launched, manned flights with the glider being dropped from a B-52, five unmanned booster launches, and eleven manned booster launches from the Atlantic Missile Range (AMR). The first unmanned booster launch is scheduled for November 1963 with a one and one-half month span between launches. The manned booster flights are programmed to start in September 1964 with a two month span between launches. The range from Wendover AFB, Utah, to Edwards AFB is adequately instrumented for the tracking and telemetry required during the air-launched tests of the DYNA SOAR glider. Instrumentation sites for the AMR launches will be located at Cape Canaveral, San Salvador, Mayaguana, Antigua, Santa Lucia, and Fortaleza. Instrumentation, tracking, and recovery ships will be provided to supply additional support for the AMR launches. Landing facilities will be provided at Fortaleza, Brazil; Santa Lucia, Lesser Antilles; and Mayaguana, Bahama Islands.

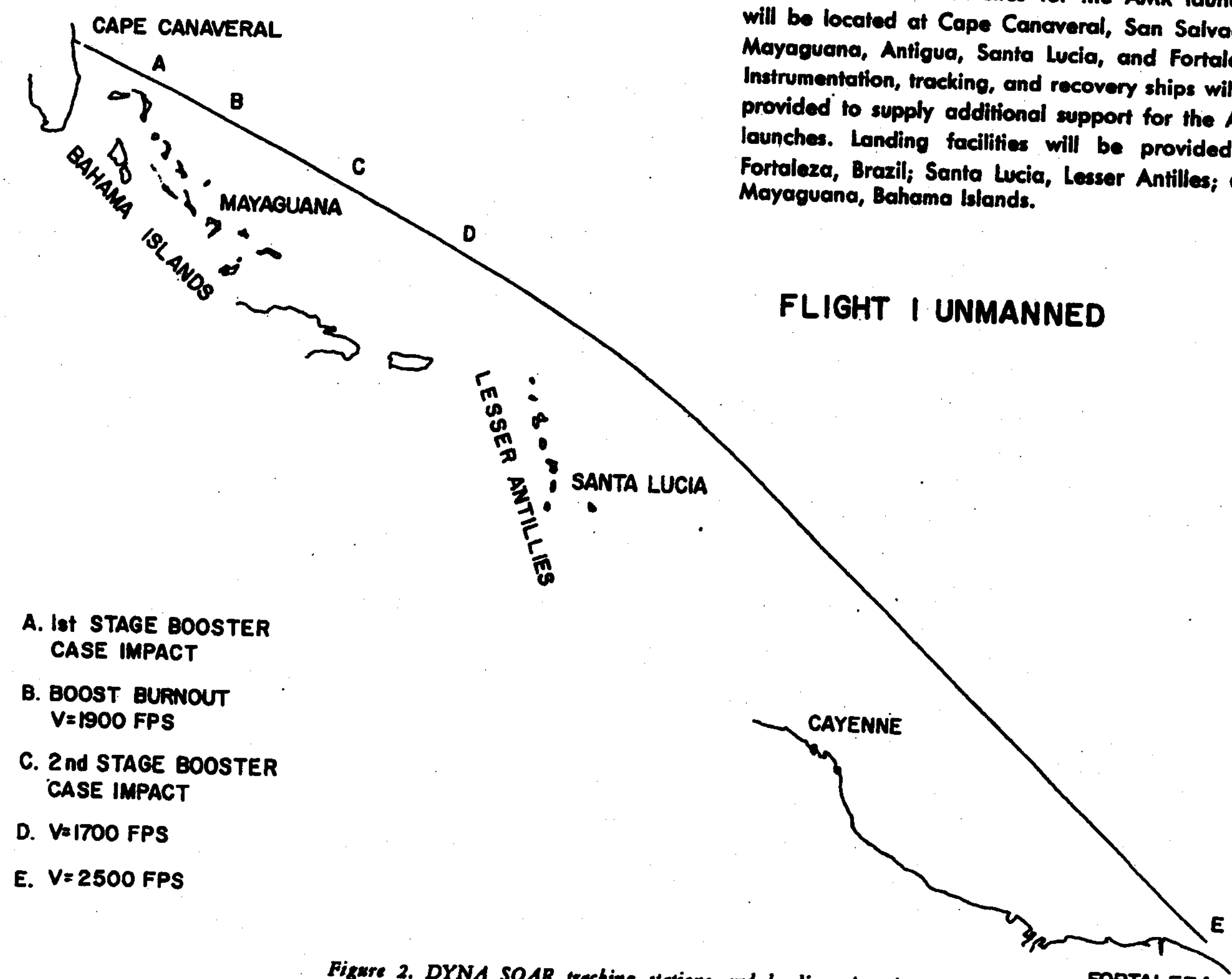


Figure 2. DYNA SOAR tracking stations and landing sites for launches from the Atlantic Missile Range.

Program Responsibilities—Steps I and II of the DYNA SOAR Program are to be conducted by the USAF with NASA participation. USAF will provide program management and technical direction, with WADD having responsibility for over-all system management.

AFBMD is responsibile for the booster, booster support equipment, special air-borne systems, ground support equipment, and booster requirements of the launch complex. WADD will have responsibility for glider and subsystem development. NASA will provide technical support in the design and operation of the glider in obtaining basic aeronautical and space design information.

Technical Approach—AFBMD's technical approach to meet the objectives of the program are:

1. Modifying a TITAN ICBM by adding stabilizing fins; strengthening the holddown and skirt area, intertank and interstage sections; redesigning the guidance bay; incorporating a malfunction detection system; and initiating a new staging technique (fire in the hole).
2. Modifying the LR 87-AJ-3 or LR 91-AJ-3 rocket engines to obtain structural compatibility with the modified booster; include malfunction shutdown and fail safe systems; and adding a cartridge start system.
3. Lighten and simplify the second stage engine.
4. Modification of an AMR launch pad.
5. Provide an integrated launch countdown.

Monthly Progress—DYNA SOAR Program

Program Administration

The DYNA SOAR Program is still in the preliminary planning stage and it will be some time before the assembly of hardware begins and component or subsystem tests commence. Until the program advances from the planning stage, the monthly progress section will include the results of studies that have been conducted and significant meetings that have been held.

- The Martin Company final report on the erector versus gantry tower modification study is scheduled to be submitted by 1 October.

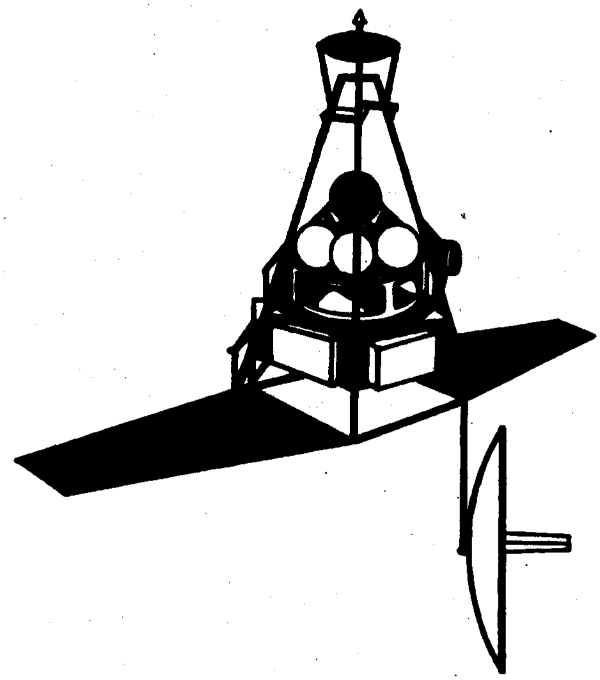
- American Machine and Foundry has been selected as the architect and engineering contractor for the launch complex modifications. This will permit planning of the design program and criteria development to begin.

- Significant progress has been made toward completing the trade-off studies in the following areas:

1. Booster structural design
2. Staging techniques
3. Propulsion and pressurization
4. Malfunction detection (abort sensing)
5. Booster-glider interface
6. Reliability

- Stage II booster configuration studies have been initiated.

NASA AGENA "B" PROGRAM



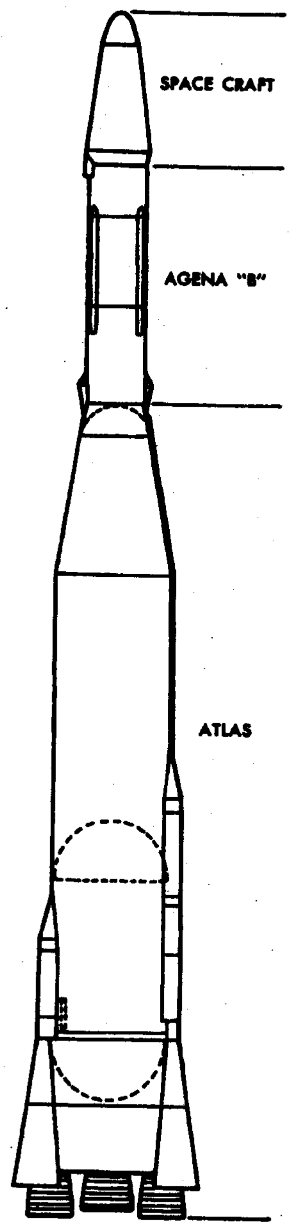
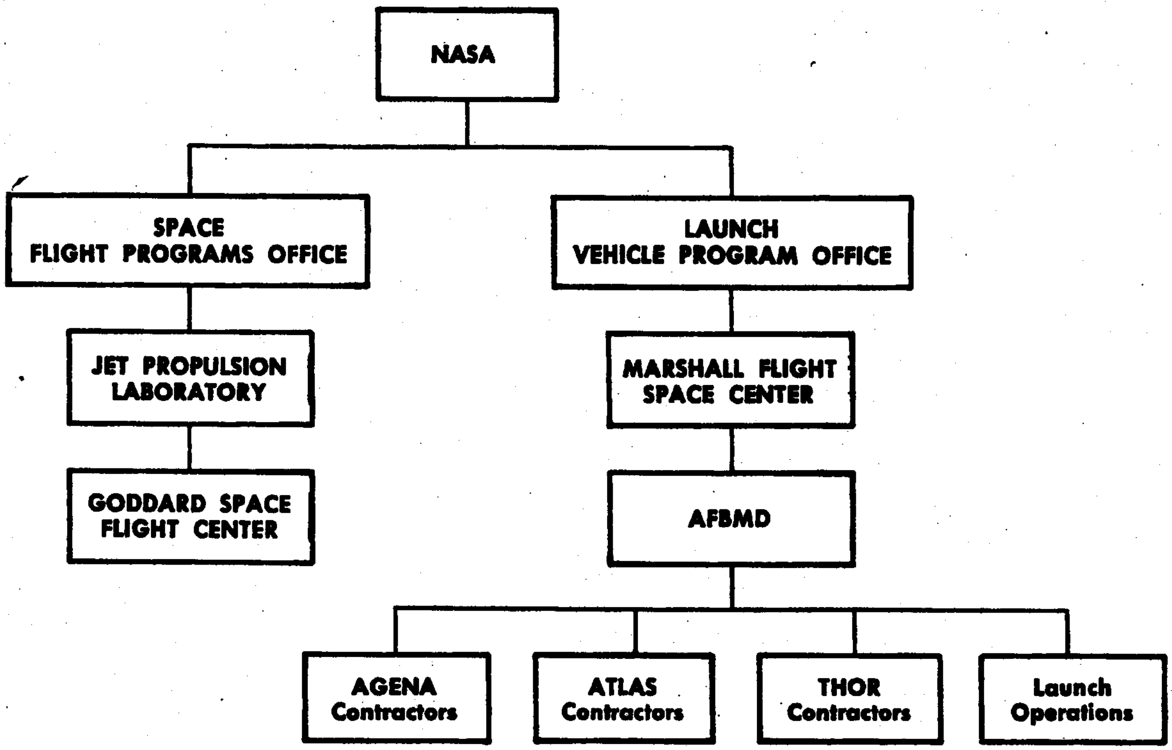


Figure 1. NASA AGENA "B" configuration for Ranger flights (left). Proposed Ranger lunar spacecraft (above) which will be launched from the Atlantic Missile Range.

Program Objectives—The basic objective of the NASA AGENA "B" Program is to place a separable spacecraft on a prescribed ballistic trajectory or into lunar orbit to gather scientific information and data. The program will first demonstrate the capability of jettisoning the spacecraft shroud and separating the spacecraft from the AGENA "B" vehicle. The program will also develop and demonstrate the capability of the AGENA "B" retro system to retard the second stage. To achieve these objectives the experience gained by the Air Force in designing equipment, developing techniques and preparing procedures for launching and tracking spacecraft will be utilized.



NASA and AFBMD AGENA "B" project responsibilities

Flight Program—Although it is intended that this program will continue for several years beyond 1962, only the launches through 1962 are firm. The current schedule is as follows:

Launch Date		Booster	Mission
July	1961	ATLAS	Lunar Test Vehicle
October	1961	ATLAS	Lunar Test Vehicle
January	1962	ATLAS	Lunar Impact
March	1962	THOR	Scientific Satellite
April	1962	ATLAS	Lunar Impact
April	1962	THOR	Meteorological Satellite
July	1962	ATLAS	Lunar Impact
July	1962	THOR	Backup
October	1962	THOR	Meteorological Satellite

Note: Lunar flights will be launched from the Atlantic Missile Range; all others will be made from Vandenberg Air Force Base.

Program Responsibilities—Under NASA Order No. S4601-G the Air Force is supporting the NASA AGENA "B" Program. This will permit NASA to take full advantage of the technical and operational background and experience developed by the Air Force in space booster projects; permit contractors to discharge their contractual obligations with NASA and USAF utilizing already established management relationships, insofar as practicable; and provide NASA the benefits of contract administration services and procedures already established for USAF programs employing the same basic vehicles as those scheduled for this program.

Program Status—AFBMD has taken the following action to support the NASA AGENA "B" Program:

1. Awarded Lockheed Missile and Space Division a contract (letter Contract -592) dated 12 April 1960) for the procurement of modified AGENA "B" second stage vehicles, jettisonable spacecraft shrouds, overall systems engineering and vehicle launch.
2. Issued a contract change notice to Convair Astronautics for five modified ATLAS "D" boosters to support the lunar flights.
3. Allocated eight THOR boosters to NASA.
4. Initiated contractual action with General Electric and Bell Telephone Laboratories for guidance systems to be used on the ATLAS and THOR boosters, respectively.
5. Published the program requirements document setting forth the requirements to be imposed upon the Atlantic Missile Range to support this program.

SPACE

defense programs

SAINT

SPACE DEFENSE PROGRAMS

SAINT

● Project SAINT is a program for the development of a satellite inspector system. The initial effort is concerned with the design, fabrication and ground launch of a reliable prototype vehicle to demonstrate the feasibility of satellite rendezvous and inspection. At the same time, studies and analysis will be undertaken to define the configuration of the system. Development effort on certain long lead components required for the system will be included. The program is being conducted by AFBMD under System Development Requirement No. 18, 21 April 1960.

Program Objectives

● Design a prototype interceptor vehicle utilizing conservative choices of subsystems and a deliberate step-by-step development progression, emphasizing reliability and component compatibility. Conduct a feasibility demonstration of the rendezvous and inspection capability after ground tests have given assurance of system reliability. The flight demonstration will utilize an existing target satellite if one is properly orientated, otherwise a specially launched, passive, target satellite will be utilized. Conduct studies to determine the configuration and techniques of operation of the eventual system.

● Develop and ground test the critical subsystems required for the system but not provided in the demonstration program. These include a rendezvous maintenance system, additional inspection and data processing equipment, an integrated launch and homing guidance system, an advanced power supply and selected countermeasures equipment.

Satellite Inspector Feasibility Demonstration

● The Satellite Inspector System will provide a capability to intercept and inspect unidentified earth satellites which threaten the United States. In the demonstration, the prototype inspector vehicle will achieve a co-orbital rendezvous to within some fifty feet of the target satellite, obtain an image of the target through the TV System and relay the image to a ground station. The inspector vehicle will be sized and components selected so that much of the design might be applicable to the initial system which will be developed following a successful feasibility demonstration. Major subsystems of the interceptor vehicle are: maneuvering propulsion, radar seeker, guidance, TV inspection, computer, communications and telemetry, attitude control and electrical power.

● A total of four launches are planned from the Atlantic Missile Range, with the first launch in December 1962. The SAINT vehicle includes an ATLAS booster, an AGENA "B" second stage and the rendezvous vehicle which weighs approximately 1800 pounds.

● The demonstration program will utilize existing launch, tracking, and data reduction facilities insofar as possible. There will be requirements for additional ground support equipment at the Atlantic Missile Range and augmentation of the southeast Africa Tracking site to handle the telemetry and communications requirements for the demonstration. The target ephemeris will be determined for the demonstration program by tracking data from existing FPS-16 and Millstone Radars.

Satellite Inspector System

● Following the successful feasibility demonstration of a prototype satellite inspector, continued development could lead to an operational system. The complete system will provide a considerable increase in capability. For example, rendezvous would be maintained for a period of 48 hours to allow sufficient time to evaluate the sensor data. Additional sensors such as ferret, IR, X-Ray detectors, magnetometers, etc., will be included in the payload. Orbital altitude coverage will be extended to at least 1,000 nautical miles and the reaction time will be reduced to 12 hours after the target ephemeris has been determined. The system will comprise a complex of launch facilities, ground support equipment, assembly and launch checkout equipment, boosters, launch guidance equipment, rendezvous vehicle, telemetry and command and control subsystems, ground communications stations, together with any necessary technical manuals, procedures and personnel required to support the system. The launch vehicle may be an ATLAS first stage with a CENTAUR second stage.

SPACE
program boosters

Space
Program

BOOSTERS

● *The primary pacing factor in the accomplishment of space missions has been, and for some time will continue to be, the availability of Air Force ballistic missiles and upper stages to boost the payload vehicle. Space flight planning requires close examination of all technological areas wherein advances provide increases in booster and mission capability. This, in turn, has required that space schedules be sufficiently flexible to incorporate rapidly those advances in the state-of-the-art which increase the potential for reliable and predictable space research.*

● *Because of the wide range of its activities, AFBMD has accumulated a broad base of experience in booster selection for space missions. Experience in ballistic missile R&D programs and in development of upper stage vehicles have provided much information. Research programs in the propellant and materials areas also are providing new capability for space research. The number and variety of boosters available permit the selection of a combination of stages tailored to provide specific capabilities for specific missions.*

● *The following pages describe briefly the booster vehicles currently being used by AFBMD to support military and civilian space programs. Nominal performance data is given to permit nominal comparisons of vehicle capabilities. Specific qualifications are made where necessary for clarity.*

THOR

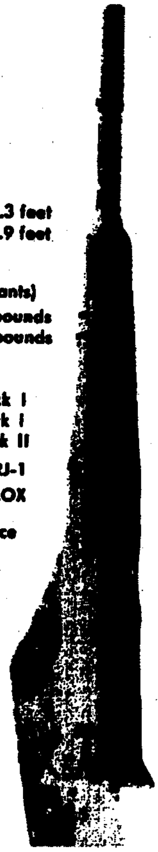
Prime contractor:
Douglas Aircraft Co.

Engine manufacturer:
Rocketdyne Div., North American Aviation

Height	
DM-18	61.3 feet
DM-21 (without re-entry vehicle)	56.9 feet
Weight (no residual propellants)	
DM-18	106,546 pounds
DM-21	108,395 pounds
Engine	
DM-18	MB-3 Block I
DM-21	MB-3 Block I
	MB-3 Block II
Fuel	RJ-1
Oxidizer	LOX

Guidance—removed on space booster flights

Used as first stage for:
DISCOVERER
ABLE-3 and -4
TRANSIT
COURIER
TIROS
NASA/AGENA B
DELTA



Early in 1958, the decision to accelerate the national space effort was made effectively possible only because of the availability of the THOR IRBM. THOR No. 127 was diverted from the R&D flight test program for use as the ABLE-1 space probe first stage. With top national priority assigned to the space research effort, THOR No. 163 was used to boost the DISCOVERER I into orbit on 28 February 1959. Since then, the THOR has become operational as an IRBM and has been very reliable as a space flight booster. During 1959 all THOR boosted space flights achieved successful first stage performance. THOR performance has been increased through weight reduction modifications and use of RJ-1 (instead of RP-1) fuel. A modified THOR, designated DM-21 incorporates a shortened guidance compartment and additional weight reduction changes. A later version of the DM-21 provides an increase in thrust to 167,000 pounds through installation of the MB-3-Block II engine.

ATLAS

Prime contractor:
Convair

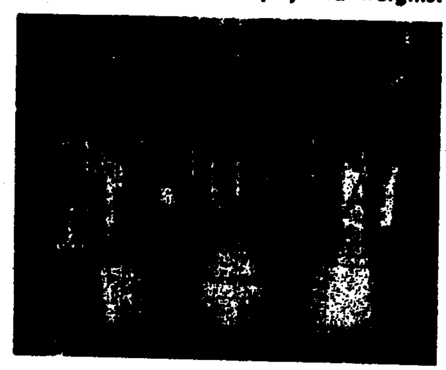
Engine manufacturer:
Rocketdyne Div., North American Aviation

Height	69 feet
Diameter	10 feet
Weight	261,206 pounds
Engine	
Series D ATLAS	MA-2
Fuel	JP-4
Oxidizer	LOX

Guidance—Radio-Inertial
General Electric (radar)
Burroughs Corp. (computer)

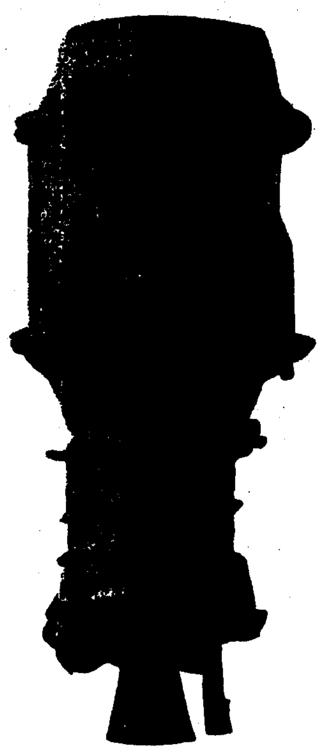
Used as first stage for:
SAMOS
MIDAS
COMMUNICATIONS SATELLITE
ABLE-4 and -5
PROJECT MERCURY

THE ATLAS ICBM, providing over twice the thrust of the THOR, is being used as the first stage booster for the three Advanced Military Satellite Programs and for Project Mercury man-in-space. The first ATLAS boosted space flight was launched from the Atlantic Missile Range on 18 December 1958. Designated Project Score, this vehicle (ATLAS 10B) successfully placed a communications payload into orbit around the earth. In November 1959 the ABLE-4 space probe did not attain its objective, however, ATLAS first stage performance was successful. The first ATLAS-boosted flight test vehicle in Project Mercury was launched on 7 September with test objectives satisfactorily achieved. ATLAS performance on both the 26 February and 24 May MIDAS launches also was satisfactory. Future flights will use modified ATLAS series "D" missiles to carry increased payload weights. Project Mercury boosters also include abort-sensing and other pilot safety features. The success of the ATLAS boosted space flights to date plus the performance and reliability being demonstrated in the ATLAS R&D flight test program, lend confidence in this booster as a reliable means of realizing advanced space objectives.



AGENA

Although originally designed as the basic satellite vehicle for the Advanced Military Satellite Programs, flight testing of the AGENA was accelerated when the DISCOVERER program was created, using the THOR/AGENA combination. Because of its availability, the Bell Aircraft LR81-Ba-3 rocket engine was selected for AGENA propulsion, and later modified to use unsymmetrical di-methyl hydrazine instead of JP-4 fuel. Subsequent modifications resulted in the AGENA "B" configuration, in which propellant tank capacity was doubled and the engine modified to provide single restart and extended burn capabilities. The increased performance of this design greatly enhanced the potential of the THOR/AGENA combination. An optical inertial system for guidance and orbital attitude control was developed to meet the critical orbital eccentricity and attitude requirements for the programs involved. Gas jets and reaction wheels are used to control attitude. Payloads may be installed on the forward equipment rack or distributed throughout the vehicle. The flight test program also has been used to develop a recovery capability for a payload capsule which is ejected from the orbiting satellite.



Prime contractor:
Lockheed Missile and Space Division

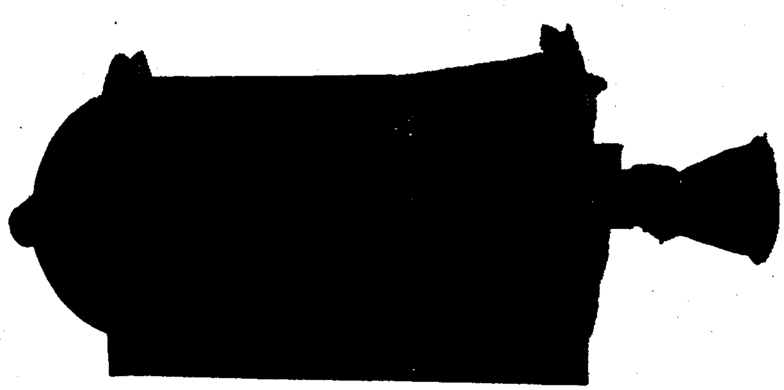
Engine manufacturer:
Bell Aircraft Corp.
American Aviation

Length	
"A" version	14 feet
"B" version	19.5 feet*
	21 feet**
Diameter	60 inches
Weight	
"A" version	7,987 pounds
"B" version	14,800 pounds
Engine	
"A" version	YLR81-Ba-5
"B" version	XLR81-Ba-7*
	XLR81-Ba-9**
Fuel	UDMH
Oxidizer	IRFNA
Guidance	optical-inertial

Used as second stage for:
DISCOVERER
SAMOS
MIDAS

ABLE-STAR Vehicle

The ABLE-STAR upper stage vehicle contains an AJ10-104 propulsion system which is an advanced version of earlier Aerojet-General systems. In addition to providing increased performance capability, the system includes automatic starting, restarting, shutdown, ground control, coast period pitch and yaw control, and ground monitoring systems. Propellants are fed to the thrust chamber by a high pressure helium gas system. The thrust chamber is gimballed by electrical signals to provide pitch and yaw control during powered flight. Roll control during powered flight is achieved by expelling nitrogen through a system of nozzles in response to electrical signals. Roll control during coast periods uses a parallel circuit at lower thrust. Attitude control for coast periods up to one-half hour provided in the current design can be extended by increasing the nitrogen supply.



Contractor:
Aerojet-General

Height	14 feet 3 inches
Diameter	4 feet 7 inches
Weight	9772 pounds
Engine	AJ10-104

with Restart Capability
Nozzle Expansion Ratio—40.1

Fuel
Unsymmetrical Dimethyl Hydrazine

Oxidizer
Inhibited Red Fuming Nitric Acid

Guidance
STL Advanced Guidance System
Burroughs J-1 Computer

Used as second stage for:
TRANSIT 1B, 2A, 2B
COURIER 1A, 1B

ABLE Vehicle

The ABLE upper-stage vehicle has been flight tested successfully as the second stage on THOR re-entry vehicle tests, ABLE Projects and TRANSIT 1A. The vehicle uses AJ10-42 or AJ10-101 propulsion systems (improved versions of systems used originally on the Vanguard Program), guidance systems, and electronic and instrumentation equipment. The ABLE vehicles are guided during second stage engine burning. Vehicles using the AJ10-101 system are spun with the third stage and payload prior to second stage engine burnout to provide spin stabilization of the unguided third stage and payload. On flight vehicles using the AJ10-42 propulsion system, only the third stage and payload are spun prior to second stage separation by a spin table bearing system located at the second to third stage separation plane. Only minor differences exist between the two propulsion systems.

Contractor:
Aerojet-General Corp.

Height	18 feet 7 inches
Diameter	4 feet 8 inches
Weight	
AJ10-42	4622 pounds
AJ10-101	4178 pounds

Fuel
Unsymmetrical Dimethyl Hydrazine

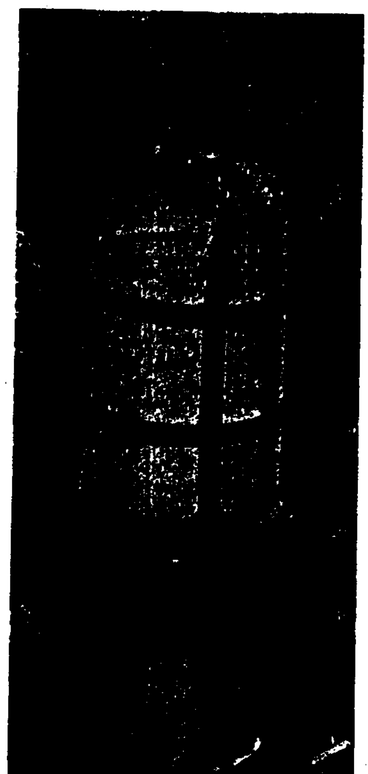
Oxidizer
Inhibited White Fuming Nitric Acid

Guidance
AJ10-42
Radio-inertial (BTL)
AJ10-101
Advanced Guid. Syst. (STL)
Computer (Burroughs J-1)

Used as second stage for:
AJ10-42 — TRANSIT 1A, TIROS
AJ10-101 — ABLE 3 and 4

ABL 248 Vehicle

Development of the Allegany Ballistics Laboratory X-248 engine for the Vanguard Program was accelerated when it was selected as the third stage for Project ABLE-1. The unit represented the most advanced solid propellant engine of its size available at the time. Since the engine had not been qualification or flight tested, test firings were conducted in a vacuum chamber simulating approximately 100,000 feet altitude. Design modifications involving the igniter, nozzle, and internal insulation were found to be required. The modified engine performed with complete satisfaction on the successful flight of ABLE-1 and subsequently on ABLE-3 and ABLE-4 THOR.



Contractor:
Allegany Ballistic Laboratory

Height	4 feet 10 inches
Diameter	1 foot 6 inches
Weight	515 pounds
Fuel	Solid

Used as third stage on:
ABLE 3 and 4
TRANSIT 1A, TIROS

Specifications....

FIRST STAGE

THOR	A DM-18	B DM-21
Weight—dry	6,950	6,500
Fuel	33,700	33,700
Oxidizer	68,200	68,200
TOTAL WEIGHT	108,850	108,400
Thrust-lbs., S.L.	152,000	167,000
Spec. Imp.-sec., S.L.	247.8	248.3
Burn Time—sec.	163.0	148.0

ATLAS	C Series D
Weight—wet	15,100
Fuel	74,900
Oxidizer	172,300
TOTAL WEIGHT	262,300
Thrust-lbs., S.L.	
Boost	356,000
Sustainer	82,100
Spec. Imp.-sec.	
Boost	286
Sustainer	310

SECOND STAGE

AGENA	D "A"	E "B"	F "B"
Engine Model	YLR81-Ba-5	XLR81-Ba7③	XLR81-Ba-9④
①Weight—inert	1,262	1,328	1,346
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
②TOTAL WEIGHT	8,165	14,789	14,807
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn Time—sec.	120	240④	240④

NOTES

① *Payload weight not included. Does include controls, guidance, APU and residual propellants.*

② *Does not include THOR adapter (225 lbs.) or ATLAS adapter (315 lbs.).*

③ *Single restart capability.*

④ *Dual burn operation.*

⑤ *Allegany Ballistic Laboratory.*

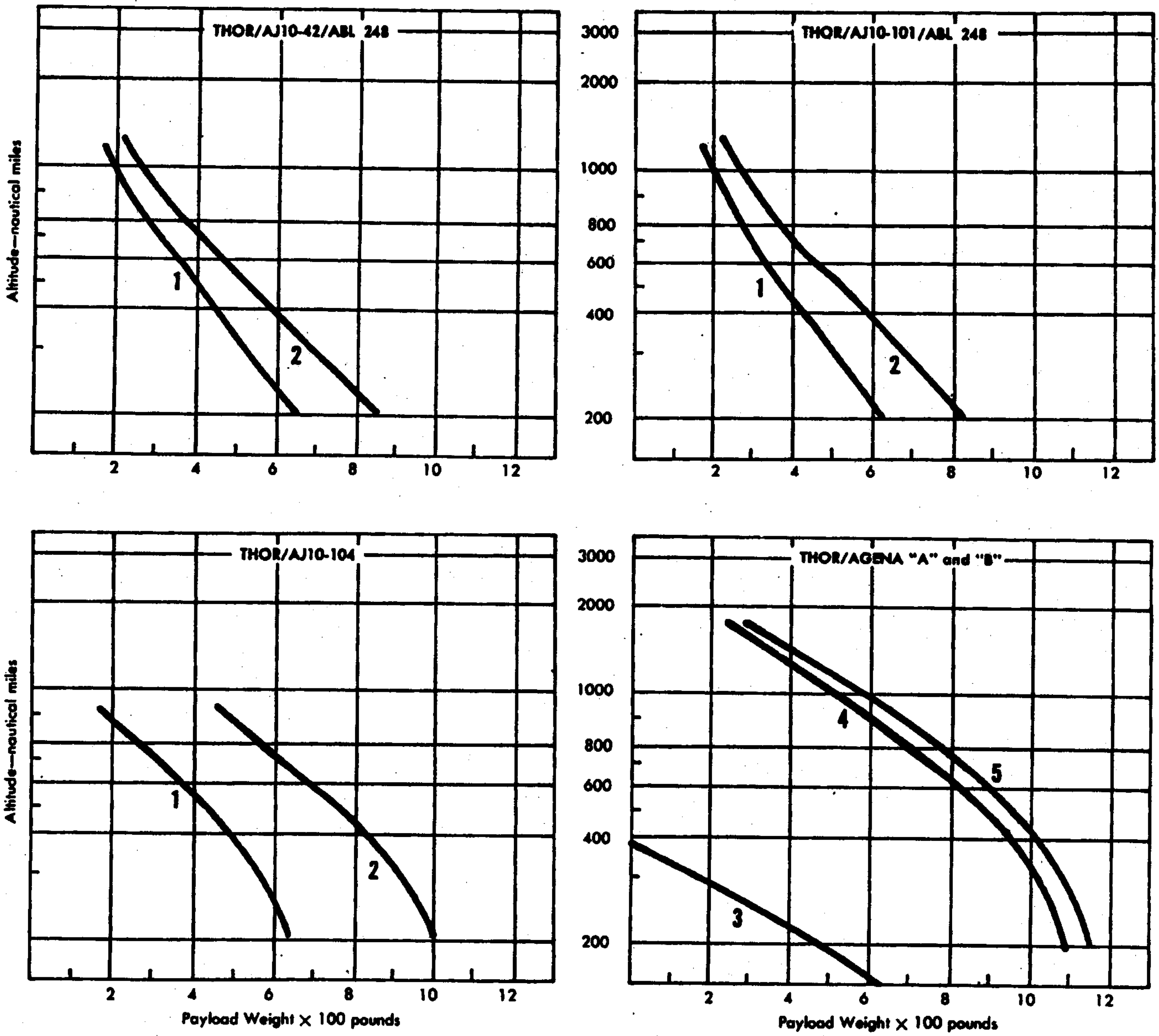
SECOND STAGE / THIRD STAGE

	G AJ 10-42	H AJ 10-101	J AJ10-104 ABLE-STAR	K ⑤ABL 248
Weight—wet	1,247.1	847.9	1,297	59.5
Fuel	875.1	869.0	2,247	455.5
Oxidizer	2,499.6	2,461.0	6,227	(solid)
TOTAL WEIGHT	4,621.8	4,177.9	9,771	515
Burnout Weight	1,308.6	944.1	1,419	50.5
Thrust-lbs., vac.	7,670	7,720	7,900	3,100
Spec. Imp.-sec., vac	267	267	278	250.5

Program Vehicle Combinations

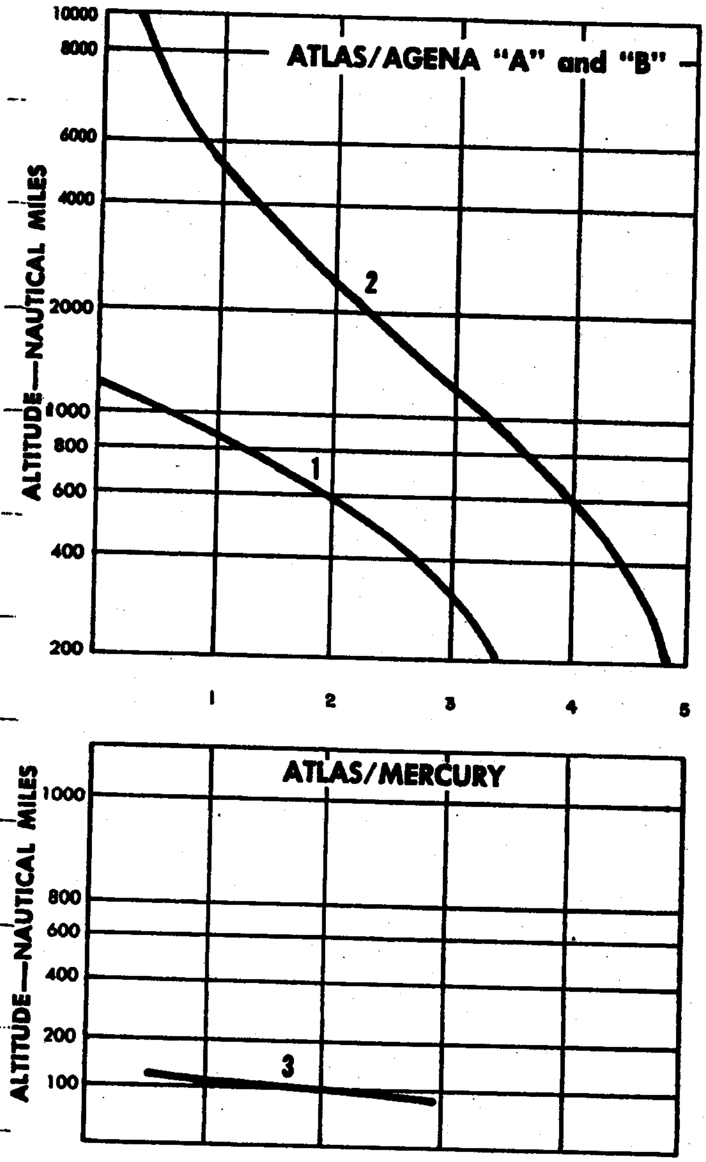
DISCOVERER (1 thru 15).........A-D
DISCOVERER (16 thru 19)........A-E
DISCOVERER (20 and subs)........B-F
COMM. SATELLITE ....C-E
COMM. SATELLITE ....C-F
MIDAS (1 and 2).............C-D
MIDAS (3 and subs.)..........C-F
SAMOS (1 thru 3)............C-D
SAMOS (4 and subs)..........C-F
ABLE-1 and -3.............A-H-K
ABLE-4 and -5............C-H-K
ABLE-4 ....A-H-K
TRANSIT IA ....A-G-K
TRANSIT 1B, 2A, 2B..........A-J
COURIER ....A-J
TIROS ....A-G-K

Performance Graphs — THOR BOOSTED

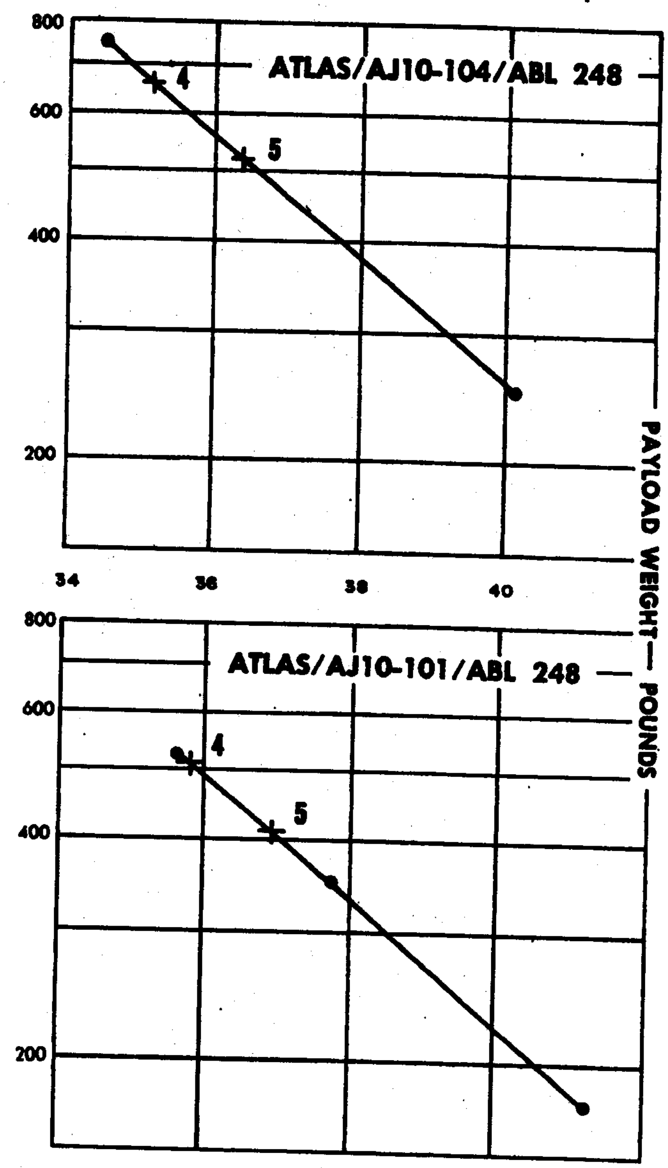


1. Polar—AMR or VAFB
2. AMR—90 degrees
3. VAFB—AGENA "A"
4. VAFB—AGENA "B" (XLR81-Ba-7)
5. VAFB—AGENA "B" (XLR81-Ba-9)

Performance Graphs — ATLAS BOOSTED



PAYLOAD WEIGHT × 1000 POUNDS



BURNOUT VELOCITY—FPS X 1000

1. AGENA "A"— Polar Orbit
2. AGENA "B"— Polar Orbit
3. AMR—90 degrees
4. Lunar Probe
5. Venus Probe

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6594 Test Wing (Satellite)	2
1002 Insp. Gen. Group	1
3415 Technical Training Group	1
Tactical Air Command	2
8th Air Force	1