
SPACE

a foreword to...

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

31 July 1960

FOREWORD

Activities summarized in the report include the major space systems, support programs, defense programs and studies 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 occuring advances in the state-of-the-art.

for Col USAF
O. J. RITLAND
Major General, USAF
Commander

SATELLITE

systems

DISCOVERER
SAMOS
MIDAS
COMMUNICATIONS SATELLITE

SATELLITE SYSTEMS

DISCOVERER

The DISCOVERER Program consists of the design, development and flight testing of 35 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.

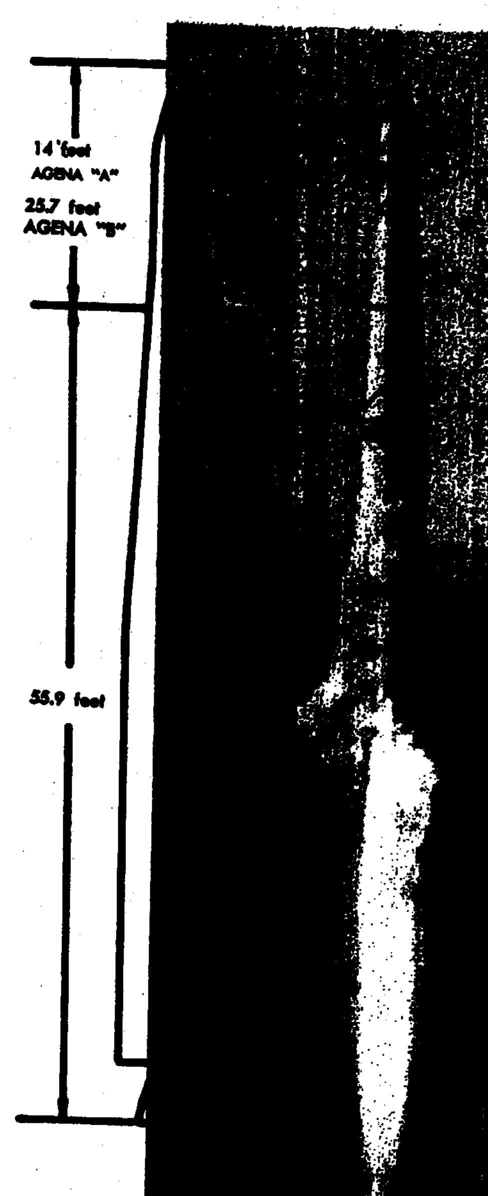
(e) Testing of ground support equipment and development of personnel proficiency.

(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 Altô, 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.



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

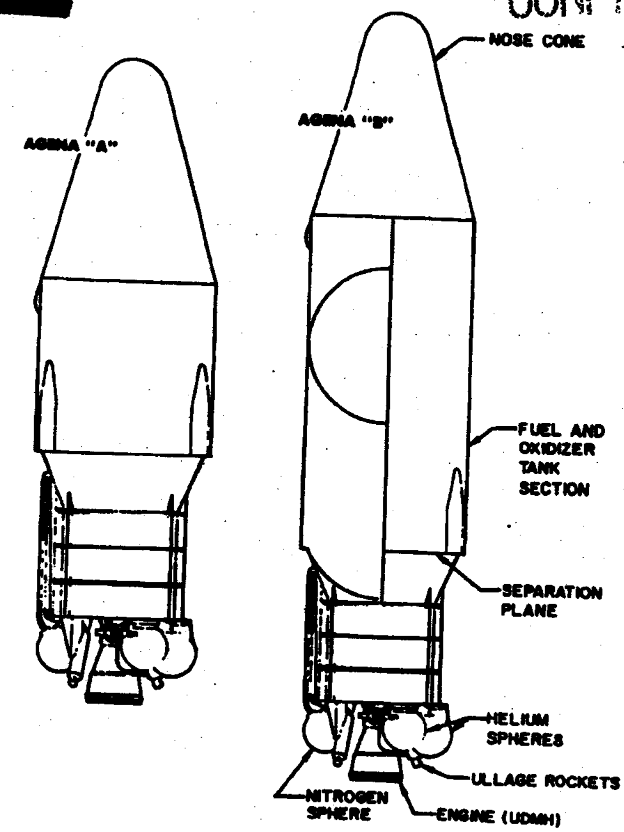
Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and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

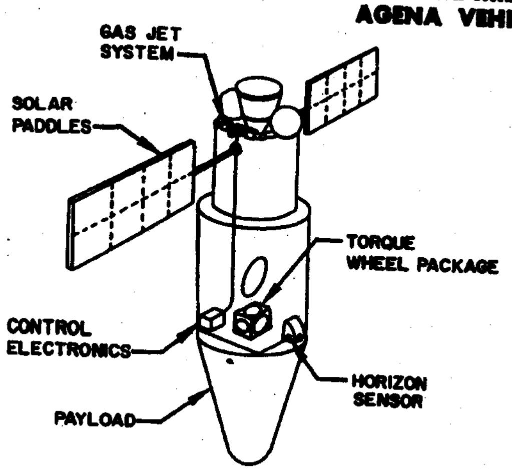
AGENA VEHICLE DEVELOPMENT

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

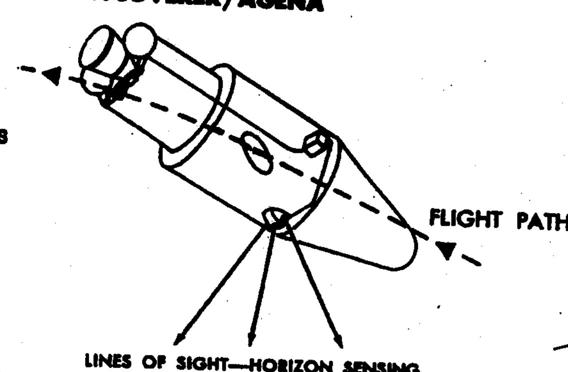


DISCOVERER/AGENA

PERFORMANCE CAPABILITIES

ALTITUDE
200–20,000 MILES

ATTITUDE
ROLL – 0.1 DEGREE
PITCH – 0.1 DEGREE
YAW – 1 DEGREE



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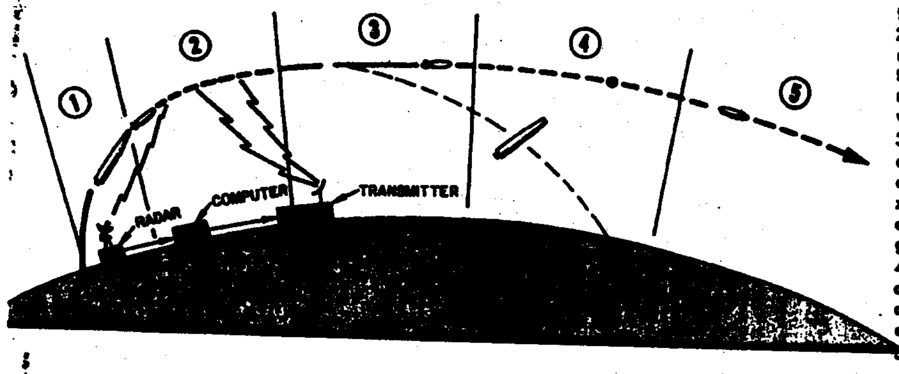
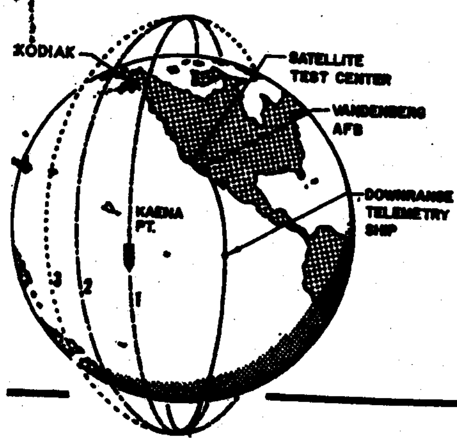
Powered Flight Trajectory

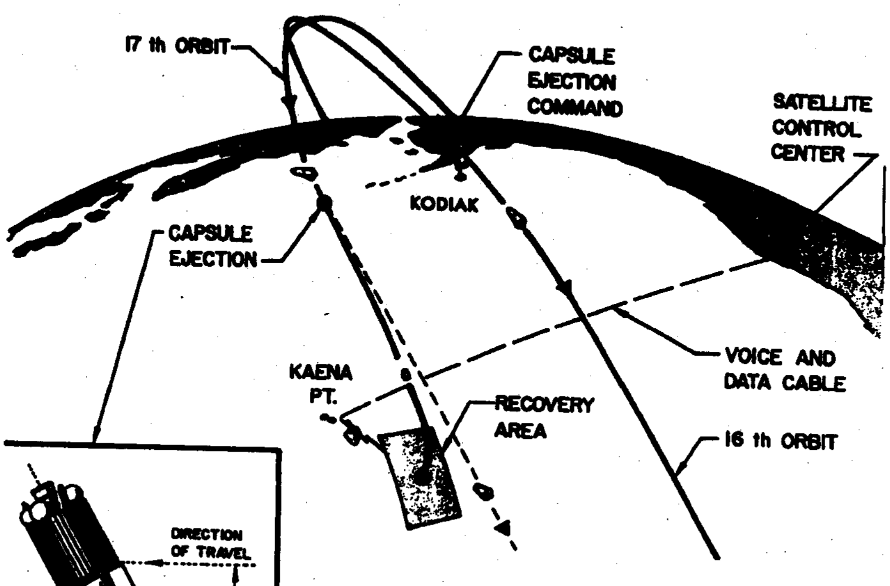


1. **First Stage Powered Flight**—2.5 minutes duration, 78 n.m. downrange, guided by programmed auto pilot.
2. **Coast Period**—2.4 minutes duration, to 380 n.m. downrange; altitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity 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).



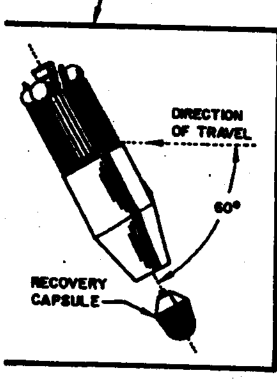
Orbital Trajectory

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.



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 RECOVERY SEQUENCE

Capsule ejection command is sent to the satellite by the Kodiak, 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.

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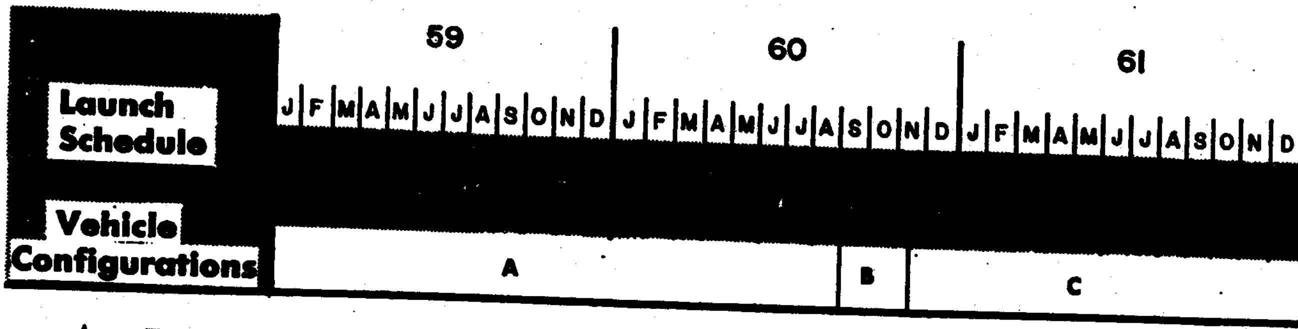
Facility	Equipment*	Flight Function
Satellite Test Center	A	Over-all control, convert tracking stations data to obtain a predicted orbit and generate subsequent ephemerides issue acquisition data to tracking stations for subsequent passes, predict recovery area.
Vandenberg AFB	BCDEFGHIJK	Launch, ascent 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

0 Attained orbit successfully.

● Failed to attain orbit.

Flight History

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

Monthly Progress—DISCOVERER Program

Flight Test Progress

- The launch of DISCOVERER XIII is scheduled for 10 August. DISCOVERER XIV is scheduled for 18 August.

- DISCOVERER XIII will carry a diagnostic payload in addition to the normal recovery equipment. This payload contains instrumentation to determine capsule environment and the functioning of separation and recovery sequence events. A five-channel telemetry system is installed to transmit this data. To assure receipt of all data, a tape recorder is 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, this stored data will be transmitted. The high speed of re-entry induces ionization over the skin of the capsule which effectively blocks telemetry transmission. An S-band transponder is also provided to aid in tracking the capsule from ejection through recovery.

Technical Progress

Second Stage Vehicles

- Three AGENA "B" vehicles (XLR-81-Ba-7 engines) are now in storage following Air Force acceptance.

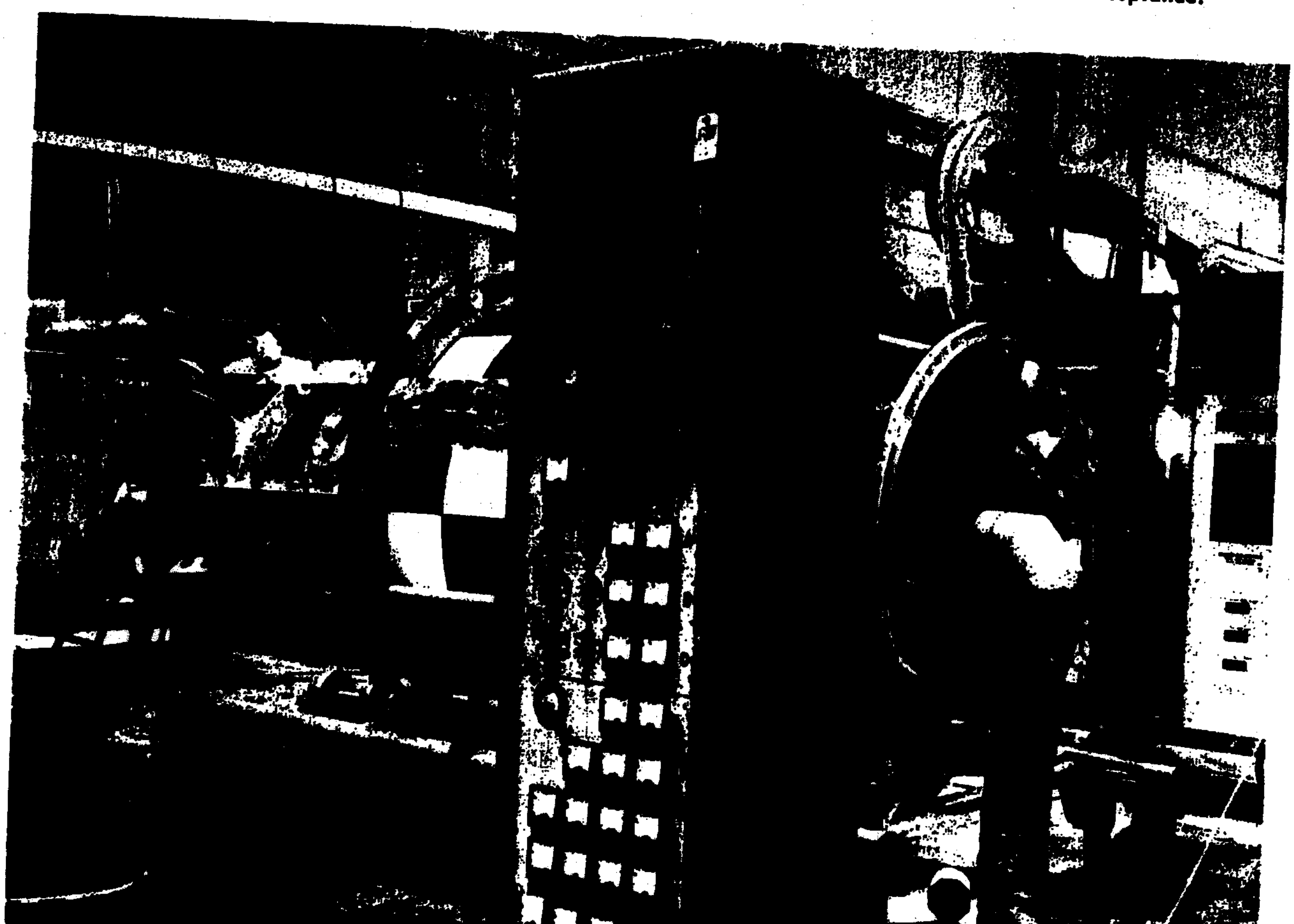


Figure 1. DISCOVERER XIII AGENA "A" vehicle (No. 1059) undergoing systems tests in the missile assembly building at Vandenberg Air Force Base. Following these checks the fairings will be installed and the vehicle will be transported to the launch pad for installation on the THOR booster. DISCOVERER XIII is scheduled for launch on 10 August.

These vehicles will be moved to the Vandenberg Air Force Base missile assembly building as required for launch. The first two AGENA "B" vehicles using the XLR-81Ba-9 engine are undergoing hot firing acceptance tests at Santa Cruz Test Base.

RF Interference Test Program

- The cause of improper horizon scanner operation during the DISCOVERER XII flight was determined to be RF interference from the satellite telemetry transmitter. A modification has been incorporated to correct this condition. Subsequent testing has revealed on RF interference with the scanner at any frequency or transmitter power level.

Recovery System Component Test Program

- The third and fourth successful balloon drops of the recovery system series were made at Holloman Air Force Base on 23 and 27 July. The retro rocket and spin/de-spin systems functioned satisfactorily. These were the second and third successful dynamic tests of the "cold gas" spin system. In both test chaff was dispensed from the pilot chute deployment bag and did not contact the main chute, indicating that the prior interference problem has been solved.

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

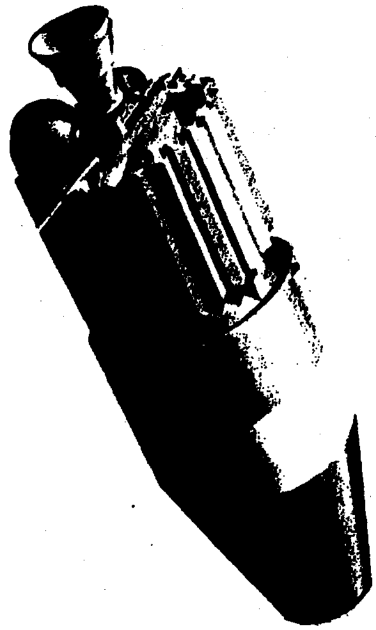
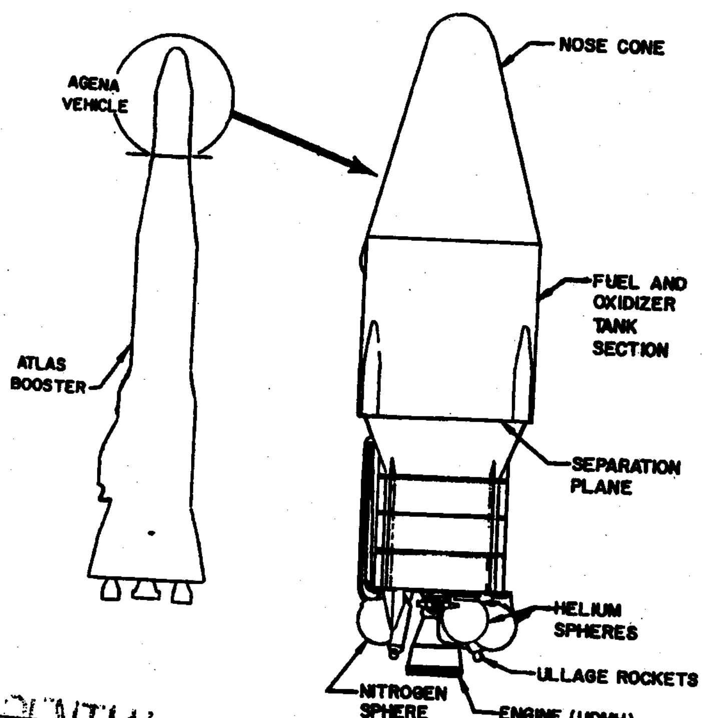


Figure 1.

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.

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. Determination of characteristics of enemy electronic emissions.

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

c. Location and evaluation of defenses.

d. Evaluation of military and industrial strength.

e. Assessment of high-yield weapons damage.

f. Reconnoitering of troop movements.

g. Location of naval forces throughout the world.

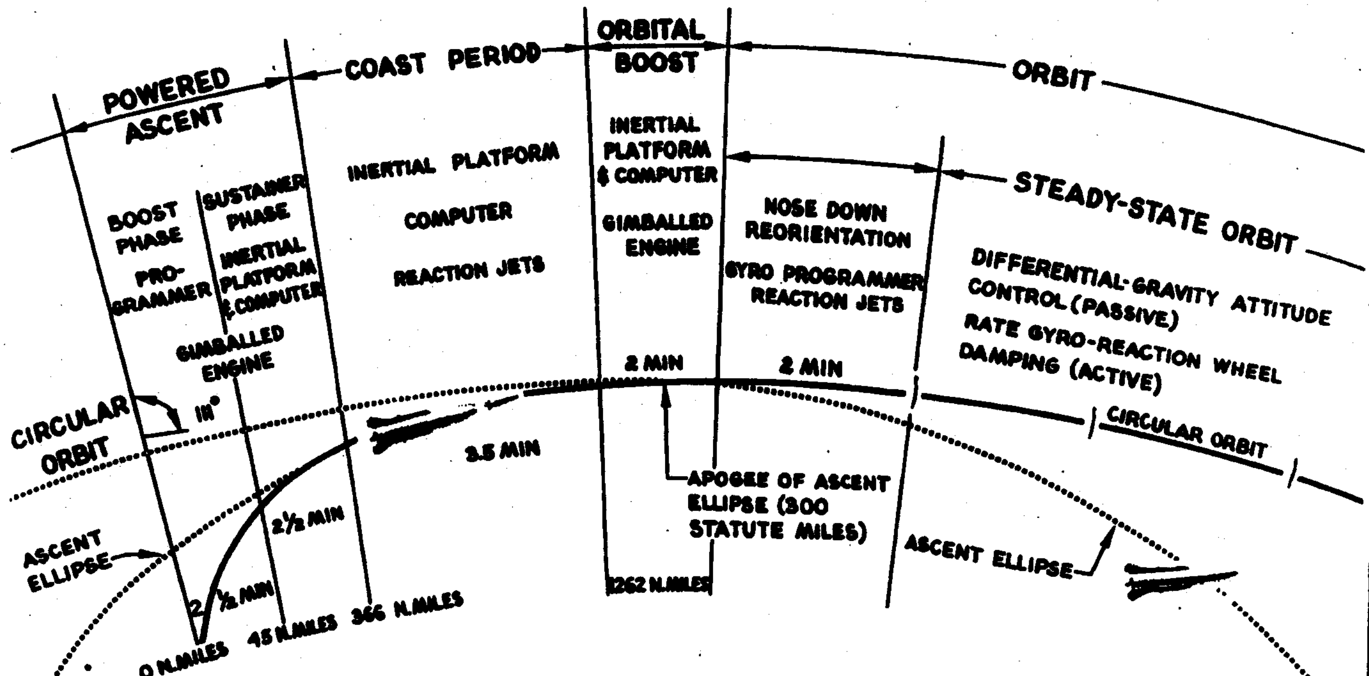


Figure 2. Typical SAMOS trajectory, launch-to-orbit.

Ferret Reconnaissance...

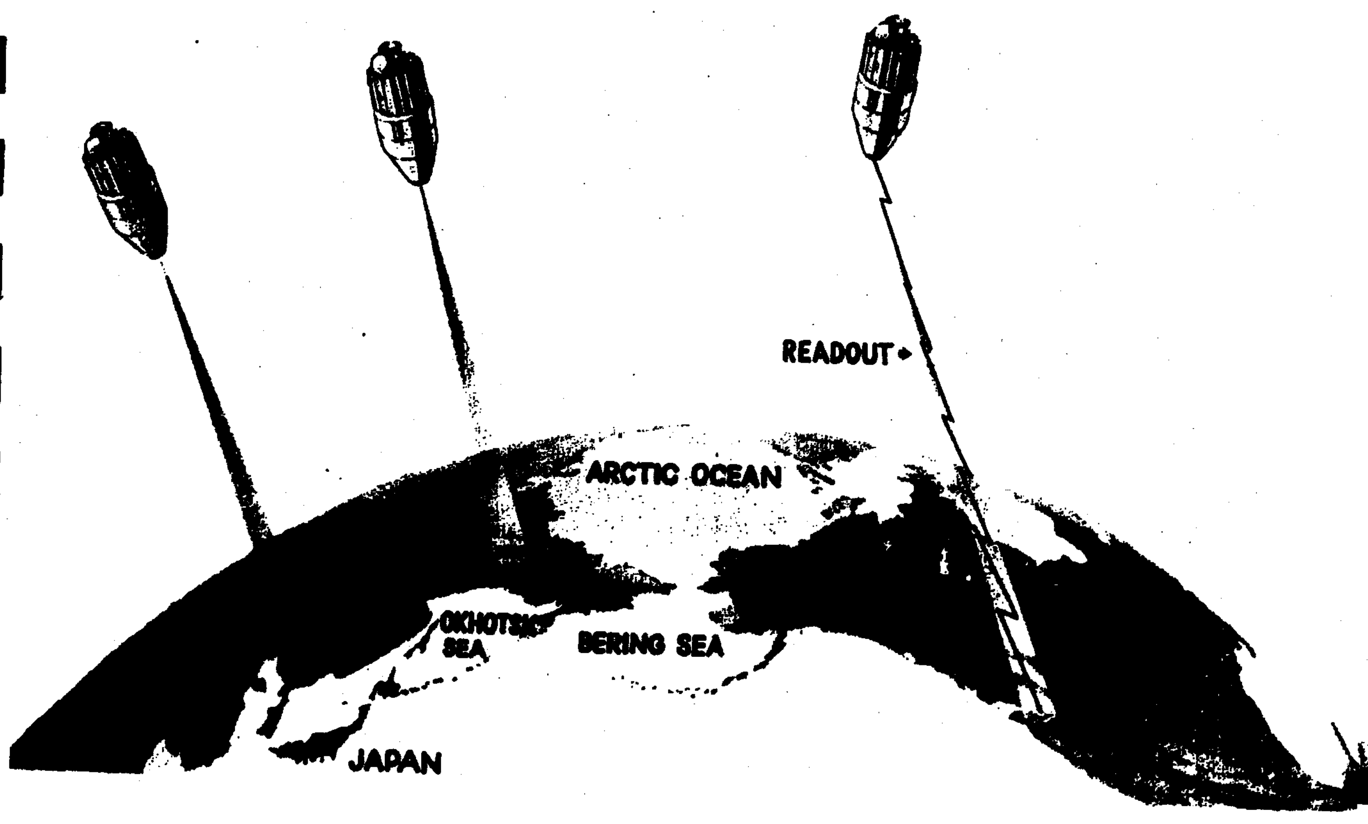


Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over areas of interest.

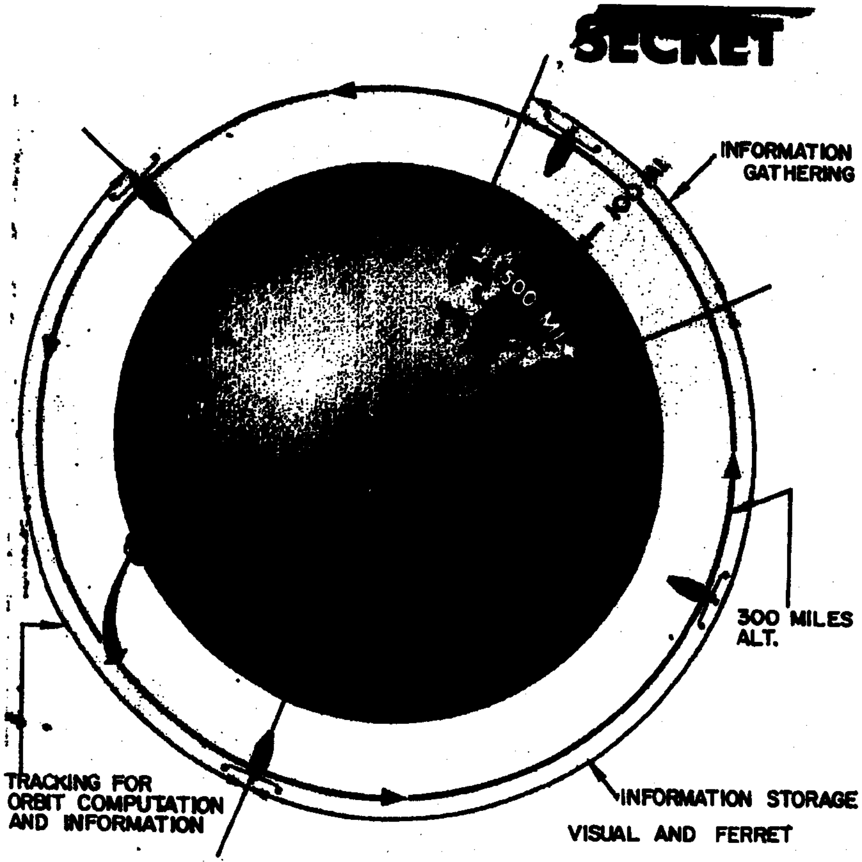


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over the area of interest the sensing equipment is turned on (Information gathering). When it leaves the area of interest the sensing equipment is turned off and the sensing data is processed (Information storage). When the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

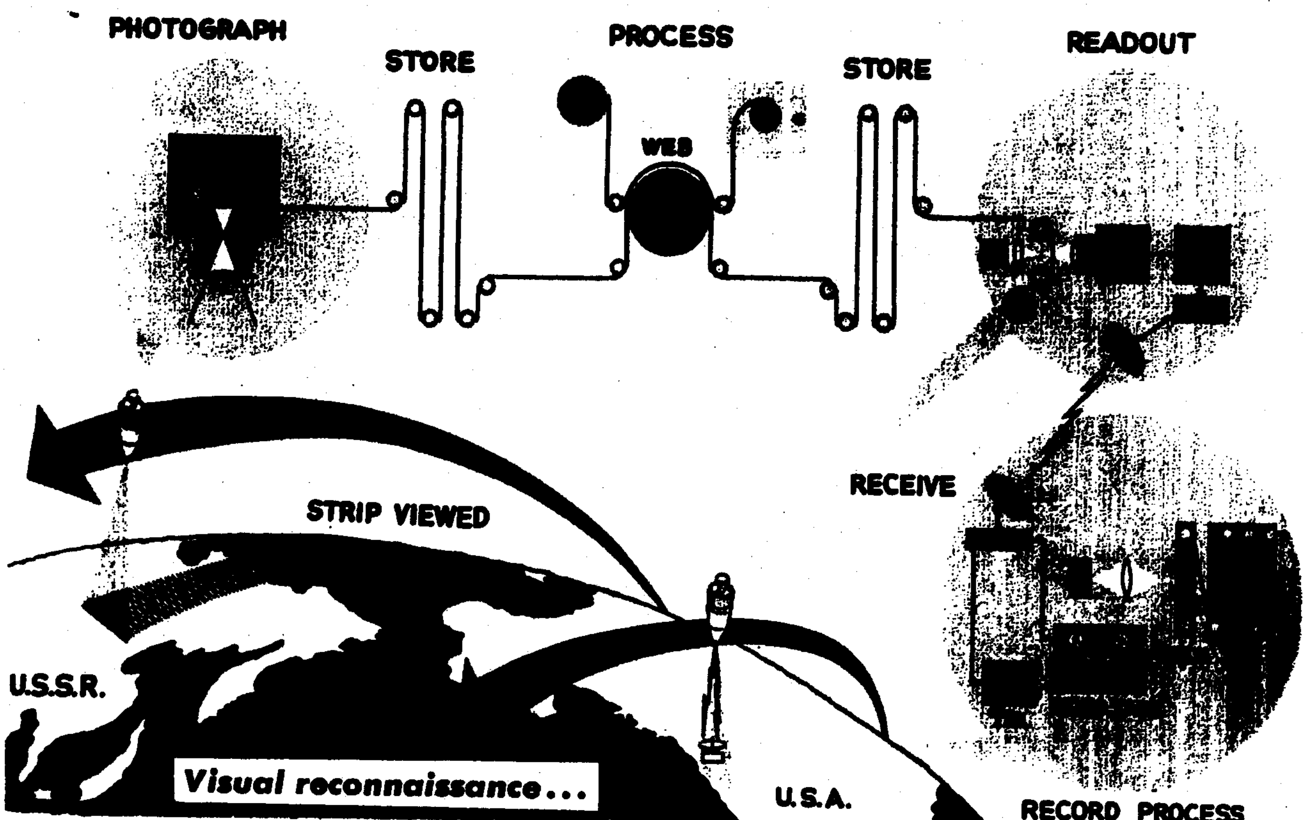


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects 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 used during the early development phase. 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 and retrieved 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 also include a re-entry capsule and a recovery force.

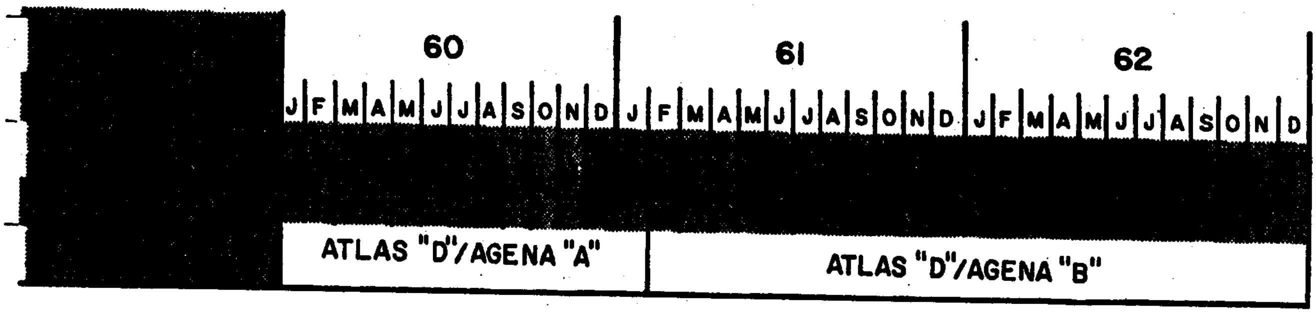
CONCEPT

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 23 ½ 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 [illegible] days. [illegible] dependent upon the 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—Three versions (E-1, E-2, and E-5) 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.

Ferret Program—Ferret payloads are being developed on a progressively more advanced basis from R&D (F-1) to advanced systems (F-4). 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 AGENA vehicle for the first SAMOS flight was delivered to Vandenberg Air Force Base following successful captive hot firing tests and completion of dynamic systems testing at Santa Cruz Test Base. The vehicle is proceeding on schedule through modification and subsystem bench testing in the missile assembly building. Although impeded by parts shortages and the recent strike, schedules are being maintained to assure transfer of the vehicle to the launch pad by 19 August.

- The AGENA vehicles for the second and third flights are currently in the modification and subsystem test phases at the systems test area. Both vehicles are behind schedule because of the recent one-month strike and parts shortages. Efforts to recover current schedules are dependent upon continued availability of airborne communications equipment. The second flight vehicle is short the UHF narrow-band and wide-band data link transmitters. A firm delivery date is not available from the narrow-band transmitter contractor; however, a backup flight unit was received on 25 July. Delivery of a wide-band transmitter to replace the one used in the first flight vehicle has been made. The third flight vehicle has eight major airborne communications equipment shortages. Since delivery of these units is not expected before mid-August, it is doubtful that the schedule can be recovered.

- The first AGENA "B" vehicle is in the major subassembly phase of manufacture. Assembly was delayed by the recent strike, but every effort is being made to regain the schedule.

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—General Area Coverage, Recoverable Payload (with at least 20-foot ground resolution)

Payloads

E-1 Payloads—Checkout and testing of the E-1 payload are progressing satisfactorily at Vandenberg Air Force Base.

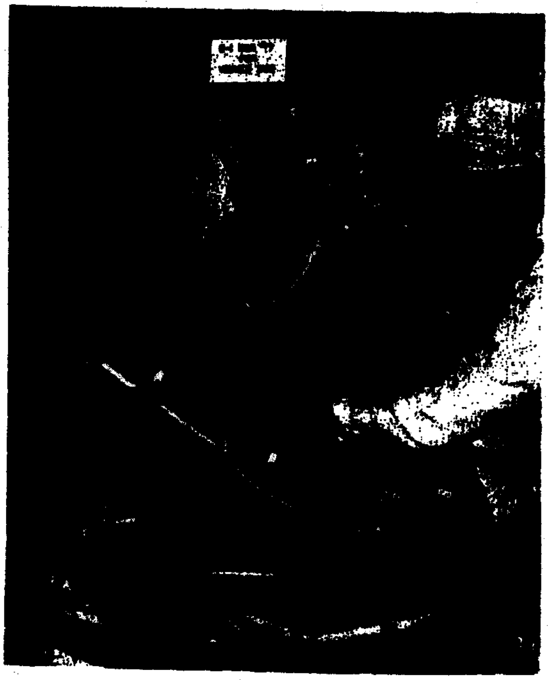


Figure 7. E-1 payload for first SAMOS flight showing technician installing pre-exposed, predeveloped film prior to testing the payload readout phase of operation.

E-2 Payloads—Initial E-2 payload component testing and assembly is progressing satisfactorily at Eastman Kodak. All components for the first flight payload (to be carried on the fourth SAMOS flight) are assembled and component qualification tests arc underway prior to final payload assembly. Environmental tests of the thermal mock-up in the high altitude temperature simulator indicate that successful environmental control of critical components can be achieved under both hot and cold orbital conditions.

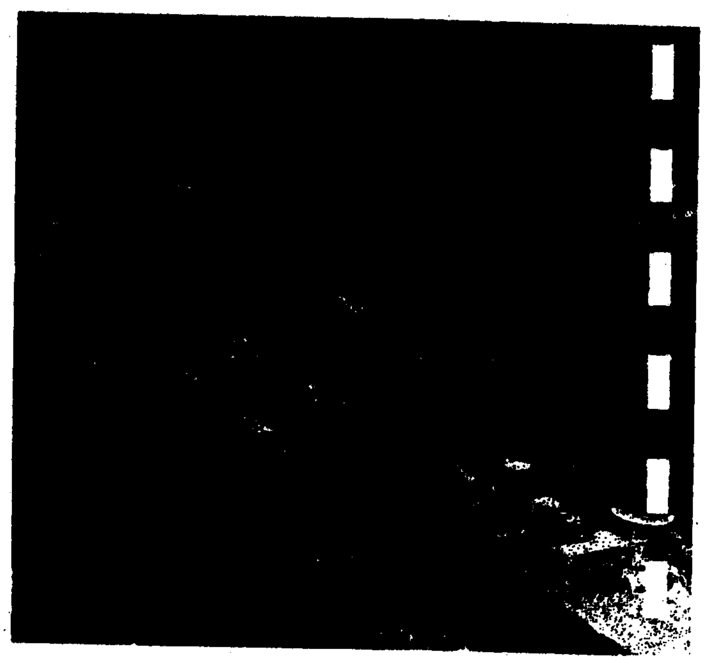
E-5 Payload—Development of the E-5 recovery payload continues on schedule. Design releases for the full-scale test models are nearing completion and fabrication of the initial test capsules is in progress. Wind tunnel tests of the aerodynamic configuration have been completed, except for the shock tunnel tests now being conducted at Cornell Aeronautical Laboratories. Aerodynamic/thermodynamic tests of the ablative heat shield are scheduled to begin at the Avco Corporation test facility in early August. A series of drop tests were initiated on 11 July at El Centro, California to evaluate the merits of a single large parachute and a cluster of three smaller parachutes to determine the most suitable configuration for capsule final descent. Tests to determine capsule drag and oscillation characteristics during retrieval into a recovery aircraft have started at Edwards Air Force Base.

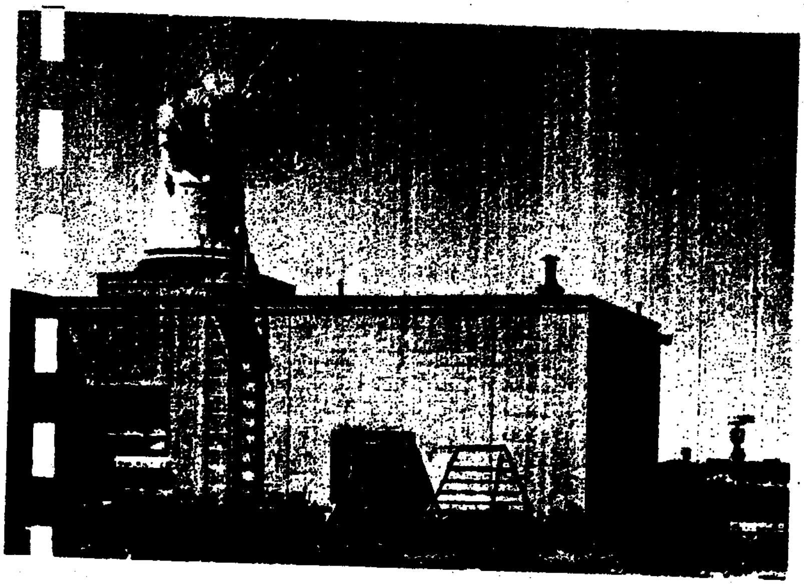
Ground Support Equipment

- Delivery of major items of ground equipment to Vandenberg Air Force Base in support of the initial SAMOS flights is now complete. The electronics package for the visual reconnaissance payload vacuum test chamber was shipped to the missile assembly building on 20 July.

- Installation of the E-1 operating console, the second set of E-1/E-2 visual reconnaissance ground reconstruction electronics equipment, and two primary record cameras in the Vandenberg Air Force Base data acquisition and processing building were completed during the report period. Installation of the UHF equipment required for initial SAMOS operations at the Vandenberg Air Force Base tracking and acquisition station is complete, and the equipment is undergoing systems integration. Also completed was the installation of the Model 1604 computer.

- Assembly and checkout of the Programmable Integrated Control Equipment (PICE), to be available for the third and subsequent SAMOS flights, are





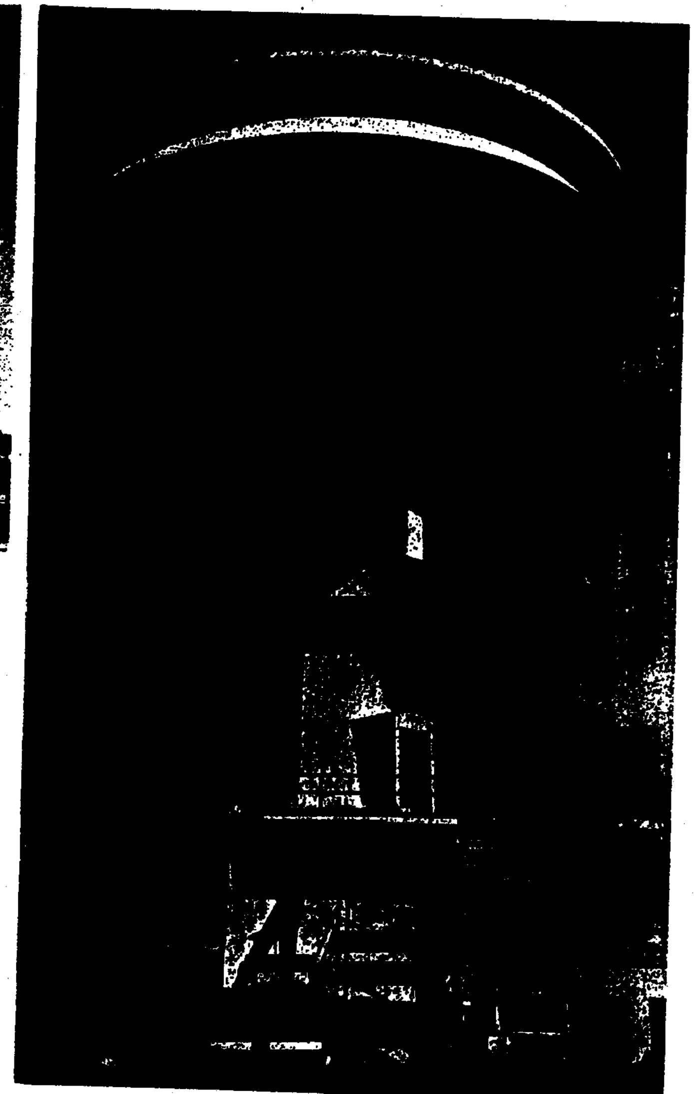
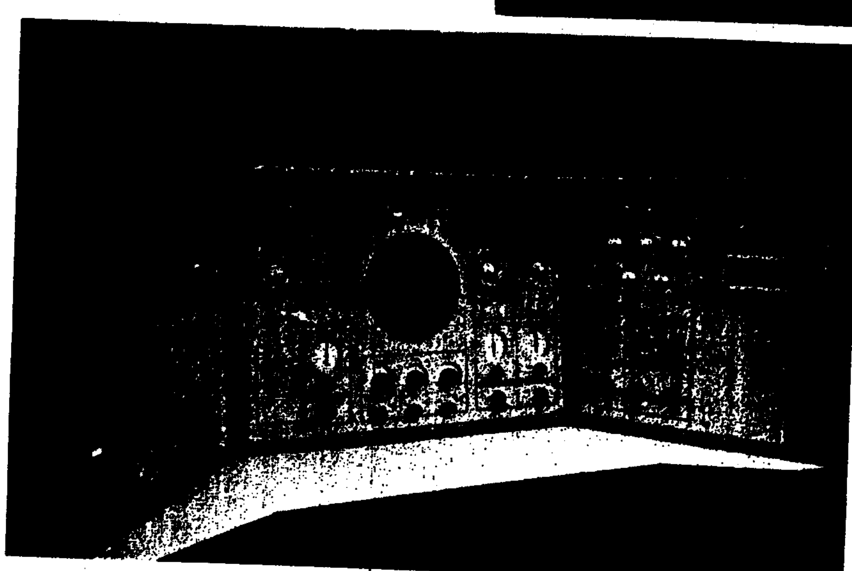


Figure 8. Aerial view (opposite page, lower) of the Vandenberg Air Force Base tracking and data acquisition station. The TLM-18 VHF antenna is in the upper left of the picture and the 60-foot telemetry and data antenna is in the lower right. UHF angle tracking antenna and control building (above) at Vandenberg Air Force Base. Sixty-foot antenna is in the background. Closeup (right) of the 60-foot UHF tracking and data antenna. Angle tracker console (below) with equipment racks in the background. This equipment is undergoing systems integration tests.



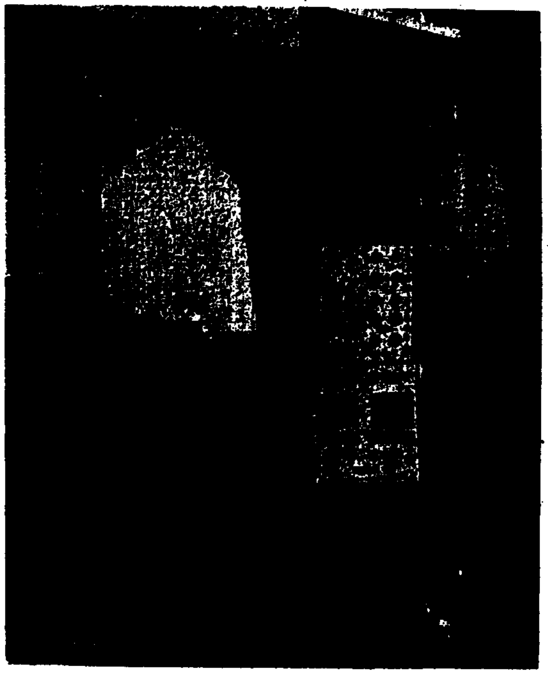


Figure 9. Checking Programmable Integrated Control Equipment (PICE) control cabinet operation. The first set is scheduled for installation at Vandenberg Air Force Base in September.

progressing on schedule at the contractors facility. Functional checkout and compatibility tests of set No. 1 are now in progress. Delivery to the Vandenberg Air Force Base tracking and acquisition station is scheduled for September. Set No. 2, scheduled for delivery to the Satellite Test Center 60 days after completion of Set No. 1, is in final assembly.

Ferret Reconnaissance System

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

F-1—Component Test Payloads

F-2—Digital General Coverage Payloads

F-3—Specific Mission Payloads—Analog Presentation

Payloads

F-1 Payloads—The F-1 payload, previously deleted from the first SAMOS flight, was reinstated on 26 July. Checkout and testing of the payload has been accelerated at Vandenberg Air Force Base.

Ground Support Equipment

● The F-1 operating console has been delivered to the data acquisition and processing building at Vandenberg Air Force Base.

Facilities

● Construction of all facilities required for the first SAMOS flight is complete, and installation and checkout of equipment are progressing at a rate compatible with the scheduled launch date. Systems testing of the Pad 1 complex at Point Arguello was completed late in July.

● Bid opening for the Point Arguello diesel generator building was held on 26 July. A total of twelve bids ranging from $184,000 to $249,000 were received.

● The SAMOS laboratory building at Vandenberg Air Force Base was completed and accepted on 18 July, with minor deficiencies remaining to be corrected. Design of the Vandenberg Air Force Base helium unloading and storage facility has been initiated with design completion scheduled in early October.

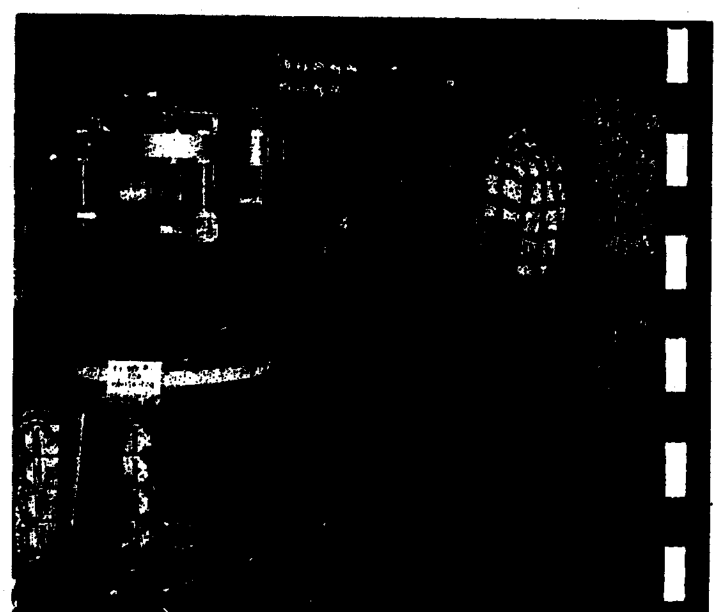
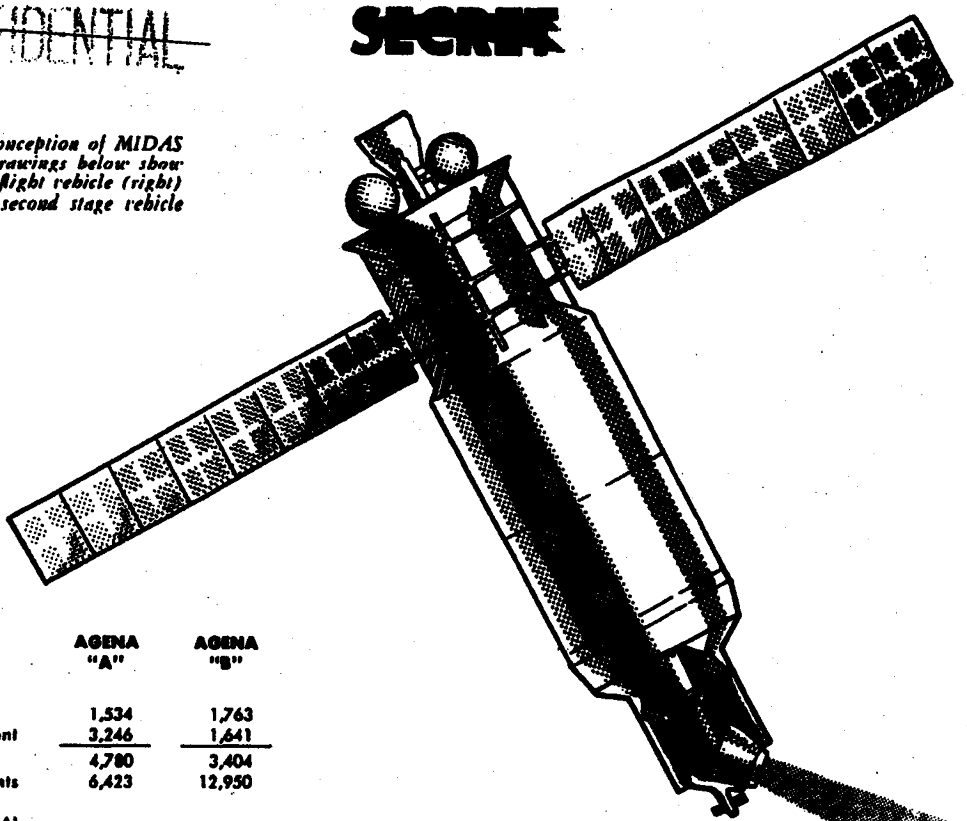


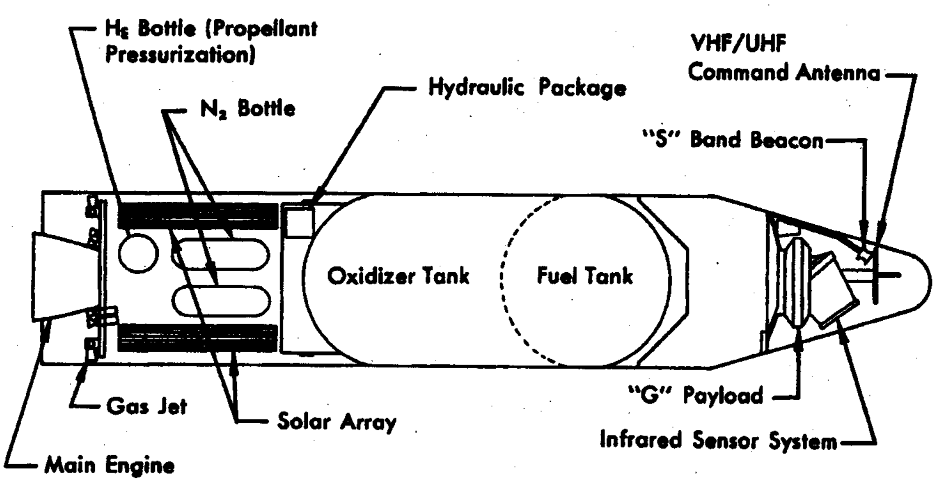
Figure 10. Adjusting the checkout console signal generator during functional testing of the F-1 payload. These tests consist of checking payload readout against calibrated inputs. The telemetry monitoring equipment is in the left-hand section of the console.

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).

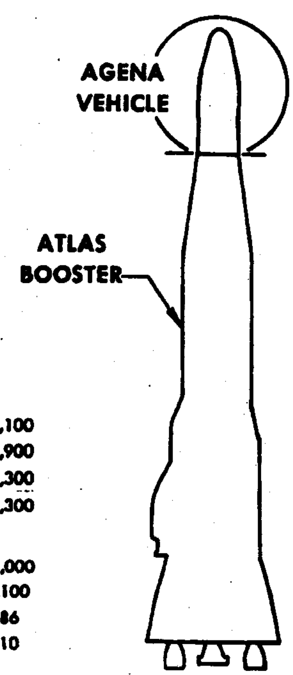


Midas

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

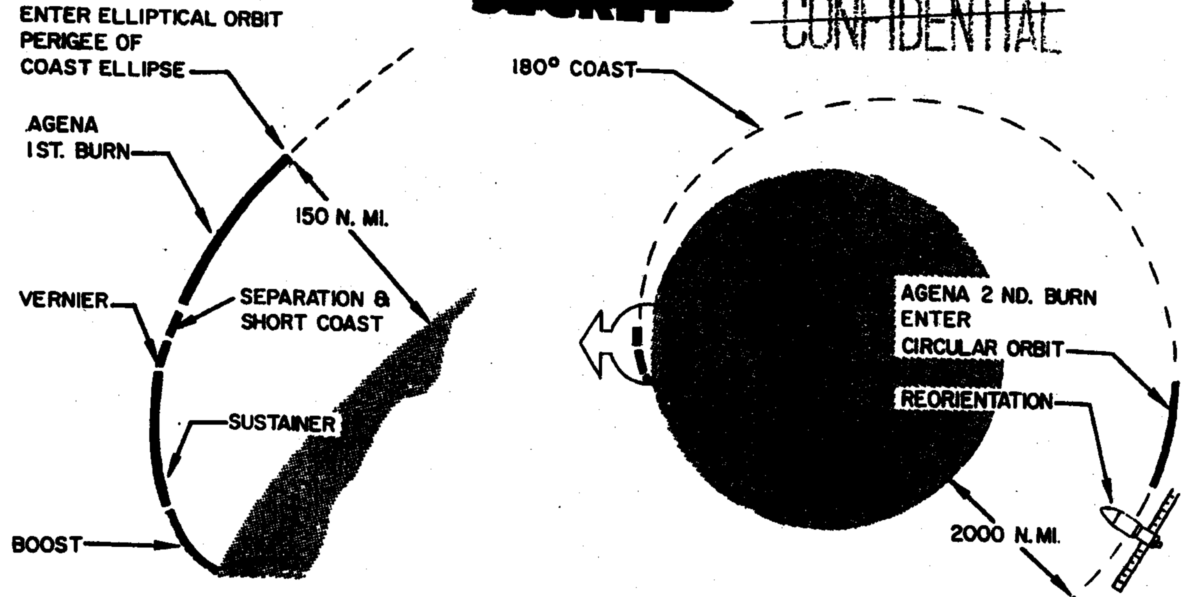


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. Optimum ATLAS boost, guided by radio-inertial system. AGENA ascent (coast, burn, coast, second burn) provides attitude reference. Also governs velocity magnitude and direction by inertial guidance system monitored by horizon scanner.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

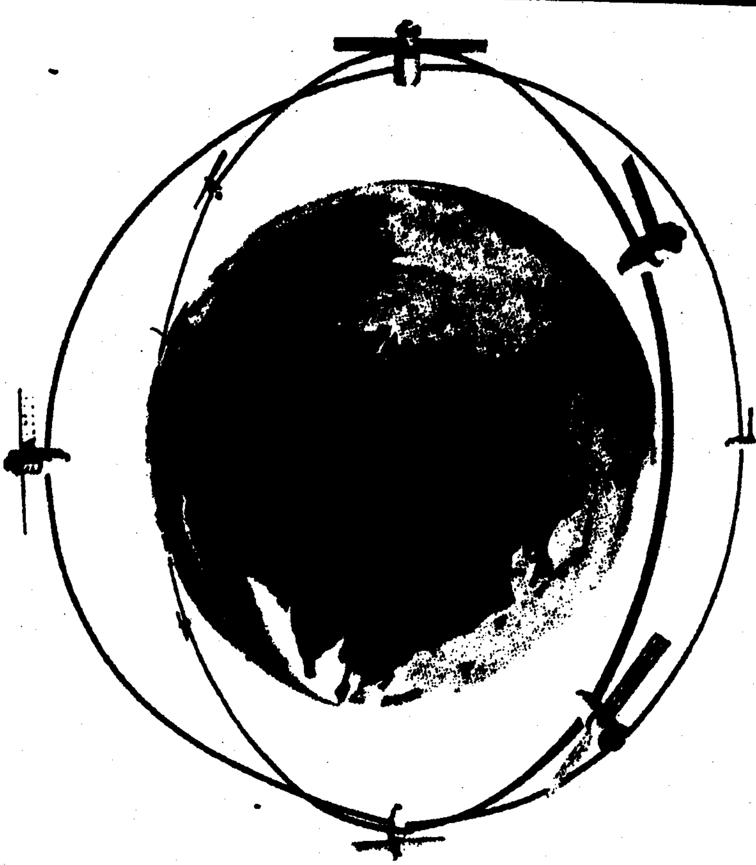


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency. 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. This R&D Program should make possible the achievement of an operational system by 1963.

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 total payload weight is 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.

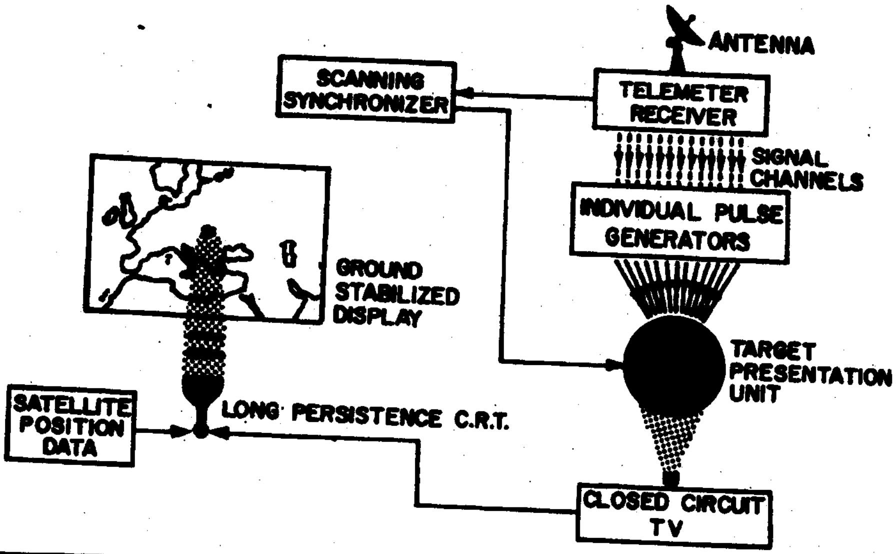
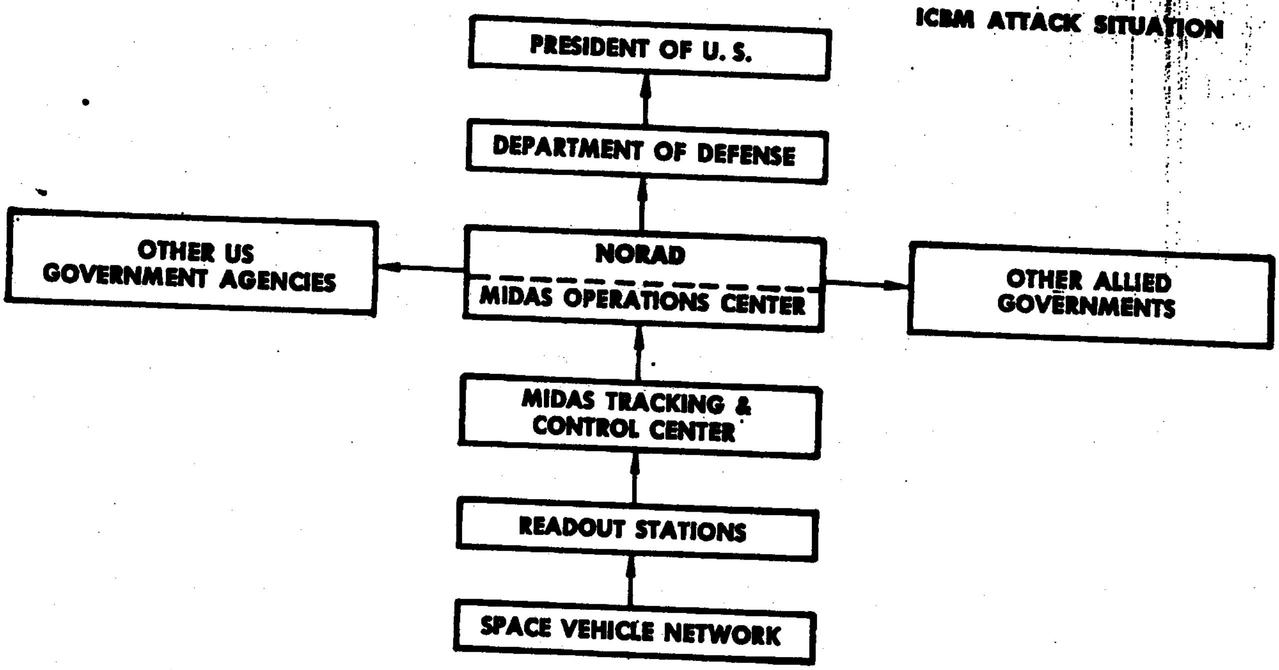


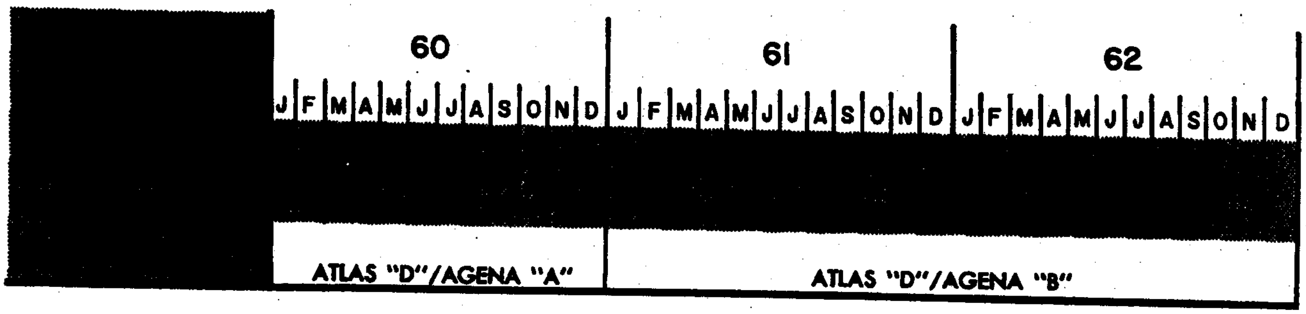
Figure 5. Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies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

ICBM ATTACK SITUATION



CONCEPT

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



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MIDAS Launch Schedule

Monthly Progress—MIDAS Program

Program Administration

- The Air Force Ballistic Missile Committee has authorized two additional MIDAS flights, designated RM-1 and RM-2. These flights will be THOR-boosted and will use AGENA "B" vehicles currently in the DISCOVERER Program. A background radiometer will be carried rather than an infrared missile detection payload. These flights will provide infrared background measurements for a wide variety of conditions, as may exist between arctic and tropical regions. They will assist in determining the magnitude of background radiance in the 2.7 and 4.3 micron absorption range and in establishing the spatial and spectral background characteristics which must be known for current as well as future MIDAS requirements.

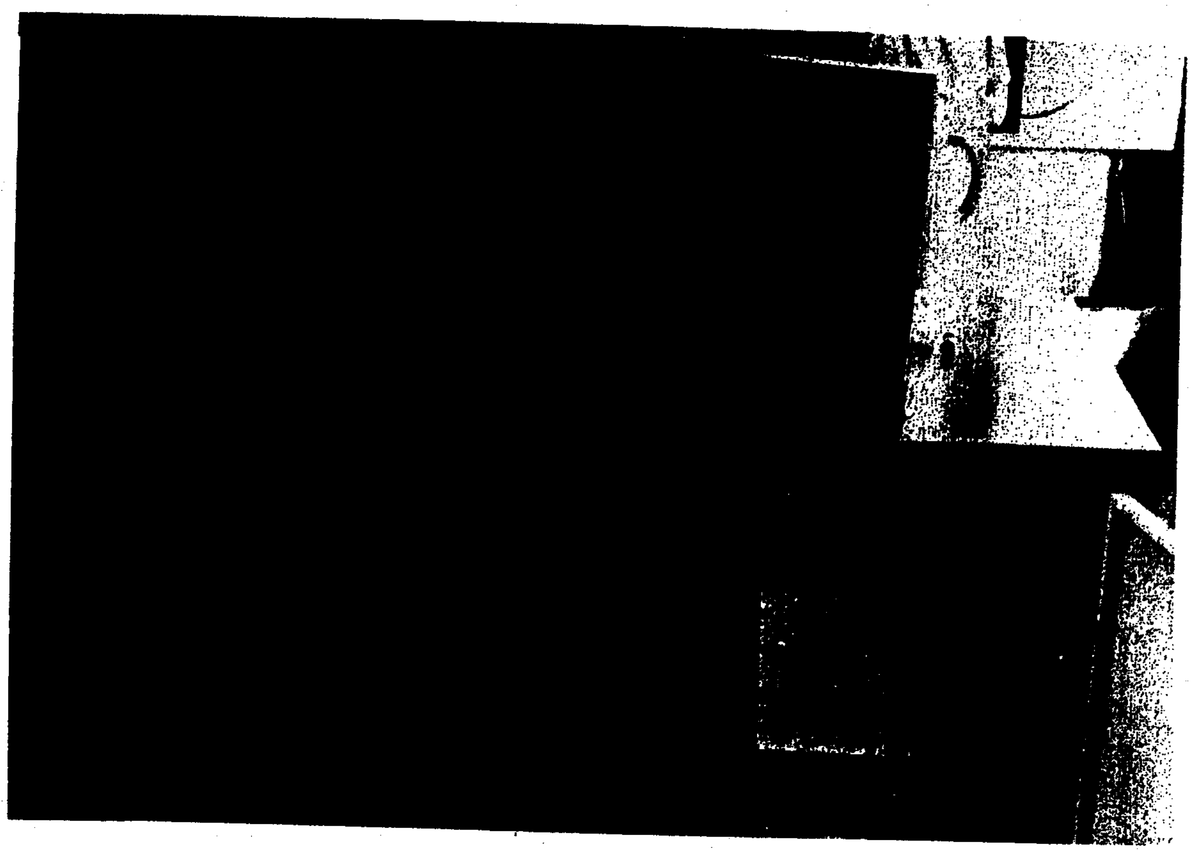

Figure 6. MIDAS ground presentation console installed in the Vandenberg Air Force Base blockhouse.

Technical Progress

Second Stage Vehicles

- Assembly of the AGENA "B" vehicle for the third MIDAS flight is proceeding on schedule. Delivery to the systems test area is scheduled for 3 August. This is the first MIDAS vehicle to have restart capability.

- Because of the recent strike, a schedule slippage has been incurred in the fabrication phase of the two subsequent AGENA "B" flight vehicles. The impact of these schedule slippages is not well defined at this time.

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.

- Production and organizational changes directed toward achieving the desired production quality and delivery rate have been instituted at Baird-Atomic, Inc. A reevaluation of their infrared delivery schedule has established 29 August as the delivery date for the initial flight unit. Five flight payloads are scheduled for delivery.

- Should the results of acceptance testing indicate the desirability of replacing the drive motors or the turret bearing, larger drive motors have been ordered and a new bearing is being designed.

- A detailed reliability test program is being developed for the Aerojet-General advanced infrared detection payload configuration. In addition to developing the service test model of this payload, Aerojet is now contracted to procure long-leadtime items for the flight payloads. The definitive contract for this payload is expected to be completed in August.

Facilities

[redacted]

North Pacific Station—Construction of the Donnelly Flats, Alaska, technical facilities is proceeding on schedule. Because of last year's prolonged steel strike and the late thaw this spring, construction of the support facilities at Fort Greely, Alaska, will be delayed approximately two months. Completion is now scheduled for December.

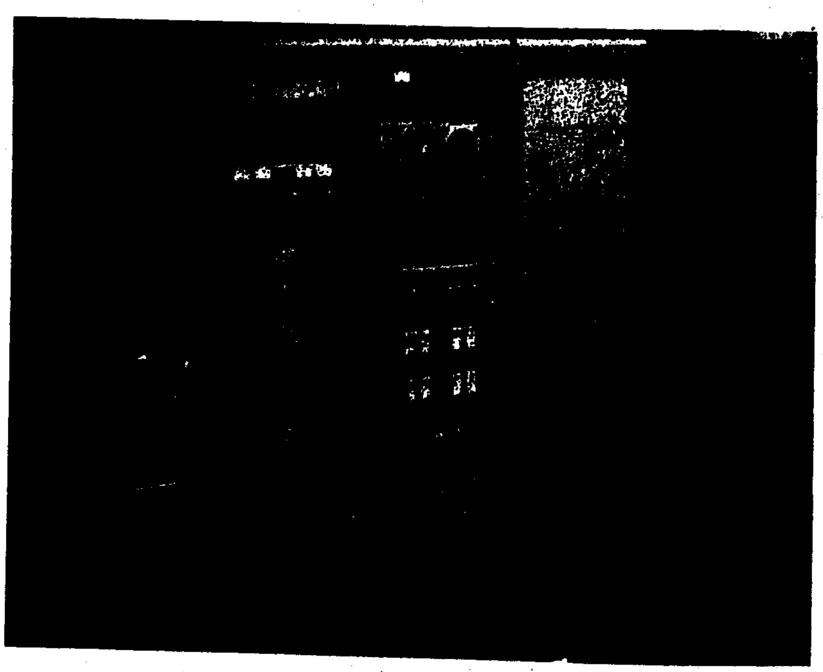

Figure 7. MIDAS data processing equipment installed at the Satellite Test Center.

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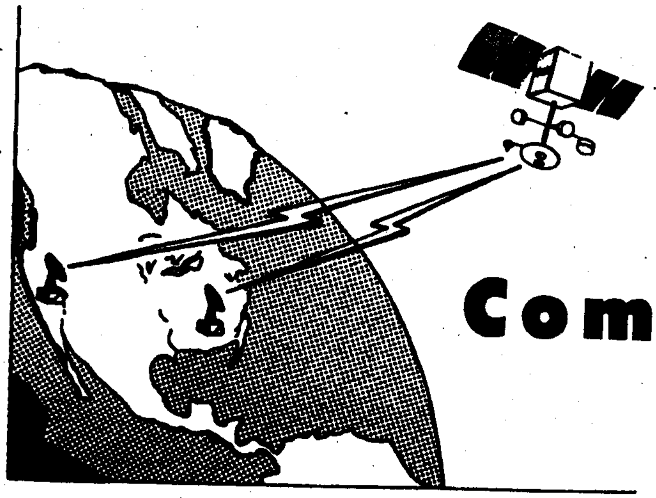


Communications Satellite

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

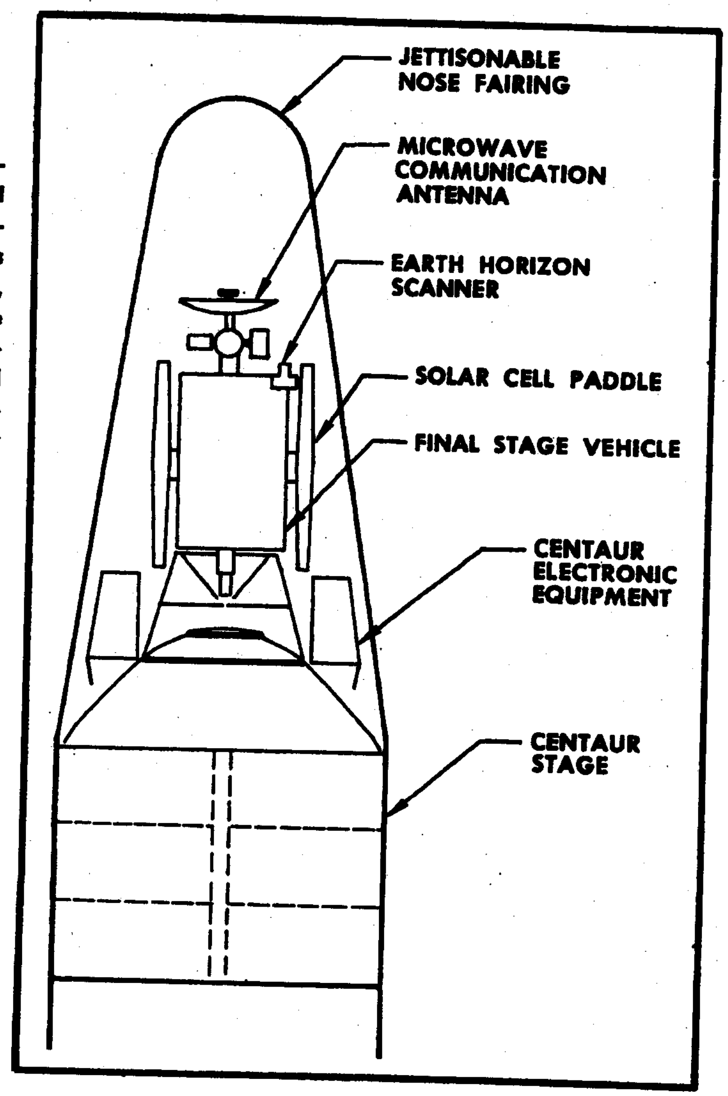


Figure 1. Proposed satellite with jettisonable fairing mounted on CENTAUR second stage.

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. 8, dated 11 July, 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.

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

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

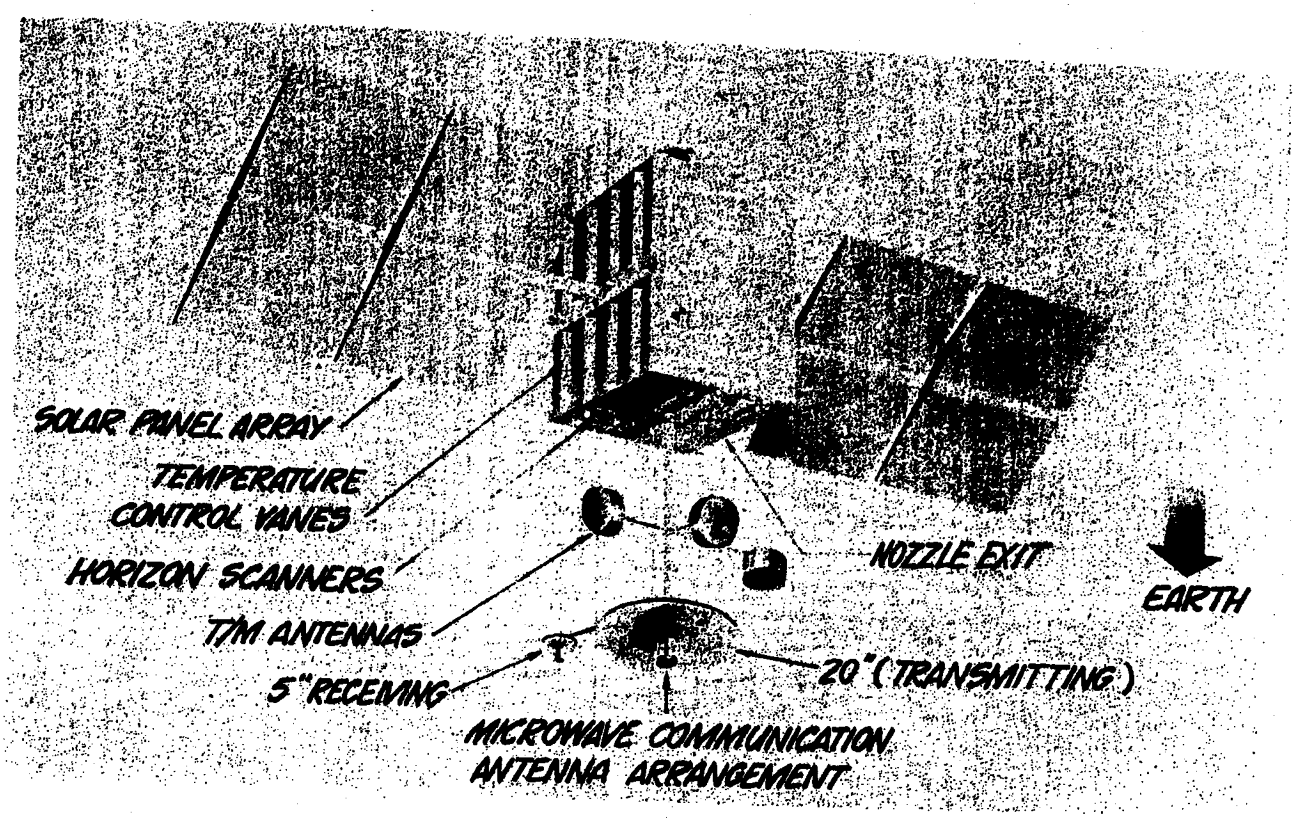


Figure 2. Initial design of final stage vehicle.

Monthly Progress—COMMUNICATIONS SATELLITE Program

Program Administration

● Amendment No. 8, dated 11 July 1960, to ARPA Order No. 4 approved the ADVENT Development Plan dated 25 April 1960 with modifications as specified in the amendment. Amendment No. 8 specified the following launch schedule:

Launch Date		Booster	Second Stage	Booster Funded By
December	1961	ATLAS	AGENA "B"	ARPA
March	1962	ATLAS	AGENA "B"	ARPA
June	1962	ATLAS	AGENA "B"	ARPA
December	1962	ATLAS	CENTAUR	NASA
February	1963	ATLAS	CENTAUR	NASA
March	1963	ATLAS	CENTAUR	ARPA
May	1963	ATLAS	CENTAUR	ARPA
July	1963	ATLAS	CENTAUR	ARPA
September	1963	ATLAS	CENTAUR	ARPA
November	1963	ATLAS	CENTAUR	ARPA

● Representatives of ARPA, United States Army Signal Research and Development Laboratories (USARDL), AFBMD and STL met on 28 July and agreed that in order to provide adequate time for design effort prior to the first ATLAS/AGENA "B" launch, the schedule for the first three flights would be as follows: March 1962, June 1962, and September 1962. As requested by ARPA, a letter will be prepared by AFBMD and forwarded to ARPA presenting formal justification for this launch schedule.

Technical Progress

Communication Equipment

● Bids have been received for both the 60-foot automatic tracking antenna system for the ground terminal equipment and the microwave communication equipment for the satellite and ground terminal. Evaluation of bids is in progress and will be completed in August. During this report period, AFBMD representatives visited USASRDL and participated in the evaluation of the interface areas in connection with the procurement of the ADVENT communications equipment.

● USASRDL has delivered two electrical mock-ups of the ADVENT satellite antennas to General Electric. These antennas will be used for conducting tests on a mock-up of the satellite to determine the extent of interference to the satellite communication antennas, by the telemetering antennas, solar panels and other external appendages on the satellite.

● Investigations continued to verify stage-by-stage and detailed general performance of the proposed satellite-borne design. A repeater channel is being assembled having an input frequency of 8000 kmc and an output frequency of 2000 kmc. Considerable effort is also being expended on investigating methods of improving overall satellite package efficiency. Investigation of traveling wave tubes with respect to the presently proposed system and possible future systems has been initiated both internally and by consultation with traveling wave tube manufacturers.

● General Electric is continuing a study of design considerations applicable to the development of a high capacity instantaneous communication system for the final stage vehicle. Tasks presently under investigation include satellite electronics, reliability, outer space environment and anti-jamming capability.

Launch Vehicles

● The Stage I and Stage II work statements have been completed and are being coordinated within AFBMD prior to sending them to ARPA for approval.

● Space Technology Laboratories revised the performance specification recommended for use in the procurement of ADVENT Stage II specification and the latest NASA/ABMA (Army Ballistic Missile Agency) CENTAUR engine specification is that the NASA specification calls for an engine to operate at a 5:1 (oxidizer-to-fuel) mixture and the ADVENT requires a 5.1:1 mixture. This mixture ratio change results in a specific impulse degradation (estimated to be from 420 seconds minimum down to 418 seconds minimum), but provides an increase of 60 to 70 pounds in payload capability for the communication satellite mission.

Final Stage Vehicle

● The work statement and attachments for the final stage vehicle have been completed in final form and submitted to ARPA for approval.

● Pending approval of the final stage vehicle work statement by ARPA, General Electric is continuing its sustaining effort program of preliminary engineering and design studies, with preliminary development tests as required, in the following areas:

1. final stage vehicle system and subsystem.
2. final stage vehicle configuration.

3. tracking, telemetry and command (including instrumentation).

4. ground support equipment.

- AFBMD is evaluating the validity of a General Electric Missile and Space Vehicle Department request for funds to purchase laboratory and test equipment (industrial facilities).

Tracking, Telemetry and Command Equipment

- A contract has been awarded Philco Corporation for the completion of preliminary design and specification data to meet the ADVENT tracking, telemetry and command equipment requirements.

Ground Stations

- Site surveys have been conducted on both east and west coasts of the United States to determine suitable location for ADVENT ground stations. Air and ground surveys of both regions resulted in the preliminary selection of Fort Dix, New Jersey and Camp Roberts, California.

BOOSTER

support programs

ABLE
TRANSIT
COURIER
MERCURY
609A
DYNA SOAR

BOOSTER SUPPORT PROGRAMS

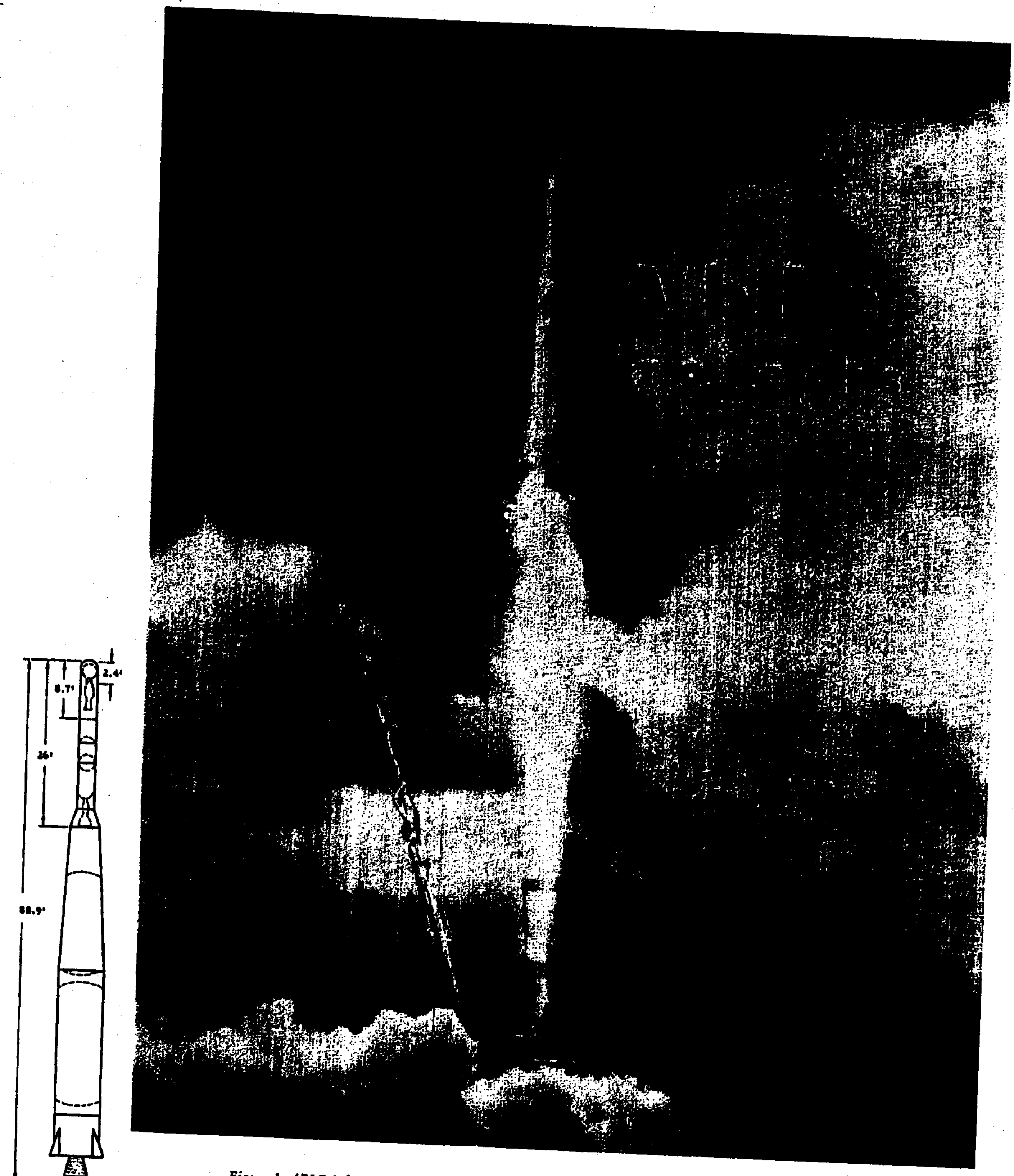


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.

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.

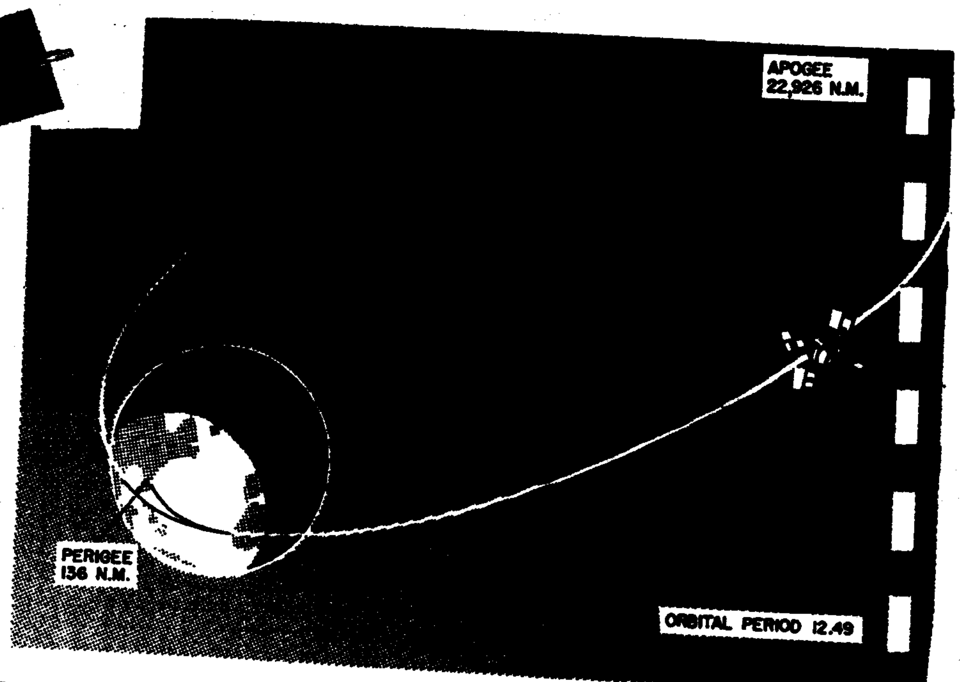
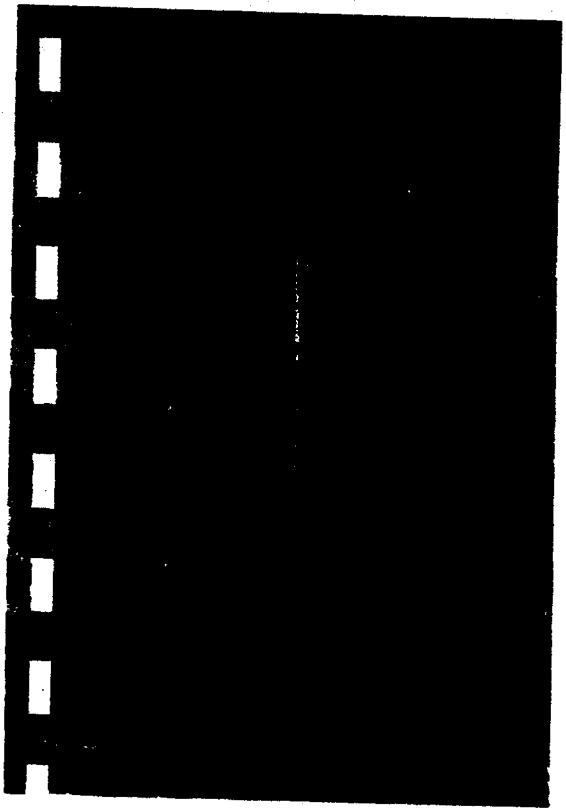
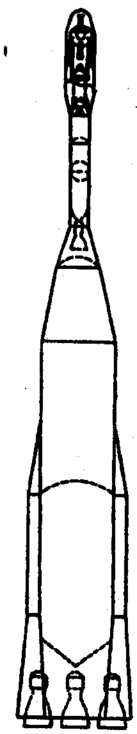


Figure 2. ABLE-3 third stage and payload (above) with solar paddles fully extended. Drawing of extremely elliptical orbit achieved by ABLE-3 (EXPLORER VI).

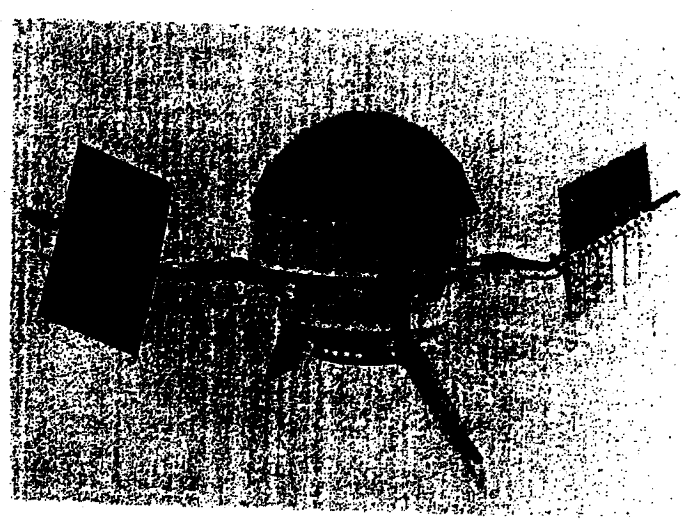


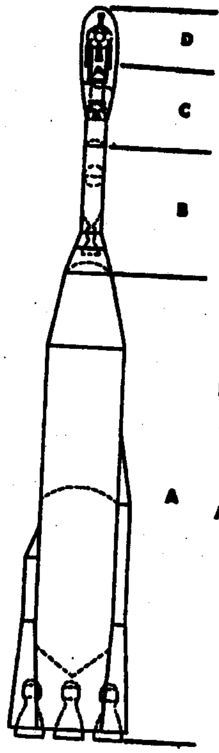


ABLE-3—This four stage flight vehicle was launched from the Atlantic Missile Range on 7 August 1959. The vehicle consisted of a THOR booster, a second stage using the AJ10-101A rocket engine, a third stage powered by the ABL-248 A3 engine, and a fourth stage consisting of the payload and an injection 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 occurring on the more than nominal side. The payload was the most sophisticated to have been placed in orbit by this nation at the time and contained provisions for conducting 13 experiments in space environment and propagation. A wealth of valuable data was obtained from satellite telemetry until the last transmission was received on 6 October. It is believed that the satellite, while yet in orbit, is incapable of generating sufficient power for transmitting signals due to solar paddle damage suffered during initial paddle extension and the resultant unfavorable sun "look" angle.

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

ABLE-4 THOR—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





D. Satellite Vehicle	
Gross Weight	371.6 lb
Gross Weight (Burnout)	233.6 lb
Specific Impulse (vac)	230 sec
Thrust (vac)	18.3 lb
C. THIRD STAGE ABL 248-A9	
Gross Weight	897.4 lb
Gross Weight (Burnout)	432.7 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

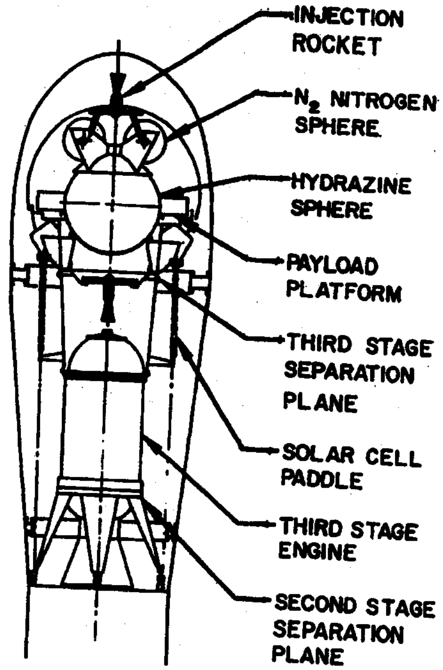
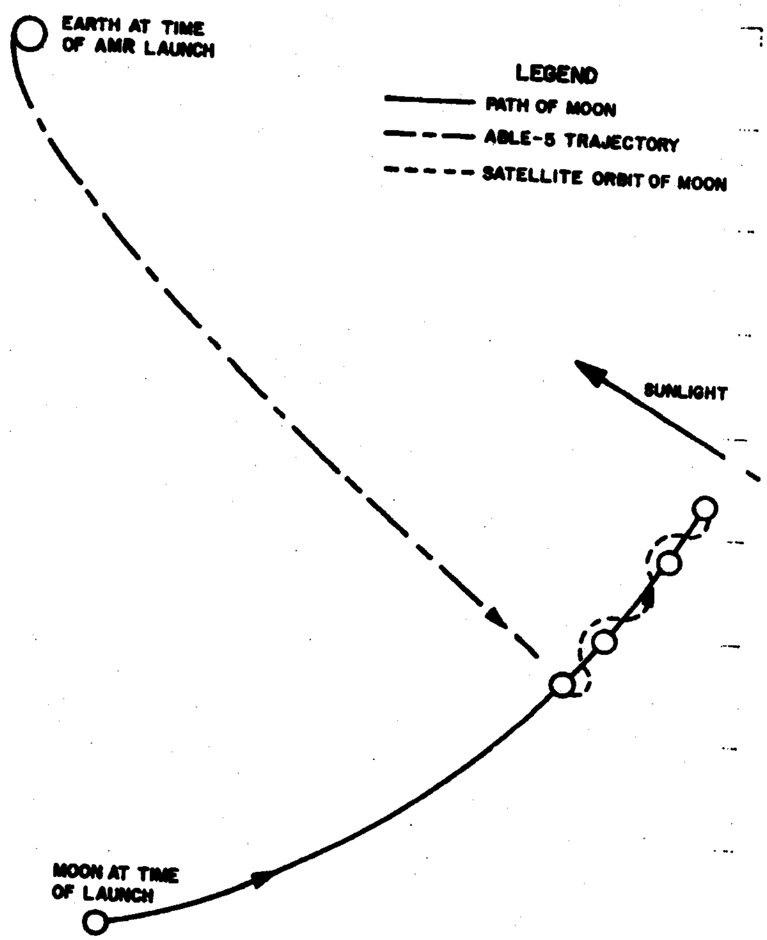


Figure 5. ABLE-5 vehicle configuration drawing and specification list. Third stage and payload configuration (right). Trajectory of ABLE-5 into lunar orbit is shown in drawing (below).

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.



Program Objectives

1. Place a satellite into lunar orbit with an apogee of 3,000 nautical miles and a perigee of 2,000 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 371.6 pounds.

Launch and Powered Flight

These vehicles will be launched from the Atlantic Missile Range on a true azimuth of 92.5 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	0.209848 x 10^9 feet
Eccentricity	0.245859 degree
Orbital period	765.4 minutes
Apolune	4,303 nautical miles
Perilune	2,605 nautical miles
Duration of eclipses	less than 90 minutes

Payload Experiments

Scintillation Counter and Pulse Height Analyzer—measure electron energy (greater than 50 Kev per particle) and proton energy (greater than 1.0 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 25 Mev per particle).

Proportional Counter Experiment—measure integrated intensity of cosmic ray particles: electrons greater than 12 Mev per particle and protons (greater than 70 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 Probes Experiment—measure the energy and momentum 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 25 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.

ABLE-4 THOR (PIONEER V SATELLITE)

Flight Status

● At 0733 hours EST, on 26 June, the last radio signal from PIONEER V was received. The transmitter has been operated throughout the three and one-half month period and has been commanded "ON" over 400 times. During the following week repeated efforts by the Manchester station failed to establish communication with the satellite. At the time of the last transmission the vehicle was 22,462,740 miles from the earth, traveling at a velocity (relative to the earth) of 18,621 miles per hour.

Equipment Operation

● The power conversion system provided reliable operation. The interference filter and paddle coating design kept the temperature of the solar cells within the desired range. Surface coatings and heat sinks kept all PIONEER V internal temperature within the proper operating ranges. Operation of all satellite equipment was satisfactory.

● The integrated telemetry, tracking and command link performed satisfactorily and proved itself an efficient means of commanding a satellite, tracking it, and receiving its telemetry using a single system. The system in PIONEER V 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.

● The sensors, the telebit unit and the lightweight command receiver operated continuously from launch, gathering and storing data and on command, appropriately phase modulating the transponded signal in the transmitter. The transmitter continued to provide 5-watts of power until 26 June and acted as a driver for the 150-watt amplifier until battery degradation would no longer permit the power drain of that unit. On 8 May, after two months in a nearly absolute vacuum, the 150-watt transmitter responded promptly and efficiently to its "ON" commands.

● All other components of PIONEER V except the storage batteries have worked satisfactorily throughout its communication lifetime. The batteries degraded gradually in their ability to hold a charge until by 5 June the capacity had dropped to a point that permitted an average of about two minutes of transmitter operation. Surprisingly, this capacity was increased during the last six days and reached a high of eight minutes.

Scientific Discoveries

● Our knowledge of space, of the sun, and of the solar system has been substantially increased by the information transmitted by PIONEER V. Analysis of the data obtained during the satellite's journey into space has revealed the following major scientific discoveries:

1. An interplanetary magnetic field exists with a steady magnitude of more than one Gamma and a peak of up to ten Gamma. These fluctuations observed in the strength of the field indicate that the field is disturbed by solar flare activity.
2. The planar angle of the interplanetary magnetic field forms a large angle (about 90 degrees) with the plane of the elliptic.
3. The exospheric ring current of 25,000 miles diameter encircles the earth as a giant doughnut at a distance of 40,000 miles from earth. The five million ampere current moves westward around the earth.
4. The geophysical magnetic field extends at times to 65,000 miles and this field oscillates in intensity in the outermost exosphere.
5. The sudden decrease in galactic cosmic rays (the Forbush decrease) always associated with large solar flares does not depend on the presence of the earth's magnetic field. This unexpected discovery will require formulation of a new theory to explain the Forbush decrease.
6. Penetrating radiation in space is not limited to the Van Allen belts. At least during periods of solar activity 5 to 50 Roentgens per hour are incident on the satellite.
7. The energy levels of the particles in the Van Allen radiation belts are not commensurate with the energy levels observed in the solar wind. It must therefore be presumed that some process, as yet unknown, is responsible for accelerating the particles after their injection into the Van Allen Belts.

Summary of PIONEER V's Firsts in Space

● **Technological**

1. The greatest range over which man has maintained command of an instrumented space vehicle.
2. The greatest range over which man-made object has been tracked.
3. The greatest range from which man has received telemetry.

4. The first instrumented space laboratory which has permitted measurements of the following physical properties of interplanetary space.

a. The interplanetary magnetic field.

b. The planar direction of this field.

c. Total flux and energy levels of radiation.

5. The first test of an interplanetary guidance system component (with no force control of the satellite available).

6. The first interplanetary probe to carry its own, self-sustaining auxiliary power supply.

7. The greatest velocity of any man-made vehicle (916 ft/sec above escape velocity from earth).

8. The highest powered transmitter (150-watts) ever carried on a space probe mission.

9. The first application of relativistic concepts to determine the velocity of a man-made object.

- **Scientific**

1. First quantitative mapping of the interplanetary magnetic field.

2. First quantitative measurement of the interaction of the solar wind and the geomagnetic field.

3. First verification of the exospheric ring current.

4. Discovery that the Forbush decrease is an interplanetary phenomenon.

5. First measurement of the radiation levels of interplanetary space.

6. First measurement of the influence of the solar wind on the Van Allen radiation belts.

7. First measurement of the size of the solar system using a space probe.

ABLE-5

Program Administration

- Amendment 4 to NASA Order S-2365G, dated 6 July, appropriated $135,000 for a Nickel-Cadmium Battery Study. The purpose of this study will be to gather basic information about this type of battery. This information will be used as a basis for future design improvements.

Technical Progress

First Stage

- ATLAS 80D is proceeding on schedule toward a 5 August acceptance date. Installation and checkout of a new autopilot, developed as part of the ATLAS R&D program, will be accomplished at the contractor's facility prior to shipment to AMR. The ATLAS booster contains a production guidance system and is standard, except for wiring modifications required for the space mission.

- Following delivery to the Atlantic Missile Range on 8 August, ATLAS 80D will proceed through a receiving inspection and a series of hangar checks. The booster is scheduled to be erected on the stand on 22 August following successful completion of the subsystem and system checks.

- The Stage I/Stage II transition section has been virtually completed and will be ready for installation on the erected ATLAS.

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

Second Stage

- The second stage vehicle for the first flight has been delivered to the Space Technology Laboratories airport facility. The auto-pilot, programmer, guidance receiver and other electronic units were installed and compatibility checks performed. The assembled second stage vehicle successfully completed a Development Engineering Inspection on 26 July. Flight system tests will be conducted through mid-August and the vehicle delivered to the AMR on 1 September. On 8 September, following the receiving inspection and system checks, the second stage will be mated on the ATLAS booster.

- The first acceptance test firing of the second stage propulsion system for the ATLAS/ABLE flight was satisfactorily completed in mid-July. Successful completion of the acceptance test program will permit delivery of the unit in mid-August, substantially in advance of the need date for the unit. Telemetry, guidance and autopilot equipment are also nearing the end of fabrication and manufacturing tests and will be installed in the propulsion unit during the last half of the month. The complete second stage is scheduled for shipment to the Atlantic Missile Range in late October.

Third Stage

- Three ABL-X-248-A9 engines have been delivered to Arnold Engineering Development Center (AEDC) for firing in a simulated high altitude environment. The tests will measure: engine performance, characteristics, case surface temperatures and the 600 cycle per second vibration phenomenon.

- The third stage for the first flight will be delivered on 12 September and attached to the second stage on 18 September.

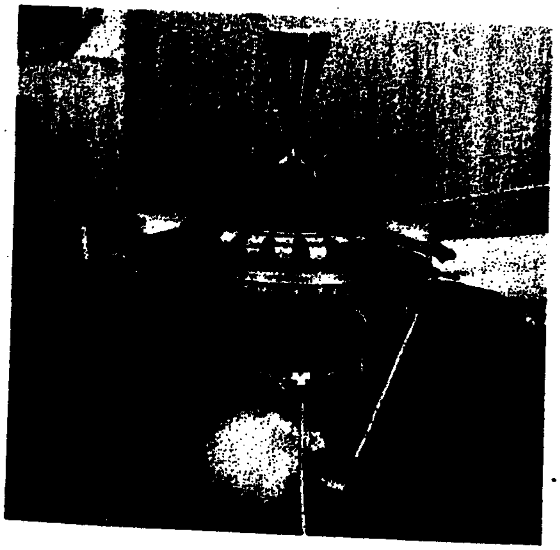


Figure 6. ABLE-5 hydrazine engine showing injection rocket nozzle, three nitrogen spheres and related plumbing. Antennas and leads are shown.

Satellite Vehicle

- The type test satellite vehicle is in the vacuum chamber for thermal vacuum testing; the last of the environmental tests. Other environmental tests successfully completed are spin, centrifuge, vibration, temperature, and humidity.
- Assembly and initial electronic testing of the first flight satellite vehicle has been completed and a pre-environmental inspection was held during the week of 18 July. Experiment and performance sensor calibration was completed and environmental tests will follow. Calibration of the satellite vehicle in the new Fanselau coil apparatus has been completed successfully.
- The hydrazine engine for flight one has been installed and the engine for the second flight has been received.
- The first flight satellite vehicle will be shipped to AMR on 1 September. Electrical verification and functional tests will be conducted prior to mating with the third stage two days before launch.
- A new experiment, the University of Chicago solid state detector, will be incorporated into the second flight payload. Assembly of the vehicle and electronic testing will begin early in August.

Guidance Equations

- ATLAS guidance equations have been simulated on the 709 computer and used to guide closed loop flights. The results in terms of errors at the end of Stage III appear excellent in all respects except look angles. The look angles can be made satisfactory by changing the look angle restrictions or using the value of .97 of the normal ATLAS booster pitch program. Changing the pitch program could create a problem of the ATLAS sustainer impacting on the African coast. Probability studies are being conducted with the results to be published in August.

Ground Support Equipment

- The fabrication and certification of test van No. 4 is nearing completion. The test van is undergoing electrical subsystem checkout while connected to the second stage electrical system. Additional guidance transponder evaluation equipment is to be installed prior to the first launch.
- Installation and checkout of the new 50-watt transmitter for the Advanced Guidance System has been completed at AMR.
- The guidance computer chassis and power supply wiring has been completed. The magnetic drum memory and logic cards are in fabrication. The computer is scheduled for initial checkout in mid-August.

Facilities

- Conversion of Pad 12 was started in mid-July on a non-interference basis. Fabrication of the Stage II propellant lines and gantry platforms has started. Umbilical tower work, umbilical drop test, and associated tasks which cannot be accomplished on a non-

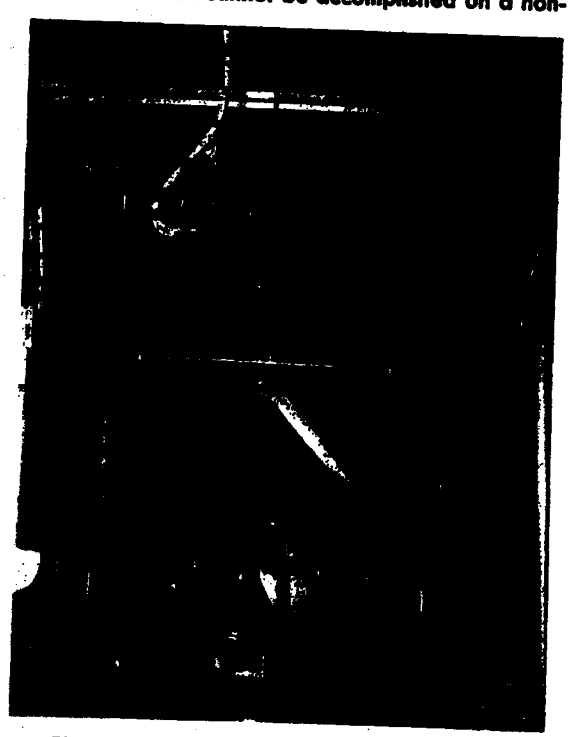


Figure 7. Preparing to raise the satellite vehicle into the new Fanselau coil prior to calibrative magnetic sensitivity of payload experiments.

interference basis are scheduled for the period 8-22 August, following the launch of ATLAS 32D.

- Construction of a non-magnetic building to house a modified Fanselau coil has been completed. The new building will enable scientists to calibrate the magnetic sensitivity of payload instrumentation more precisely than has been possible before. The new coil will also permit calibration of larger payloads.

- The building, 30 feet in diameter and constructed entirely of non-magnetic materials, is located in Solstice Canyon above Malibu Beach (north of Los Angeles). The site was selected after extensive tests for natural or man made magnetic disturbances in the surrounding earth and air. Temperature stability was also a factor in the selection of the site due to the necessity for maintaining close dimensional tolerance on the Fanselau coils. To preserve a uniform magnetic field, the concrete base of the building does not utilize reinforcing steel. Also, the plywood wall sections are anchored to the floor by aluminum bolts and aluminum fittings join the wall and roof sections together.

- Personnel in the building while the coil is in operation will wear clothing containing no magnetically attractive materials. All support equipment for the experiments will be located in a van parked some distance from the building. The magnetic coils have been installed and the site has been used to calibrate the initial flight payload.

Figure 8. Model of Fanselau coil (above) showing the six rings in three planes. This coil will accommodate larger payloads and permit more precise calibration than previous coils. The non-magnetic building that houses the coil (below) and the van that contains the support equipment.

Transit

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

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

B. SECOND STAGE—AJ10-42 (Aerojet-General)

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

C. FIRST STAGE—THOR IRBM

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

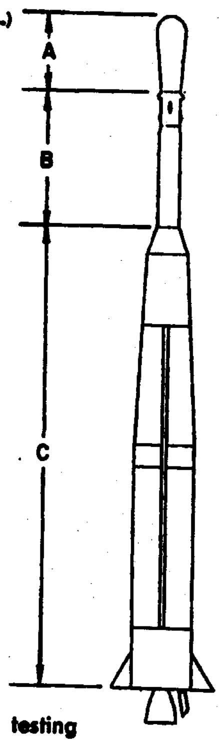


Figure 1. TRANSIT 1A three stage flight vehicle.

TRANSIT 1A launched from Atlantic Missile Range

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.

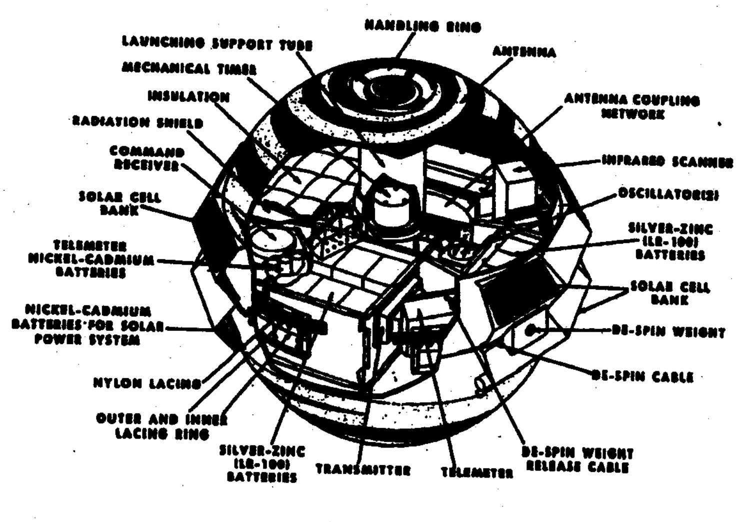
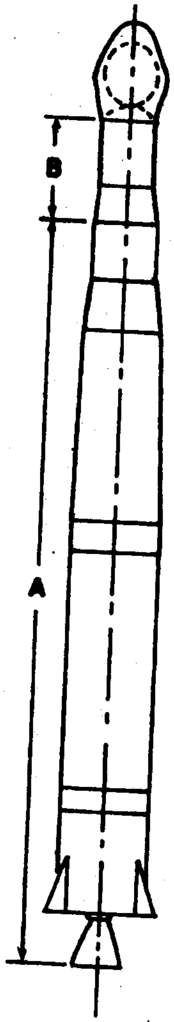


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV I).

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 Ordnance. Applied Physics Laboratory is the payload contractor.

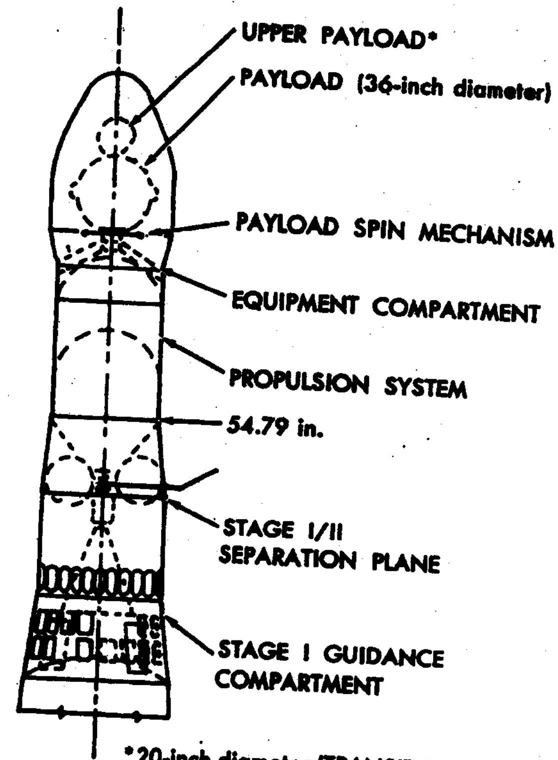


B. SECOND STAGE—ABLE-STAR (AJ10-104)

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 only)

—TRANSIT 1B, 2A, 3A and 3B

Program Objectives

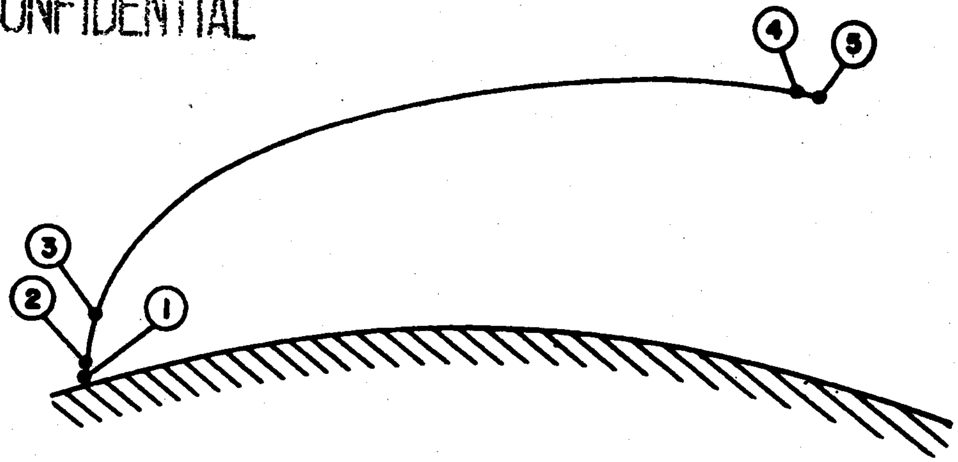
1. Provide accurate navigational reference information for POLARIS launches.
2. Precise determination of satellite position by measuring the doppler shift of satellite transmitted radio signals.
3. Investigate the refractive effect of the ionosphere on radio transmissions.
4. Acquire additional geodetic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



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, 2A and 2B

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

Ground Support Stations Tracking stations will be operated in Maryland, Texas, New Mexico, Washington and Newfoundland. First and second stage tracking and telemetry and second stage guidance will be provided by the Atlantic Missile Range. A mobile tracking and telemetry van 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—TRANSIT PROGRAM

Program Administration

- The TRANSIT 1B Final Mission Report document was issued on 27 July. This report contains an evaluation of the test vehicle, except for payload information. The payload evaluation will be published by Applied Physics Laboratory.

Flight Test Progress

TRANSIT 2A

- The TRANSIT 2A flight data are being analyzed for the purpose of preparing a final report by 15 August. Major areas of analysis are control, vibration and guidance. The special task group investigating the abnormal flight behavior concluded that propellant sloshing may be compounded in the pitch and yaw planes to produce rolling and coning of the vehicle. Vehicle modifications to eliminate the problem are being studied for incorporation into the TRANSIT 2B system.

TRANSIT 2B

- Aerojet-General Corporation and Space Electronics Corporation are continuing assembly and checkout of the ABLE-STAR stage to meet the 1 November launch date. Delivery of components and subsystems are continuing on schedule.

- Preliminary information received from BuWEPS indicated a change in the payload weight and spin requirements. The programmer and autopilot setting are being changed to accommodate a new launch azimuth of 90 degrees true. No further changes in system design will be made until firm information on payload weight, payload spin at injection, and payload attitude orientation requirements at injection is received.

- Due to the early stage of fabrication of the TRANSIT 2B ABLE-STAR stage, the modifications determined necessary as a result of the TRANSIT 2A abnormal flight behavior study can be accomplished within existing schedules. Therefore, no change in the established assembly and checkout schedule is anticipated.

Courier

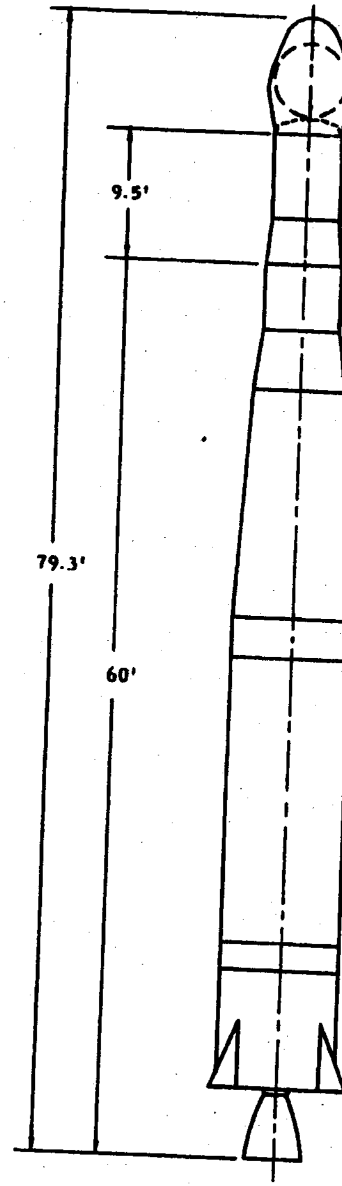
The ARPA COURIER Program consists of two flight vehicles to be launched from the Atlantic Missile Range. The program objective is to test delayed repeater communications between a satellite and ground stations. The program also will be used to determine the operating characteristics and capabilities 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)	2.3×10^6 lbs/sec
Burning time	294 seconds
Propellant	Liquid

FIRST STAGE—THOR IRBM

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

Monthly Progress—COURIER Program

Program Administration

COURIER 1B

- The Detailed Test Objectives document for COURIER 1B will be issued early in August.

Flight Test Progress

COURIER 1A

- Upon completion of COURIER 1A checkout, the vehicle was placed under protective covering and a gaseous nitrogen atmosphere was provided to protect the vehicle pending investigation of the abnormal TRANSIT 2A flight behavior. The analysis and experiments have shown that lateral propellant sloshing may be compounded in the pitch and yaw planes to produce rolling and coning of the vehicle about its nominal flight path. Modifications designed to eliminate the slosh problem are as follows:

1. Nose fairing jettison will be delayed an additional 17 seconds to provide a greater stability margin through the first 200 seconds of Stage II flight.
2. Autopilot position gains will be decreased to reduce the sloshing tendency.
3. Anti-slosh baffles will be installed in the fuel tank, which is the most critical of the two tanks.

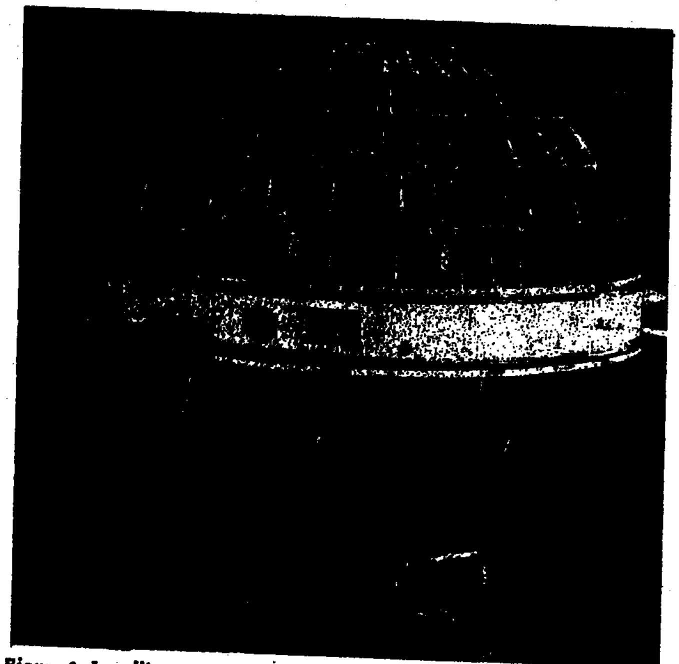


Figure 1. Installing antenna on the 500 pound COURIER 1A satellite vehicle. Solar cells cover the upper and lower halves of the 60-inch sphere.

4. Adding two nitrogen storage bottles will increase the available attitude control nitrogen by 50 per cent.

- Modifications are scheduled to begin on 1 August with the vehicle scheduled to be installed on Stand 17B on 3 August. The launch is scheduled for 16 August.
- The down range tracking van has been relocated at Salisbury, Southern Rhodesia, and will be ready before 16 August.

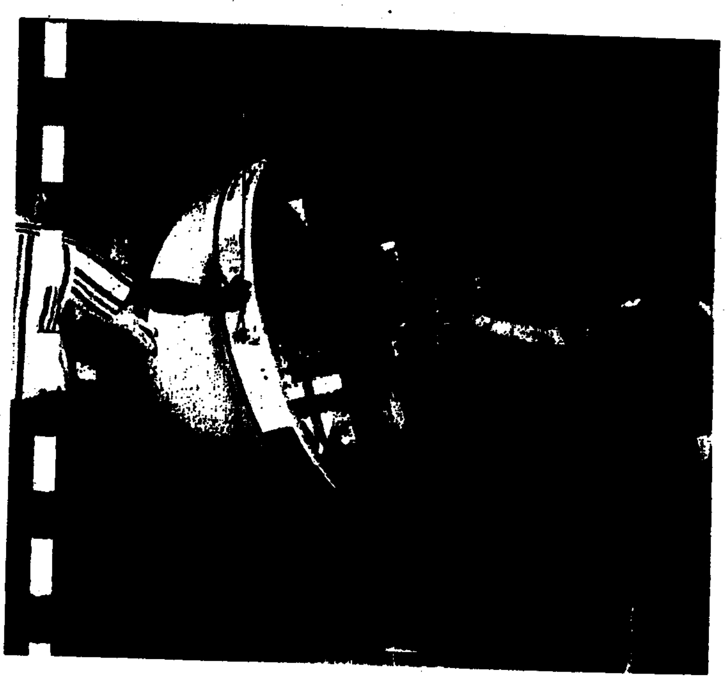
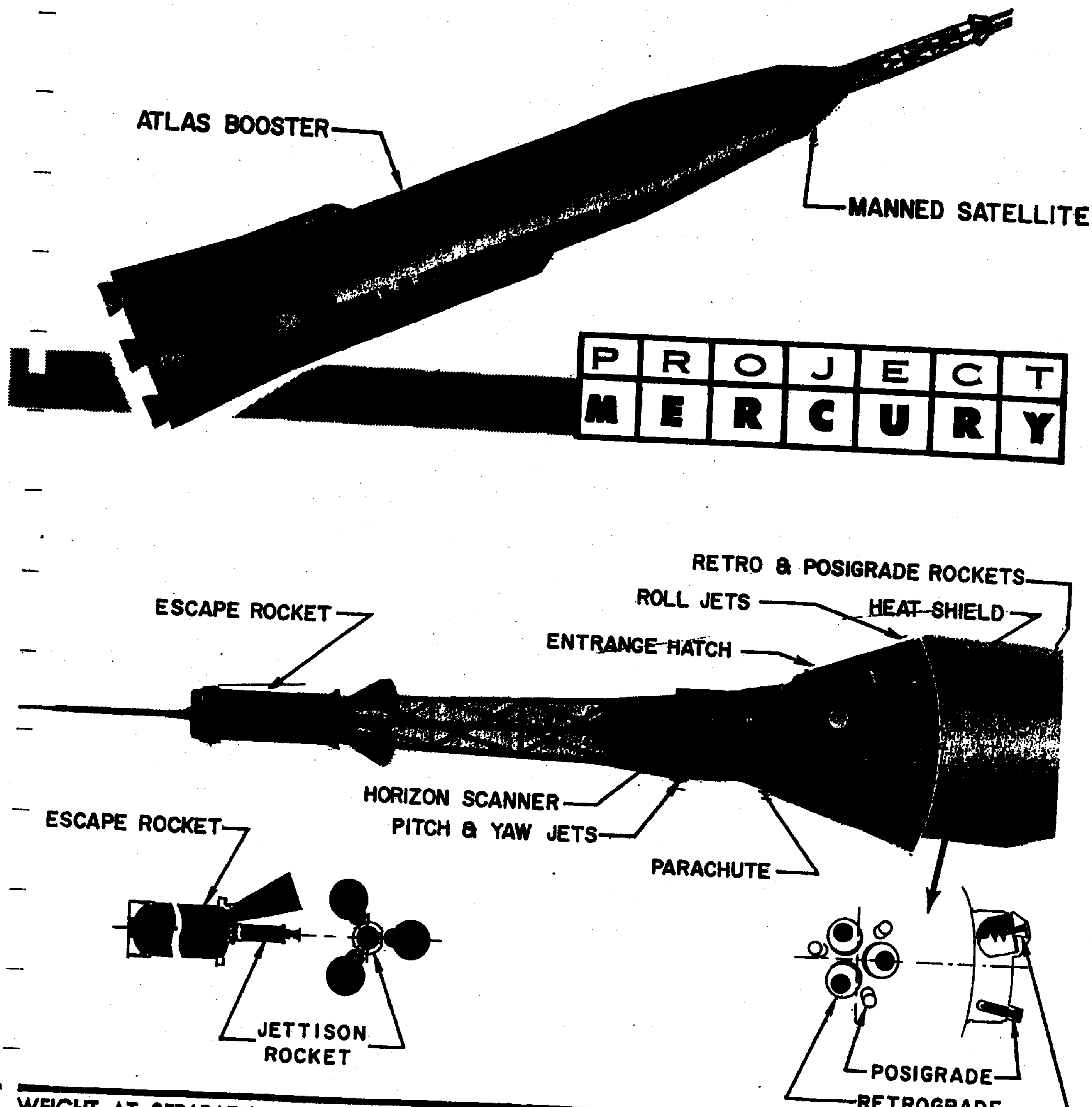


Figure 2. Satellite vehicle with lower hemisphere removed revealing transmitters, storage and memory equipment, power supply and supporting structure.

Technical Progress

COURIER 1B

- The continuing failure of the gyro reference assembly to pass autopilot acceptance test has required the replacement of two units before the test could be successfully passed. This problem has delayed the assembly and checkout operations so that at the end of July this vehicle was approximately three weeks behind the previous schedule.
- Because of the rescheduling of COURIER 1A and the checkout status of the COURIER 1B vehicle a re-evaluation of the COURIER 1B launch schedule was made. Because of the time required for guidance ground station preparation and the delay in vehicle availability, the launch of COURIER 1B can not occur earlier than 4 October.



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 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.

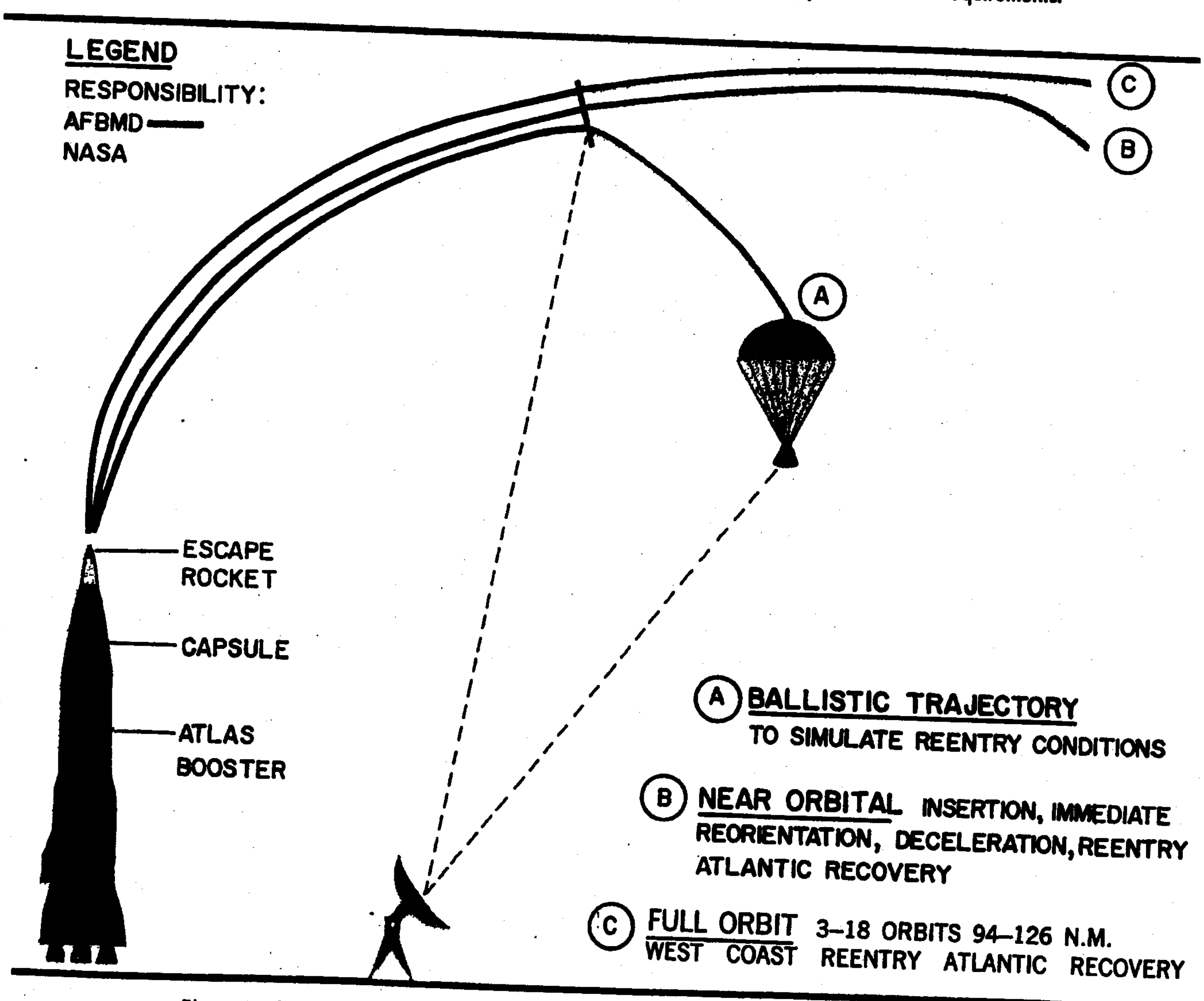


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.

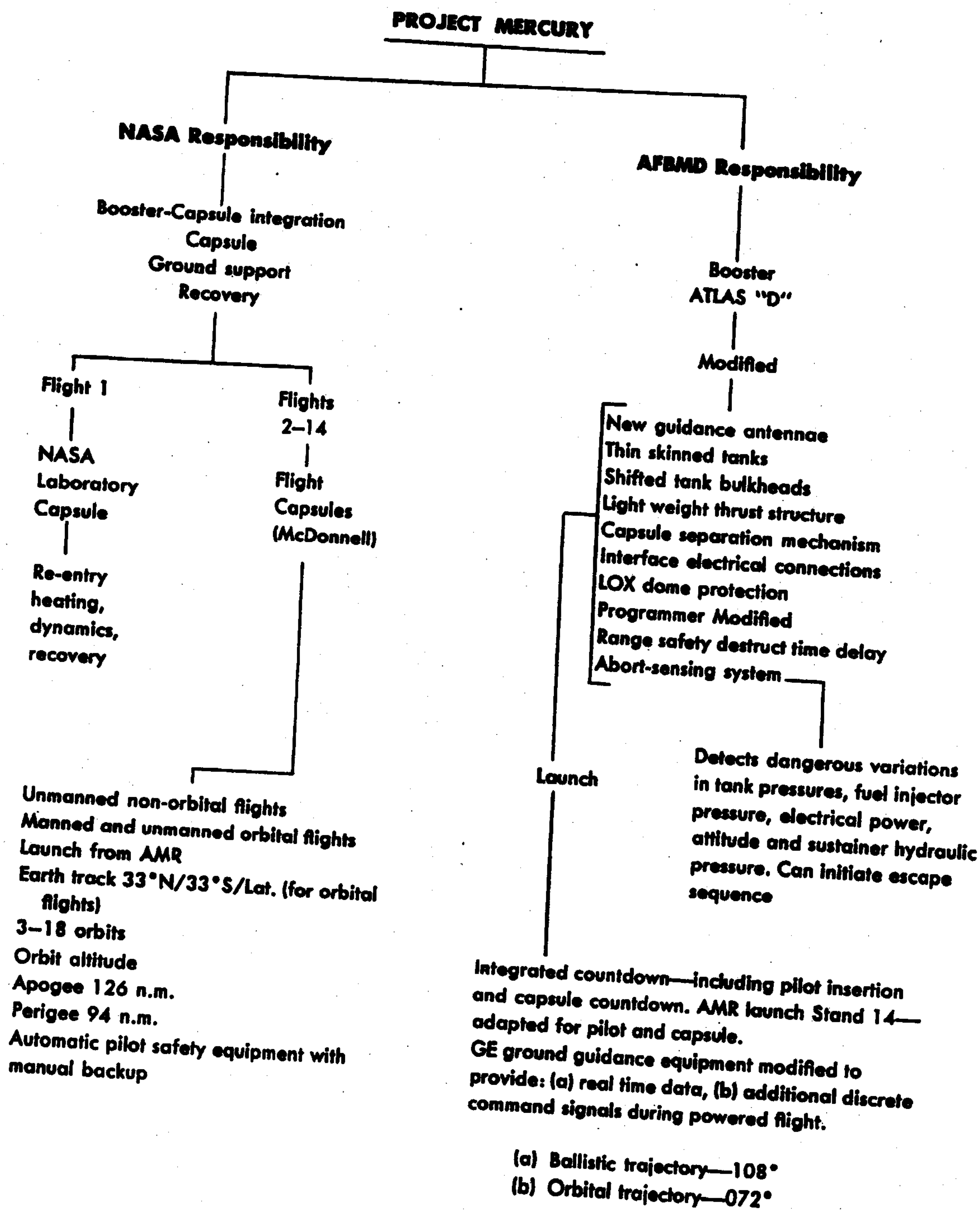


Table 1. Outline of NASA and AFBMD responsibilities in PROJECT MERCURY.

PROJECT MERCURY

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

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

Provide 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.

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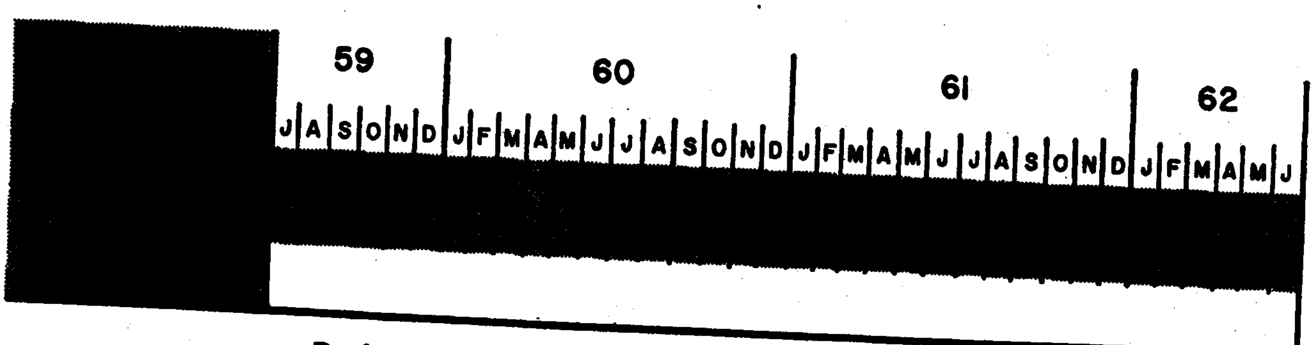
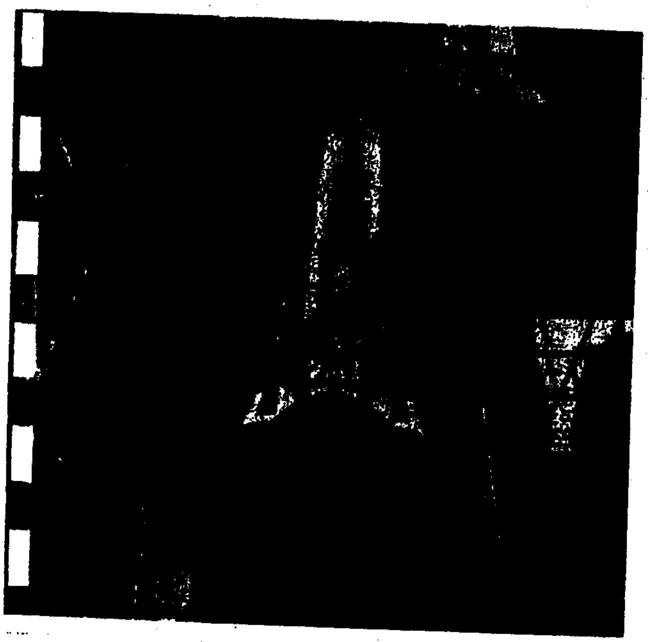
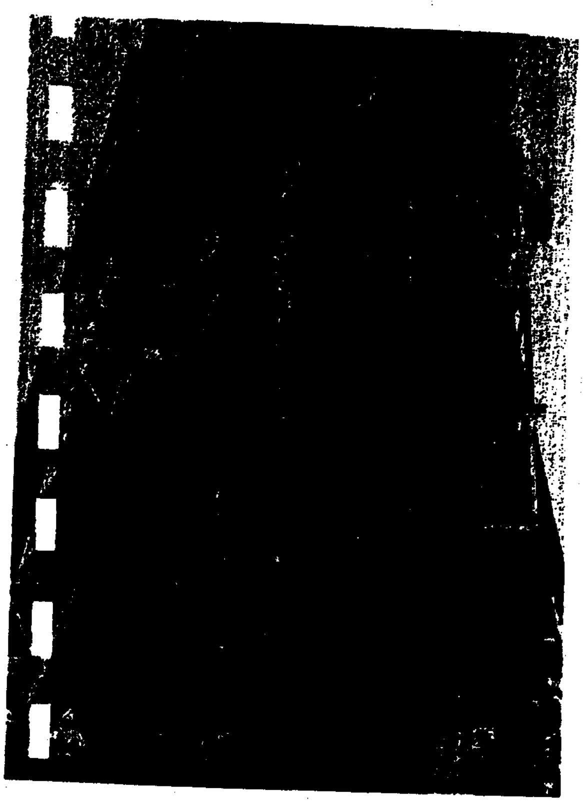


Project MERCURY Launch Schedule





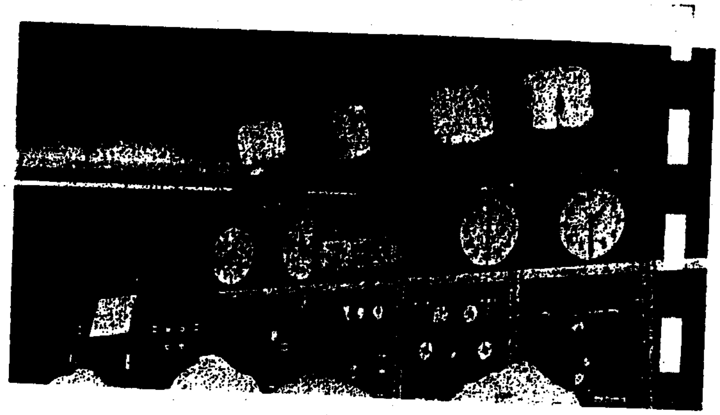
ATLAS 50D booster being delivered to Launch Stand No. 14 . . . Attaching the booster to the stand hold down trunion mounts . . . raising the booster and transporter into the vertical position . . . the capsule during installation on the ATLAS booster . . . gantry with work platforms raised surrounds the MA-1 test vehicle.

Monthly Progress—PROJECT MERCURY

Flight Test Progress

- The NASA MERCURY capsule was mated with ATLAS booster 50D, at Atlantic Missile Range stand No. 14, on 5 July. The mating of the booster and capsule formed the second MERCURY test vehicle designated MA-1.
- The Flight Acceptance Composite Test was held on 18 July. NASA required that a Flight Readiness Firing (FRF) be performed on this vehicle so that critical capsule data could be obtained under simulated environmental conditions. The FRF was conducted on 21 July and was considered completely successful.
- The ATLAS booster had been modified to meet the requirements of the NASA capsule. One of the booster modifications was the installation of the Abort Sense and Implementation System which was to be tested open-loop. The NASA capsule used in the MA-1 test was not a production model, but a production structural shell with instrumentation and components installed by NASA to meet the MA-1 mission objectives. The capsule escape system which is triggered by the booster Abort Sense and Implementation System, in the event of booster malfunction, was not installed on the MA-1 capsule.
- MERCURY MA-1 was launched from Stand 14 Atlantic Missile Range at 0813 EST, on 29 July. Approximately 60 seconds after a normal engine start sequence and vehicle liftoff, all guidance rate and track lock were lost simultaneously with booster telemetry signals and the missile was destroyed. No booster or capsule abnormalities were indicated during the first 60 seconds of flight. Data received during the flight and hardware recovered after are being analyzed to determine the direct cause of the malfunction.
- The launch of the third MERCURY flight test (MA-2) is scheduled for the week of 17 October.

Figure 4. View inside Complex 14 blockhouse (right) showing test controllers, launch control panels and closed circuit television screens on which the test can be monitored. Test vehicle MA-1 after liftoff on 5 July. Umbilical has just pulled free of the capsule.

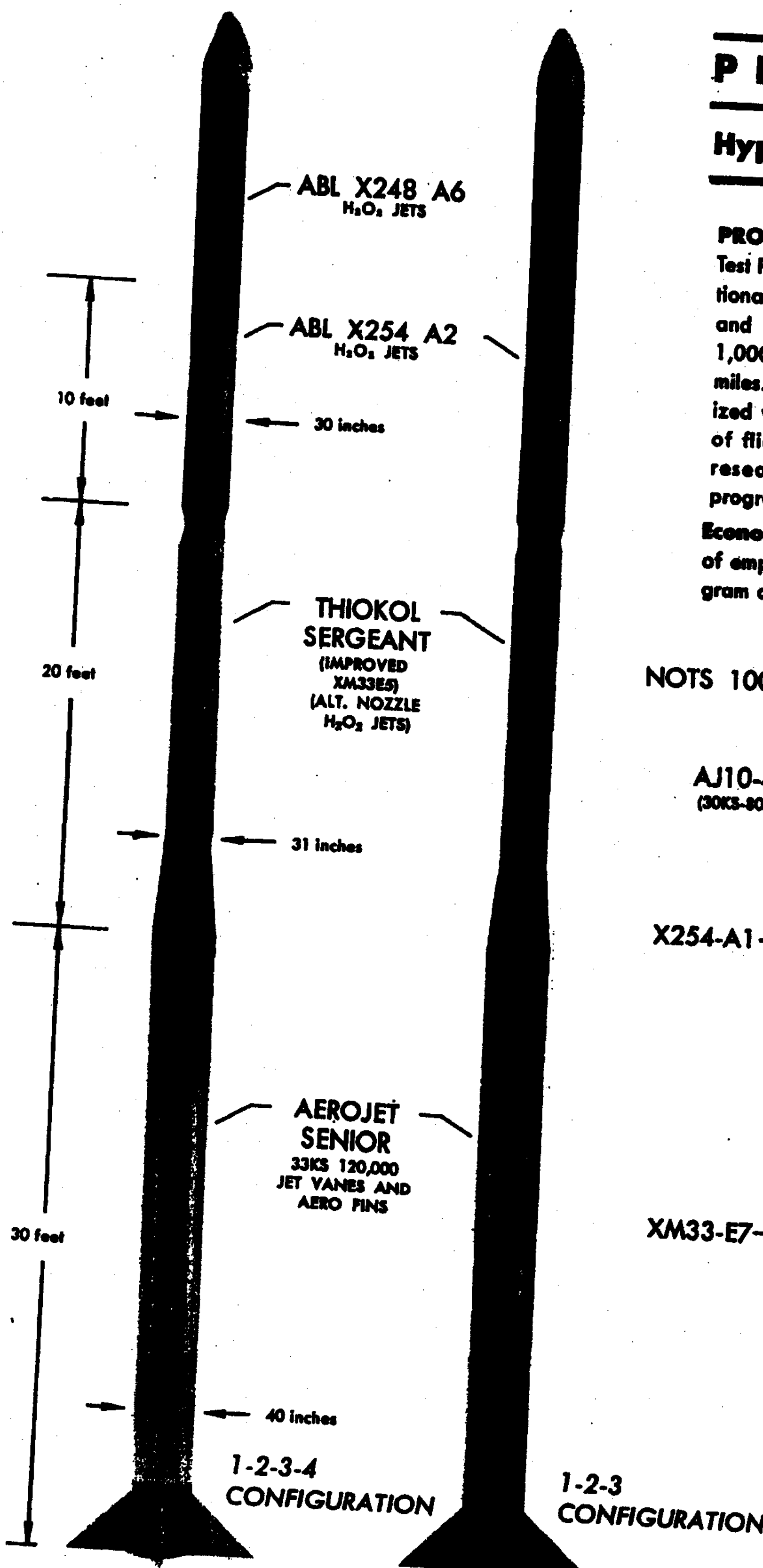


PROJECT 609A

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



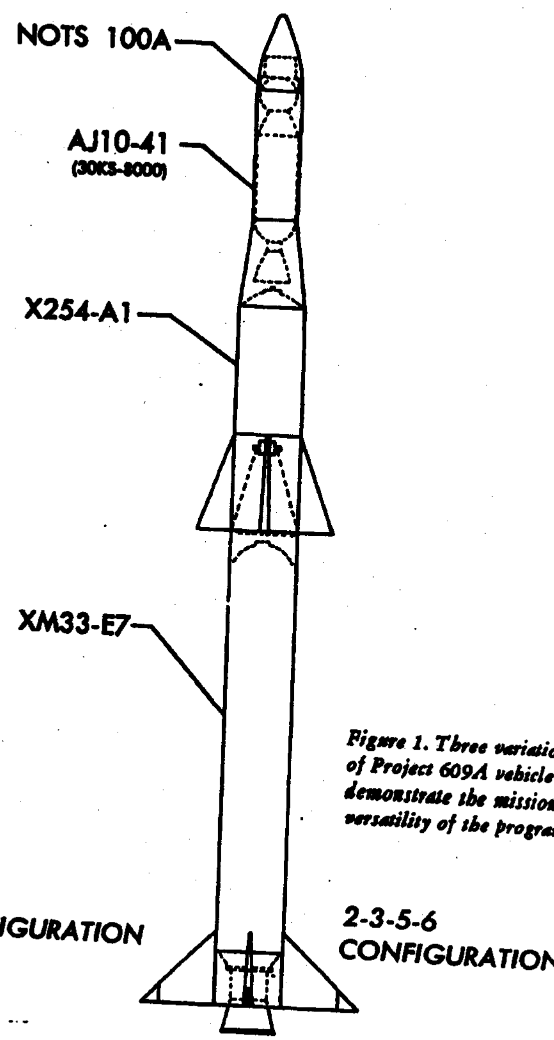


Figure 1. Three variations of Project 609A vehicle demonstrate the mission-versatility of the program.

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 effect an economy in vehicle development. Necessary modifications include provisions for stabilizing the fourth stage without spin and use of the vehicle in less than the full four-stage configuration. Close integration with the current ballistic missile program will effect an economy by permitting tests and experiments to be conducted on regularly scheduled ballistic missile test flights whenever possible without delaying schedules. Economy in the operational phase will be exercised by the use of this low-cost vehicle as a standard flight test platform to perform scientific and military experimental research in support of all Air Force facilities. RELIABILITY will be obtained by a 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/altitude 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 $9,361,000 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 (Piggyback Program). In June 1959, Aeronutronic Division of the Ford Motor Company was chosen through normal competitive bidding as the Payload, Test, and Systems Integration Contractor. Arrangements have been made for the procurement of vehicle components and associated support equipment, modified to meet Program 609A requirements, through NASA, rather than through the SCOUT Program contractors. Atlantic Missile Range facilities consisting of launch complex 18 will be made available to the Air Force for this program. A Project 609A division has been established within the 6555th Test Wing (Development) at AMR to supply Air Force technicians to participate in the assembly, checkout and launch operations of the R&D phase under the direction of the Payload and Test Contractor. An all-military operational capability will be developed from within this group.

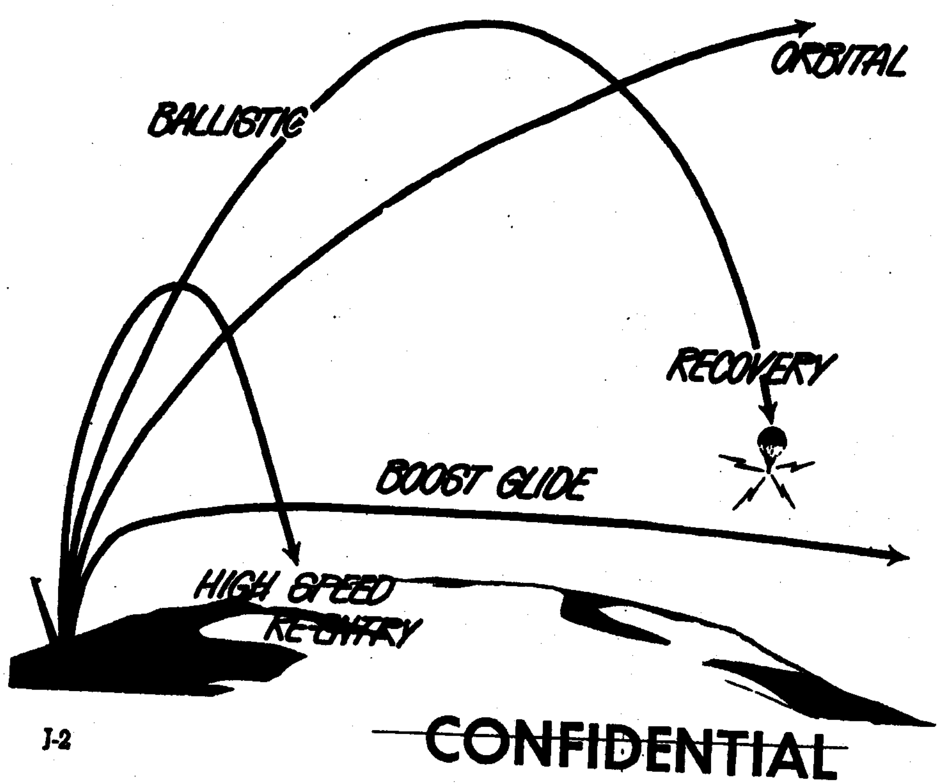
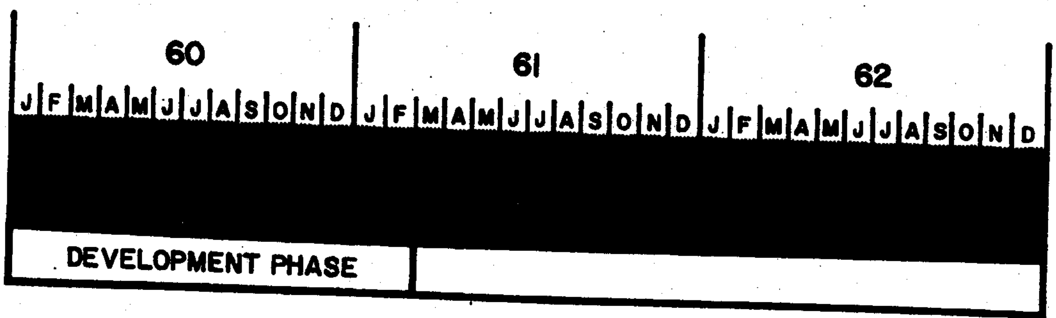


Figure 2. Four different trajectories possible using different arrangements of Project 609A stages.



Project 609A Launch Schedule

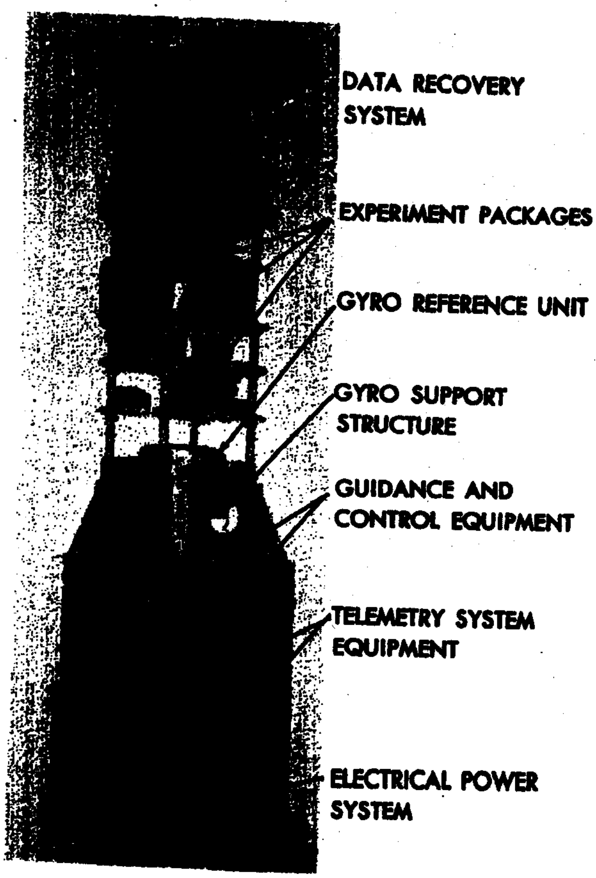


Figure 3. Mockup of 609A payload carrier locating major components mounted on the equipment racks. This carrier is designed for installation on either the 1-2-3 configuration or the 1-2-3-4 configuration.

Monthly Progress—Project 609A

Program Administration

- Although Hq ARDC approved the 1 June revision of the 609A Development Plan to Hq USAF for purposes of procurement and funding, minor changes based on comments from various Hq ARDC offices and AFRD are being incorporated. As directed by Hq ARDC, many of the functions of the AFBMD Payload Review Committee are being transferred to the Air Force Research Division.
- Representatives of AFBMD, Boeing and Aeronutronic have met to establish a program for 609A support of DYNA SOAR. It appears that the only requirement for modification will be in the guidance system. Aeronutronic is currently furnishing preliminary data to Boeing regarding the 609A vehicle and its capabilities. Minneapolis-Honeywell is studying the DYNA SOAR requirements to determine the guidance system modifications necessary to meet the accuracy requirements of that program.

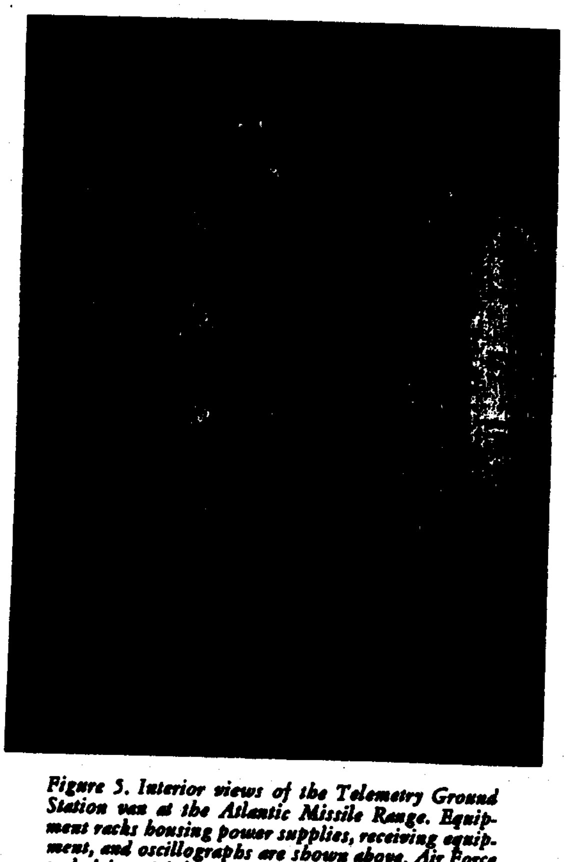
Technical Progress

- Satisfactory results were attained during the detailed fit checks of the 1-2-3 and 1-2-3-4 vehicle configuration conducted at Chance-Vought. These checks were made during the first two weeks of July.
- A payload recovery system drop test was conducted at the Salton Sea Range on 5 July. This was the second partially successful drop test conducted to date. A thorough review of the system design and quality control is being made by AFBMD/BMC.

- The waiver request on the flight termination system for the unguided 609A vehicle was rejected by AMR Range Safety. This has required a redesign of the system and caused a two months' delay in the program. Range Safety has agreed to waive destruct requirements for the third and fourth stages. Redesign and testing of the new flight termination system for the 2-3-5-6 vehicle and the computation of vehicle failure modes and impact data are being accomplished in accordance with the recommendations of range safety. All data on the new system are scheduled to be submitted to AMR Range Safety by 25 August to permit the 15 September launch.

- The first NASA SCOUT was launched from Wallops Island, Virginia, on 1 July. During third stage burning the vehicle appeared to turn off course causing range safety to prevent fourth stage ignition. This apparent deviation was found to have been caused by erroneous radar indications. The vehicle attained an altitude of 800 nautical miles and a

Figure 4. Performance monitoring equipment (foreground) for the 609A 2-3-5-6 vehicle (first flight test) during checkout at the contractor's facility. Telemetry equipment racks (background) will be used for airborne telemetry equipment checkout and also used to analyze and evaluate telemetered flight data for all 609A vehicles.



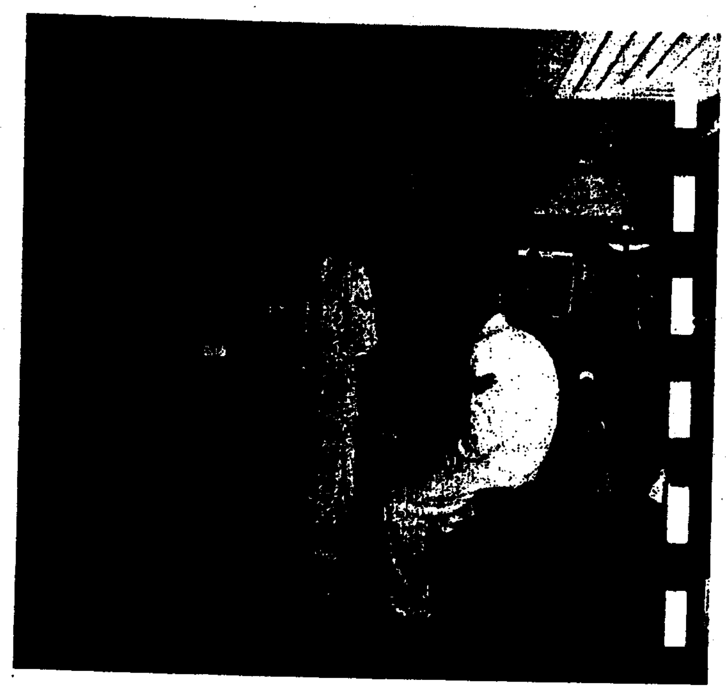


Figure 5. Interior views of the Telemetry Ground Station van at the Atlantic Missile Range. Equipment racks housing power supplies, receiving equipment, and oscillographs are shown above. Air Force technicians (right) are checking a component in the maintenance area of the van. Work table and main power busses are shown.

range of 1500 nautical miles. The next SCOUT launch is scheduled for October.

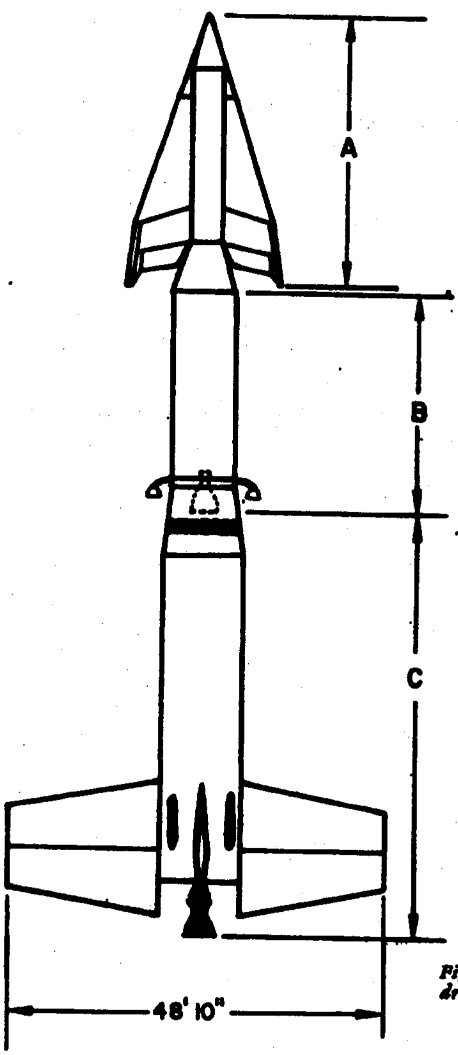
Facilities

- During the week of 26 July the AMR facility plans for the Operational Phase were reviewed with the 6555th Test Wing (Development). It is apparent that no existing rocket motor storage can be made available for the first stage motors, and an existing assembly building cannot be utilized for payload checkout. Therefore, the following new buildings are planned: rocket motor storage building; payload building, two missile assembly buildings, and a combined systems checkout building. It is anticipated that half of an existing industrial hangar will be utilized for technical support. These buildings will allow a launch rate of approximately 38 vehicles per year. The first assembly building is scheduled to be available for occupancy in March.

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

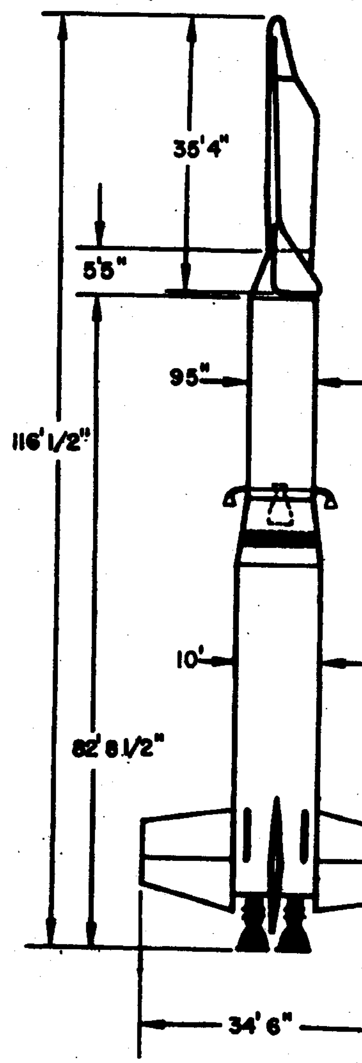


Figure 1. DYNA SOAR vehicle configuration drawing and specification list.

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 September 1963 with a one and one-half month span between launches. The manned booster flights are programmed to start in mid-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 Antillies; and Mayaguana, Bahama Islands.

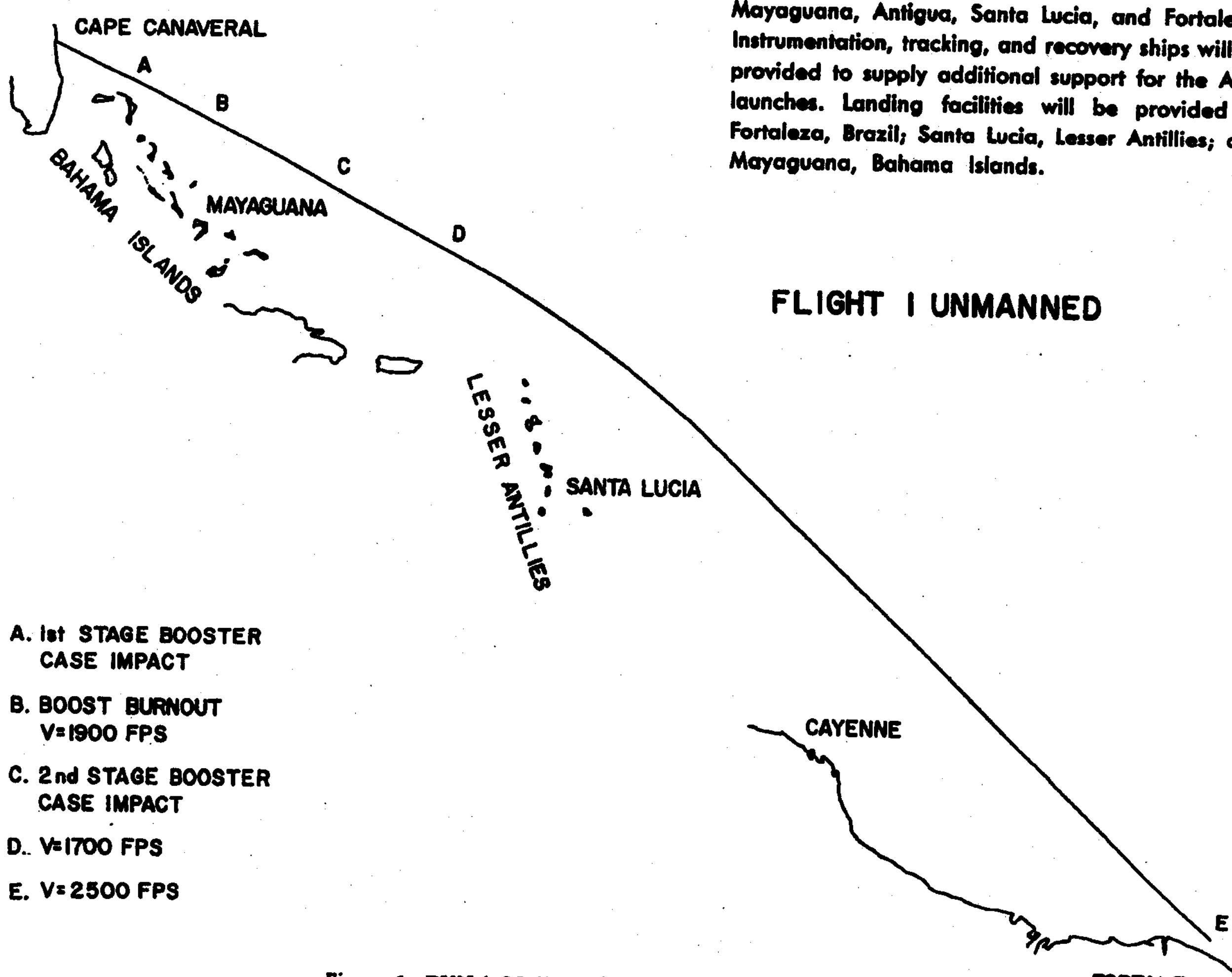


Figure 2. DYNA SOAR tracking stations and landing sites for launches from the Atlantic Missile Range.

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 responsible 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.**
- **A reconsideration of the approach to be used in modifying the TITAN launch stand has been initiated. Martin Company and Boeing Aircraft Company are conducting a study which will provide data that will enable the DYNA SOAR Facility Work Group to decide which approach will be used—erector or gantry tower modification. The final report on this study is due the first week in October.**
- **An Architect and Engineer Evaluation Board has been established to select the contractor who will design the modified launch facility. Planning of the design program and criteria development will start following the selection of a contractor.**
- **The Test Force has established an engineering work group which is responsible for developing the test program requirements at the Atlantic Missile Range. A working relationship among the various agencies concerned has been established.**
- **Briefings and meetings held to discuss ground support equipment have resulted in a plan for the generation of the equipment list required to conduct the DYNA SOAR program. Existing TITAN equipment will be utilized to the maximum extent. Modifications to existing equipment and development of new equipment will be identified and monitored on a continuing basis.**

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 available, 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 any 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. Alternate vehicles under consideration are the ATLAS booster with an ABLE-STAR second stage.

- 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

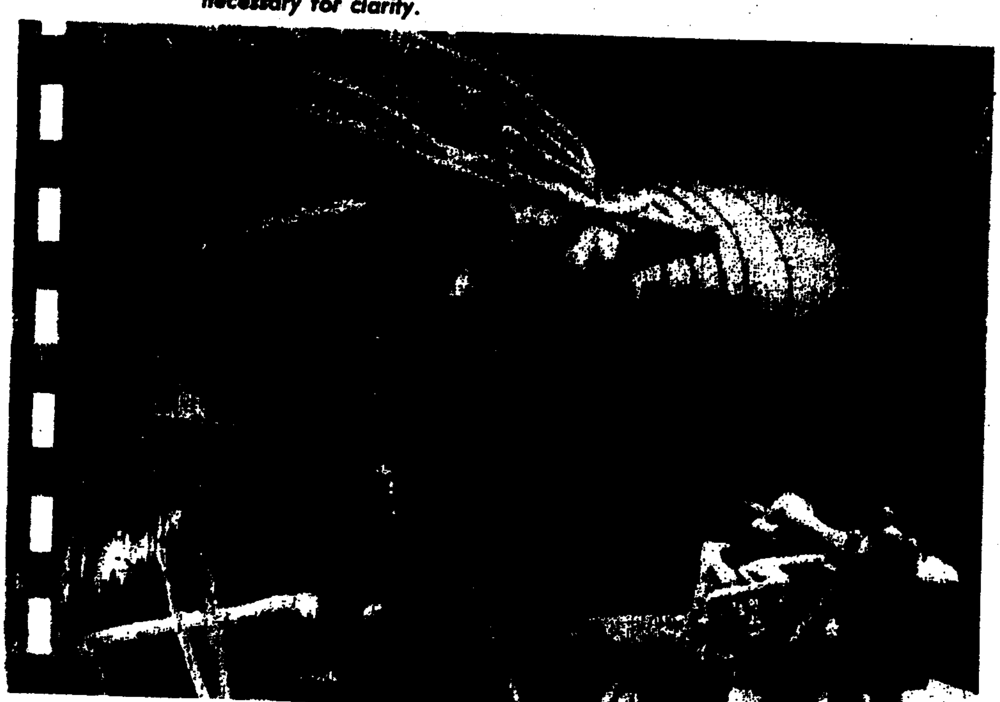
Space Program

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

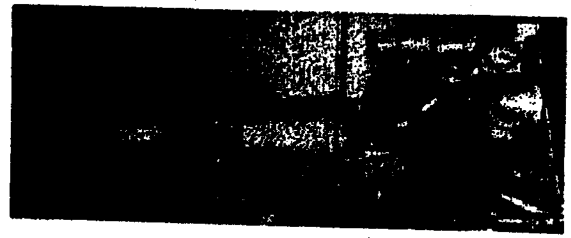
DM-18	MB-3 Block I
DM-21	MB-3 Block I
	MB-3 Block II

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

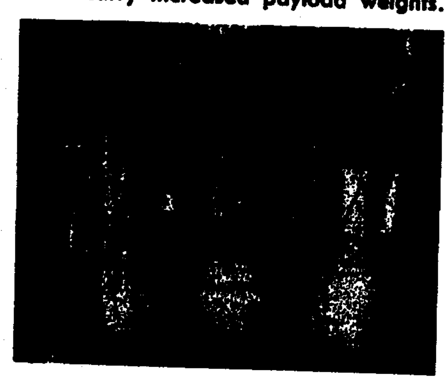
Engine

Series D ATLAS	MA-2
Fuel	JP-4
Oxidizer	LOX

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

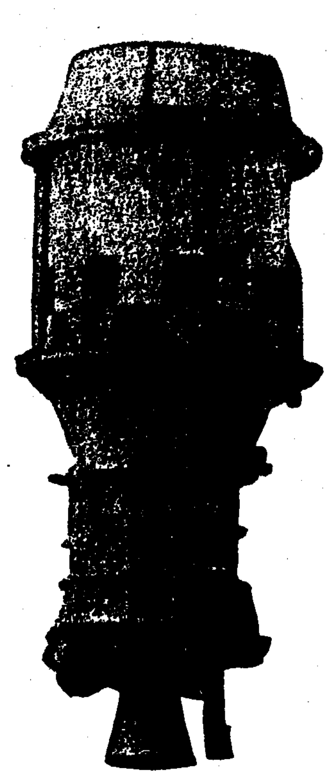
Used as first stage for:
SAMOS
MIDAS
COMMUNICATIONS SATELLITE
ABLE-4 and -5
PROJECT MERCURY

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

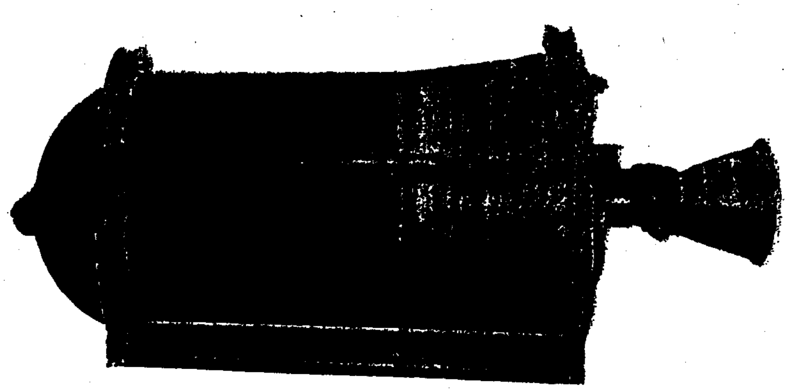
Engine manufacturer:
Bell Aircraft Corp.

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 (XVII & subs)
SAMOS (flight 4 and subs)
MIDAS (flight 3 and subs)

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

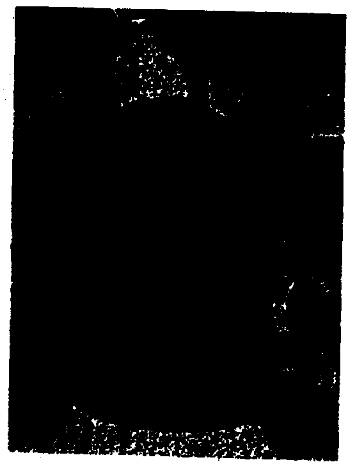
ABLE Vehicle

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



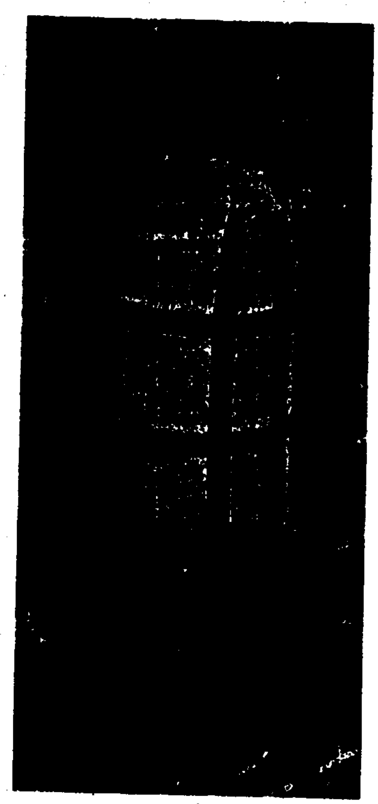
Oxidizer
Inhibited White Fuming Nitric Acid

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 of 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....

THOR	A DM-18	B DM-21
Weight—dry	6,950	6,500
Fuel	30,700	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	
Fuel	15,100
Oxidizer	74,900
	172,300
TOTAL WEIGHT	262,300
Thrust-lbs., S.L.	
Boost	356,000
Sustainer	82,100
Spec. Imp.-sec.	
Boost	286
Sustainer	310

FIRST STAGE

AGENA	D "A"	E "B"	F "B"
Engine Model	YLR81-Ba-5	XLR81-Ba-7③	XLR81-Ba-9③
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

SECOND STAGE

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.*

	G AJ 10-42	H AJ 10-101	J AJ10-104 ABLE-STAR
Weight—wet	1,247.1	847.9	1,297
Fuel	875.1	869.0	2,247
Oxidizer	2,499.6	2,461.0	6,227
TOTAL WEIGHT	4,621.8	4,177.9	9,771
Burnout Weight	1,308.6	944.1	1,419
Thrust-lbs., vac.	7,670	7,720	7,900
Spec. Imp.-sec., vac	267	267	278

SECOND ⟷ STAGE

	⑤ABL 248 K
Weight—wet	59.5
Fuel	455.5
Oxidizer	(solid)
TOTAL WEIGHT	515
Burnout Weight	50.5
Thrust-lbs., vac.	3,100
Spec. Imp.-sec., vac	250.5

THIRD STAGE

Program Vehicle Combinations

DISCOVERER (1 thru 16)......A-D
DISCOVERER (16 thru 21).....A-E
DISCOVERER (21 thru 29)......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

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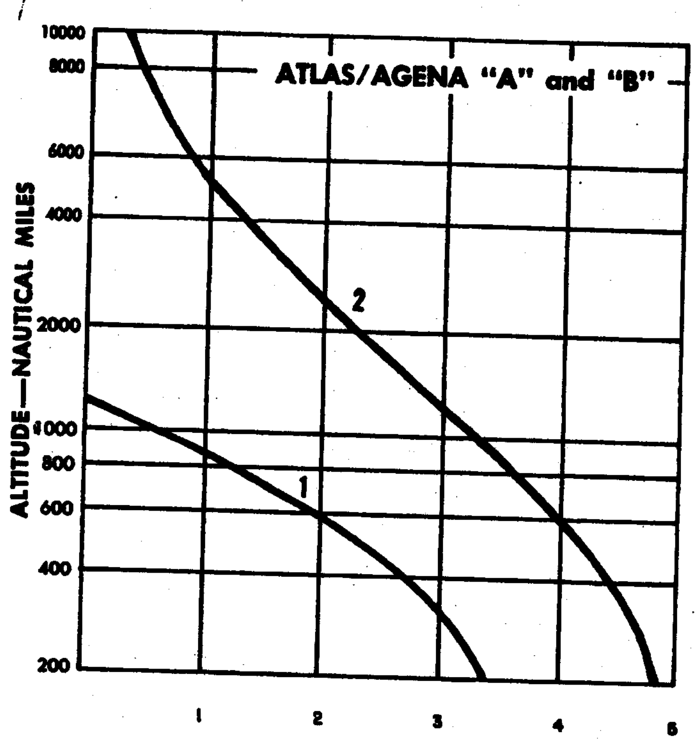
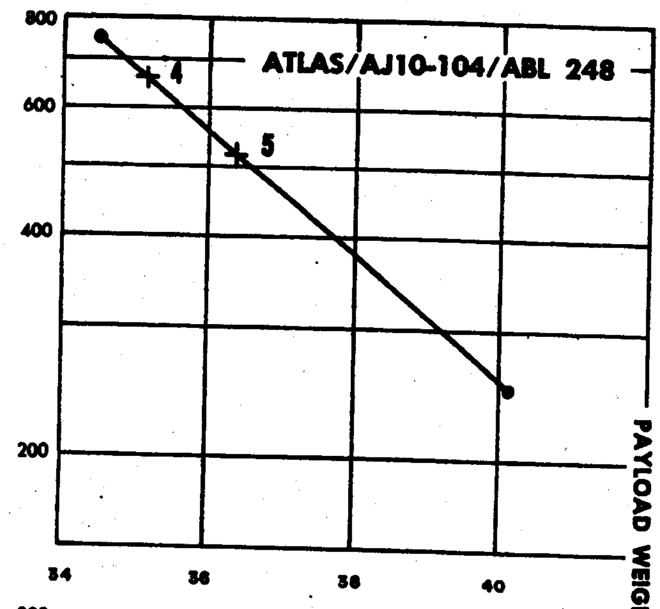
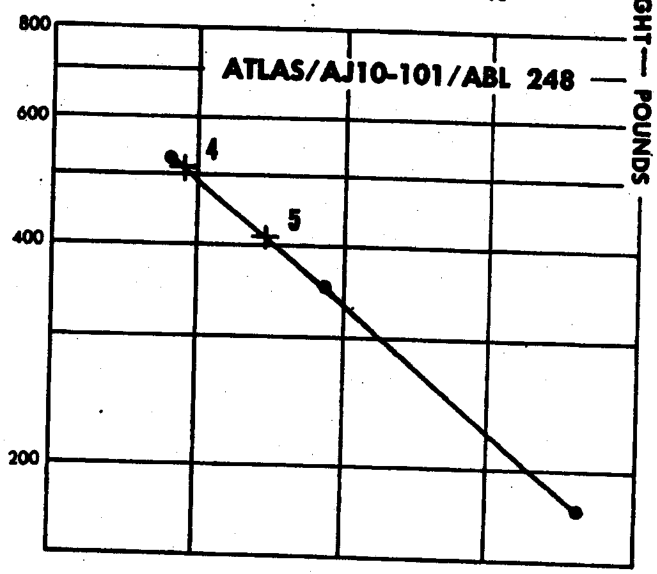
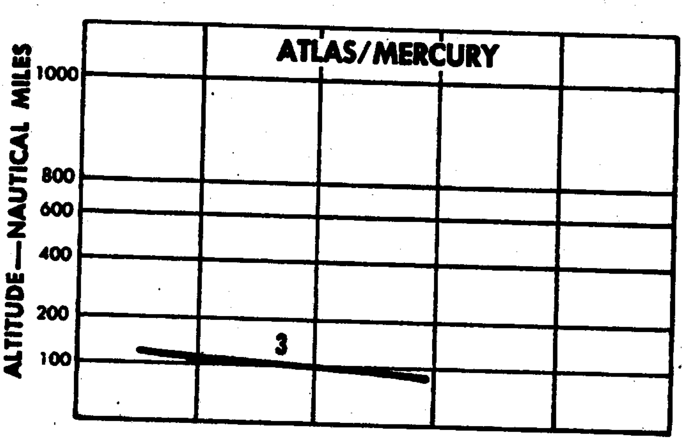
Performance Graphs — ATLAS BOOSTED









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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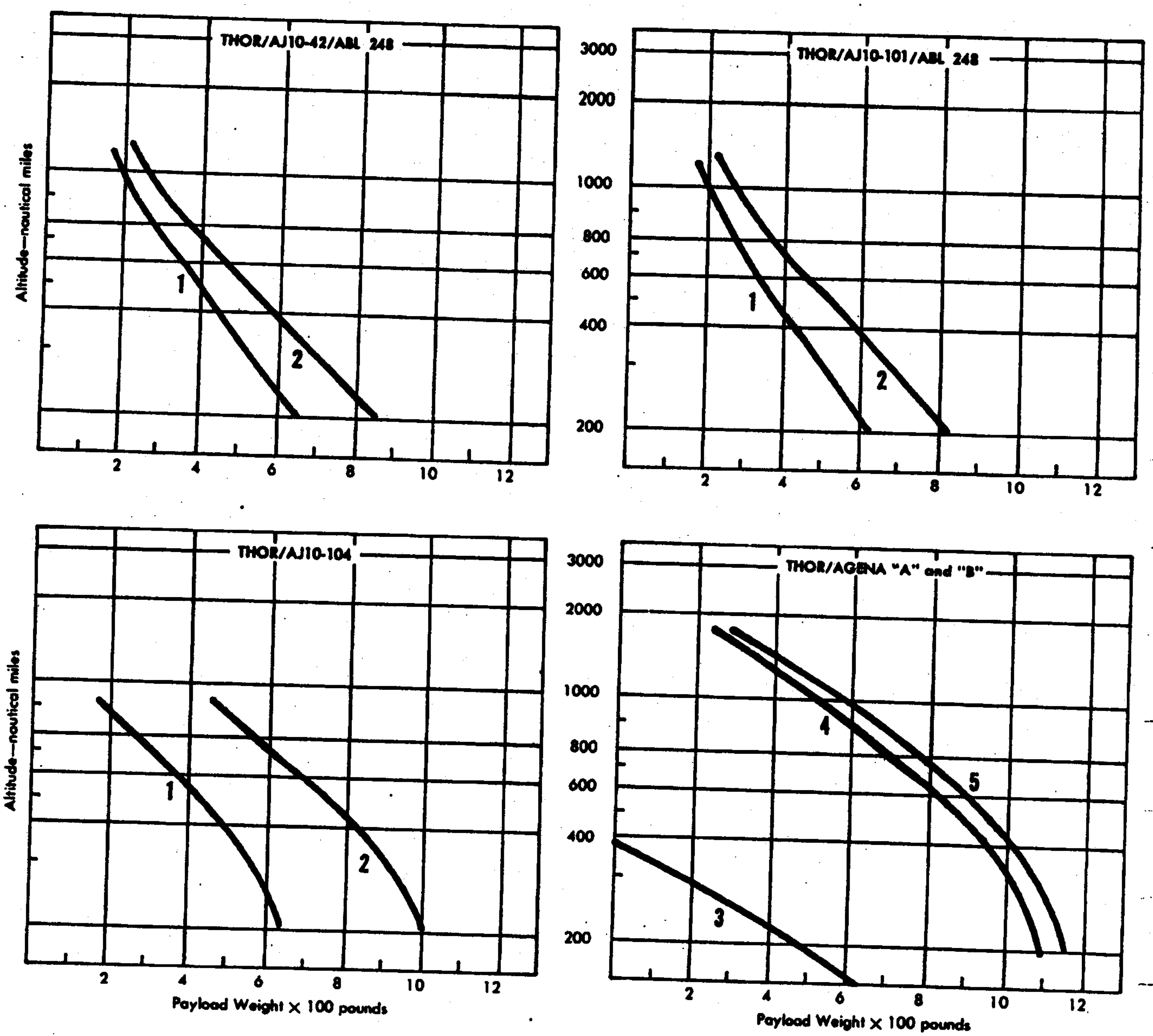
Performance Graphs — THOR BOOSTED



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)