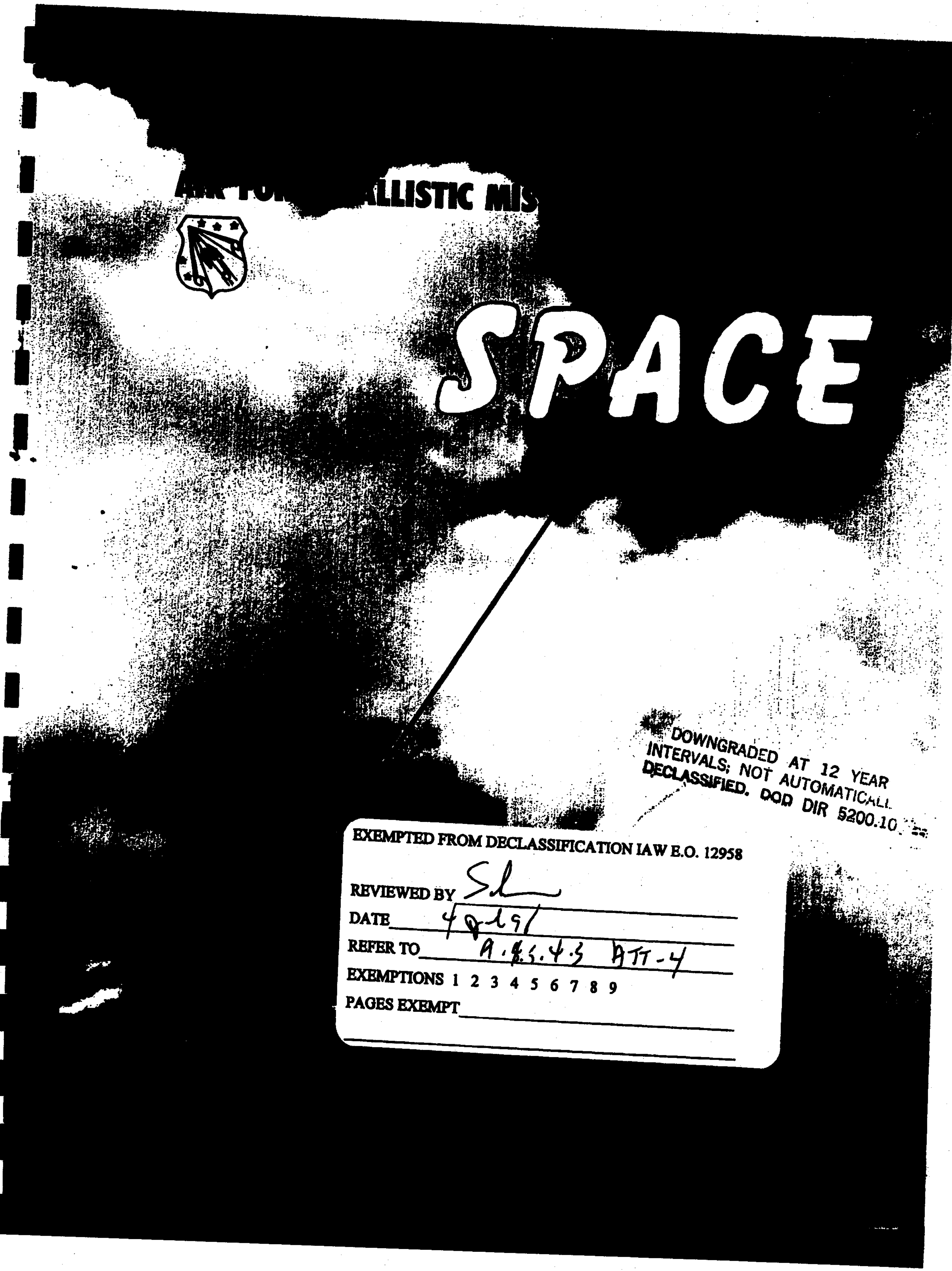
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SPACE

FOREWORD

a foreword to...

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

WDLPR-4

10 November 1960

Summary of AIR FORCE BALLISTIC MISSILE DIVISION Activities in Space

October 1960

FOREWORD

The only AFBMD space vehicle to be flown during the month was DISCOVERER XVI, launched from Vandenberg Air Force Base on 26 October. This was the first flight test of an AGENA B vehicle. Also in the DISCOVERER section, is a report of significant progress achieved during the month in the biomedical subsystem. The MIDAS section includes photographs and progress reports on the Donnelly Flats tracking station in Alaska. With the successful flight and orbital performance of COURIER 1B, all objectives of this program were fulfilled. Coverage of this program is being terminated with the program summary given in this issue.

O. J. RITLAND
Major General, USAF
Commander

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SATELLITE

systems

DISCOVERER
MIDAS
ADVENT

Discoverer

The DISCOVERER Program consists of the design, development and flight testing of 37 two-stage vehicles, using the Douglas DM-21 Space Booster 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.

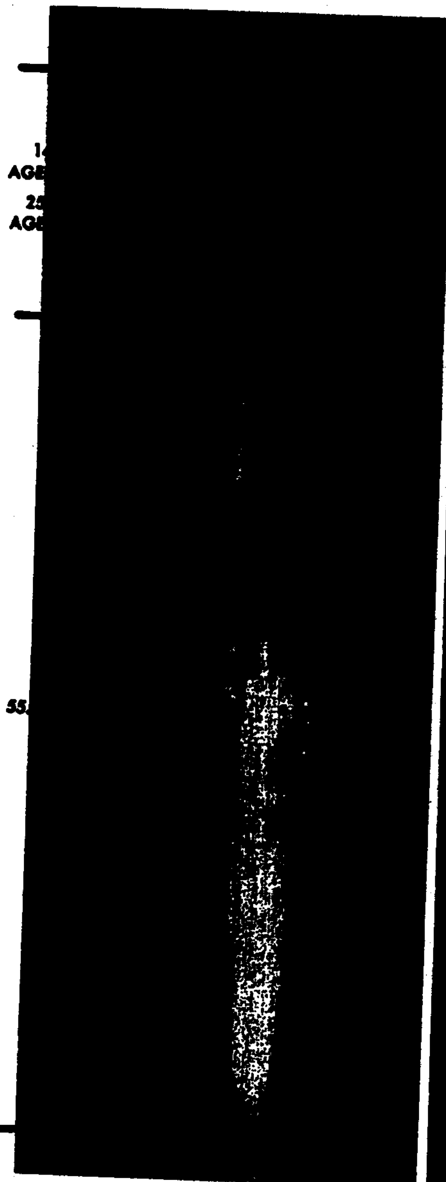
(e) Testing of ground support equipment and development of personnel proficiency.

(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, Sunnyvale, California

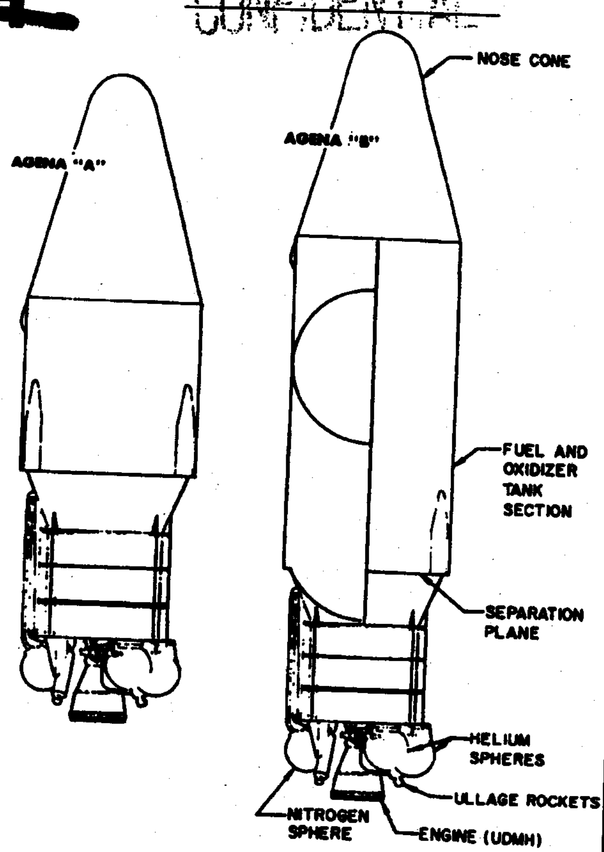
Tracking and command functions are performed by the stations listed in the Table on page A-4. A history of DISCOVERER flight to date is given on page A-5.



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	169,000
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

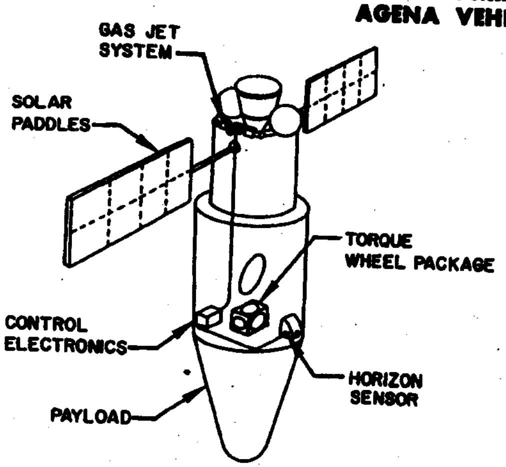
The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page A-5. Specifications for the two THOR configurations and three AGENA configurations used are given on page A-1.

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 stabilization system suited to achieving orbital injection in a horizontal attitude. As a result, an optical inertial system was developed for vehicle stabilization 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

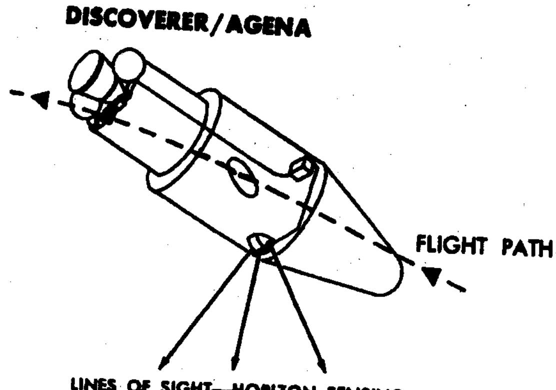


DISCOVERER/AGENA

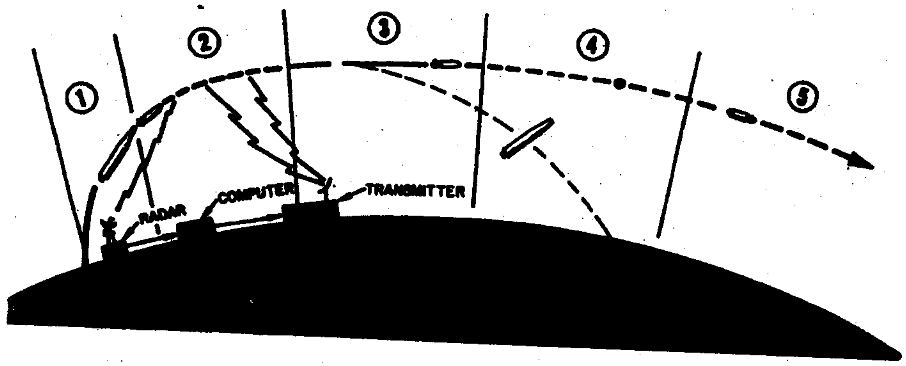
PERFORMANCE CAPABILITIES

ALTITUDE
200-20,000 MILES

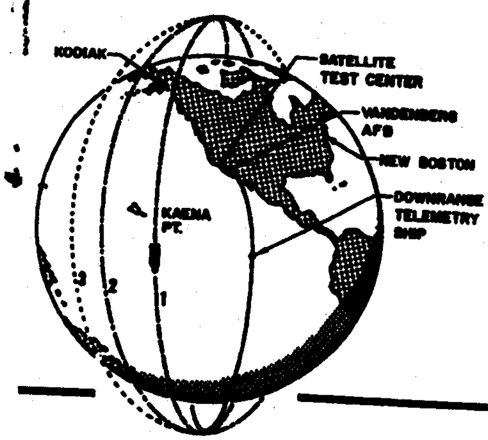
ATTITUDE
ROLL — 0.1 DEGREE
PITCH — 0.1 DEGREE
YAW — 1 DEGREE



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, attitude 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).

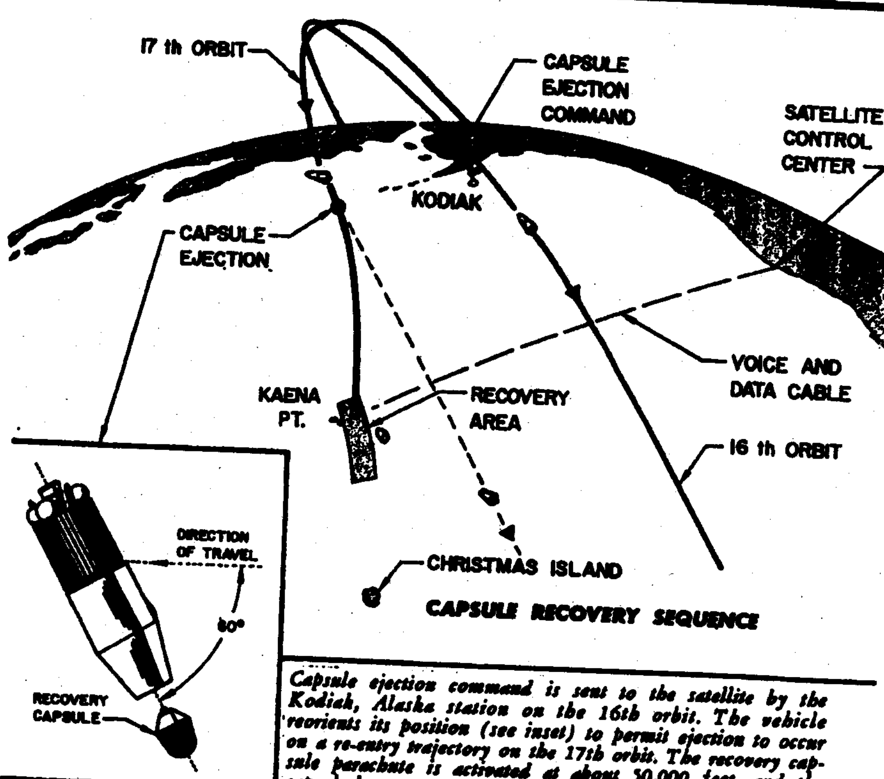


Orbital Trajectory

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 near 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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GROUND SUPPORT FACILITIES

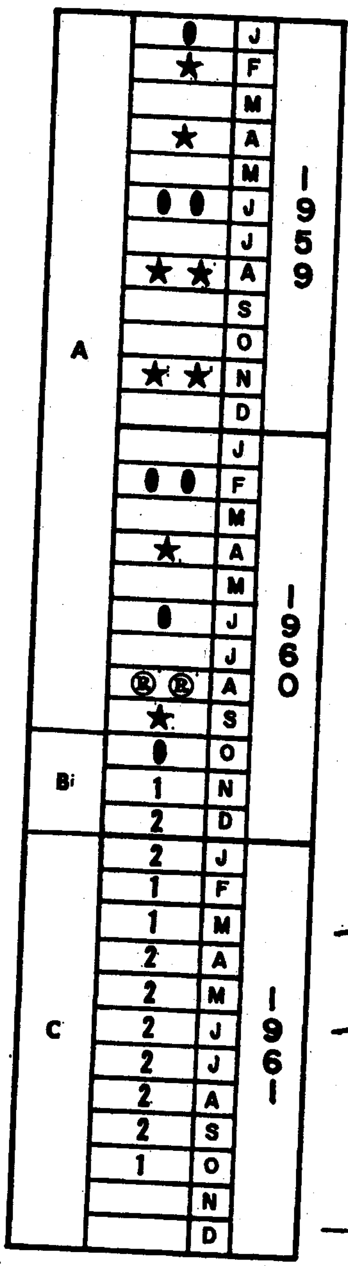
Facility	Equipment*	Flight Function
Satellite Test Annex	ABCD	Over-all control, orbit computations and predictions, acquisition data for tracking stations, prediction of recovery area.
Vandenberg AFB Tracking Station	BDEFGHIJ	Ascent and orbital tracking, telemetry reception, trajectory measurements, command transmission.
Mugu Tracking Station	BDEFGHI	Ascent tracking, telemetry reception, computation and transmission of ignition and shutdown corrections.
Downrange Telemetry Ship	BGIJK	Telemetry reception and tracking during ascent and early part of first orbit.
New Hampshire Tracking Station	BDFGHIJ	Orbit tracking, telemetry reception, commands to satellite.
Kodiak Tracking Station	BDFGHIJ	Orbit tracking, telemetry reception, initial acquisition on pass 1, monitor events in recovery sequence.
Hawaiian Tracking Station	BDFGHIJ	Orbit tracking, telemetry reception and transmission of commands to satellite.
Hickam AFB Oahu, Hawaii		Over-all direction of capsule recovery operations.

NOTE: In addition to equipment listed, all stations have inter- and intra-station communications equipment and check-out equipment.

Equipment

A. General Purpose Computer(s) and Support Equipment
B. Data Conversion Equipment
C. Master Timing Equipment
D. Control and Display Equipment
E. Guidance and Command Equipment (DISCOVERER ascent only)
F. VERLORT
G. VHF FM/FM Telemetry Station
H. VHF Direction Finding Equipment
I. Doppler Equipment
J. VHF Telemetry Antenna
K. APL Doppler Equipment

LAUNCH SCHEDULE



★ Attained orbit successfully.

Ⓡ Capsule recovered.

⬮ Failed to attain orbit.

FLIGHT HISTORY

DISCOVERER No.	THOR No. / AGENA No.		Flight Date	Remarks
0	160	1019	21 January 1959	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	163	1022	28 February	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	170	1018	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	174	1020	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	179	1023	25 June	*Same as DISCOVERER III.*
V	192	1029	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	200	1028	19 August	*Same as DISCOVERER V.*
VII	206	1051	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	212	1050	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	218	1052	4 February 1960	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	223	1054	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer. Severe pitch oscillations caused by booster autopilot malfunction.*
XI	234	1055	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
XII	160	1053	29 June	*Launch, ascent, separation, coast and orbital stage ignition were successful. Failed to achieve orbit because of AGENA attitude during orbital stage boost.*
XIII	231	1057	10 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit. Capsule was recovered after a water impact with negligible damage. All objectives except the airborne recovery were successfully achieved.*
XIV	237	1056	18 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit and was successfully recovered by the airborne force. All objectives successfully achieved.*
XV	246	1058	13 September	*Attained orbit successfully. Ejection and recovery sequence completed. Capsule impact occurred south of the recovery forces; located but lost prior to being retrieved.*
XVI	253	1061	26 October	*Launch and ascent normal. AGENA failed to separate from booster and failed to attain orbit.*

VEHICLE CONFIGURATIONS

A. THOR—DM-18/AGENA "A"

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

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

Monthly Progress—DISCOVERER Program

Flight Test Status

DISCOVERER XVI Flight

• DISCOVERER XVI was launched from Vandenberg Air Force Base at 1226 PDT on 26 October. DISCOVERER XVI was the first vehicle to carry an AGENA "B" second stage. Countdown was normal and DM-21 performance was satisfactory except that the vernier engines did not operate after main engine cutoff. Normally, the vernier engines burn nine seconds longer to damp out any attitude errors induced during main engine thrust decay.

• Following cutoff of the DM-21 main and vernier engines, the AGENA Subsystem D timer is programmed to initiate a series of events which should result in injecting the satellite into its planned orbit. These events include firing explosive separation bolts, activating satellite control and stabilization equipment, firing the retro-rockets on the adapter, firing ullage rockets, initiating AGENA engine firing and reorientation events. A failure in the timer prevented successful separation of the THOR and AGENA and the satellite plunged into the ocean 660 nautical miles downrange.

• Telemetry data reveal that the signal initiating separation was not sent by the sequence timer. A malfunction within the computer rendered the sequence timer inoperative. The computer has been modified to prevent a recurrence of this problem.

DISCOVERER XVII

• The launch of DISCOVERER XVII is now scheduled for early November. The AGENA vehicle has been delivered to the launch pad for checkout and installation on the DM-21 booster. DISCOVERER XVII will carry an advanced engineering text payload, optical tracking lights and an Applied Physics Laboratory doppler beacon. Flight objectives are similar to previous DISCOVERER flights, except that in the event the satellite is performing satisfactorily on orbit a decision may be made to de-orbit after two days instead of one.

Radiometric Measurement Flights

• The Radiometric Measurement flights are currently scheduled for mid-December and early February. The purpose of these flights is to gather infrared background radiation data for the MIDAS program. No attempt will be made to recover the payloads on these flights.

Technical Status

Mark II Capsule Tests

• A completely successful orbital simulated test of the Mark II biomedical capsule with a live female Rhesus monkey passenger was conducted in October. The monkey was put in the life cell of the capsule on 21 October at Vandenberg Air Force Base during a simulated launch countdown. The sealed capsule was then flown to Sunnyvale and placed in the high altitude simulator on 22 October. It was removed from the simulator on 24 October. The primate was dependent upon the life cell for its existance throughout the 65-hour period. This is twenty percent longer than required by project specifications. The 42 hours the capsule was in the high altitude chamber is the longest time in the United States space programs history an animal has been confined under orbital conditions.

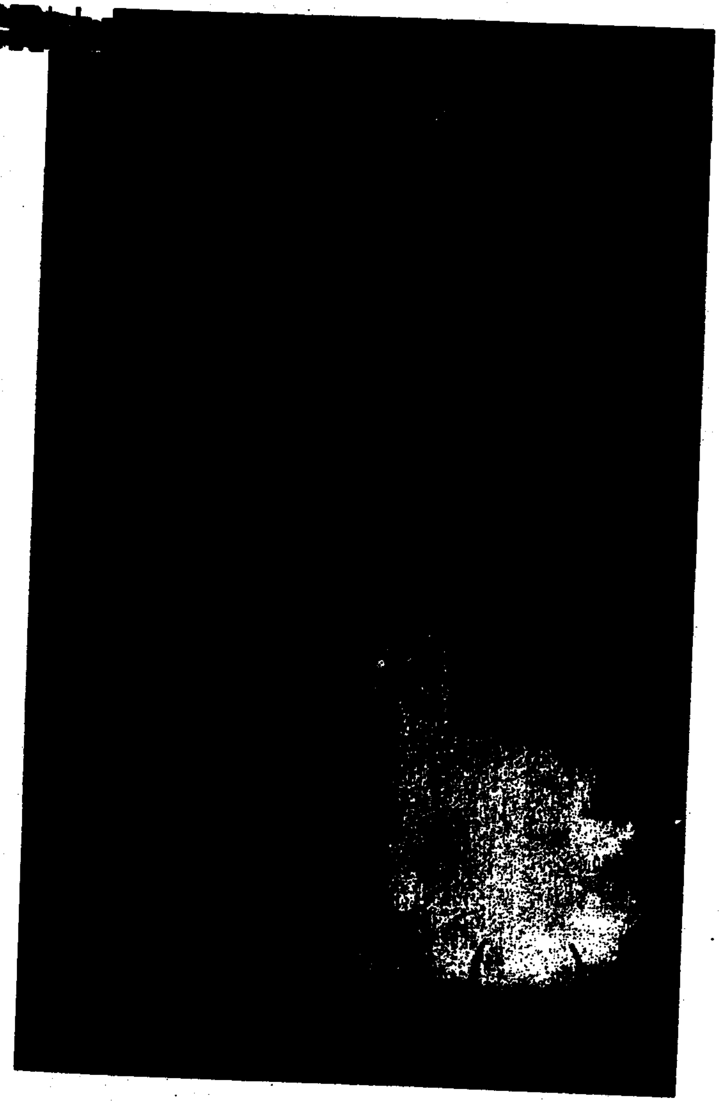
• The primate emerged from the life cell in an exceptionally vigorous condition. She lost about a half pound in weight, as expected, and exhibited very mild effects of exposure to carbon monoxide. The results demonstrated that the capsule can sustain a primate in satisfactory condition for a longer period than required by present DISCOVERER flight objectives.

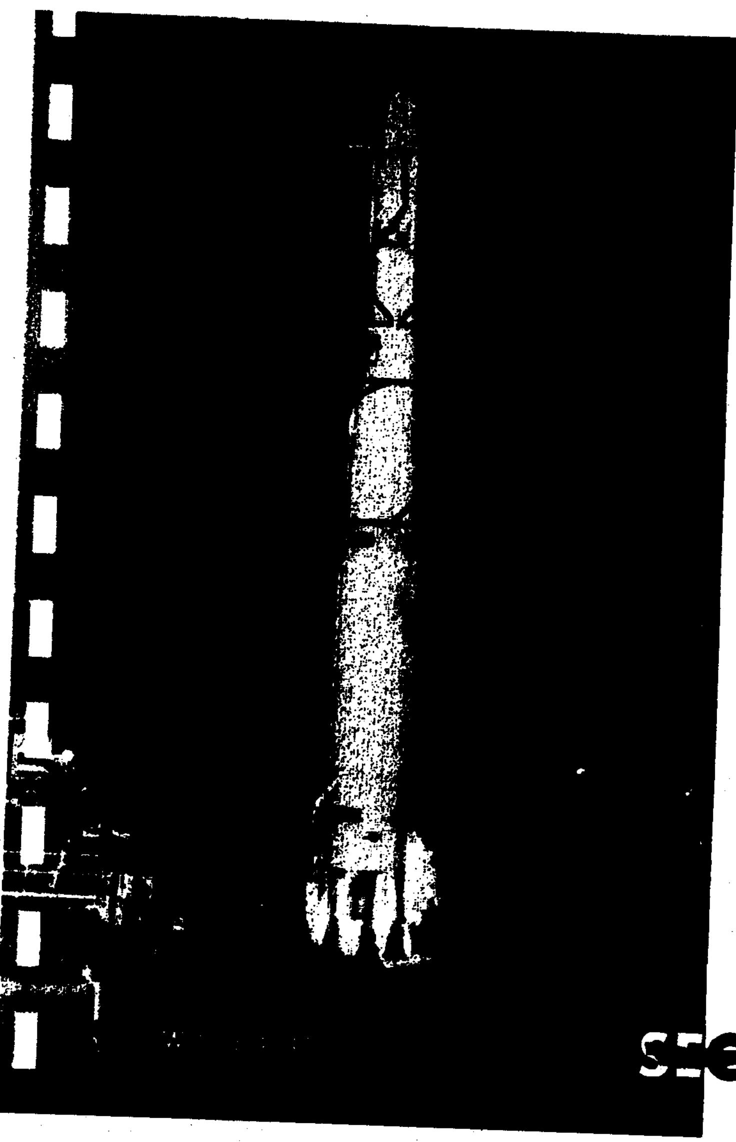
Mark II Life Cell Operation

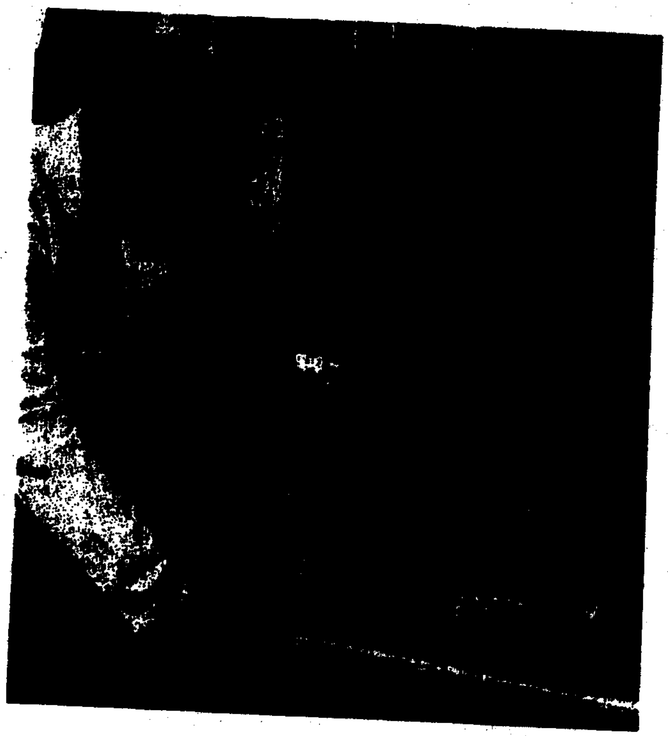
• The life cell uses a closed cycle ducted air regeneration system pressurized to approximately one-half atmosphere. During normal operation, the cell atmosphere contains a mixture of oxygen, carbon dioxide and water vapor. Some carbon monoxide is also present. The mixture is regenerated by the filtering action of lithium hydroxide, lithium chloride and activated charcoal. Pure oxygen is introduced into the system by a pressure regulated valve.

• The monkey is trained to operate a lever in response to a red light which can be turned on by the vehicle programmer or by command from the ground. The purpose of the lever device is to provide a psychomotor performance measure, in order that evaluation of space environment stresses upon higher order functioning may be made. The primate must operate the lever back and forth as long as the light is on. If she holds the lever in any position longer than 2½ seconds, she receives a shock. A feeder provides pieces of parafine covered apple at regular intervals throughout the test. The animal is instrumented to provide data on her condition and

Figure 1. Checkout of the first AGENA "B" vehicle (lower right) at Vandenberg Air Force Base. Some of the many pieces of test equipment required are visible in the right foreground. The duct which brings air to cool the precision electronic equipment is visible in the upper left. DISCOVERER XVI during liftoff (below) on 26 October. The ground support equipment, erector, and shelter are visible. Seconds later the stand is hidden by flame and smoke as the air conditioning cover is pulled free and the missile is on its way.







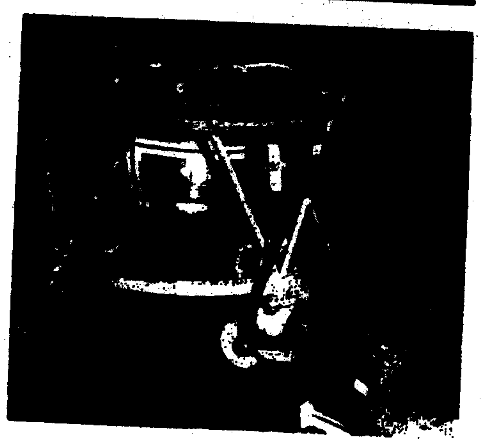


Figure 2. Device (left) used in training monkeys for space flights. When the red light on top of the trainer flashes, the monkey pulls the lever. The primate is conditioned to respond to the light signal in order to avoid a mild shock. Performance of this psychomotor task provides scientists with information as to how well man will be able to perform his duties as pilot of a spacecraft. Center photograph shows the biomedical capsule after its arrival from Vandenberg Air Force Base during the simulated orbital test. The equipment in the right foreground cools the interior of the capsule. Bottom view shows the capsule, encased in its ablative shell, prior to insertion into the high altitude simulation chamber. The consoles in the background record pressures and temperatures inside the chamber.

A scientist (opposite page) checking the readings of the air within the capsule. All impurities (carbon dioxide, water vapor, etc.), are removed by the self-contained air filtering system. Lower photo shows the removal of the sealing cover from the life cell. The feet of the monkey are visible (arrow). "54 Easy" following her removal from the life cell. During this test she spent 65 hours in the cell, 42 of them under orbital conditions. Rhesus monkeys are used in these tests because of the enormous amounts of information available from previous experimentation with this species.

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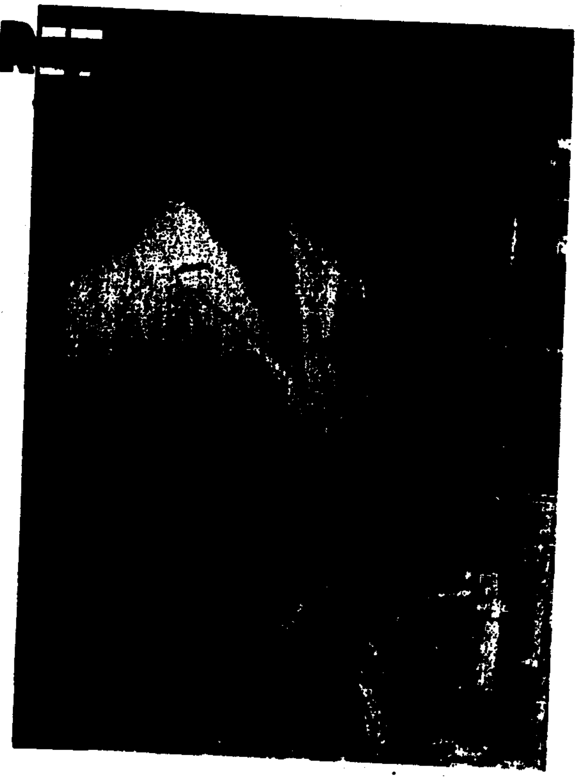

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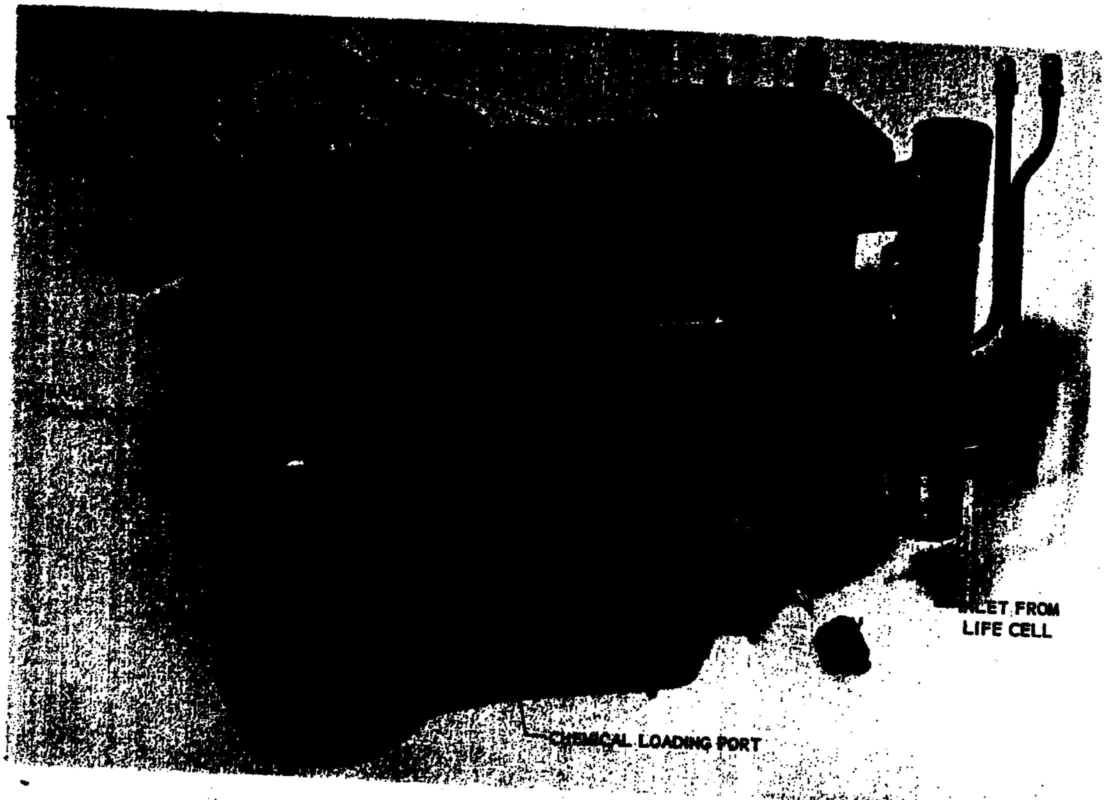

Figure 3. Upper photo shows the air conditioner assembly with major parts labeled. The air returns from the life cell, passes through a chemical filter, over a coil in the heat exchanger and returns to the cell. Lower photo of the life cell shows the pallet on which the monkey rests, the fan which circulates the air and the feeder from which the primate receives pieces of paraffin-covered apple.

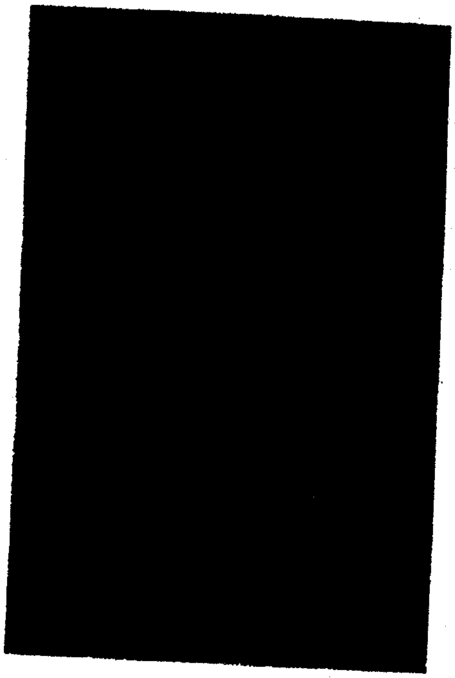

Figure 4. Recovery operations which will permit picking DISCOVERER capsules from the water if they should impact some distance from the recovery force. Frogman with life raft (left) during descent from C-54 aircraft. Frogman in large raft with capsule in net behind one-man raft. Erecting the mast which will allow a C-119 recovery aircraft to snatch the capsule from the sea. Frogmen are shown with smoke bombs which show wind direction and position of capsule. C-119 as its lines catch the mast to initiate capsule recovery. Shot of the raft showing the mast and capsule during pickup attempt.

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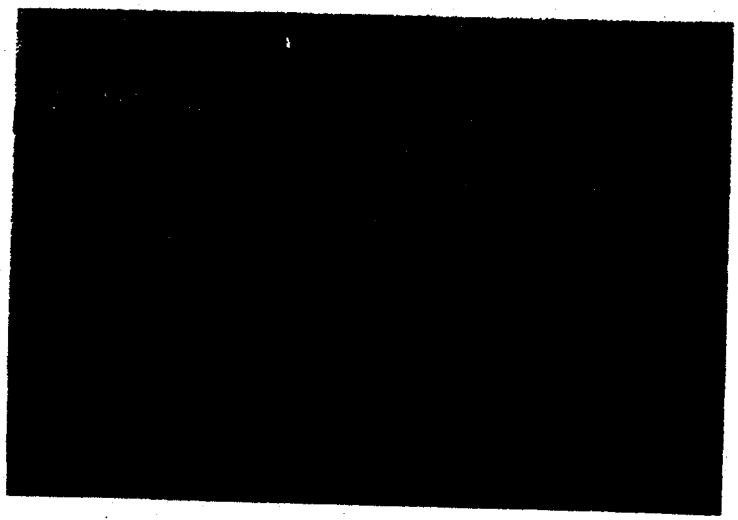

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Figure 5. Photo showing smoke bomb in the distance, capsule at the end of the rope, and the snag hook midway between the capsule and the aircraft. Lower photo shows the capsule being pulled aboard the C-119 recovery aircraft.

a camera photographs her every three seconds throughout the mission.

Second Stage Vehicles

• Three AGENA vehicles, in addition to those scheduled for DISCOVERER XVII and XVIII, have been accepted by the Air Force. Eight other AGENA vehicles are proceeding through manufacturing and systems tests on schedules compatible with present launch requirements.

• The XLR-81Ba-9 engine (Serial No. 306) completed the final start-stop test in the Preliminary Flight Rating Test program satisfactorily. Upon completion of component functional checks the engine was shipped to Bell Aircraft for use in the reliability program which began on 25 October. Vibration tests, with an XLR-81Ba-9 engine installed in a mount with a higher natural frequency than previously used were conducted with satisfactory results. The engine was tested in the longitudinal and lateral planes. Testing in the vertical plane is scheduled next.

• Two XLR-81Ba-9 thrust chambers developed blisters in the hardkote coating of the barrel section during hot firing acceptance tests conducted at the Bell facility. These chambers were coated using the new cleaning and handling procedures which were expected to eliminate this problem. The cause of the blistering is being analyzed.

Balloon Drop Tests

• A two-stage parachute development program is currently being conducted. This program includes high altitude balloon drop tests to evaluate system operation and select a radar reflective parachute pattern compatible with the APS-95 radar.

Capsule Ablative Shell

• The capsule ablative shell used on DISCOVERER XVI was constructed of pheolic nylon. Since this material exhibits certain advantages over the previous shell, it will be used on subsequent flights. During the qualification tests, under low pressure and high temperature conditions, this material was found to crack circumferentially on the ojive and conical skirt section. The development program initiated to correct this condition, resulted in the machining of stress relieving grooves in the ojive of the shell. This configuration has successfully passed qualification tests in the high altitude test chamber with only minor cracks occurring. Extensive tests have indicated that minor cracks, as experienced in the stress relieved shells, does not materially degrade the structural and ablative integrity of the shell. Other manufacturing techniques are being studied in an effort to eliminate this minor cracking.

Facilities

• An additional capsule tracking facility is being installed on Tern Island, northwest of Hawaii. This station will be operative by 15 December and will provide additional capsule position data during re-entry to increase the possibility of recovery.

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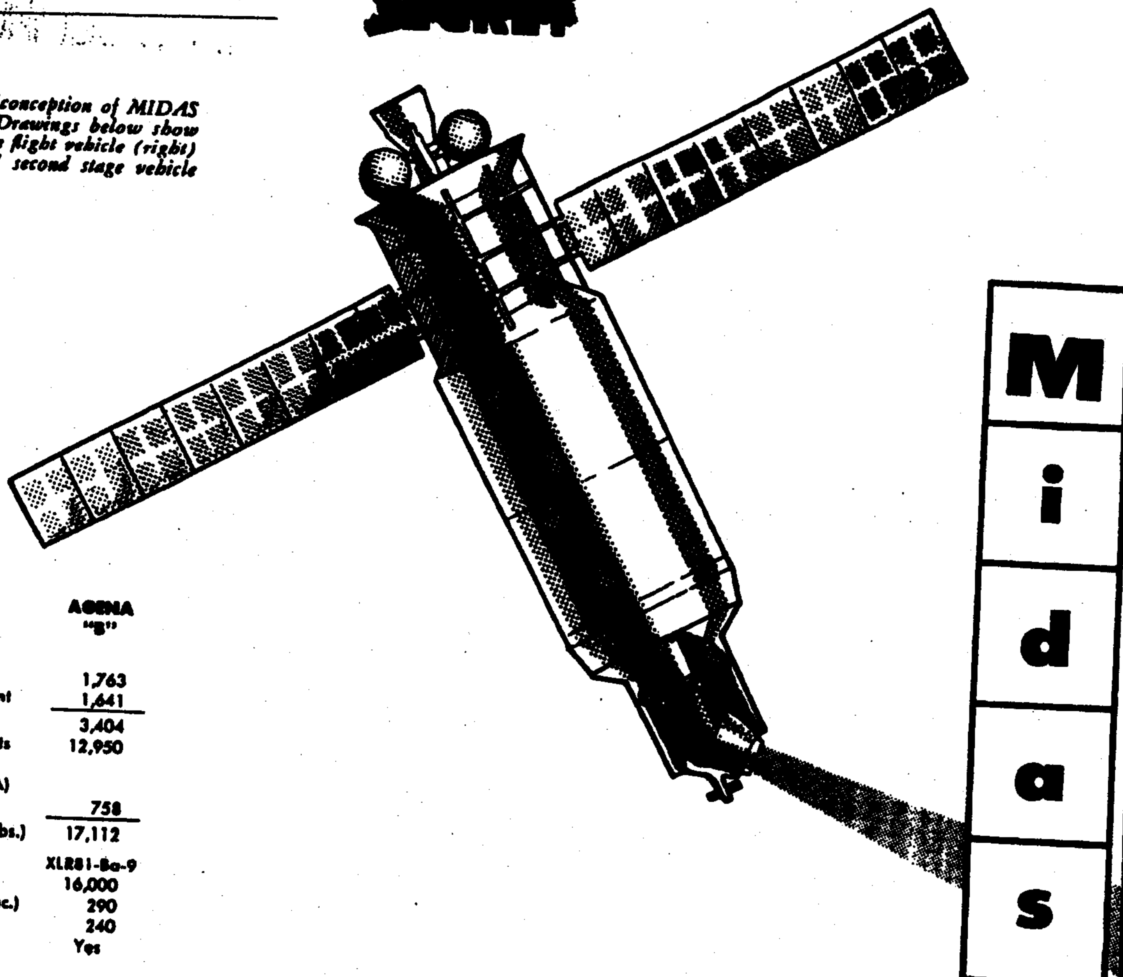
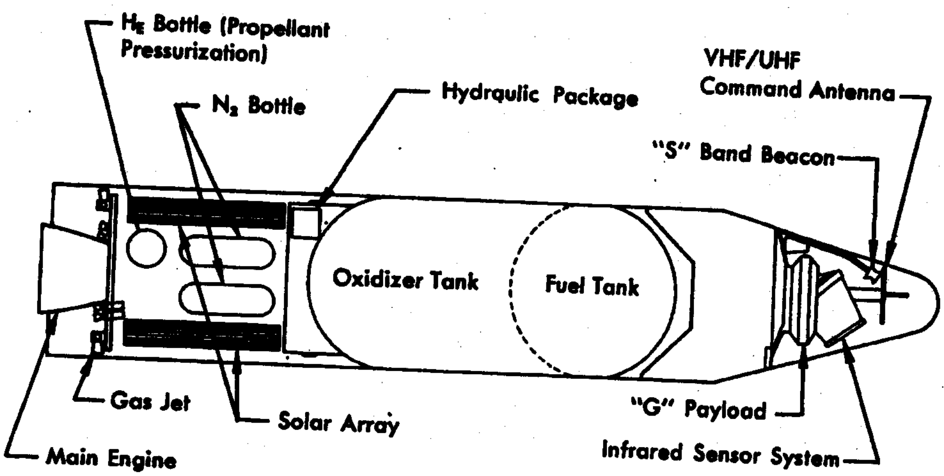
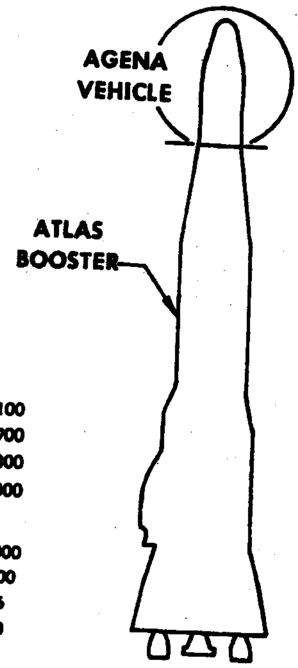
Figure 1. Artist's conception of MIDAS satellite (right). Drawings below show complete two-stage flight vehicle (right) and AGENA "B" second stage vehicle (left).



SECOND STAGE	AGENA "B"
Weight—	
Inert	1,763
Payload equipment	1,641
Orbital	3,404
Impulse Propellants	12,950
Fuel (UDMH)	
Oxidizer (IRFNA)	
Other	758
GROSS WEIGHT (lbs.)	17,112
Engine	XLR81-Ba-9
Thrust, lbs. (vac.)	16,000
Spec. Imp., sec. (vac.)	290
Burn Time, sec.	240
Restart Provisions	Yes



MIDAS, Configuration II, AGENA "B" Satellite



BOOSTER—ATLAS ICBM	
Weight—Dry	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

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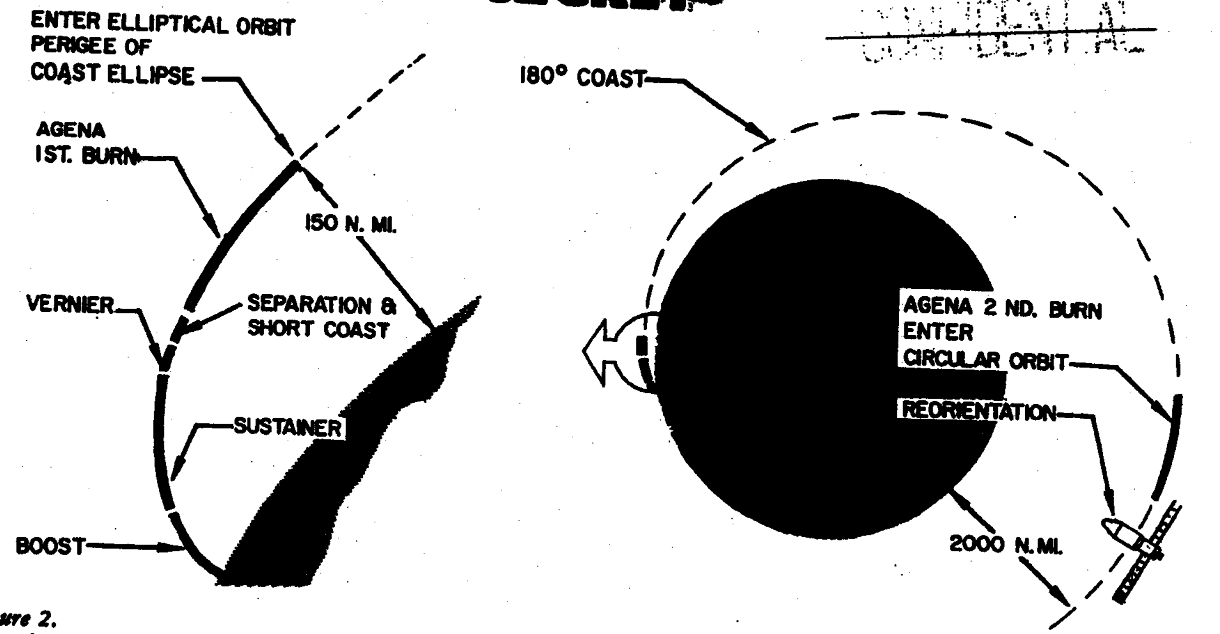


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. From boost through separation guidance and control is provided by the ATLAS radio inertial system. The AGENA inertial guidance system, with horizon scanner, provides attitude, velocity and directional control to establish the orbit and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

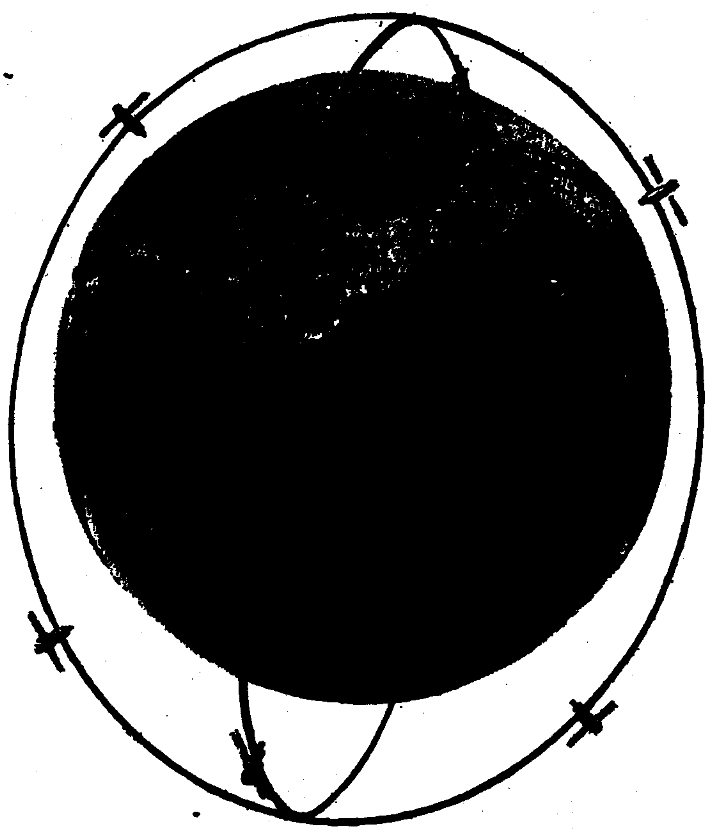
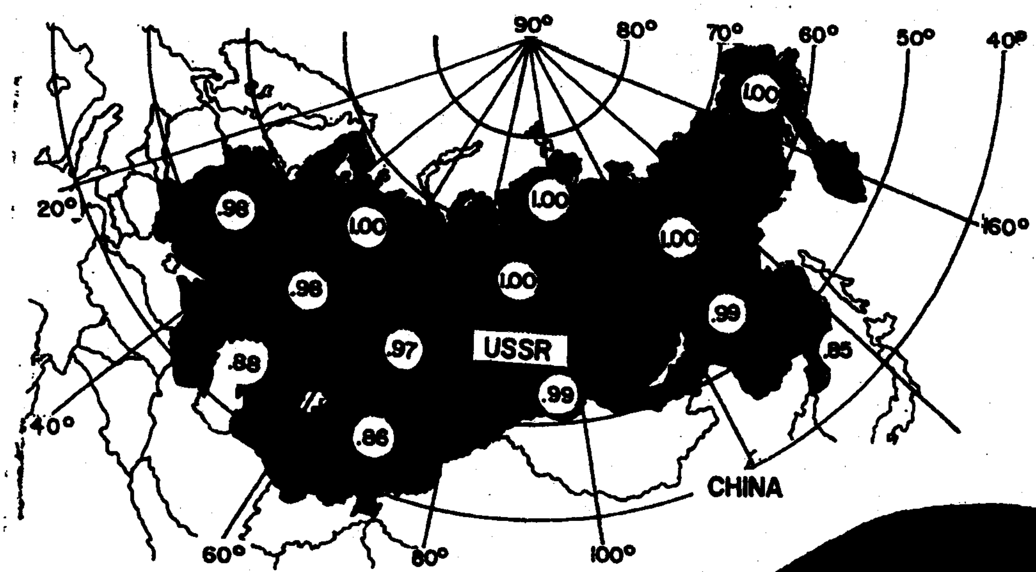


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared early warning system. The MIDAS (Missile Defense Alarm System) Program was directed by ARPA Order No. 38, dated 5 November 1958 until transferred to the Air Force on 17 November 1959. A ten launch development plan for MIDAS (WS-239A) has been approved. Additional authorization has been obtained to utilize two DISCOVERER flights (designated RM-1 and RM-2) to carry background radiometers in support of MIDAS.



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

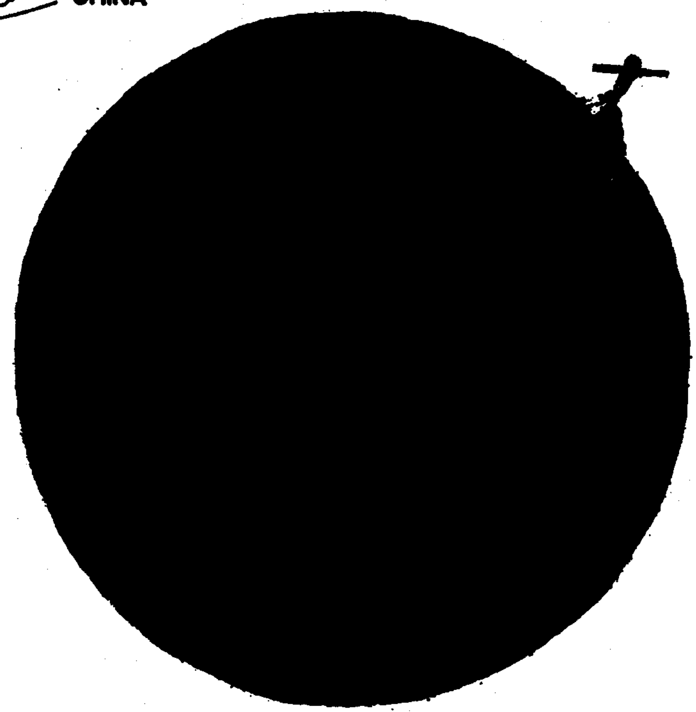


Figure 4.
Orbiting satellites detect infrared radiation emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveal approximately the number of missiles launched and launch location, direction of travel and burning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

TECHNICAL HISTORY

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

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

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

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

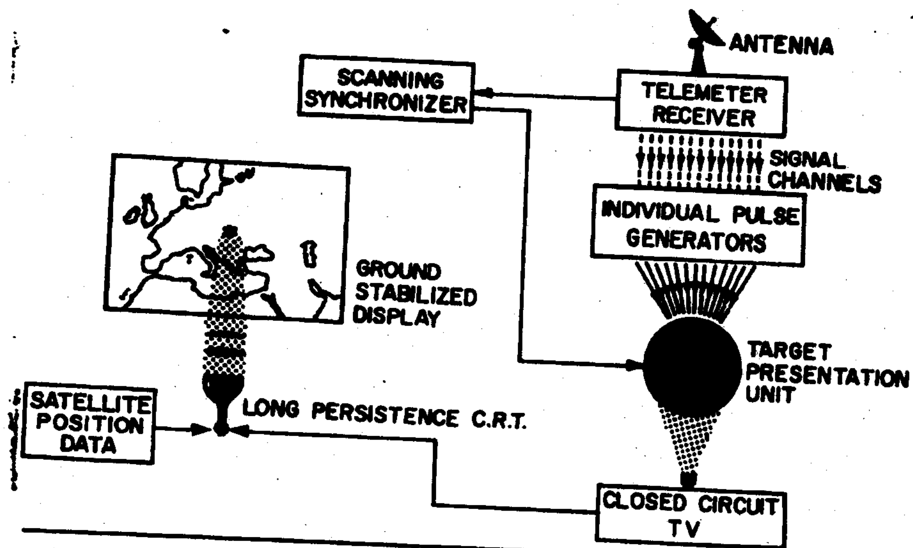
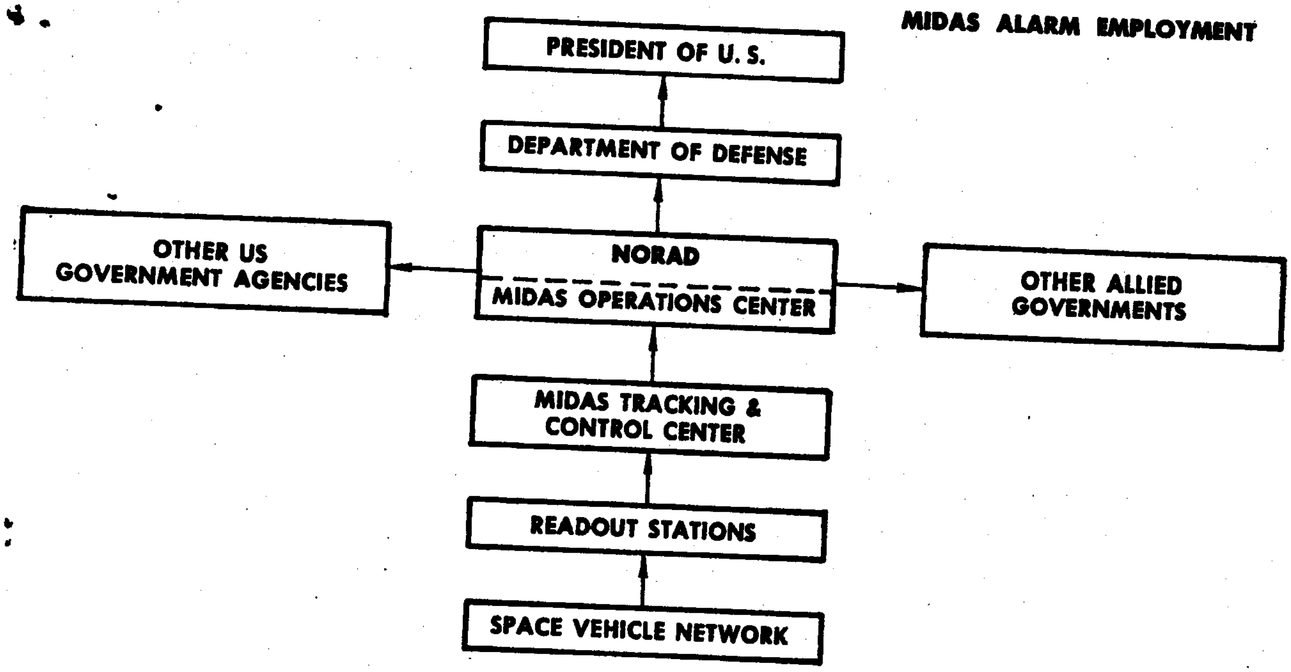


Figure 5.
Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies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

MIDAS ALARM EMPLOYMENT



CONCEPT

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

[redacted]	60	61	62
	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
[redacted]	[redacted]	[redacted]	[redacted]
	ATLAS "D"/AGENA "A"	ATLAS "D"/AGENA "B"	

MIDAS Launch Schedule

MIDAS GROUND SUPPORT FACILITIES

Facility	*Equipment**	*Flight Function*
Satellite Test Annex	ABCDEP	Operations control, orbit computations and predictions, initiation of commands to satellite (via tracking stations), process payload data.
Vandenberg AFB Tracking Station	ABCEFGHIJKLMP	Ascent and orbital tracking; telemetry reception; trajectory computations; command transmission; reception recording and processing of payload data.
Downrange Telemetry Ships	GHIJNO	Tracking and data reception during ascent. (Three ships are available for this function. Equipment is typical.)
Hawaiian Tracking Station	BEFGHJ	Orbital tracking, telemetry reception, payload data reception.
AMR	HJ	Orbital data reception.
New Hampshire Station	ABCEFGHIJKLM	Orbital tracking; telemetry reception; command transmission; reception, recording and transmission of payload data.
African Tracking Station	BEGJ	Telemetry reception and recording during second burn.
North Pacific Station	BCEHKMP	Satellite and payload data reception, command transmission.
Kodiak Tracking Station	FJ	Orbital tracking.
Mugu Tracking Station	BEFGJ	Tracking and telemetry reception.

NOTES: (1) In addition to equipment listed, all stations have inter- and intra-station communications equipment and checkout equipment.

(2) Equipment listed is either presently available or planned and approved for procurement.

**Equipment*

- A. General Purpose Computer(s) and Support Equipment
- B. Data Conversion Equipment
- C. PICE
- D. Master Timing Equipment
- E. Control and Display Equipment
- F. VERLORT
- G. VHF FM/FM Telemetry Station
- H. PAM/FM Ground Station
- I. Doppler Equipment
- J. VHF Telemetry Antenna
- K. UHF Tracking and Data Acquisition Equipment (60 foot F&D Antenna)
- L. UHF Angle Tracker
- M. UHF Command Transmitter
- N. APL Doppler Equipment
- O. SPQ-2 Radar
- P. Midas Payload Evaluation and Command Equipment

Monthly Progress—MIDAS Program

Program Administration

• The MIDAS Development Plan was completed on 24 October and presented to Headquarters ARDC, Headquarters USAF and the AFBMC during the week of 31 October through 4 November. The new plan stresses complete system development, increases the number of development test launchings and provides back-up development efforts to provide a higher confidence of success.

• Representatives of AFBMD visited the Lincoln Laboratory to review progress on MIDAS System Analysis effort. Encouraging progress is being made in system data analyses; in efforts to tape and then perform computer studies of data from the impending MIDAS 3, 4 and 5 launches; special studies on remote station data system configurations; and data display systems. A series of reports, beginning in November, will detail the results of the Lincoln efforts and give their recommended courses of action.

Flight Test Status

• The vehicle for the third MIDAS flight is expected to complete the systems test phase on 9 December. A reworked horizon scanner was received from General Electric on 15 October, as scheduled. Since bench tests indicated that the scanner is sensitive to RF interference, it was decided to eliminate the RF transient noise with the unit installed in the satellite vehicle. The scheduled launch date for this flight is still 28 February 1961.

Technical Progress

Second Stage Vehicles

• The fourth MIDAS satellite is in the final assembly phase of manufacturing. Completion is being delayed because of electronic equipment shortage and intensive schedule recovery effort has been initiated. Based on current delivery schedules for delinquent items, the vehicle is expected to complete final assembly on 10 November.

• The fifth MIDAS satellite is currently on schedule in final assembly. However, critical equipment shortages, similar to those which occurred with the fourth vehicle, could occur. A major effort is being made to avoid this situation.

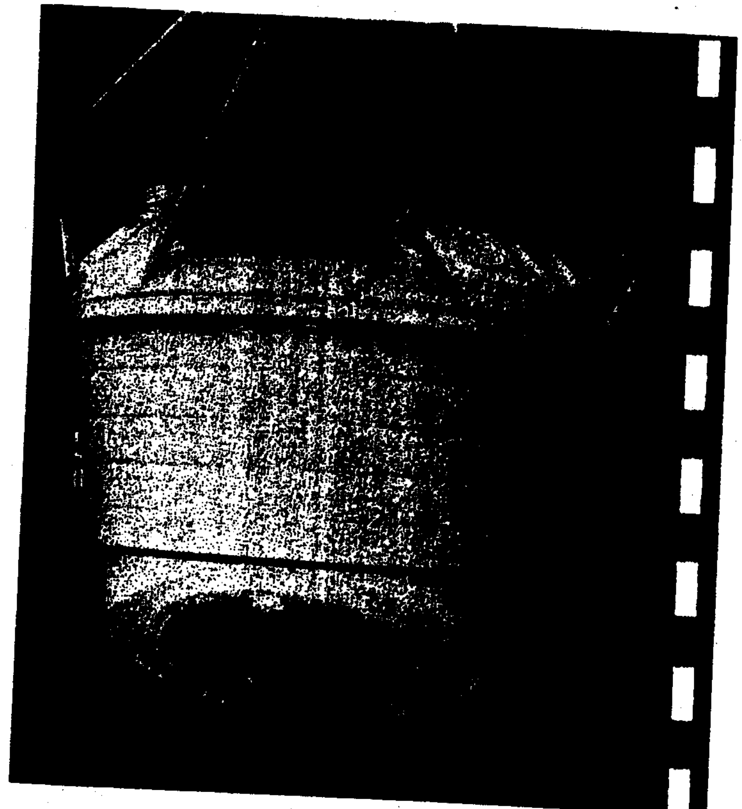


Figure 6. The first Baird Atomic, Inc., flight article infrared payload being prepared for optical checkout in the collimator. The unit projecting in front of the lens is the pre-amplifier. The meter attached to the support truss records the payload operating time.

Infrared Scanners

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.

• The first Baird-Atomic, Inc., flight article payload is currently being optically checked in the Lockheed collimator. Air Force acceptance of this unit is expected shortly. This payload will be carried in the third MIDAS satellite in a 2,000 nautical mile orbit.

• An engineering model of the Aerojet-General advanced scanner will be delivered in January.

Radiometric Measurement Flights

• The background radiometer which will be carried on the RM-1 flight is currently undergoing test in the Lockheed high altitude temperature simulation chamber. When this series of tests is completed the unit will be shipped to Vandenberg Air Force Base for compatibility checks and assembly with the satellite vehicle. The purpose of this flight is to gather infrared background radiation data. This flight is currently scheduled for December.

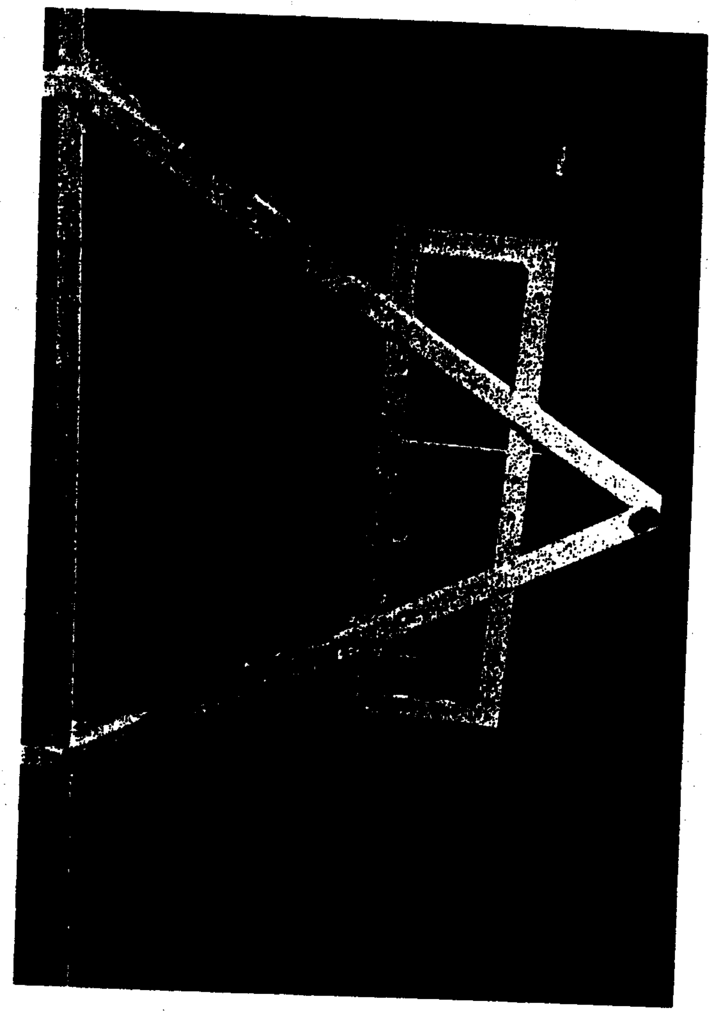
• The second background radiometer, for the RM-2 flight, is currently under construction. It is anticipated that this unit will be shipped to Vandenberg Air Force Base late in December.

Van Allen Belt Radiation Measurement Flights

• Instrumentation will be carried on the MIDAS 3 and 4 flights to measure nuclear radiation in the Van Allen belt. Since the lower Van Allen region extends from 1200 to 2400 nautical miles above the surface of the earth; the MIDAS satellites, orbiting at 2,000 nautical miles, will be functioning in the belt. This instrumentation will have its own telemetry and will be concerned primarily with radiation above the 100 mev range. The instrumentation will include means of measuring the proton radiation flux. It will also include photovoltaic cells, similar to those used in the solar auxiliary power array, which will be exposed to Van Allen belt radiation to determine the decrease in short circuit current as effected by radiation damage.

Solar Auxiliary Power Array

• Component compatibility tests have been conducted with the full-scale model of the solar auxiliary power array. The full array, including stepping motors, was operated by exposure to sunlight and refrigerated batteries were used to simulate orbital temperature conditions. The performance of the array was entirely satisfactory and the current generated exceeded expectations.



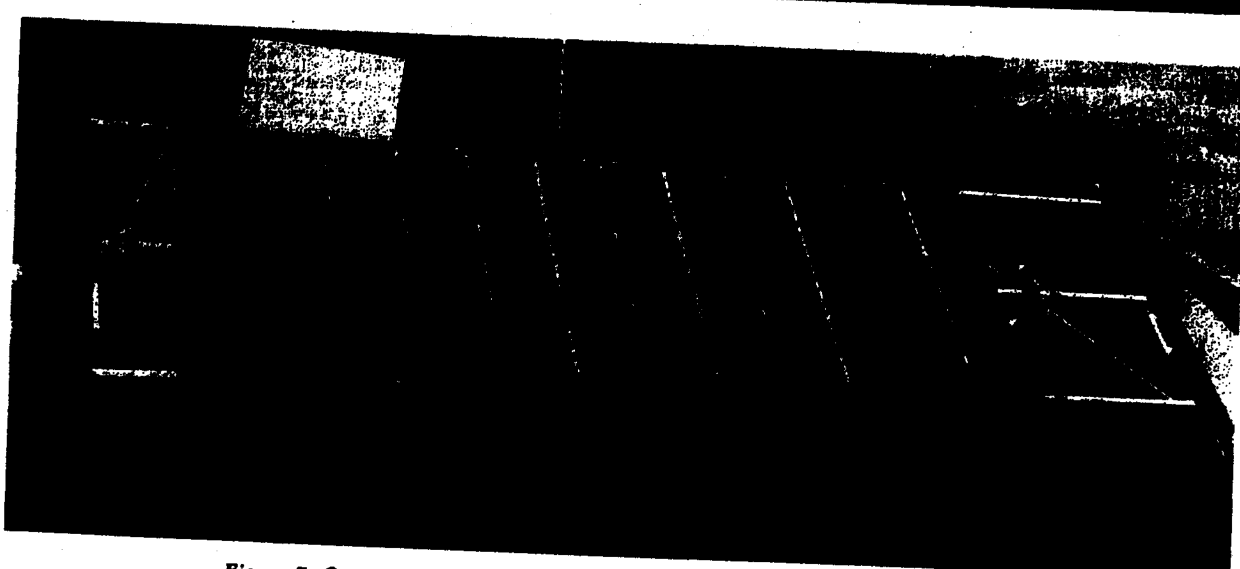
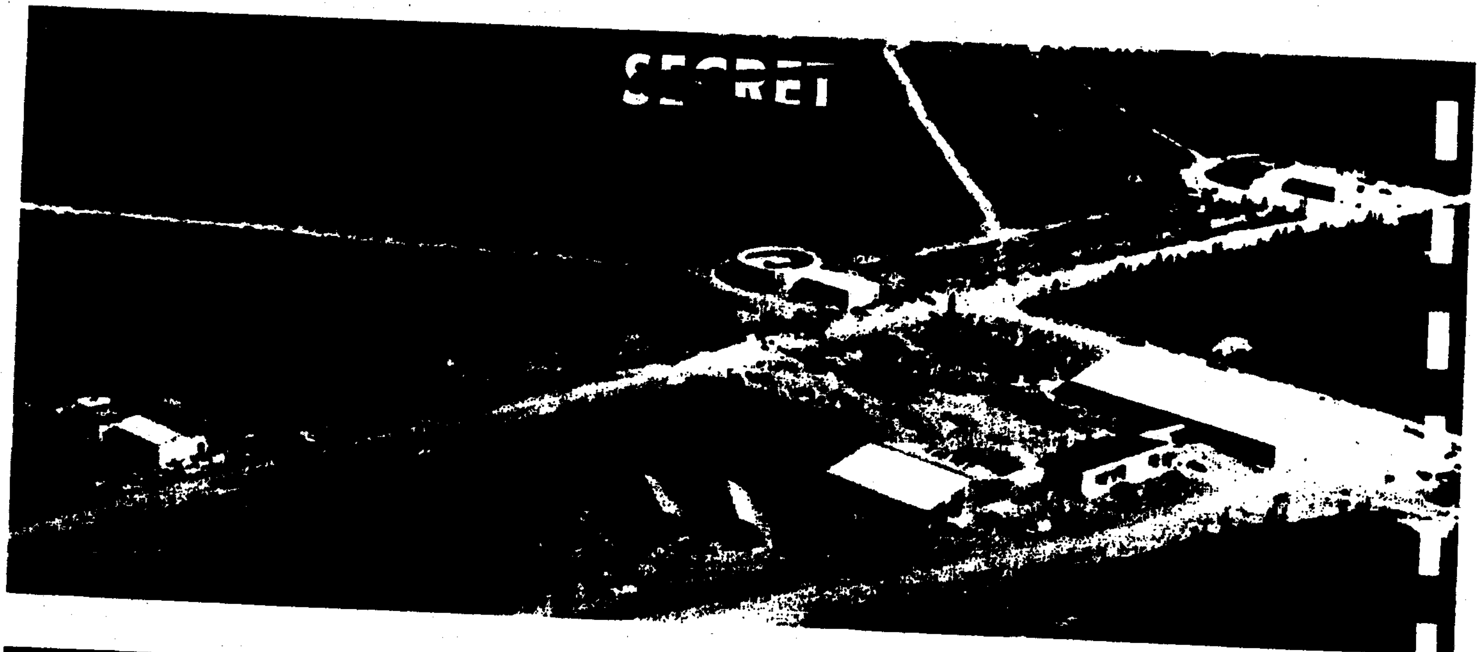


Figure 7. Operational tests of the solar auxiliary power array. For the tests, a special fixture holds the array; in space the array will be experiencing zero gravity and the light weight framework will provide sufficient support. The close up shows the sun position sensor which adjusts the array to permit maximum sun exposure for the solar cells.



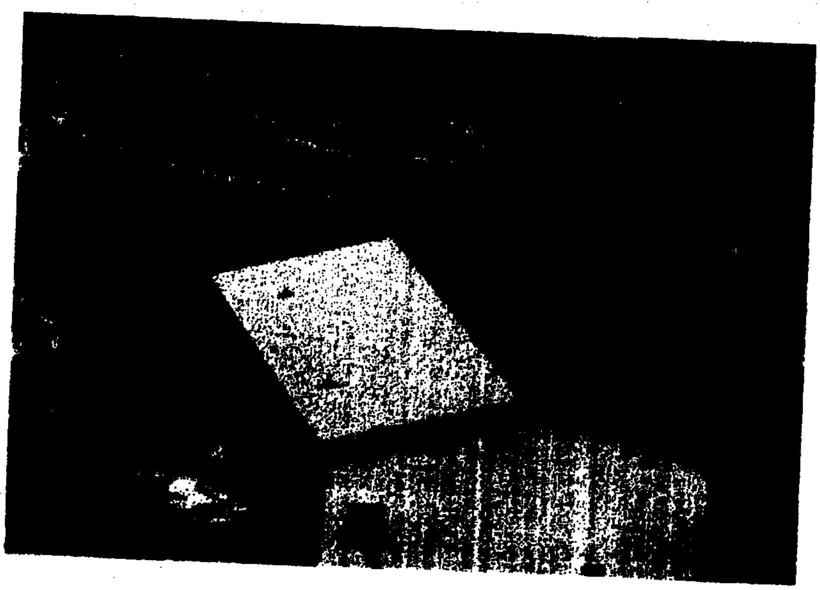
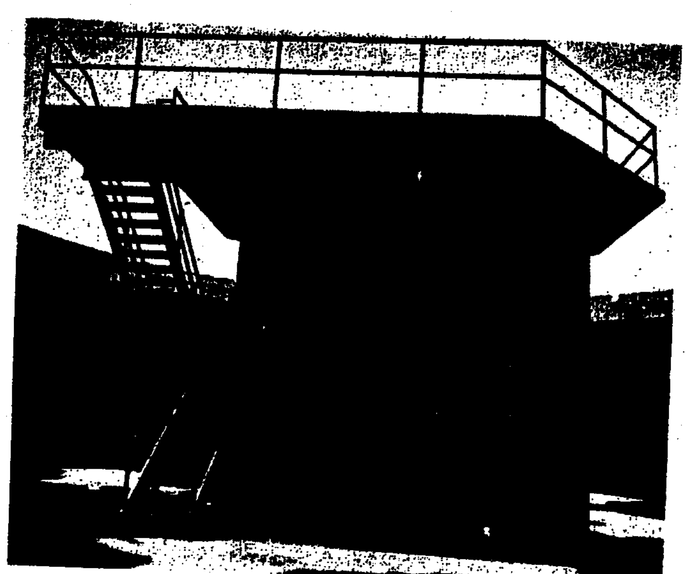


Figure 8. Aerial view (above) of the Donnelly Flats, Alaska technical facilities. The three radome structures can be seen in the background. The corrugated steel storage buildings are in the left foreground, the next building houses the diesel powered generators, next is the heated vehicle storage building and last is the data acquisition and processing building. One radome site (left) showing the radome support structure and the support equipment building. The support for the radar antenna is shown in the lower photo. On the opposite page is an interior view showing the three large diesel driven generators which provide power for this important tracking station. The lower photo shows the heated vehicle storage building with the data acquisition and processing building in the background.



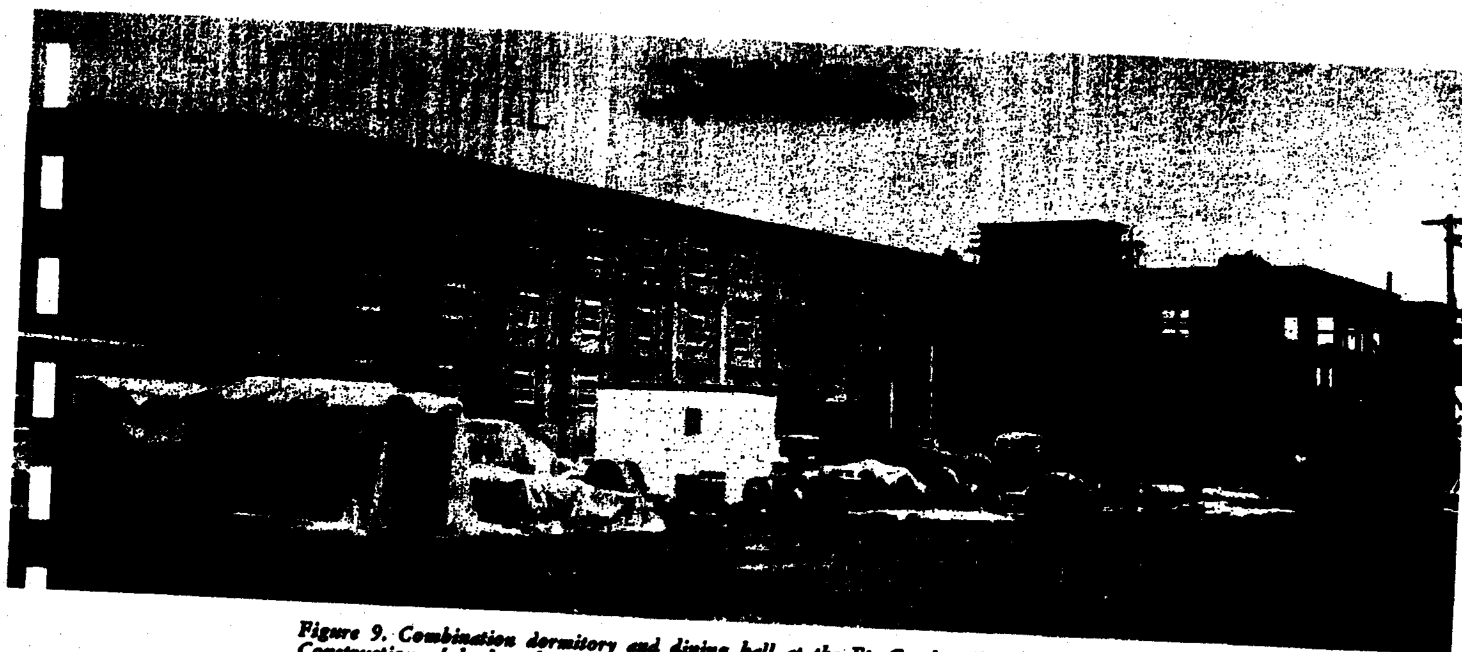
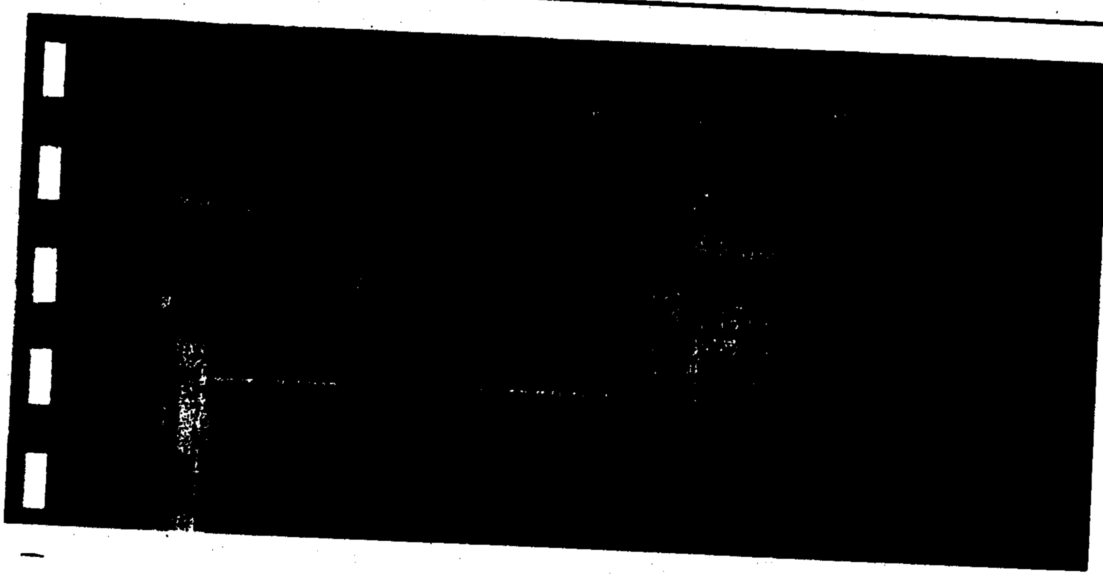
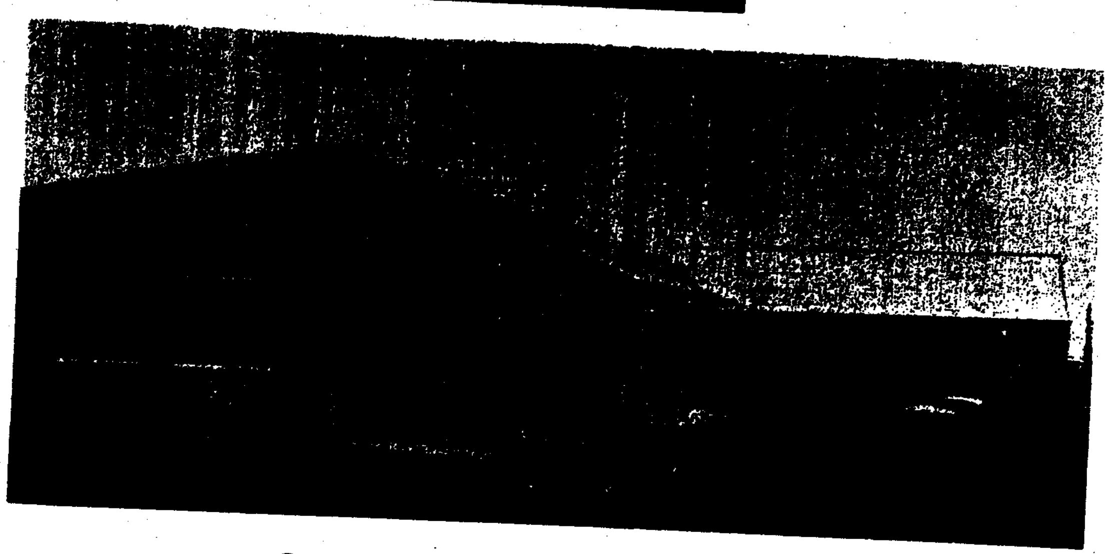


Figure 9. Combination dormitory and dining hall at the Ft. Greely, Alaska support facilities. Construction of both technical and support facilities is progressing rapidly despite the severe weather.





Ground Support Equipment

- Arrangements were completed on 18 October for the transfer of responsibility for the 60-foot automatic tracking and telemetry antenna at Eglin Air Force Base to AFBMD for relocation near Pretoria, South Africa, and eventual transfer to AFMTC for AMR Station 13.

- On 19 October, an agreement was reached on the technical approach to be used in modifying the Vandenberg Air Force Base 60-foot antenna. These modifications will comply with the requirements of SAMOS, MIDAS, and ADVENT programs.

- The provisioning of data handling equipment (PICE peripherical equipment) for the New Boston station is currently a problem. Solutions are under investigation which, if successful, will permit support of MIDAS operations on schedule.

Facilities

- The heated vehicle storage building at Fort Greely was completed on 31 October. Completion of the combined dormitory and dining hall facility is scheduled for 30 December. Construction of the Donnelly Dome microwave relay station is proceeding on schedule toward a 15 December completion date.

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- Construction of support facilities at the New Boston station is on schedule.

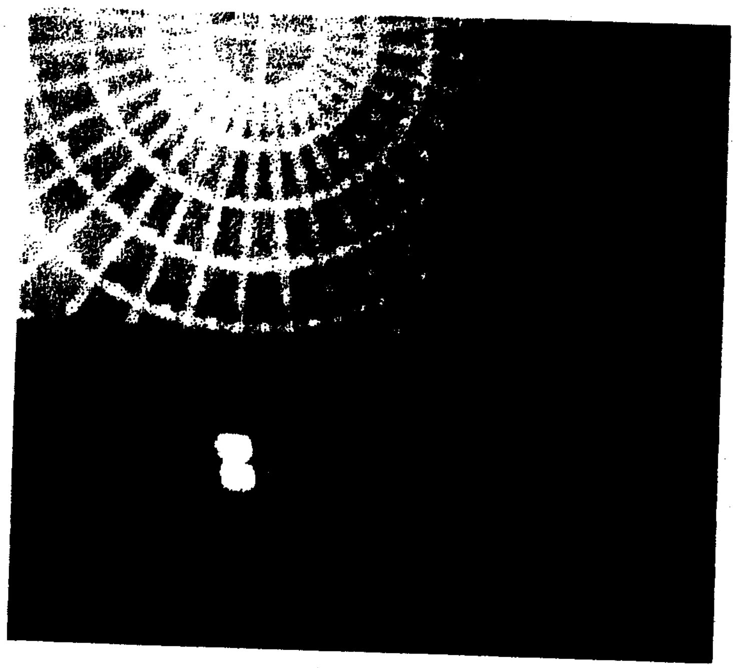
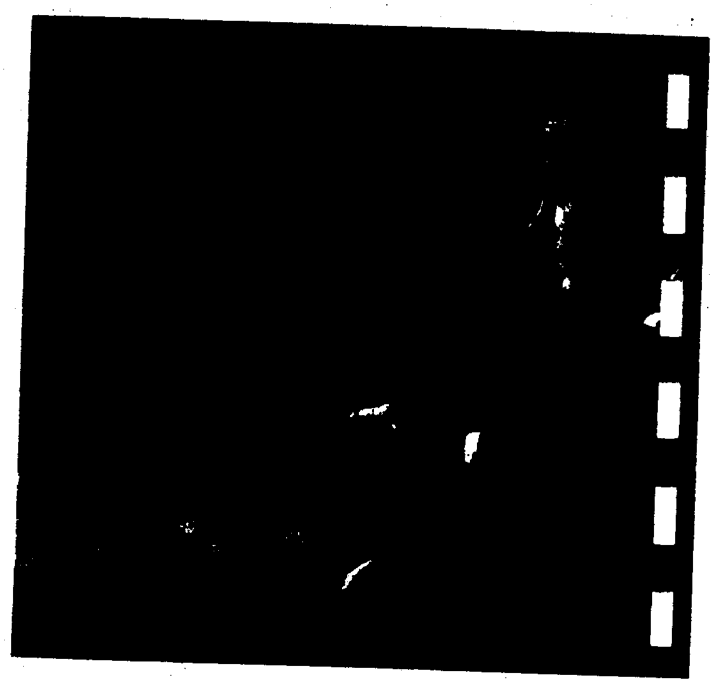


Figure 10. Advanced MIDAS display equipment mockup (left) showing control console with the presentation screen in the background. Close-up of operator and control console which is being developed by General Electric.



SECRET

ADVENT

The ADVENT Program will investigate the feasibility of using satellites in synchronous orbit as instantaneous repeaters for microwave radio communications. A satellite vehicle station in synchronous equatorial orbit will remain in a fixed position relative to any point on the surface of the earth. Active communications equipment contained in this satellite will receive, amplify and instantaneously retransmit any message beamed in its direction.

PROGRAM HISTORY

The Research and Development program for active communication satellites was initiated by ARPA in January 1959. Following early research and development, a three-phased development program (STEER, TACKLE and DECREE) was initiated in May 1959 by Amendment No. 1 to ARPA Order No. 54. Phase I (STEER) was given priority in order to demonstrate the feasibility of providing an early UHF communications capability for positive control of the SAC strike forces. AFBMD was given responsibility for the design, development, and flight testing of the complete system, including launch, satellite tracking and control, and necessary support facilities and ground equipment. WADD and the U. S. Army Signal Research and Development Laboratory (USASRDL) were delegated responsibility for the development of the communications subsystem for Phase I and Phases II and III, respectively.

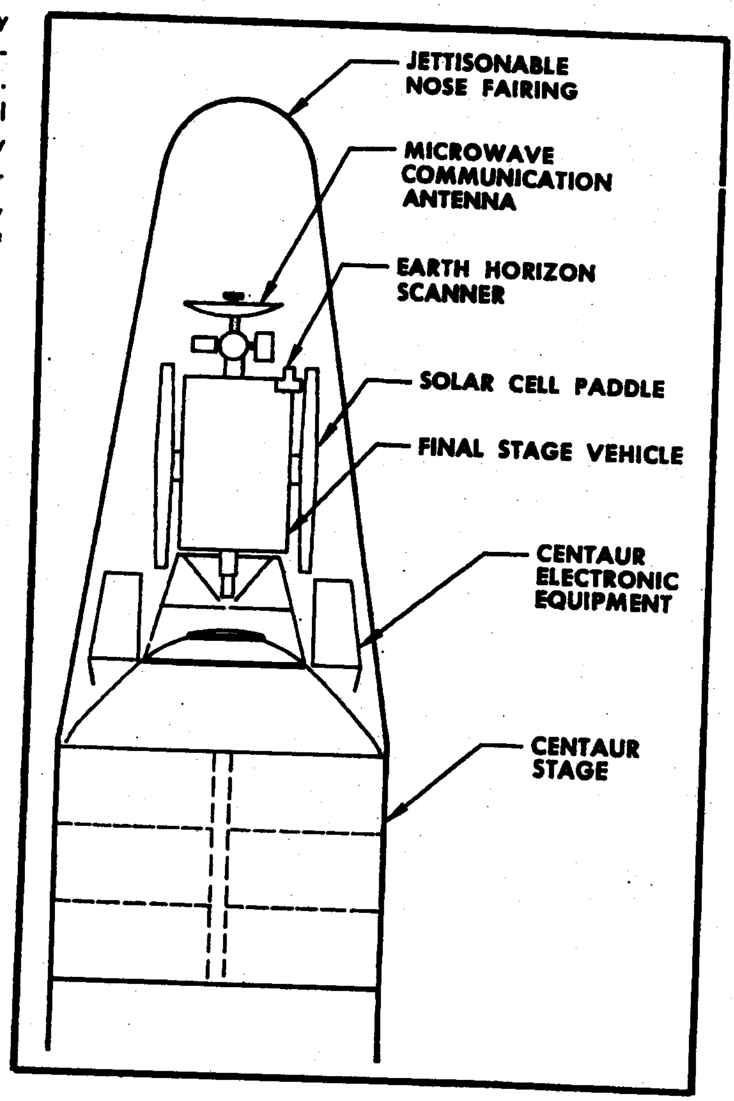


Figure 1. Proposed satellite with jettisonable fairing mounted on CENTAUR second stage.

In April 1960, Amendment No. 5 to ARPA Order No. 54 reoriented the program. The research and development effort previously directed toward providing a ground-to-satellite-to-aircraft UHF communications capability for the SAC strike forces was cancelled. A single integrated ADVENT Program for the development of a 24-hour microwave communications satellite replaced the former STEER, TACKLE and DECREE Programs.

On 15 September 1960, the Secretary of Defense transferred over-all management responsibility for the ADVENT Program from ARPA to the Department of the Army. The development responsibilities of AFBMD and USASRDL were retained essentially status quo. The Army was given responsibility for funding and for over-all systems engineering to provide guidance and a basis upon which detailed design data can be evolved by AFBMD and USASRDL.

PROGRAM OBJECTIVES

The primary ADVENT objective established by Amendment No. 5 is to demonstrate the feasibility of achieving a military system for microwave communications (surface-to-surface) employing satellite repeaters in 24-hour equatorial orbit. The feasibility of placing a satellite in a predetermined position in a 19,300 mile equatorial orbit must be demonstrated. The feasibility of being able to stabilize the satellite, control its attitude and orbit, and keep it on station within the required tolerances must also 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 No. 5 also requires the design of a single basic configuration of a final stage vehicle compatible with launching by either AGENA "B" or CENTAUR second stage boosters.

The ADVENT Program, as defined in ARPA Order 54, Amendment No. 9, dated 11 August, will consist of the following flight tests, launched from the Atlantic Missile Range:

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

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

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

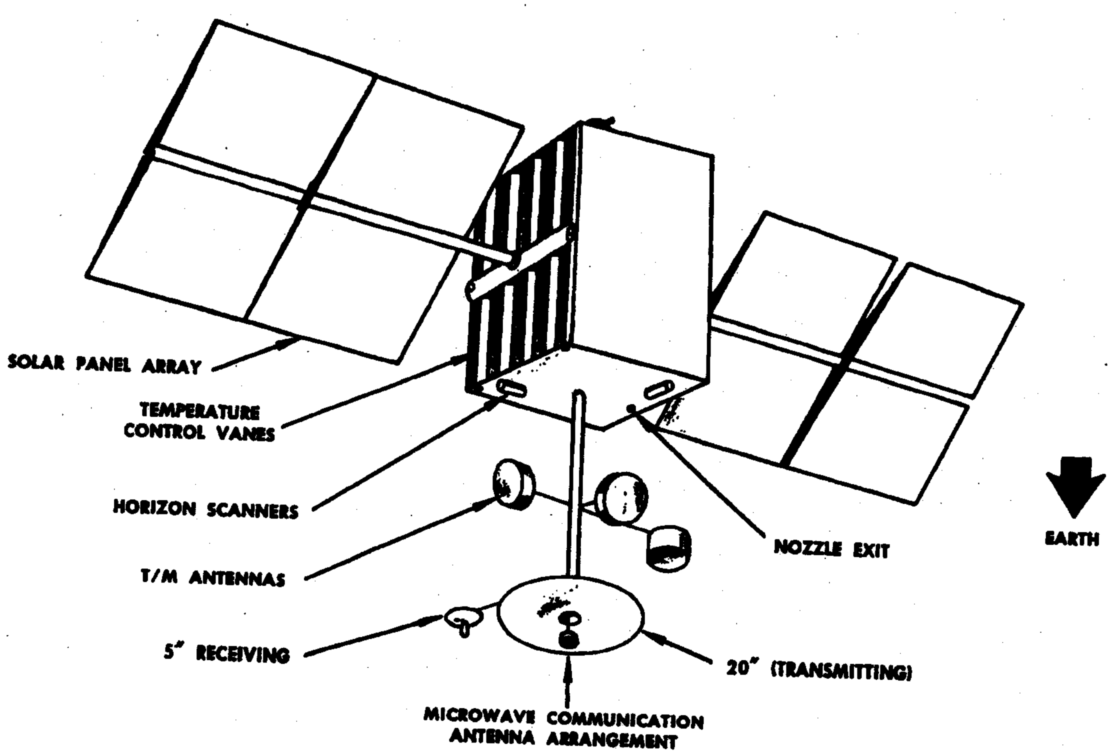
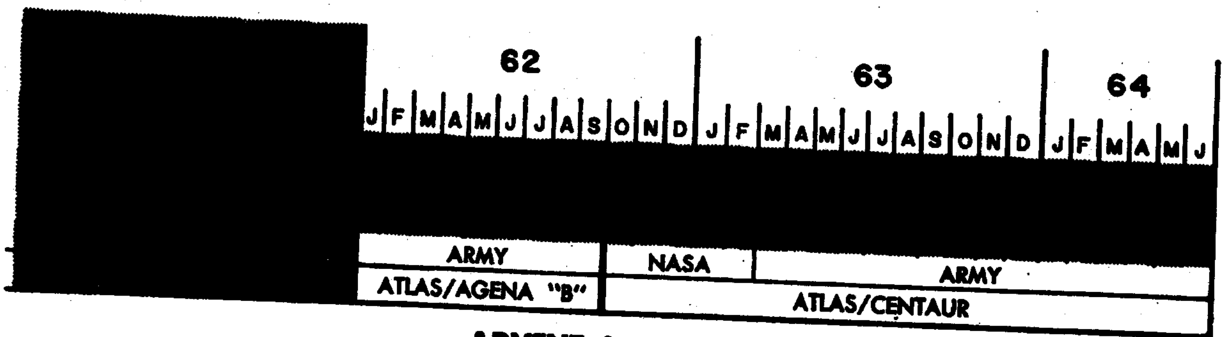


Figure 2. Initial design of final stage vehicle.



ADVENT Launch Schedule

MONTHLY PROGRESS—ADVENT Program

Program Administration

- On 4-5 October representatives of Space Technology Laboratories and AFBMD gave a briefing on all aspects of the ADVENT Program to the U. S. Army ADVENT Management Agency (USAAMA) at Fort Monmouth, New Jersey. Initial coordination on contractual work statements was accomplished and arrangements were made for the Agency to furnish AFBMD with sufficient funds to maintain program continuity until FY 61 funds are made available.

- A funding estimate for the AFBMD portion of the ADVENT program was prepared and forwarded to the Army Advent Project Office on 18 October. Justification to support the funding increases was included. There has been no indication of the Army's ability to meet the additional funds required in FY 61 over the amount originally programmed by ARPA.

- A technical presentation prepared by STL to explain the configuration and operating frequency of the ADVENT tracking, telemetry and command system was given to the Army Advent Project Office on 24 October. This presentation will be used in securing Department of Defense approval to extend the existing Philco contract into the hardware phase; thereby providing ADVENT tracking, telemetry and command at the Vandenberg Air Force Base and Kaena Point stations. A restriction exists prohibiting extension of the Philco effort beyond the design study phase which will be completed early in November.

Technical Progress

Launch Vehicles

- Contractual action to procure ATLAS and AGENA "B" vehicles has been suspended temporarily because of a message from USAAMA, dated 17 October, prohibiting major contractual action without prior approval of the Commanding General, USAAMA.

- Authority to proceed with the procurement of CENTAUR vehicles and CENTAUR engines was received from USAAMA on 27 October.

Final Stage Vehicle

- Formal contract negotiations with General Electric, Missile and Space Vehicle Department (GE-MSVD) began on 13 October.

- Meetings attended by representatives of GE-MSVD, Bendix System Division, STL, U. S. Army Signal Research and Development Laboratory (USASRDL), USAAMA, and AFBMD were held during October to discuss:

1. A GE-MSVD proposed plan for the orbit test vehicle for the ATLAS/AGENA "B" flights.
2. Launch and orbit test planning.
3. Tracking, telemetry and command equipment and antenna design facility requirements.
4. Thermal interface problems, including heat dissipation of communication equipment components.

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(Communication equipment input power requirements have increased from 97 to 108 watts per channel.)

5. The GE-MSVD design approach to the ground support equipment test sequence programmer.

- STL is continuing systems engineering studies and analyses to define the concept of system operation and to prepare design specifications.

Payload

- This functional area is the responsibility of USASRDL. When the Secretary of Defense assigned overall management responsibility for the ADVENT Program to the Department of the Army, USAAMA was given responsibility for systems engineering; therefore, AFBMD no longer has any responsibility for development of the payload.

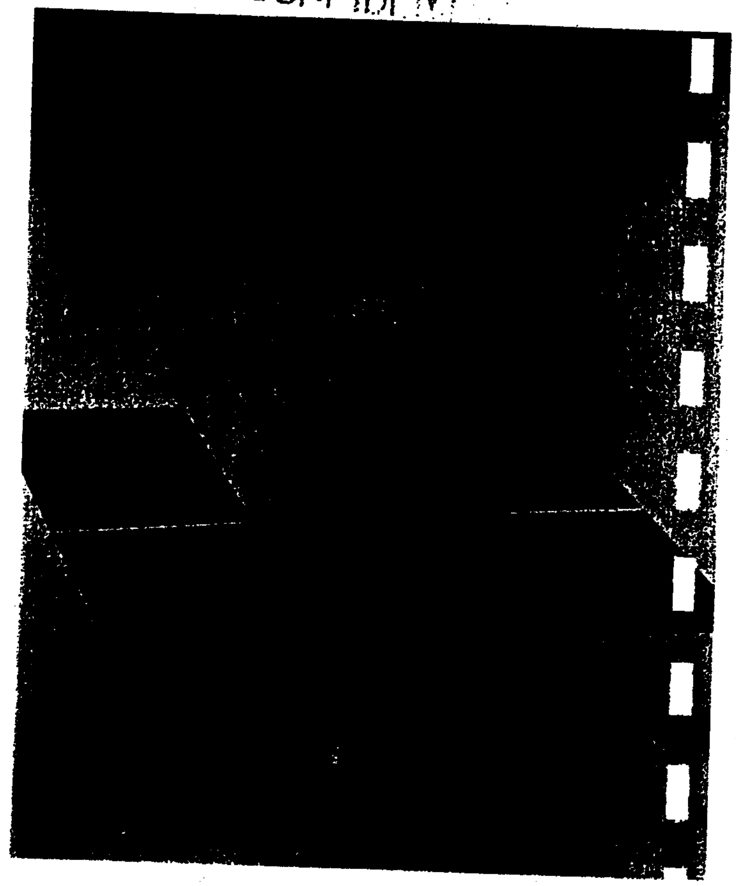
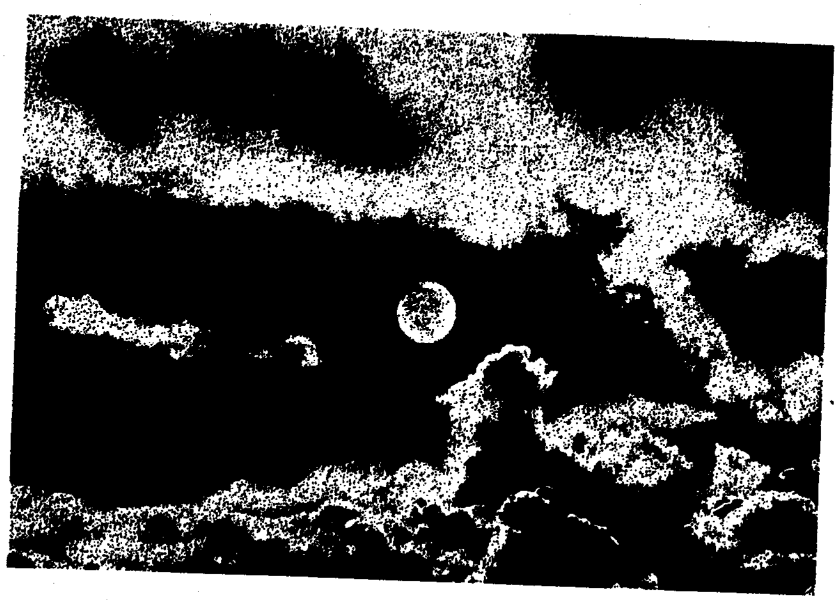


Figure 3. A model of the General Electric ADVENT final stage vehicle to be flown in a six-hour inclined orbit. These photographs show the payload with the solar paddles extended and antenna retracted (lower) and the solar paddles unfolded and the antenna extended (right). The temperature control vanes are located on the payload above and below the control arms for the solar paddles. These vanes are automatically positioned to regulate the internal payload temperature.

BOOSTER

support programs



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

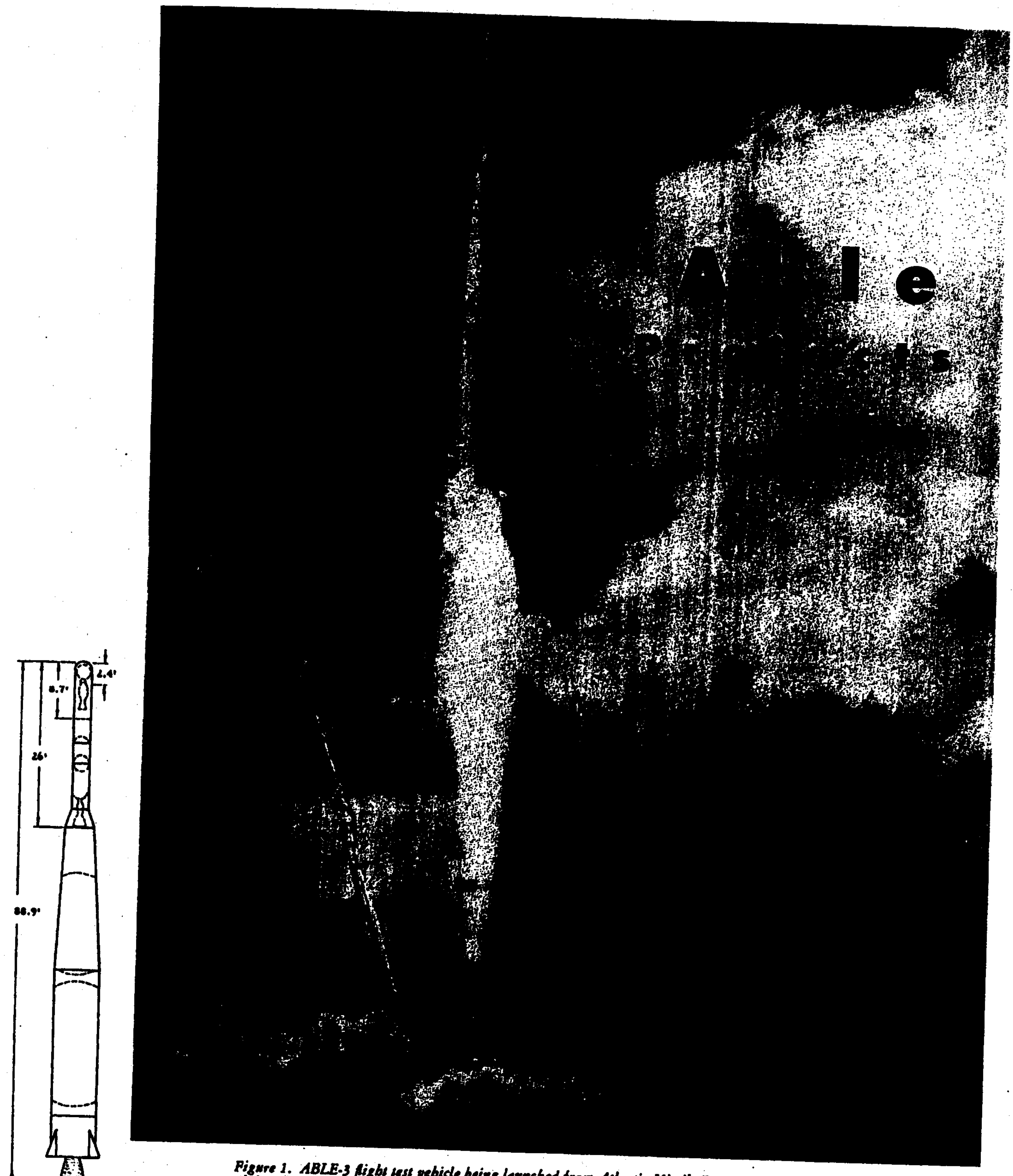


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.

The ABLE series of space probes was initiated with the ABLE-1 program in March 1958. This program, undertaken by AFBMD under direction of the Advanced Research Projects Agency, had as its over-all objective, the acquisition of data on the extra-terrestrial space environment. The design and construction of a four-stage space vehicle was initiated. The vehicle, consisting of a THOR IRBM first stage, an ABLE second stage, ABL-248 solid propellant third stage and the satellite vehicle fourth stage was successfully demonstrated in the fall of 1958. In October 1958, the National Aeronautics and Space Administration, given cognizance over the space exploration effort, authorized the ABLE-3 and ABLE-4 programs. General objectives included the demonstration of vehicle and communications capability and performance of scientific research experiments over interplanetary distances. An extensive network of ground support stations was simultaneously 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 ABLE-4 program led to the development of a space booster utilizing the ATLAS ICBM as the first stage, providing a greatly increased payload capacity. A hydrazine engine with multi-start capability was developed for the ATLAS boosted vehicles to permit mid-course vernier control and to provide controlled thrust to inject the vehicle into orbit about another planet. Under the ABLE-3 and 4 programs, a solar cell power supply system was developed and extensive original design of satellite vehicle command, telemetry, and communication equipment was accomplished.

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

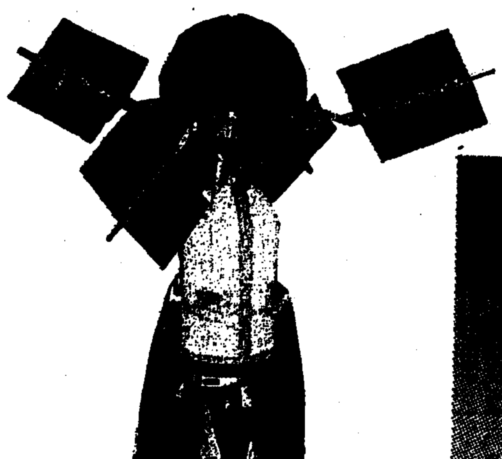
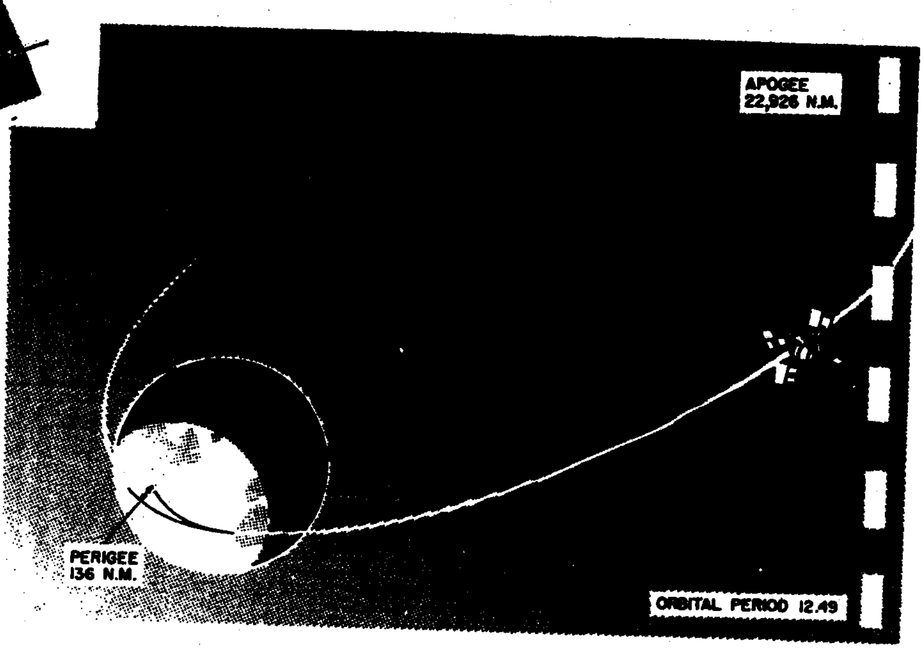


Figure 2. ABLE-3 third stage and payload (above) with solar paddles fully extended. Drawing of extremely elliptical orbit achieved by ABLE-3 (EXPLORER VI).



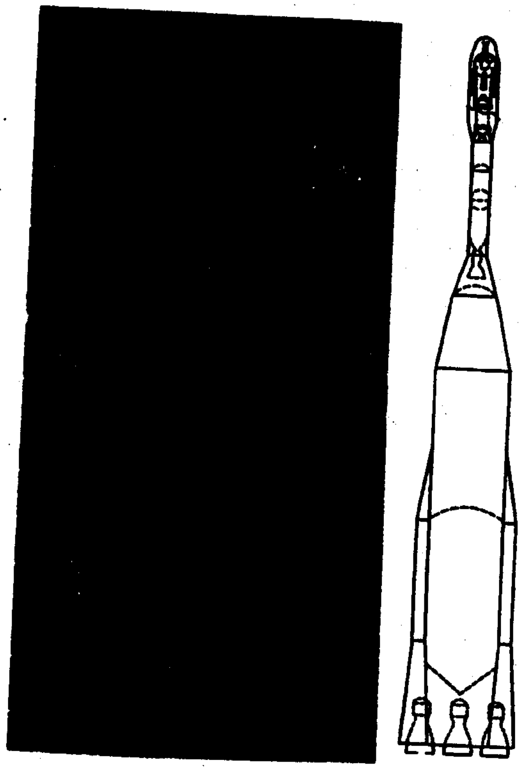


Figure 3. ABLE-4 ATLAS vehicle configuration drawing and photo of vehicle installed on Atlantic Missile Range launch stand 12.

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. Trajectory and orbit were essentially as predicted with deviations in apogee and perigee well within the range of expected values. The payload was the most sophisticated to have been placed in orbit by this nation at the time and contained provisions for conducting 13 experiments in space environment and propagation. A wealth of valuable data was obtained from satellite telemetry until the last transmission was received on 6 October. Among the significant achievements of EXPLORER VI were:

1. The first comprehensive mapping of Van Allen radiation belts.
2. The first study of dumping and filling of outer Van Allen radiation belts during a magnetic storm.
3. The first still TV photo of earth from a satellite.
4. The first computer (Telebit) operating in space with instrumentation.
5. The first direct flux measurements of low-energy electrons in the outer radiation belt.
6. Discovery of large electrical current system in the outer atmosphere.
7. Discovery of betatron acceleration in outer atmosphere.

It is believed that the satellite, while yet in orbit, is incapable of generating sufficient power for transmitting signals due to solar paddle damage suffered during initial paddle extension and the resultant unfavorable sun "look" angle.

ABLE-4 ATLAS—This vehicle differed from the ABLE-3 primarily in that an ATLAS ICBM was used as the first stage instead of a THOR IRBM, permitting installation of a hydrazine engine for midcourse velocity corrections and to accomplish the ejection of the satellite into lunar orbit. The unsuccessful launch of the ABLE-4 ATLAS occurred on 26 November 1959. Structural breakup resulted in the third stage and payload parting from the vehicle approximately 48 seconds after launch. The ATLAS performed as planned over its entire powered flight trajectory. The trajectory of this flight, from the Atlantic Missile Range to the vicinity of the moon, was established to achieve the tightest possible circular lunar orbit consistent with the highest probability of success. The final burnout conditions were to have provided an inertial velocity of 34,552 feet per

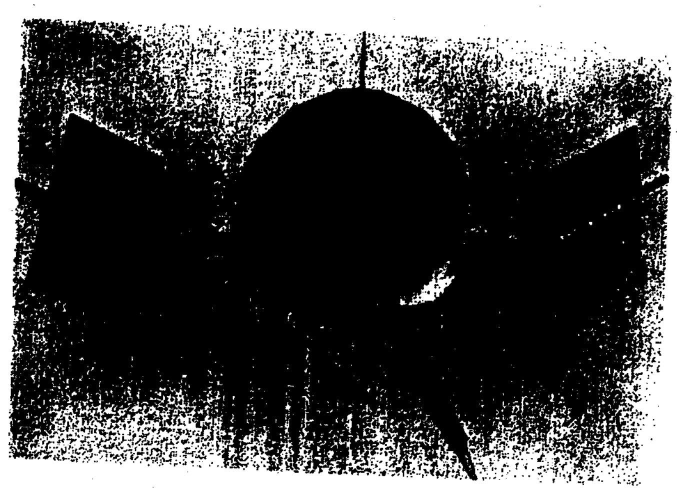
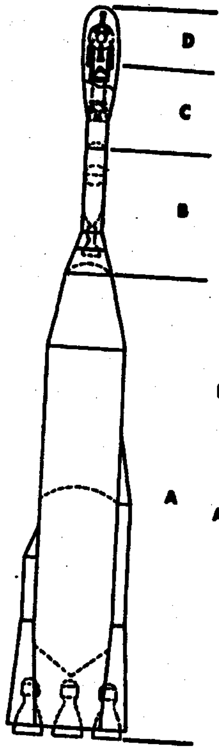


Figure 4. PIONEER V satellite vehicle shown in orbital flight position. This solar satellite was launched from the Atlantic Missile Range on 11 March 1960.



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

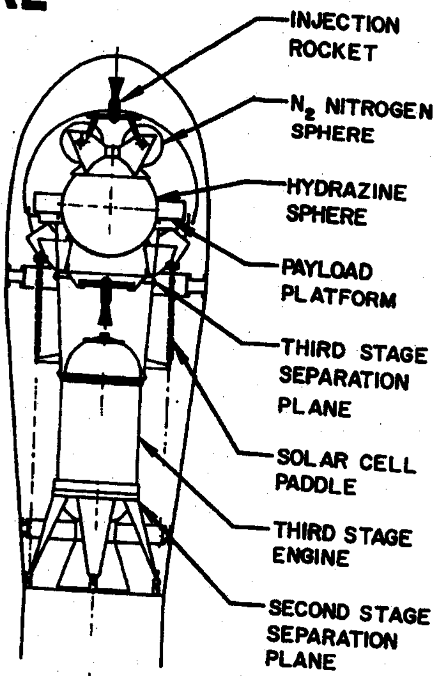
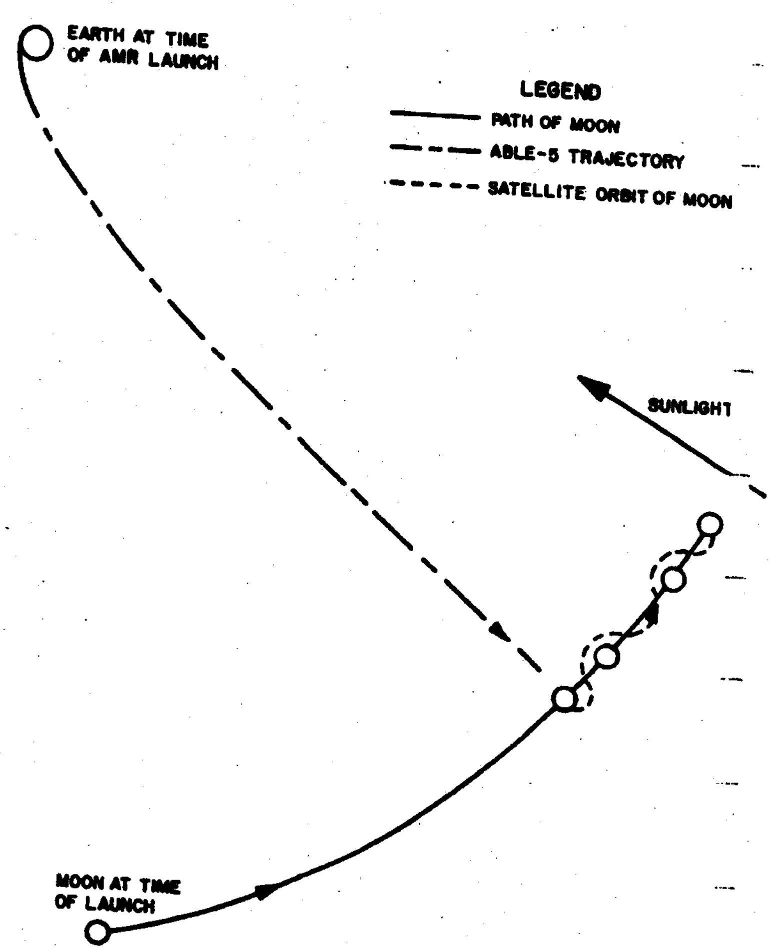


Figure 5. ABLE-5 vehicle configuration drawing and specification list. Third stage and payload configuration (right). Trajectory of ABLE-5 into lunar orbit is shown in drawing (below).

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 ABL-248A-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 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 22,462,000 miles from earth.



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. This field fluctuates in a manner that is connected to 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. Energetic particles in the Van Allen radiation belts are not ejected directly from the solar wind. Some process for particle acceleration must exist in the belt.

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 apolune of 5,000 nautical miles and perilune of 3,500 nautical miles.

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

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

4. Successful conduct of payload experiments.

Program Vehicle (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 380 pounds.

Launch and Powered Flight

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

Orbital Characteristics

Major Axis	0.3470×10^8 feet
Eccentricity	0.190
Orbital period	575 minutes
Apolune	3,399 nautical miles
Perlune	2,319 nautical miles
Duration of eclipses	less than 90 minutes

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

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

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

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

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

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

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

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

Ground Support Program

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

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

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

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

MONTHLY PROGRESS—ABLE 5

Program Administration

- A new launch date was established for ABLE-5B to allow time for evaluation of ABLE-5A flight data and installation of required modifications. Launch is presently scheduled for the period of 13-17 December. Progress to date indicates that this date will be met.

Flight Test Progress

ABLE-5A Flight Investigation

- The ABLE-5A vehicle was launched from Stand 12 at the Atlantic Missile Range on 25 September at 1013 EST. Performance of the ATLAS booster was excellent with all systems operating properly. The only abnormality in booster operation was the failure of the vernier engines to shut off after five seconds operation. This period permits correction of any guidance errors introduced during main engine shutdown.

- Stage I/II separation was initiated by a backup event (oxidizer valve position switch) rather than by the primary event (thrust chamber pressure switch). As a result Stage II thrust chamber pressure was approximately 100 percent rather than the nominal 60 percent at separation. Telemetry data did not indicate flame separation even though there was excessive back pressure in the interstage area. Immediately after separation thrust chamber pressure stabilized at 60-70 percent of the nominal value. Next the thrust chamber and yaw servo actuator were driven hard against the left hand stop. An oxidizer leak developed, probably in the thrust chamber area. The oxidizer leakage rate indicated a hole of approximately ½ inch diameter. During this time the ABLE stages were turning to the right at a rapid rate; they stabilized for approximately 45 seconds in the pitch axis, then began tumbling about both axes.

- The Ground Guidance System (GGS) transmitted the Stage II engine shutdown command which initiated the subsequent flight events. The nominal and actual second stage flight events are shown in Table I.

Stage II spin-up was achieved and the payload paddles were erected. The third stage flight was nominal, although it was spin-stabilized in a downward direction throughout the 40-second propellant burning period. Stage III/satellite vehicle separation was achieved, with no evidence of bumping. The first firing of the hydrazine engine was accomplished. Angular accelerometer readings indicated that the satellite vehicle was not properly stabilized. Analysis of satellite vehicle telemetry indicated that all subsystems functioned correctly until the signals were lost. Analysis also confirmed the events that occurred in the other stages during the flight. The duration of the flight, from liftoff to impact, was approximately 14 minutes.

Event	Time (in seconds) Nominal	Actual
Arm Stage II	140.0	134.9
Nose Fairing Separation	175.0	170.2
Sustainer Engine Cutoff	275.0	271.2
Start Stage II (Combustion)	275.0	273.3
Stage I/II Separation	275.4	273.8
Start of Chamber Pressure Decay		350.0
Zero Stage II Chamber Pressure		352.7
GGS Cutoff Command		379.0
State II Cutoff Actuated	387.0	379.0
Stage II Spin-Up	388.0	381.0
Solar Cell Paddle Release	389.1	381.0
Stage II/III Separation	389.1	381.9

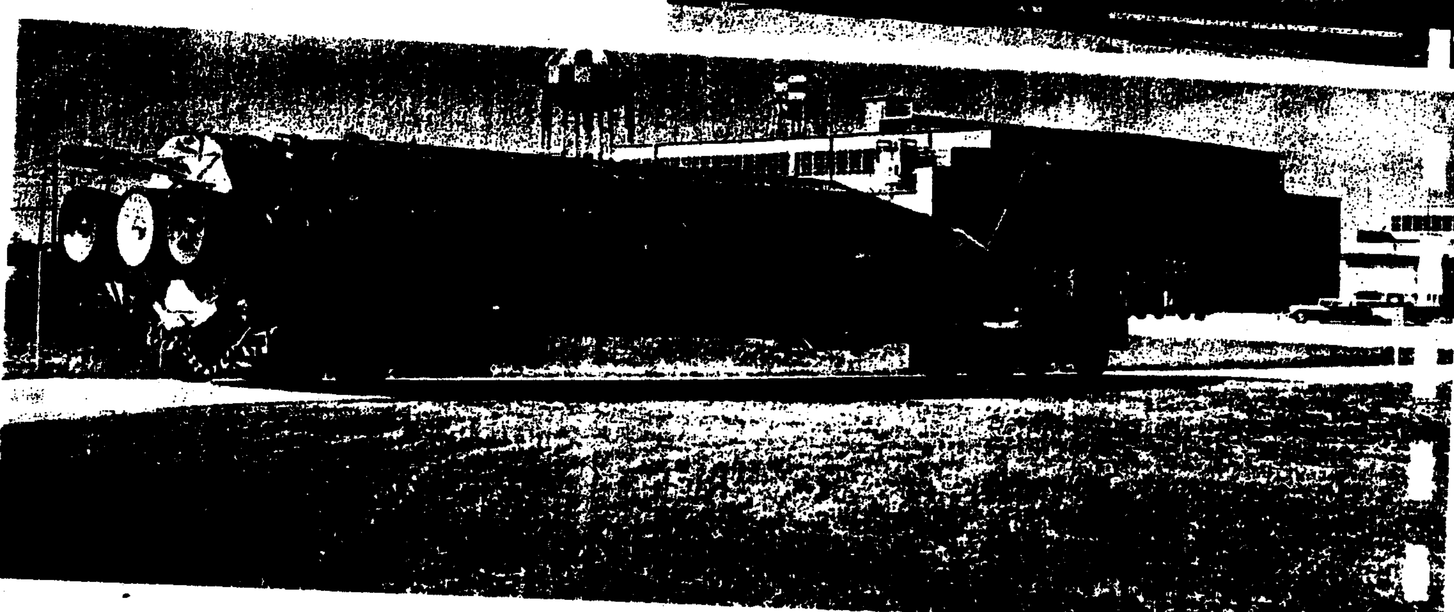
TABLE I. Second Stage Flight Events

- No single, specific cause for the engine malfunction has been determined. An oxidizer leak in the thrust chamber assembly explains the loss of combustion chamber pressure, but does not explain the gimbal actuation abnormalities observed. These were believed to have been caused by a failure in the yaw actuator cylinder. The apparent cause of the oxidizer leak is a random structural failure in the thrust chamber assembly. Since there was no indication of an abnormal starting transient or of sufficient back pressure in the transition section area to cause flame separation, the structural failure cannot be attributed to these causes.

ABLE-5B Corrective Action

- Measures have been undertaken in ABLE-5B preparations to insure that none of the possible problem areas revealed during the analysis of the ABLE-5A flight data will be encountered during the 5B flight. Some of these precautions have been:

Figure 6. ATLAS 91D booster for the ABLE-5B flight being delivered at the AMR. The booster (above) has just been unloaded from the C-133 aircraft. Note the track which is layed out to aid in unloading; also the jacks which raise the transporter to permit installation of the rear bogie and mating with the tractor. Positioning the bogie (right) prior to transporting the booster from the airstrip to the hangar. Delivery of the booster to Hangar H. After the receiving inspection the booster was placed in bonded storage to await final checkout.



1. The removal of the thrust chamber assembly from the second stage so that exhaustive structural and mechanical tests could be conducted. Analysis of test results revealed no inherent structural weaknesses and established confidence in the thrust chamber assembly.

2. The ATLAS/Stage II separation will be initiated earlier by using the thrust valve switch to initiate the sequence. This switch will initiate the separation sequence at approximately 20 percent of nominal thrust level. The thrust chamber pressure switch will be used as a back-up and will be set to operate at 40 percent of nominal thrust chamber pressure.

3. The pitch and yaw servo actuators damping orifice plug will be staked to its piston.

4. The explosive bolt cages are being modified to eliminate the possibility of shrapnel damaging the thrust chamber assembly.

5. The thrust chamber pressure switch is being subjected to additional acceptance testing, including actuation under vacuum conditions and while undergoing severe vibration.

6. While there is no evidence that lack of a thrust chamber closure contributed to the failure, it is planned to install a closure because of more flight experience with the configuration. The closure will allow combustion to occur under pressure rather than in the vacuum of space.

7. The Stage I/II transition section has been modified to provide additional blast port area thereby reducing internal pressure. Two transition sections have been reworked; one for flight and one for structural test.

Technical Progress

First Stage

• ATLAS 91D completed acceptance testing at Convair on 7 October. Throughout the manufacturing and test phases every precaution was taken to insure the quality of the ABLE-5B booster. Very few discrepancies were noted during the acceptance inspection, providing a high degree of vehicle confidence. The booster was shipped to the Atlantic Missile Range on 14 October and following its receiving inspection was placed in bonded storage to await final checkout and installation on Stand 12.

• A modification to enlarge the blast ports in the Stage I/II transition section is nearing completion. Each port is being enlarged along its horizontal axis so that the blast band width will not need to be increased. Exhaustive structural tests will be conducted following the modification.

Second Stage

• Following the mechanical and structural inspections of the thrust chamber assembly it was reinstalled in the second stage.

• Modifications have been made to the second stage electrical system to provide:

1. Ignition of the Stage I/II separation bolts by the thrust vent valve switch.

2. Telemetry for a strain gage on the pitch actuator.

3. Telemetry for an additional oxidizer jacket pressure transducer separate from the transducer presently installed. This additional transducer will provide a more reliable measurement of oxidizer pressure in the thrust chamber.

• A preliminary electrical check and an electromechanical check have been accomplished. Thrust chamber alignment and a hangar flight systems test are scheduled in early November. The second stage will be shipped to the Atlantic Missile Range on 21 November and will be installed on ATLAS 91D for the Flight Acceptance Composite Test on 3 December.

Third Stage

• The third stage for the ABLE-5B flight has been in storage at the Atlantic Missile Range since 8 September. A replacement for the backup engine which failed to meet the propellant weight specification will be delivered to the AMR on 18 November. The third stage will be attached to Stage II on 11 December.

Satellite Vehicle

• The satellite vehicle for ABLE-5B will be identical to that used on ABLE-5A, except for the addition of a University of Chicago solid-state detector and the use of non-magnetic (copper beryllium) paddle erection springs.

• Calibration of payload experiments and the pre-environmental integrated systems test have been completed. The payload successfully completed environmental vibration testing and was then subjected to a special thermal analysis in the vacuum chamber. Results of the thermal test indicate that the thermal control configuration is satisfactory. Completion of the environmental acceptance test is scheduled during the first week of November. On 27 November, following the verification of experiment calibration, magnetic field background and source measurements at the Fanselau coil facility located in Malibu the vehicle will be shipped to the Atlantic Missile Range.

• Simulated space environment tests for evaluation of the temperature control system were conducted with the type-test payload installed in the low-pressure low-temperature radiant heat facility. The first test was conducted with the light source focused on the aft engine; in the second it was focused on the forward engine and during the third the payload was spun with the light source normal to the flight axis. During each exposure all payload temperatures remained within allowable limits.

Ground Guidance System

• Acceptance testing and checkout of the Hughes Advanced Guidance System computer was completed on 3 October. The computer was shipped to the Atlantic Missile Range on 6 October for installation in the Ground Guidance van and integration into the system.

Ground Support Equipment

• Corrective action is being taken to improve the Stand 12 crane capability. During the ABLE-5A operation the crane was incapable of hoisting items to the highest gantry level and on several occasions an emergency control had to be operated manually to permit the crane to travel into and out of the gantry.

• On-stand protection against the extremely heavy Florida rains was inadequate during ABLE-5A preparations. A tent, similar to the one used during PIONEER V preparations, is being fabricated.

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

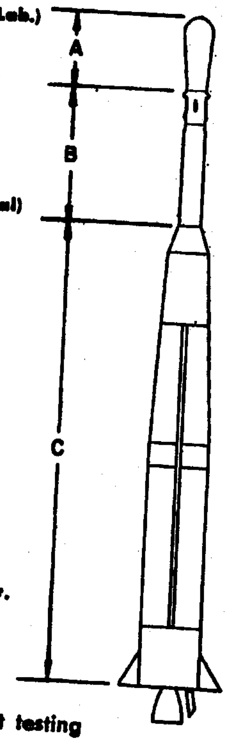
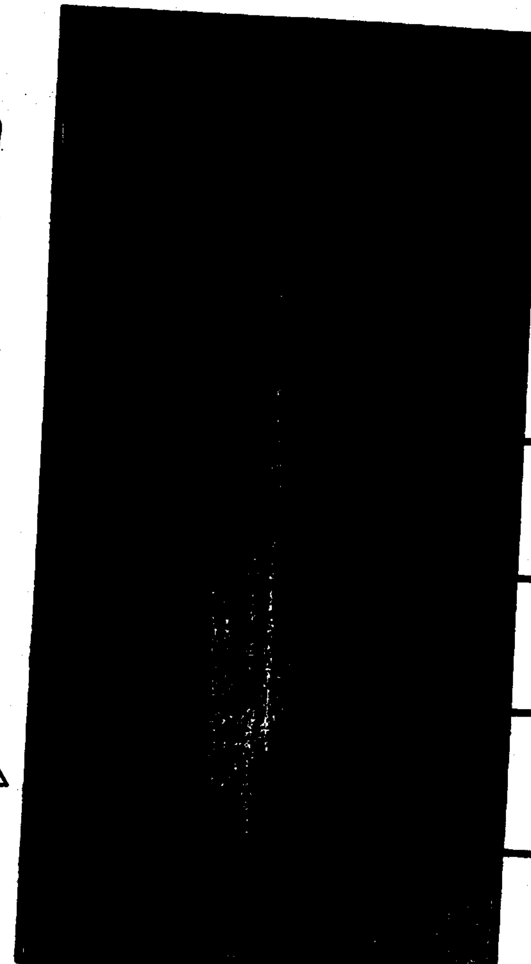


Figure 1. TRANSIT 1A three stage flight vehicle.



TRANSIT 1A launched from Atlantic Missile Range

The TRANSIT Program consists of the flight testing of nine 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. Subsequently, the Navy initiated requests for TRANSIT 4A, 4B, 5A and 5B.

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. The TRANSIT project was transferred to the Navy on 9 May 1960. The Navy has now assumed both the administrative and technical responsibility for the TRANSIT program. Payload and tracking responsibility has been assigned to the USN Bureau of Weapons. Applied Physics Laboratory is the payload contractor.

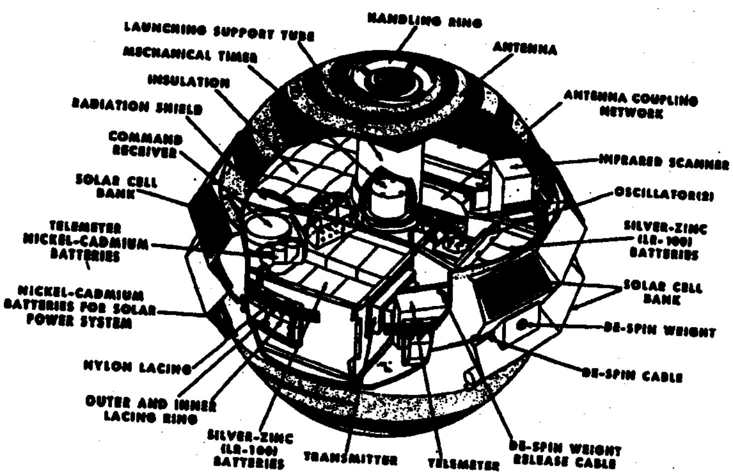
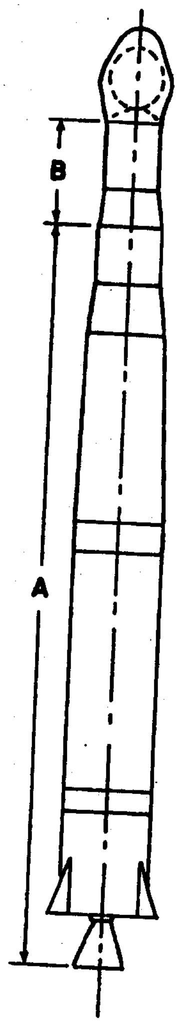


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV 1).



B. SECOND STAGE—ABLESTAR (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

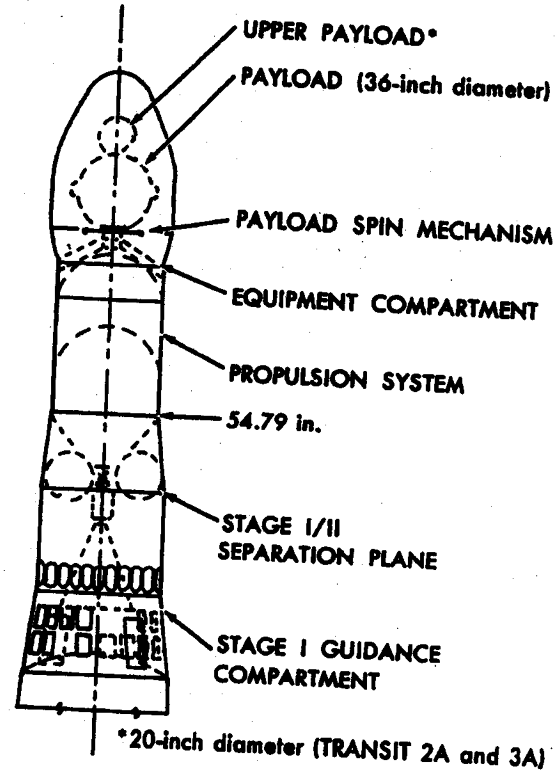


Figure 3. Two stage vehicle used for TRANSIT 1B and subsequent flights.

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 was a three stage vehicle as shown in Figure 1. TRANSIT 1B and subsequent vehicles are two stage vehicles as shown in Figure 3.

Launch Plans All vehicles will be launched from Complex 17 at the Atlantic Missile Range. Launch azimuth will vary between 44.5° and 140° for each flight.

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.

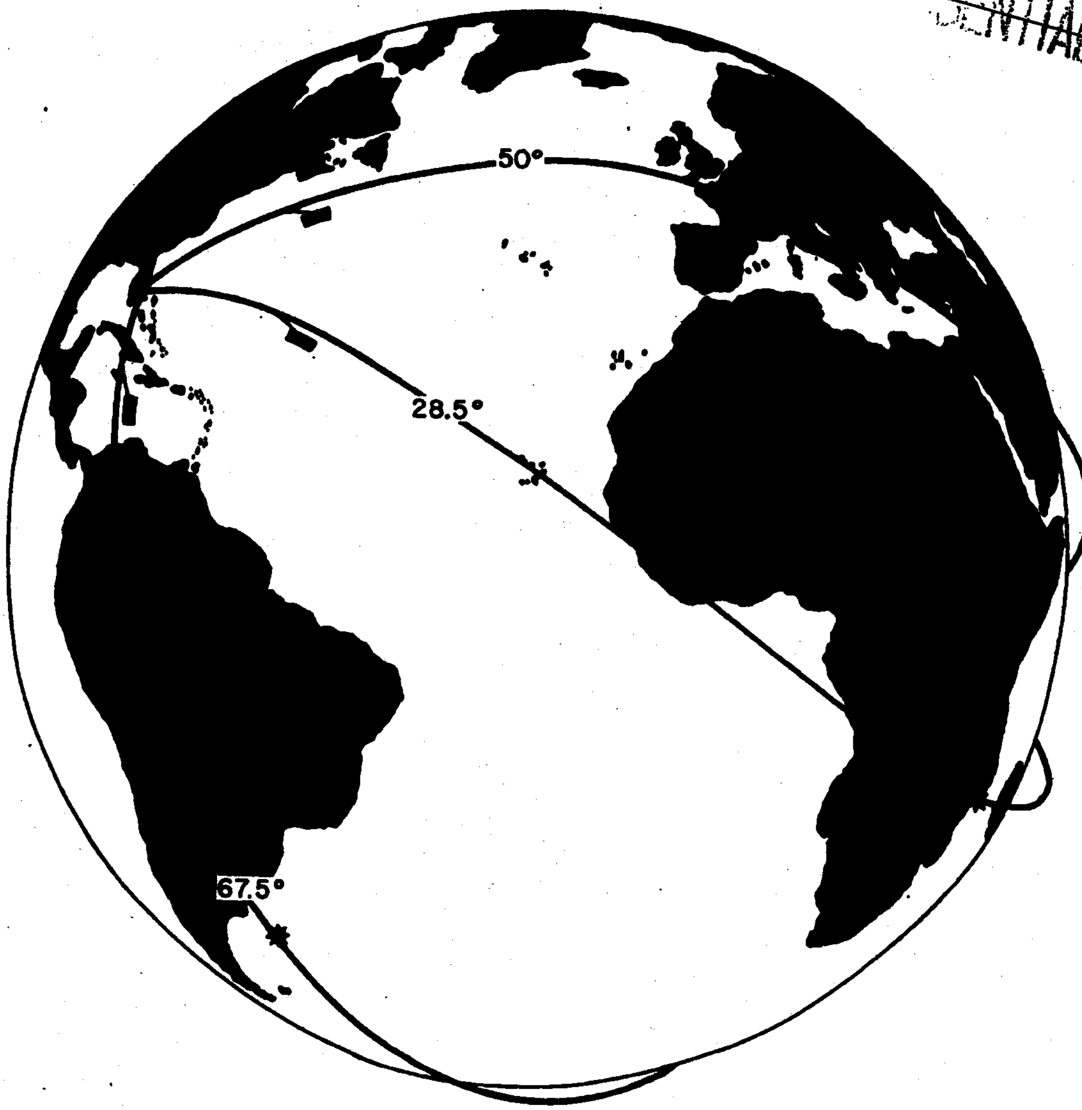
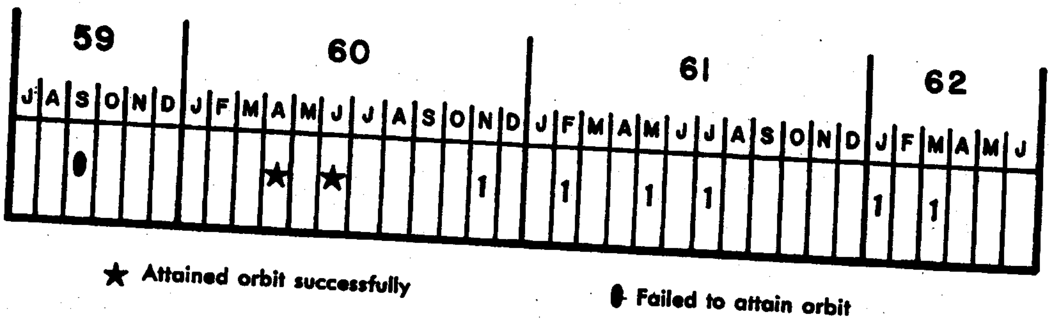


Figure 4. Typical TRANSIT orbits showing flight path, booster impact areas, and orbital injection points.

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.



FLIGHT HISTORY

TRANSIT No.	Launch Date	Remarks
1A	17 September	The three-stage vehicle was launched from Stand 17A at the Atlantic Missile Range. The payload was not injected into orbit, because the third stage motor failed to ignite.
1B	13 April	The THOR/ABLESTAR boosted satellite was launched from Stand 17B at AMR. The satellite was placed into orbit. The ABLESTAR second stage (on its first flight test) fired, shut off and coasted, then on command fired again.
2A	22 June	The dual payload was placed in orbit by the THOR/ABLESTAR combination. The orbital parameters and payload performance were so successful that TRANSIT 3A will carry an advanced payload.

MONTHLY PROGRESS—TRANSIT Program

Program Administration

- The U.S. Navy (BuWeps) has given program approval for five additional TRANSIT flights. AFBMD received approval for TRANSITS 3B and 4A on 27 May, and for TRANSITS 4B, 5A and 5B on 27 October. The launch dates and orbit inclinations for TRANSIT payloads are shown in Table I.

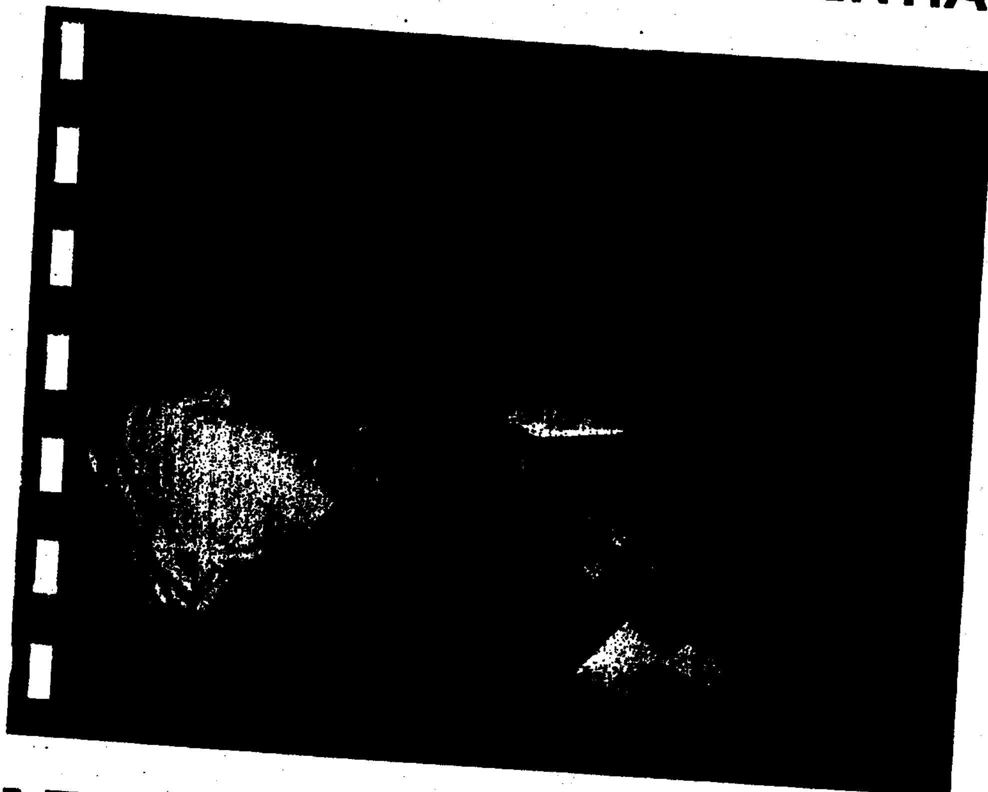
TRANSIT Payload	Launch Date	Orbit Inclination (degrees)
3A	29 November 1960	67.5
3B	February 1961	28.5
4A	May 1961	67.5
4B	July 1961	67.5
5A	January 1962	22.5
5B	May 1962	—

TABLE I. TRANSIT Launch Dates and Orbit Inclination

Because of the technical problems involved in placing a TRANSIT 5A and 5B payload in the selected orbits, these launches have not yet been approved. To attain an orbit inclination angle which is lower than the latitude of the launch site (28.5 degrees North latitude in the case of AMR Complex 17) requires a yaw maneuver after launch. The capability of the THOR/ABLE-STAR vehicle to produce this orbit has not yet been established.

Flight Test Progress

- TRANSIT 3A was scheduled for launch on 29 November with an orbital inclination angle of 28.5 degrees. On 11 October, the Navy requested that the orbit be changed to 67.5 degrees. AFBMD is working to accomplish this new requirement, but at present the solution of the technical problems associated with the altered requirement have not been solved. The guidance changes alone represent a major project. In addition to these technical problems, other problems were created in relation to range safety and relocation of the downrange tracking station from Pretoria, South Africa to Punta Arenas, Chile.



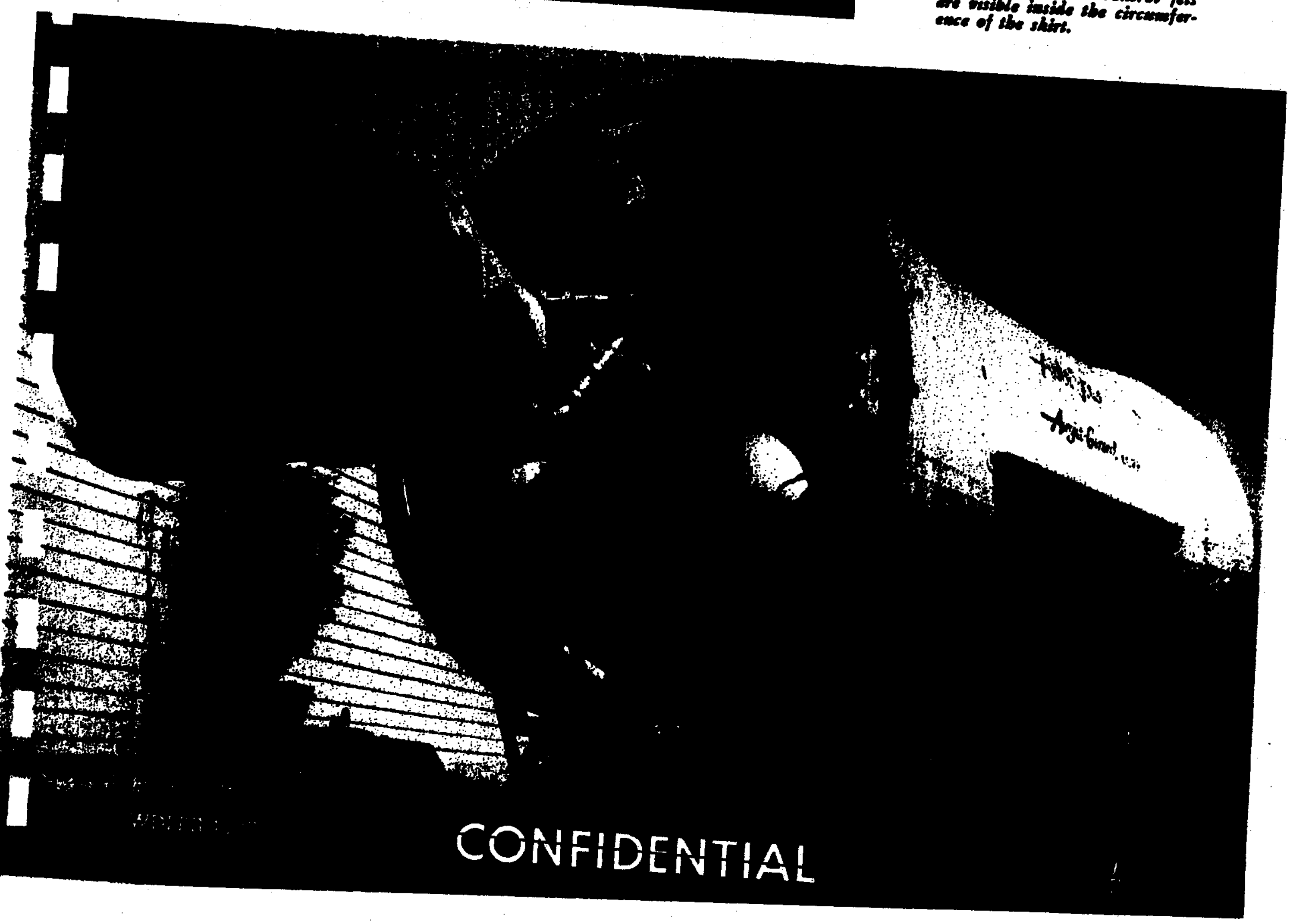


Figure 5. Able-Star vehicle during system checkout (left) at the contractor's facility. The console is used for pressure checks and TPS control and instrumentation checks. Able-Star (below) on ground handling dolly following Air Force acceptance. The 40:1 uncooled nozzle extension is on the extreme left; inboard is the regeneratively cooled nozzle. The gas in the three large spheres is used to pressurize the propellant tanks. The attitude control jets are visible inside the circumference of the skirt.

COURIER

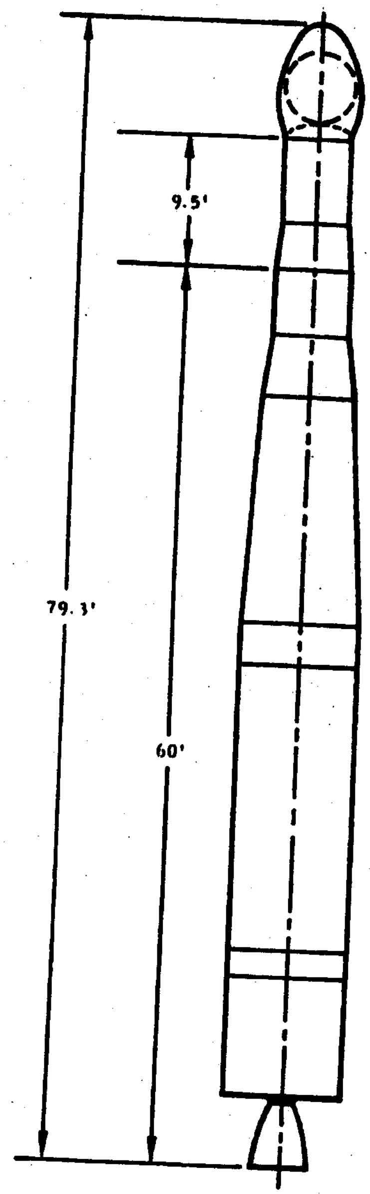
The ARPA COURIER Program consists of two flight vehicles to be launched from the Atlantic Missile Range. The program objective is to test delayed repeater communications between a satellite and ground stations. The program also will be used to determine the operating characteristics and capabilities of the ABLESTAR (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 ABLESTAR (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 ABLESTAR 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 ABLESTAR 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—ABLESTAR (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

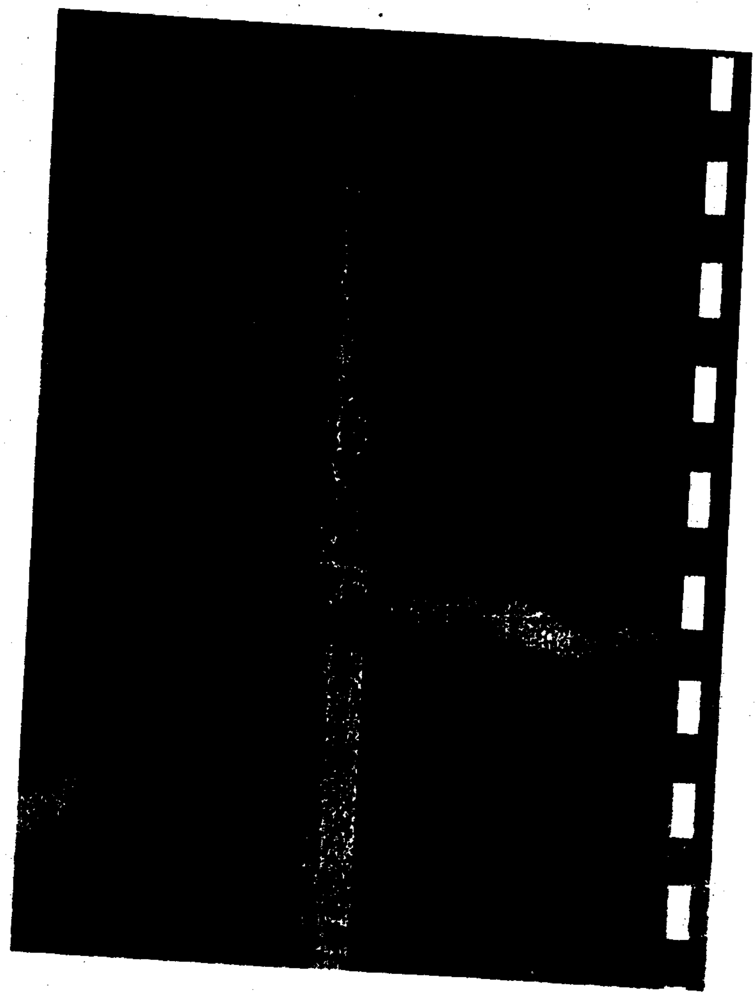
Program Administration

• With the successful launch and orbit of the COURIER 1B satellite on 4 October, AFBMD's responsibility in the program ended. The Advanced Research Projects Agency had overall responsibility for the program until 15 September 1960 when this responsibility was transferred to the Army. AFBMD was responsible for the launch vehicle, integrating the payload to the launch vehicle and providing communications to the tracking and data-handling agencies from launch through attainment of orbit. The Army Signal Research and Development Laboratory (USARDL) was assigned the task of designing, fabricating and testing the payload. Philco Corporation was the prime payload contractor.

COURIER 1A

Pre Launch

• Preliminary design of the COURIER 1A vehicle was completed in September 1959 and design of the first-to-second stage transition section was essentially complete. The nose fairing was also released for manufacture during September. In October the launch date was established as 15 May. This date



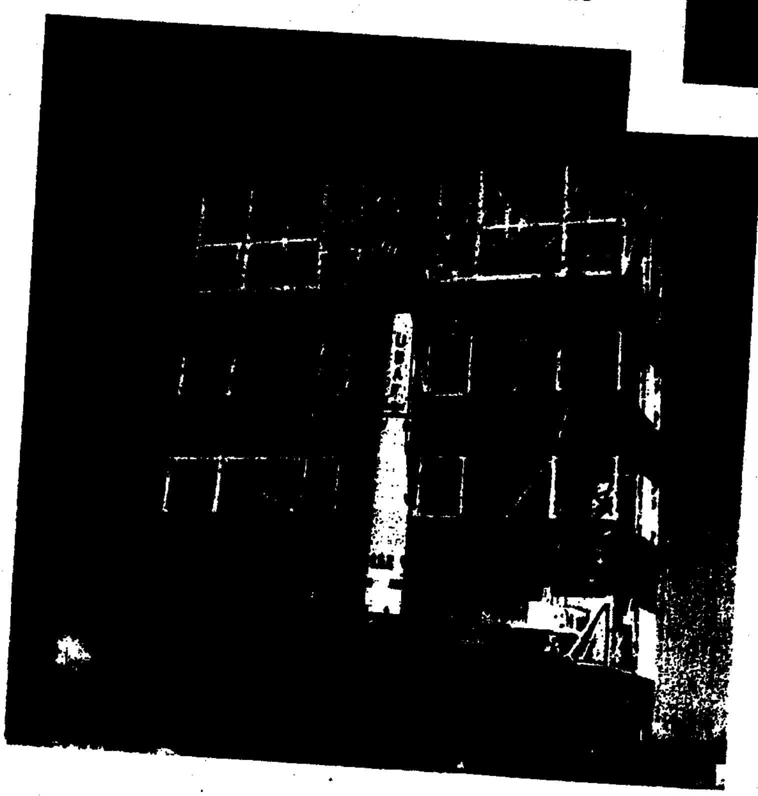


Figure 1. THOR booster 262 (left) installed on Stand 17B at the Atlantic Missile Range. COURIER 1A above prior to launch on 18 August. A loss of hydraulic pressure caused the control system to become inoperative and the missile to become unstable resulting in its destruction.

was changed in February to 15 July because of USASRDL payload availability problems.

- As a result of aerodynamic heating studies conducted in March, two aerodynamic heating problems were uncovered. The first was that the guidance antennas had inadequate protection. The application of an ablating coating solved this problem. The second indicated that protection would have to be afforded the payload because of nose fairing radiation. The payload contractor agreed that aluminum foil could be used to reduce the amount of heat transferred provided the foil did not project below the payload equator. Both the solutions proved to be adequate. Because of a stand availability problem AMR recommended that the launch be delayed four days to 19 July. Because of a TRANSIT 2A vehicle roll control problem on 22 June, the COURIER 1A launch was rescheduled for 16 August. This delay would permit the TRANSIT data to be evaluated and any necessary modifications to be incorporated in the COURIER vehicle. The rescheduling also permitted the relocation of down-range tracking van from Zanzibar to Salisbury, South Rhodesia.

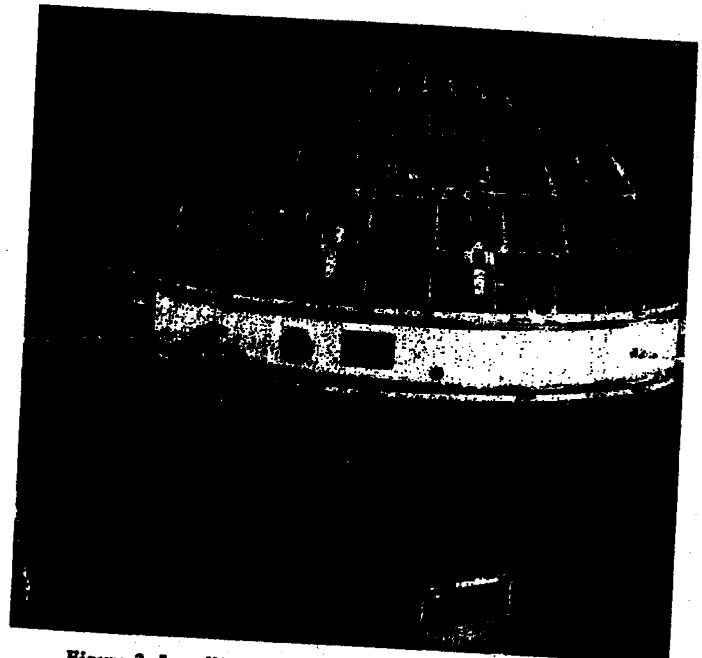


Figure 2. Installing one of the antennae on the 500-pound COURIER 1B satellite vehicle. Approximately 20,000 solar cells sheath the 60-inch sphere and keep the batteries charged.

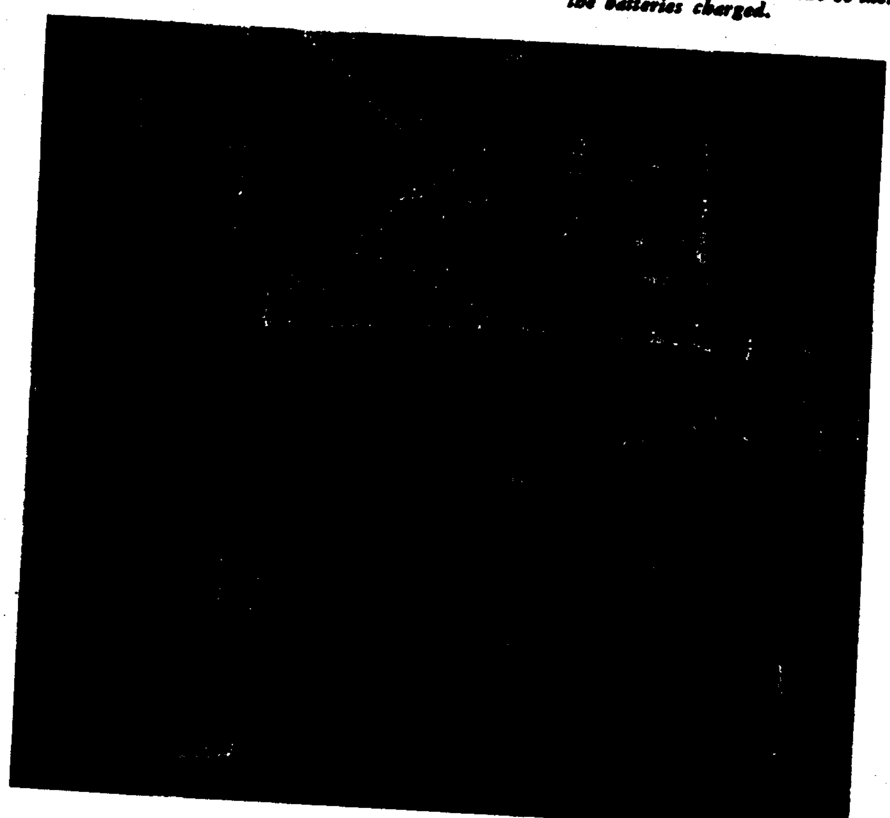


Figure 3. Preparing the payload for spin tests. The solar cell covered hemispheres have been removed revealing the UHF receivers and telemetry transmitters on the top; command decoder, microwave receivers and transmitters, and batteries on the middle shelves; and data storage units on the lower shelf.

• Since COURIER 1A checkout had been completed, a protective cover was placed around the missile and a nitrogen atmosphere was provided until the analysis of the TRANSIT flight behavior had been completed. The investigation of the abnormal performance showed that lateral propellant sloshing was producing rolling and "coning" of the vehicle about its flight path. Modification of the missile included: installing wire screen anti-slosh baffles, adding nitrogen storage bottles to provide more gas for stage stabilization, decreasing the auto-pilot position gains to reduce the sloshing tendency and delaying the jettisoning of the nose fairing to provide greater stability during the first three minutes of flight.

Launch

• On 18 August COURIER 1A was launched from the Atlantic Missile Range. Liftoff was smooth and stable and the flight was normal for twenty seconds. At this time hydraulic pressure in the THOR began to drop. At 128 seconds hydraulic pressure was lost completely and the missile subsequently broke up. Analysis of telemetry data and laboratory bench tests strongly suggested the failure of the hydraulic system low pressure relief valve. Plumbing changes were made in the THOR hydraulic system. Ground instrumentation was added and improved inspection and checkout procedures were implemented. Plumbing and instrumentation changes were accomplished on the COURIER 1B.

• The COURIER 1A ABLE-STAR second stage contained the modifications indicated as a result of the TRANSIT 2A studies. However, due to flight termination prior to second stage ignition, the effectiveness of these modifications could not be evaluated.

COURIER 1B

Pre Launch

• As a result of powered flight trajectory studies performed on the original Space Booster selected for this flight it was found that it could not provide sufficient velocity for the assigned task. A trajectory study was performed using a THOR booster selected for TRANSIT 2B, which indicated that its velocity was within the three sigma requirement. The change in booster assignments was made with no change in launch date. Because of rescheduling the launch of COURIER 1A, delays in vehicle checkout, and incorporation of the booster and second stage modifications, a re-evaluation of the COURIER 1B launch schedule was made during July. Because of the time required for guidance ground stations preparation and the delay in vehicle availability, the launch of COURIER 1B was scheduled for 4 October.

• The THOR booster was erected on Atlantic Missile Range Stand 17B on 12 September. The second stage and payload were installed on 19 September.

Launch

• The COURIER 1B satellite was launched from the Atlantic Missile Range Stand 17B at 0950 PST on 4 October. The countdown was interrupted three times by minor equipment difficulties which delayed the launch for approximately 90 minutes. Liftoff was smooth and stable, and the flight was normal. Performance of the THOR booster and ABLE-STAR (AJ10-104) second stage was excellent. The satellite vehicle was injected into orbit by restart of the ABLE-STAR stage engine at 1030 PST. The THOR operation verified the effectiveness of the hydraulic system modification incorporated as a result of the COURIER 1A flight. Table 1 lists nominal and actual orbital parameters.

PARAMETER	NOMINAL	ACTUAL
Apogee, nautical miles	650	658.2
Perigee, nautical miles	650	501.7
Eccentricity	0	0.0195
Inclination Angle, degree	28.5	28.3
Period, minutes	109	106.7

TABLE I. COURIER 1B Orbital Parameters

• The Army has informed AFBMD that the COURIER satellite is operating satisfactorily. By using the orbital elements provided by the Air Force, the Army has successfully used the satellite for both voice and TWX communication at the expected rate. The two Army ground stations have interrogated the satellite, verifying that the storage and memory components are functioning.

Figure 4. COURIER 1B (opposite page) emerging from cloud shrouded Stand 17B, Atlantic Missile Range on 4 October.

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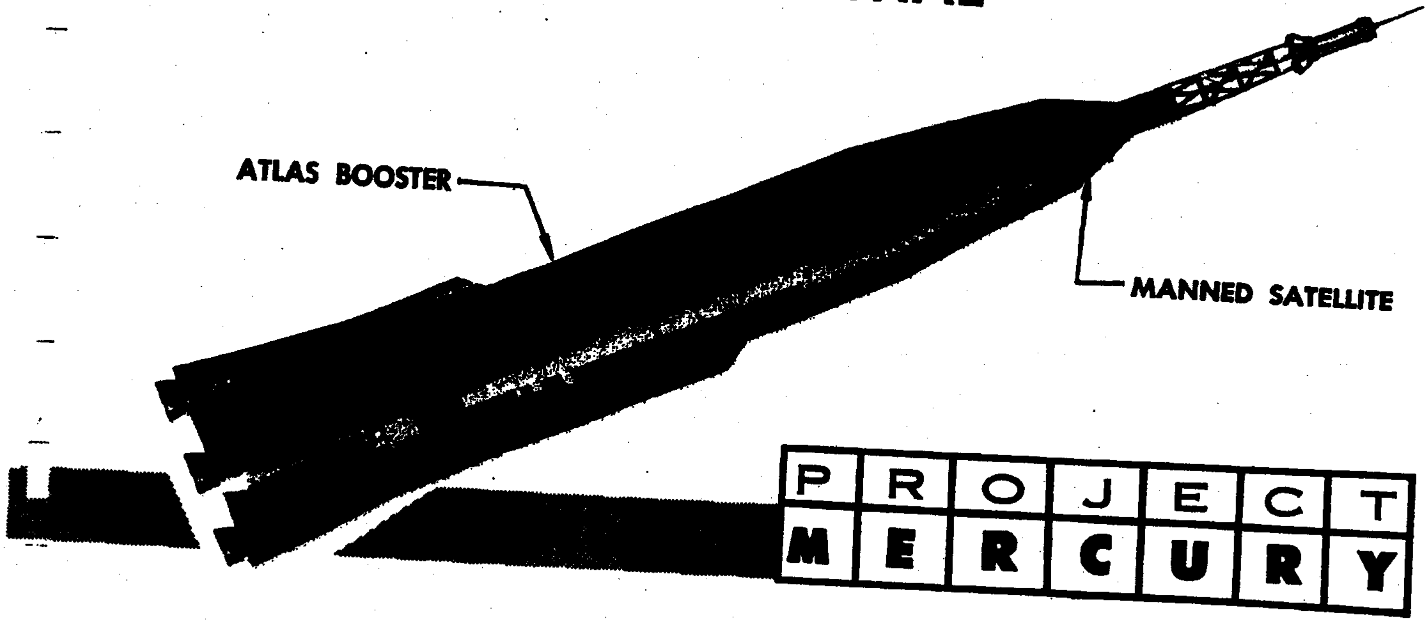
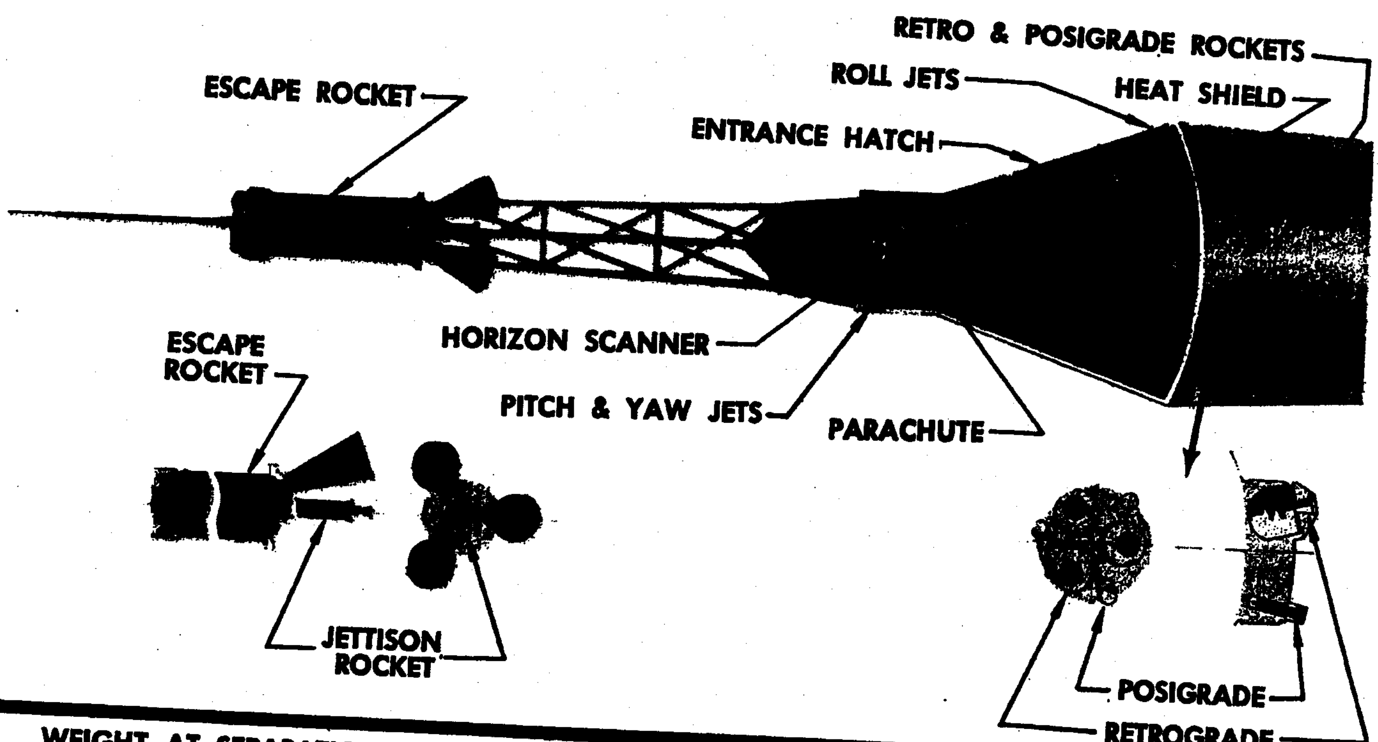




WEIGHT AT SEPARATION	2,500 lbs	ORBITAL CYCLES	3-18
ORBITAL ALTITUDE		ORBIT INCLINATION	33 Degrees
APOGEE	126 N. Miles	HEAT SHIELD	Ablative
PERIGEE	94 N. Miles	RECOVERY	Water or Land

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 16 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: Aerospace Corporation, 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.

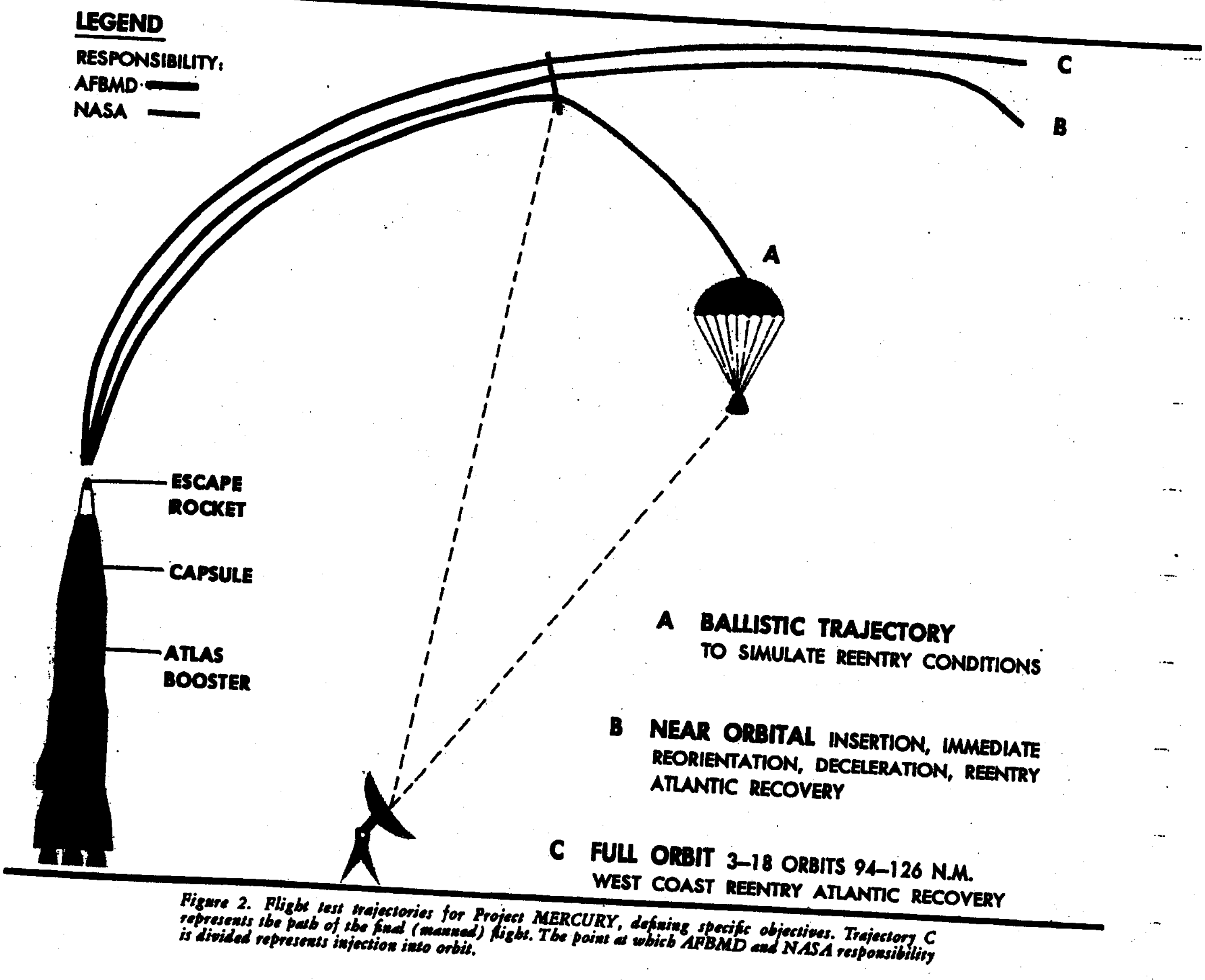


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.

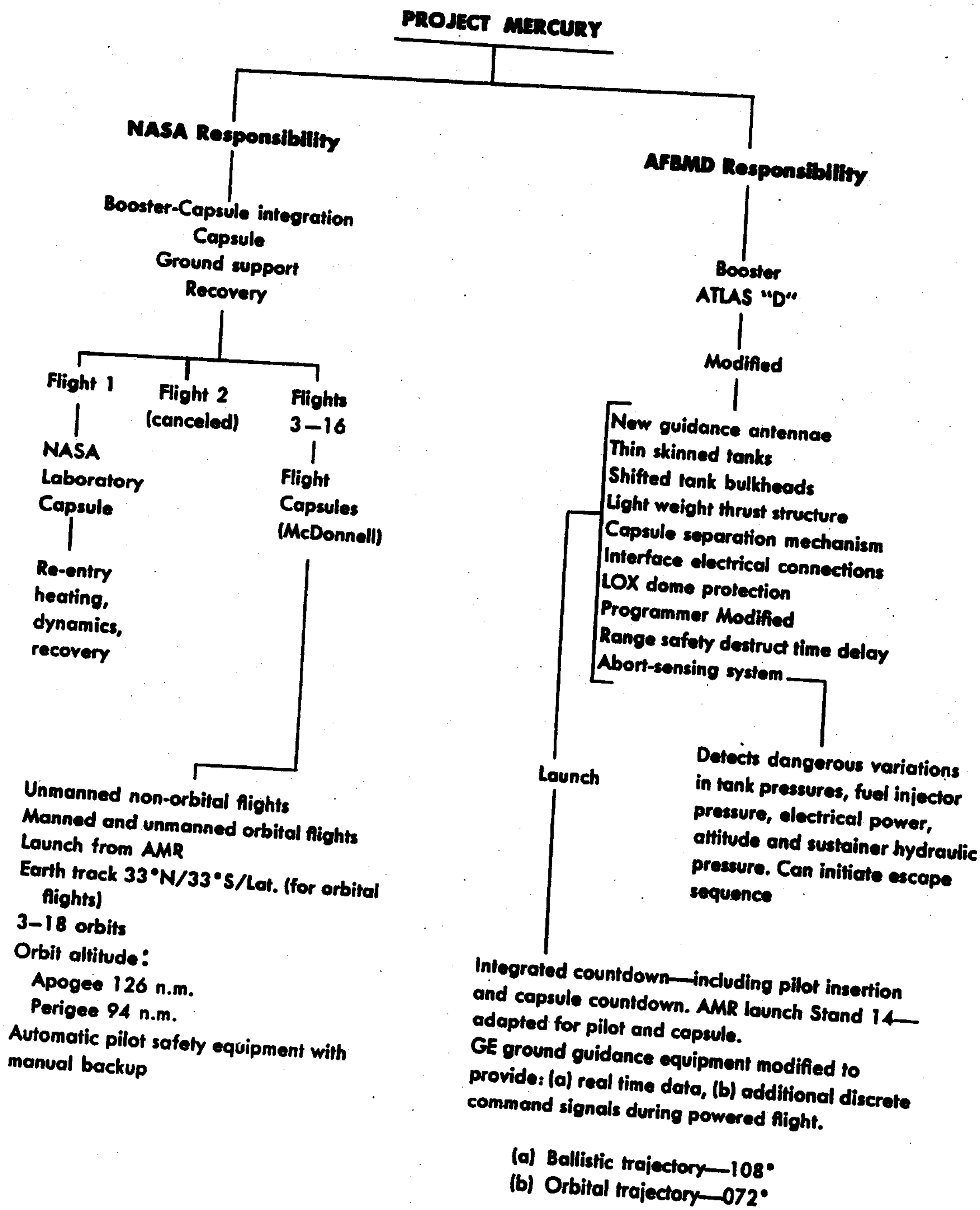


Table 1. Outline of NASA and AFBMD responsibilities in PROJECT MERCURY.

PROJECT MERCURY

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

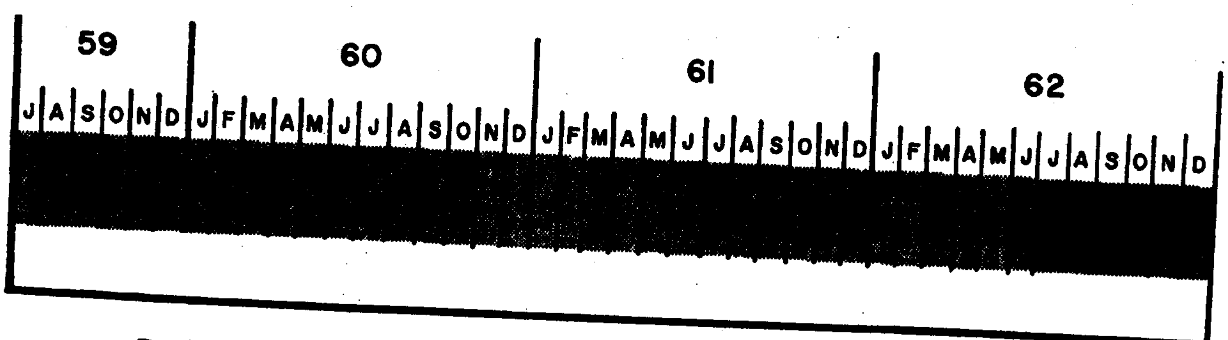
**Design, engineering studies
Equipment modification
Hardware fabrication**

**Launch support
Trajectory data
Missile allocation**

Flight scheduling

Provide sixteen (16) ATLAS boosters.	Modify boosters for NASA preliminary research and manned orbital flight and safety objectives.	Launch, control and define trajectories of booster-capsule vehicle up to, and including, injection into orbit.

Table 2. AFBMD responsibilities in support of PROJECT MERCURY.



Project MERCURY Launch Schedule

MONTHLY PROGRESS—Project MERCURY

Program Administration

- AFBMD received authorization from NASA on 28 October to proceed with the modification of Atlantic Missile Range Launch Complex 12, for use as a reserve MERCURY launch facility. With the present 1961 launch schedule severe damage to Complex 14 would require extensive rescheduling and would seriously impair the MERCURY Program. The initial modification will require approximately four and one-half months to complete and cost $75,000. If it became necessary to use Complex 12, an additional month and $50,000 would be required to complete the modification. Contractual authorization will be given Convair Astronautics to perform the initial modification.

- In accordance with direction received from Headquarters ARDC, a brochure explaining the MERCURY/ATLAS Booster Pilot Safety Program was prepared for presentation to the Air Force Chief of Staff. This brochure, to be used in lieu of a formal briefing, was forwarded to Headquarters ARDC on 24 October.

- The House Committee on Science and Astronautics (The Brooks Committee) requested information on: the scope of Air Force support of Project MERCURY, Air Force dependance on MERCURY data for "Man-in'Space" programs, and the effect MERCURY slippages have had on high priority Air Force programs. AFBMD submitted its position on these issues to Headquarters ARDC on 17 October.

Flight Test Progress

- The MA-2 mission and test objectives have not been changed, except for the new launch date of 5 December. This rescheduling will permit installation of additional telemetry and instrumentation to provide data from areas suspected of failing during the MA-1 flight. For example, strain gages have been installed on the forward portion of the liquid oxygen tanks to measure in-flight loads on this structure. The installation of this equipment was completed on 31 October.

- ATLAS 67D, booster for the MA-2 flight, previously delivered to the Atlantic Missile Range underwent subsystem and integrated systems hangar checks. The booster is scheduled to be installed on launch stand 14 on 3 November.

Technical Progress

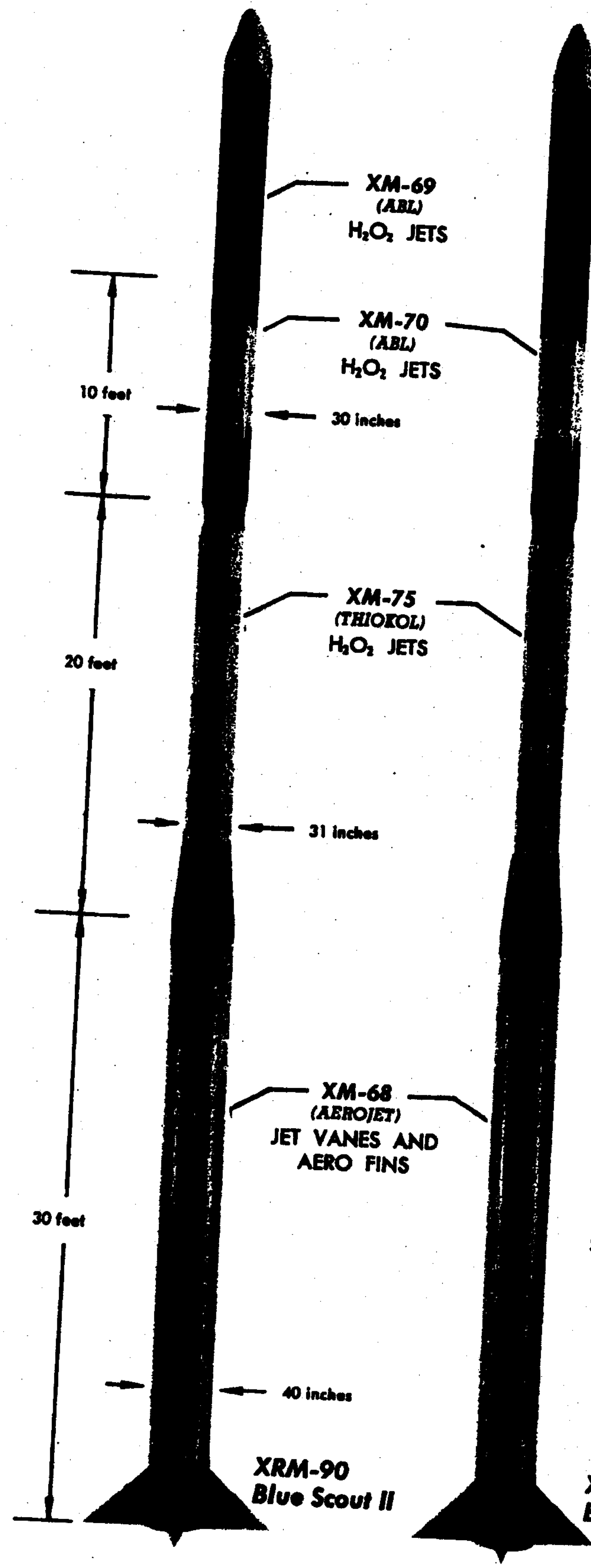
- The vibration test program conducted at the McDonnell Aircraft St. Louis facilities was completed on 7 October. Preliminary analysis of data showed no unusual results, confirming the previous analysis that the failure of the booster liquid oxygen boil-off valve on the MA-1 flight was a result of and not a cause of that malfunction. The final test report will be completed in mid-November.
- The tests of a one-third scale model of the ATLAS forward liquid oxygen tank dome, the adapter, and capsule in the Arnold Engineering Development Center wind tunnel were completed on 10 October. Both MA-1 and MA-2 configurations were tested at speeds up to 1.6 Mach. Preliminary results will be available early in November and the final report will be published in December.

PROJECT 609A

Hyper-Environment Test System

PROGRAM DESCRIPTION—The Hyper-Environment Test Program (609A) is divided into R & D and Operational Phases. The R&D phase will be used to develop and flight test vehicles capable of carrying 25 to 1,000 pound payloads to altitudes of 200 to 50,000 miles. The Operational phase will use these standardized vehicles to permit the economical performance of flight test experiments in support of scientific research and advanced military space system programs.

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



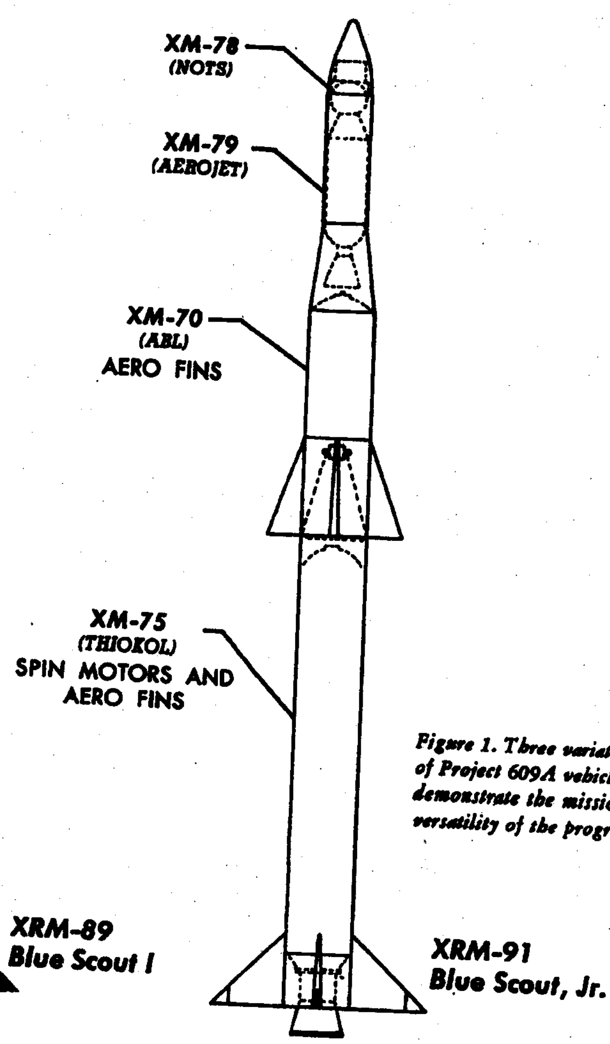


Figure 1. Three variations of Project 609A vehicle demonstrate the mission-versatility of the program.

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

Program Management—An abbreviated development plan, covering the R&D phase only, was approved on 9 January 1959. Funds in the amount of $12,651,000 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.

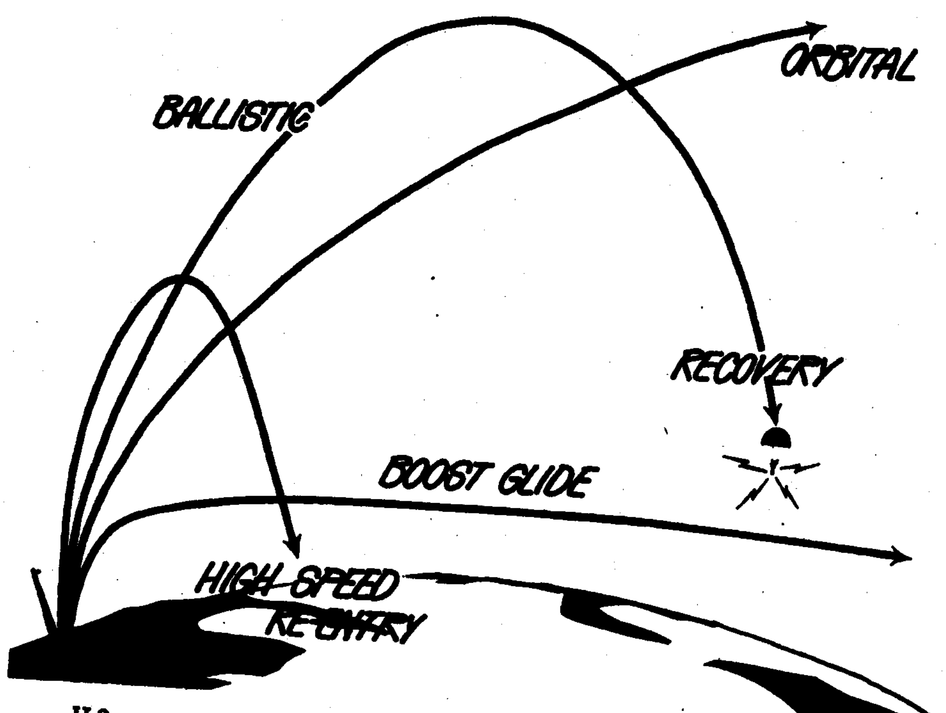
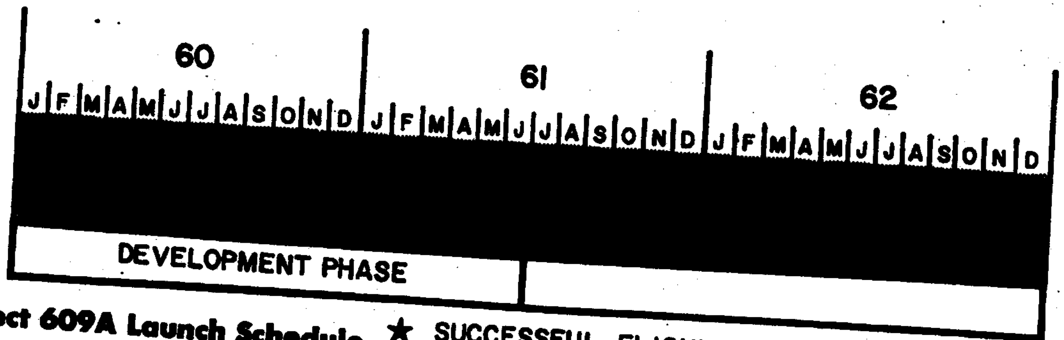


Figure 2. Four different trajectories possible using different arrangements of Project 609A stages.



Project 609A Launch Schedule ★ SUCCESSFUL FLIGHT

MONTHLY PROGRESS—Project 609A

Program Administration

- Headquarters USAF has assigned type designations to the motors that make up the stages of the Project 609A vehicles. Table I lists the old designation, manufacturer and new designation.

Old Designation	Manufacturer	Type Designation
AJ Senior	Aerojet	XM-68
TX-33	Thiokol	XM-75
X-254	ABL	XM-70
X-248	ABL	XM-69
AJ-10-41	Aerojet	XM-79
100A	NOTS	XM-78

TABLE 1. Old and New Project 609A Motor Designations

- Because the Operational Phase of the 609A Program has not been approved or funded, decisions were made to stop work on the design of Operational Facilities. It was considered uneconomical and unnecessary to continue design of these facilities, which are needed only for the Operational Phase, until the follow-on program is approved.

- Actual and predicted delays in delivery of components of the guidance and control system have necessitated extension of the schedule for the Development Flight Test Program. This will not affect the time when initial launches can be made in the Operational Phase since there is a lead time requirement of nine months between funding and launch of follow-on vehicles. Extending the duration of the test program will make a more equitable work load on the 6555th Test Wing (Dev) launch crews and reduce the amount of time between the Development and Operational Launch programs.

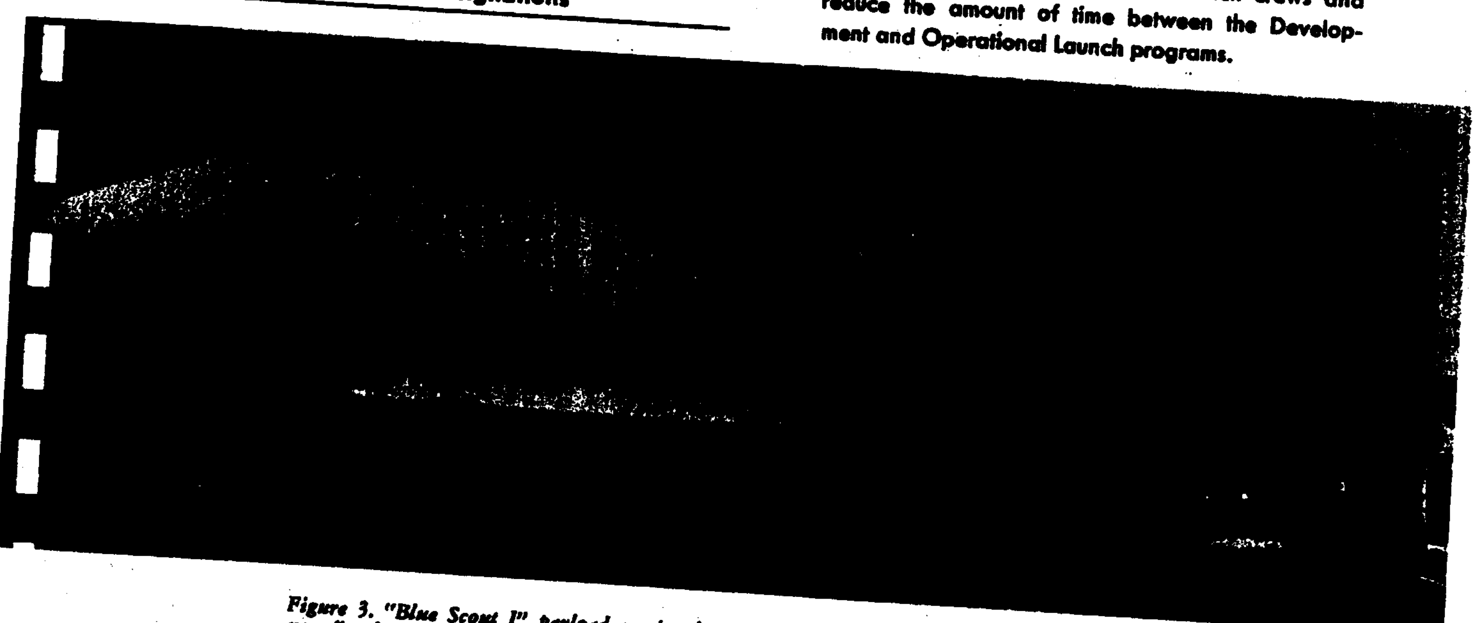


Figure 3. "Blue Scout I" payload carrier during transfer from a ground handling dolly to the new "mobiltainer." The mobiltainer protects the payload during the flight from the West Coast to the Atlantic Missile Range and during storage at AMR.

• Three XRM-91 vehicles have been procured with funds furnished by the Air Force Special Weapons Center (AFSWC) and will be launched to support an AFSWC program for space radiation investigation. They will have concurrent objectives of further development proof testing of this configuration. A recent decision has been made to schedule launch of these vehicles after the rest of the vehicles in the current development program.

The first of the three will be launched at AMR in May and the remaining two from the NERV launcher at Point Arquello in June. The launches at Point Arquello will be conducted by a TDY team from the 6555th Test Wing (Dev) at AMR. The payloads, telemetry and fourth stage hardware will be provided by AFSWC and their technicians will be responsible for checkout of this equipment. Booster vehicles and program direction will be provided by AFBMD, with AFSWC support to furnish appropriate range documentation.

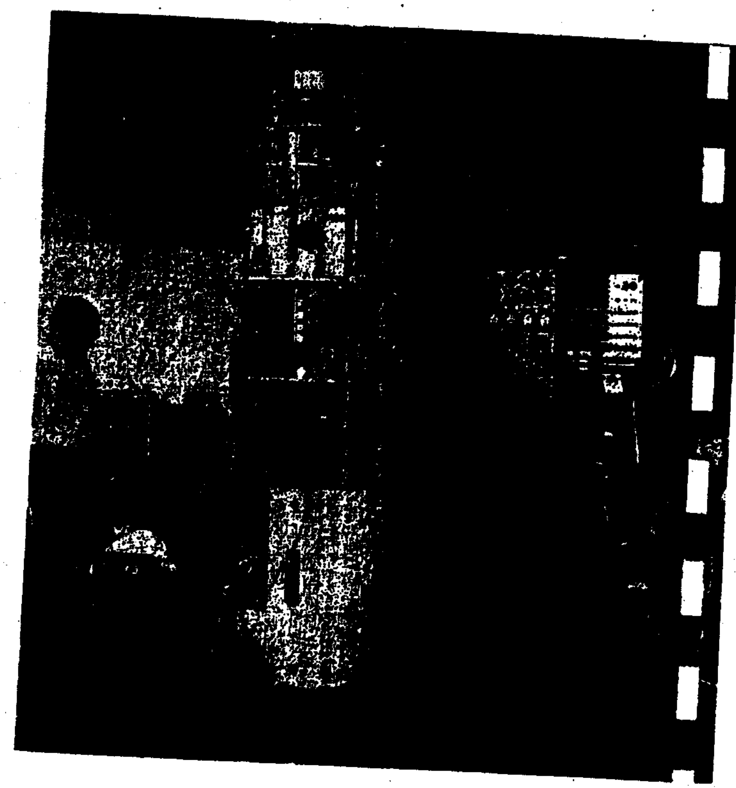


Figure 4. "Blue Scout I" payload carrier during final subsystem and system checkout. Electronic checkout consoles are in the background.

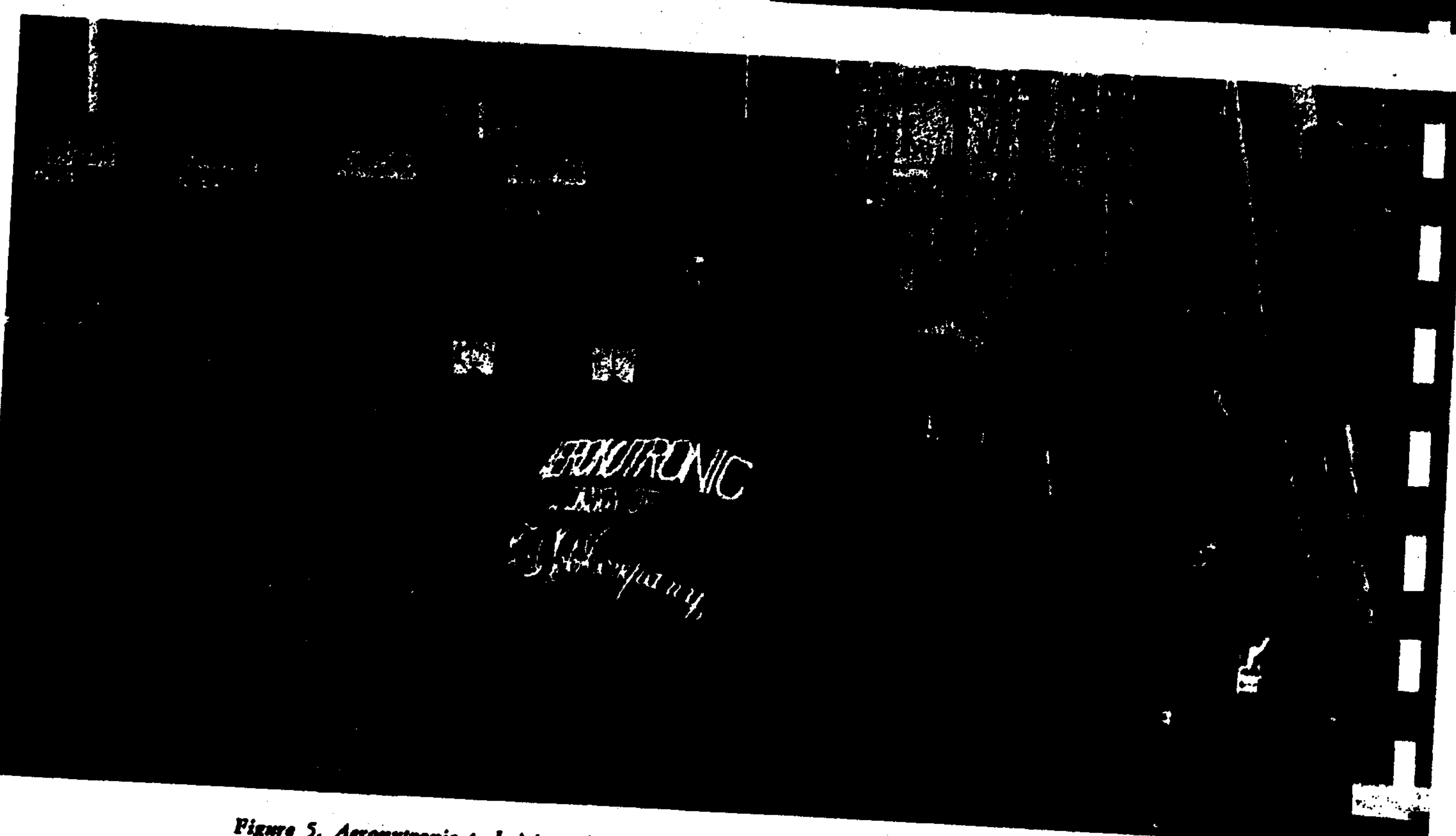


Figure 5. Aeronutronic technician adjusts an oscillograph recorder before starting "spin-heat-load" test on 609A payload. During this test the payload is spun inside the bank of heat lamps visible above the technician. By the use of a special test fixture loads are applied to the payload.

Flight Test Progress

- The second XRM-91 vehicle is now scheduled to be launched from the AMR on 8 November. The vehicle, payload and flight trajectory, will be essentially the same as that of the first XRM-91 launch. The slip from the October launch date was made necessary by payload instrumentation difficulties encountered by AFSWC. No further problems are anticipated in meeting this date.

- The third 609A Development Phase launch is scheduled for 28 November. This will be the first launch of a XRM-89 vehicle, and the first 609A vehicle to carry a recovery capsule. This launch is behind schedule due to capsule drop test problems, deficiencies in assembly of the guidance system timer unit and increased work loads at the Atlantic Missile Range. Drop tests of the recoverable nose capsule will be conducted between 3 November and mid-November. Three drops are scheduled, two at Cape Canaveral and one at Antiqua. These tests were delayed approximately one month because no recovery ships were available. The modification and rework of the timer will be completed in time to meet the current launch date. Personnel of the 6555th Test Wing (Dev) are available for vehicle preparation.

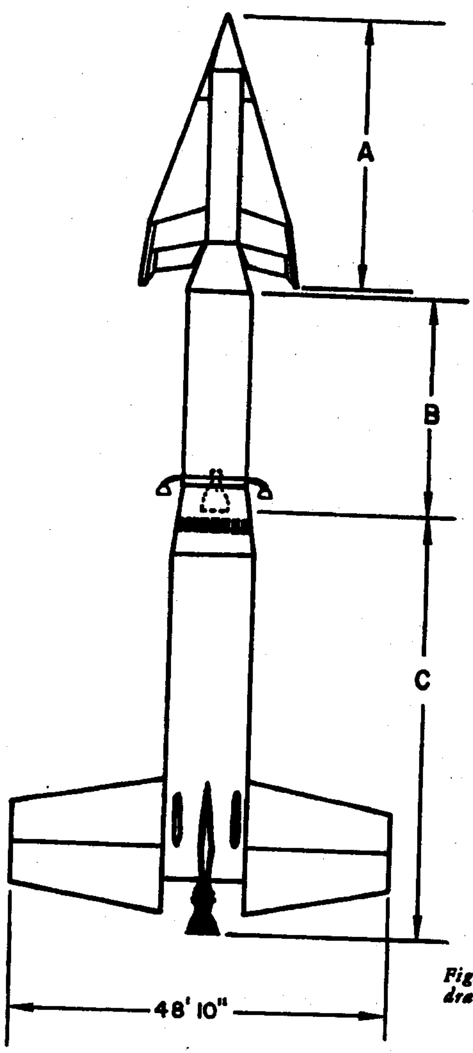
Facilities

- Review conferences were held for the final design of two assembly and checkout buildings, the combined system test building and concept drawings of the engine storage and payload carrier buildings. Further design of facilities has been stopped due to lack of approval and funding of the operational program. An option in the present contract will allow the architect-engineer to complete the design work, provided the contract is reinstated within six months.

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



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

Intertank Section Strengthened

FIRST STAGE MODIFICATIONS

Stabilizing Fins Added

Skirt Section and Intertank Section Modified and Strengthened

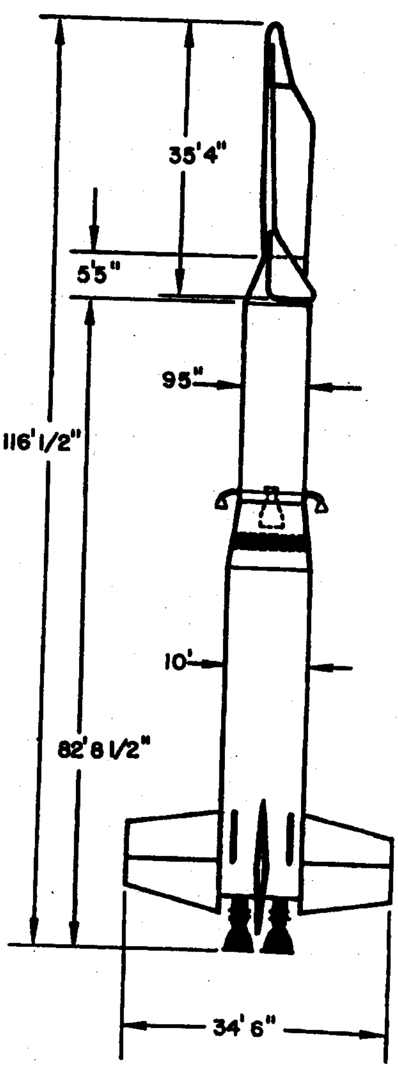
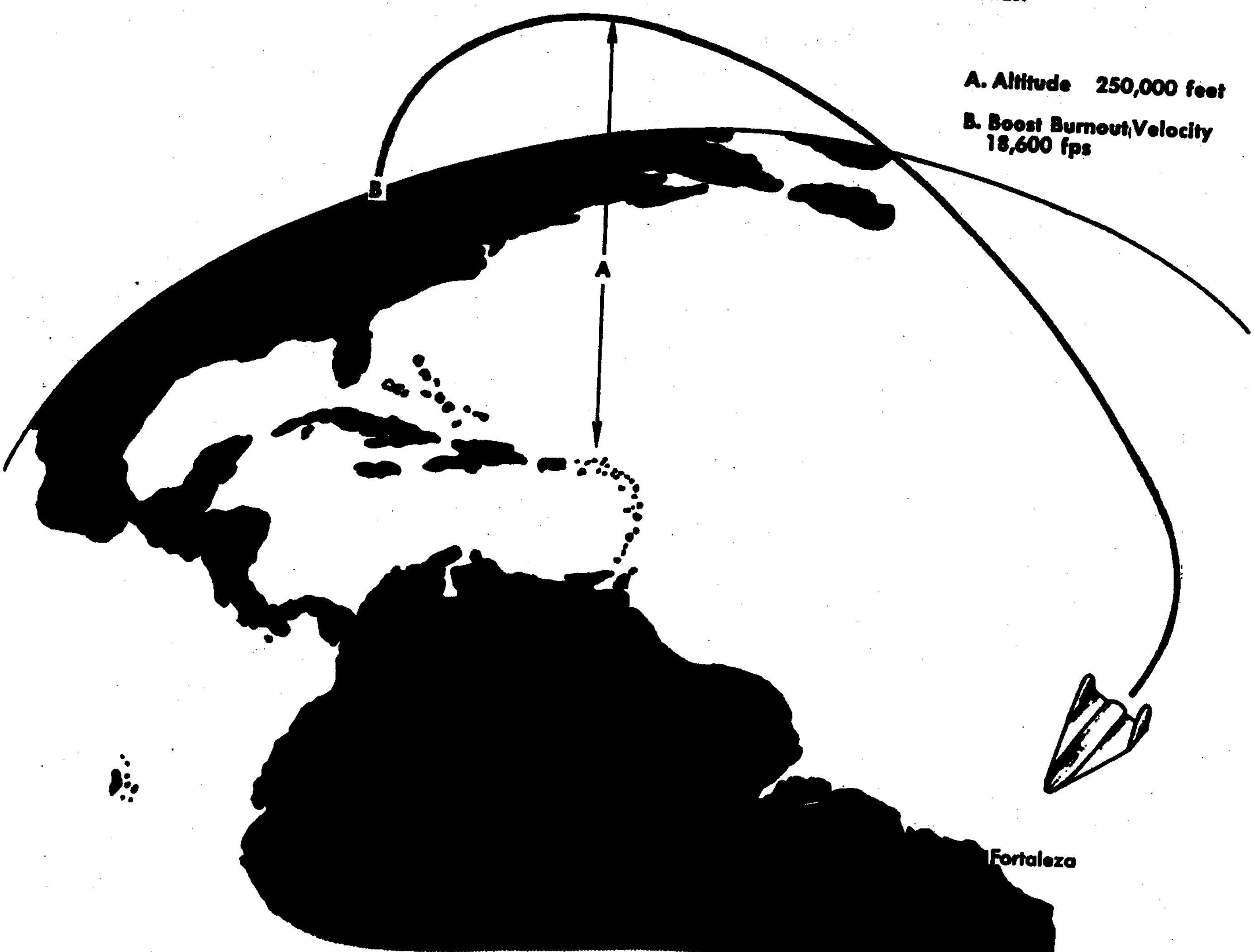


Figure 1. DYNA SOAR vehicle configuration drawing and specification list.

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

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



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 making noteworthy progress, primarily in the areas of detailed program planning, preliminary engineering and program management.

• A preliminary "corridor" study on the DYNA SOAR Step I booster was received on 5 October. The ultimate purpose of this study effort is the selection of an optimum trajectory for glider injection into the hypersonic flight regime. One selection criterion is that booster control and heating problems encountered along a given trajectory must be solved with the least modification of the TITAN booster. Additional studies are necessary to assure compatibility of the final trajectory selection with the over-all DYNA SOAR program requirements.

• The DYNA SOAR (Step II) booster studies have been initiated. Hardware go-ahead is tentatively scheduled for July 1962 with the first flight to occur in mid-1965. The basic booster will be required to place a 15-20 thousand pound glider into a low altitude orbit. AFBMD/Aerospace will:

1. Establish a booster specification.
2. Evaluate potential boosters.
3. Recommend to WADD the best prospects.
4. Assist WADD and Boeing in system analysis of the top prospects.
5. In conjunction with WADD, recommend the booster for Step II.

The final selection is prepared for July 1961.

• Program Evaluation Procedures (PEP) for DYNA SOAR are being established in accordance with standardized ARDC/AMC requirements. Preliminary booster networks (events and activities) were developed during a 27-29 October meeting attended by representatives of the Martin Company, Aerojet-General, AFBMC and AFBMD. Both booster and glider networks must be matched prior to initiation of the operational phase of analysis and evaluation.

NASA AGENA "B" PROGRAM

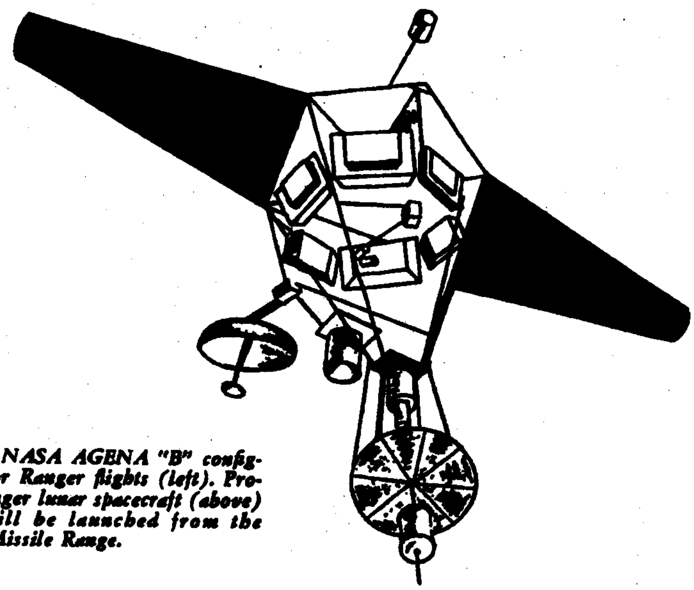
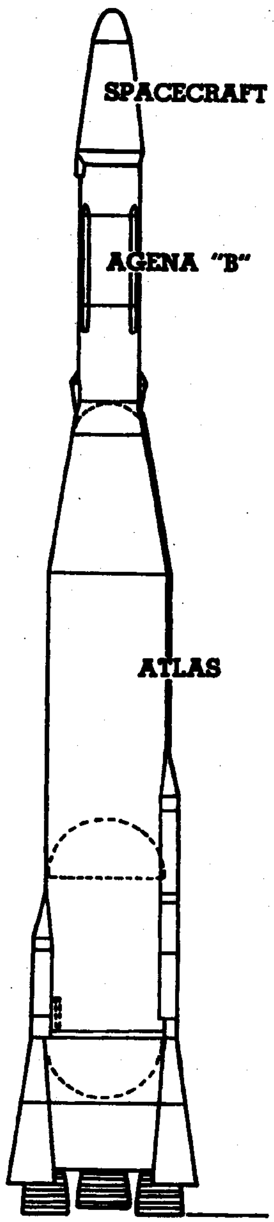


Figure 1. NASA AGENA "B" configuration for Ranger flights (left). Proposed Ranger lunar spacecraft (above) which will be launched from the Atlantic Missile Range.

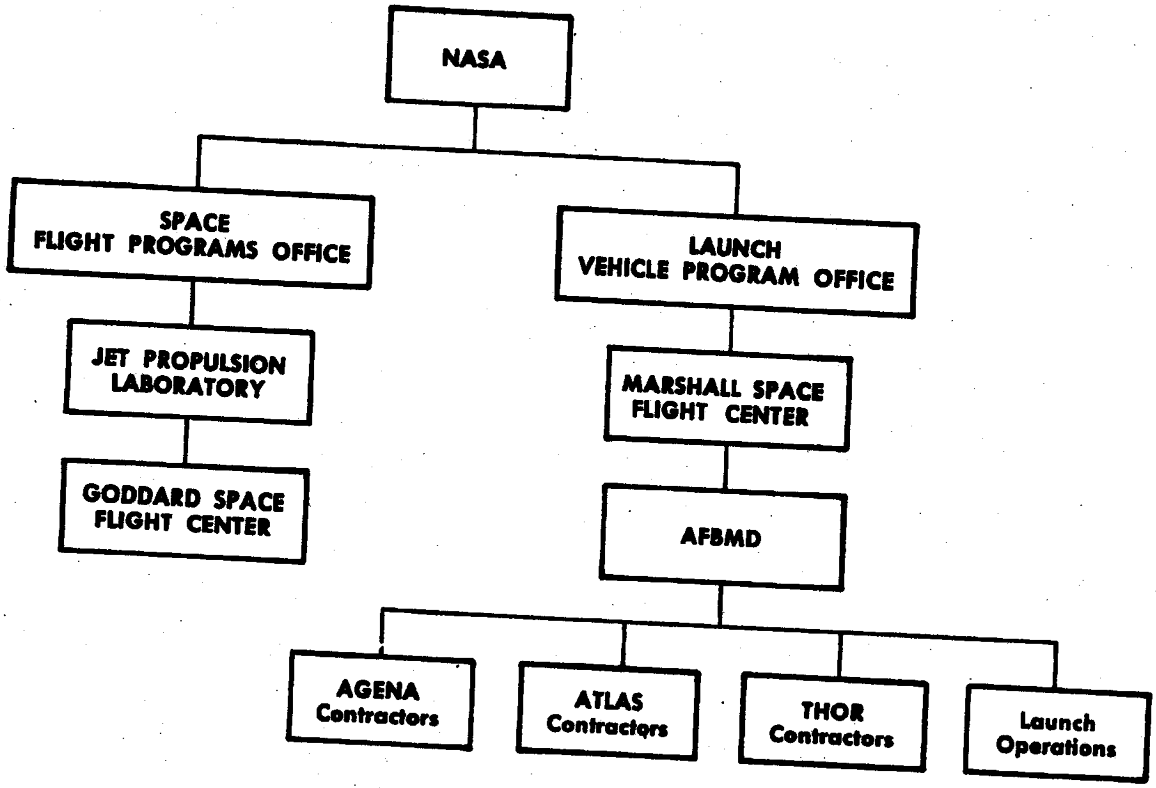


Program Objectives—The basic objective of the NASA AGENA "B" Program is to place a separable spacecraft on a prescribed ballistic trajectory or into lunar orbit to gather scientific information and data. The program will first demonstrate the capability of jettisoning the spacecraft shroud and separating the spacecraft from the AGENA "B" vehicle. The program will also develop and demonstrate the capability of the AGENA "B" retro system to retard the second stage. To achieve these objectives the NASA will use the background and experience gained by the USAF in their Satellite System programs in terms of AGENA engineering, procedures and launch operations.

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

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

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



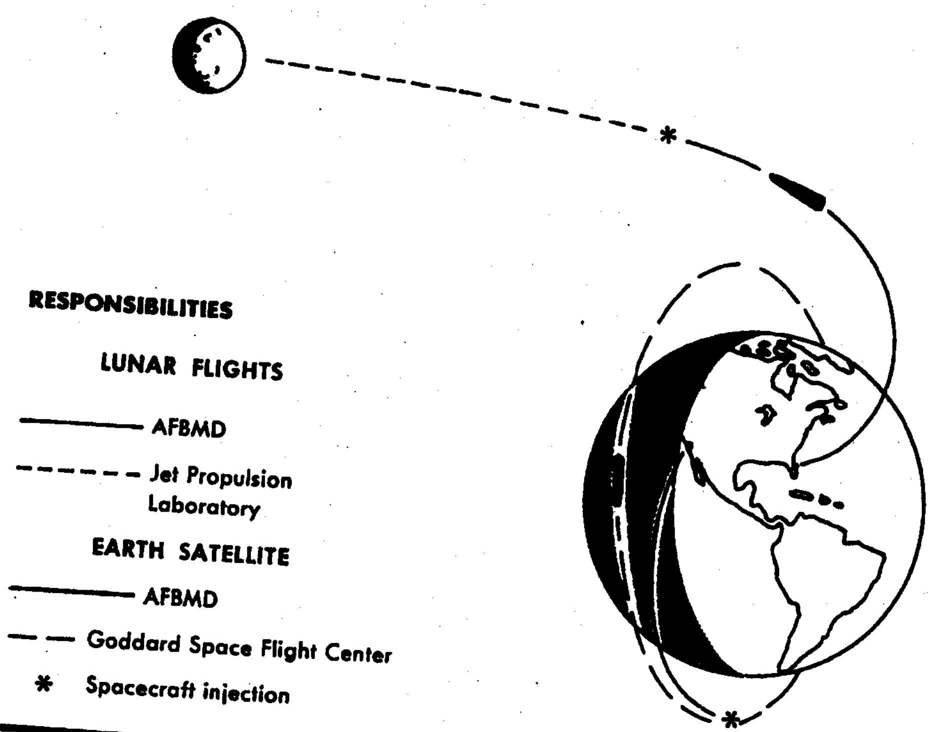
NASA AGENA "B" Project Organization Chart

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

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

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

NASA AGENA "B" Program Flights



SPACE
defense programs

SAINT

SAINT

Program Objectives

- The objective of Project SAINT is to develop a Satellite Inspector System for inspection of unidentified earth satellites which might constitute a threat to the United States. Although not specified in the currently authorized program, the ultimate system would include a capability to negate those satellites which were determined to constitute a threat.

Concept

- The current concept is that unidentified orbiting objects will be acquired, catalogued and their ephemeris accurately determined through the facilities of the National Space Surveillance Control Center (NSSCC) utilizing existing Millstone and FPS-16 Radars. (It is anticipated that, for the ultimate operational system, the capabilities of the NSSCC will be expanded to provide additional information such as target size, configuration and stability in orbit.) This information will be relayed to a Command Control Center which will determine if inspection is necessary. Should inspection be deemed necessary, the ephemeris information will be converted into guidance equations which will be inserted into the inertial guidance system of a SAINT vehicle. Launch of the vehicle will be accomplished at an opportune time to insure rendezvous and inspection. The Final Stage Vehicle would be equipped with a TV scanning capability in addition to various sensors to determine the nature of the payload of the target satellite. Early configurations of the SAINT System will consist of a Series "D" ATLAS booster, AGENA "B" second stage and a SAINT Final Stage Vehicle. In the early phase of the program the Final Stage Vehicle is expected to weigh in the neighborhood of 2,000 lbs. Later Final Stage Vehicles, having increased maneuvering capability and additional sensors, would be boosted with the ATLAS/CENTAUR.

Current Program

- The current SAINT Program consists of three phases: (1) Design and Fabrication of a prototype Final Stage Vehicle; (2) continued study toward the definition of an ultimate operational system and (3) the development of Long Lead Time Components.

- The philosophy for development of the prototype vehicle calls for a step-by-step development program with a conservative choice of subsystems and emphasis upon reliability. Ground tests will provide assurance of component compatibility and reliability before flight. In addition to a TV inspection capability, this vehicle will contain a radar seeker, inertial guidance and computer, attitude control, maneuvering propulsion, communications and telemetry subsystems.

- Four flights are planned for the feasibility demonstration with launches programmed from Cape Canaveral. The first flight is scheduled in December of 1962 with the following flights scheduled at three month intervals. In the feasibility demonstration the Final Stage Vehicle will be programmed to rendezvous with an existing satellite if one is available which is suitable for this purpose. If such a satellite is not available a target satellite will be placed in orbit utilizing the 609A system. Rendezvous will be accomplished while under surveillance of the Southeast Africa station and a TV image of the target, in addition to the telemetered data of Final Stage Vehicle performance, will be transmitted to the ground station. The image and data will also be stored and read out on command as the vehicle passes over Cape Canaveral. For the purpose of the feasibility demonstration rendezvous is defined as a closing of the Final Stage Vehicle with the target satellite to within 50 feet and a relative velocity of less than one feet per second. The demonstration program will utilize existing launch, tracking and data reduction facilities insofar as possible. However, some additional ground support equipment will be required at Cape Canaveral and at the Southeast Africa tracking site.

- Continued study toward definition of an ultimate operational system is being pursued simultaneously with the other phases of the program. This effort will distinguish certain long lead type items on which development action must be initiated and provide further refinements to the system. Included are extension of the maneuvering capability of the vehicle into higher orbits and inspections of multiple targets as well as more exotic sensor capability. For example, a sensor capable of detecting a nuclear warhead is most desirable. Effort is currently underway to proceed with the development of such a sensor. Management of this program is based upon the associate contractor structure composed of a First Stage Contractor, Second Stage Contractor, Final Stage Contractor, Payload Contractor and Systems Engineering and Technical Direction Contractor (Aerospace Corporation). Military support is provided by the National Space Surveillance Control Center through the Air Force Command and Control Development Division, and by the 6594th and 6555th Missile Test Wings.

Technical Progress

- A Source Selection Board is currently in session and is evaluating proposals received from invited contractors for the Final Stage Vehicle and for the payload of Phase II, i.e., the feasibility demonstration. It is anticipated that contracts will be definitized before 1 January 1961.

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SPACE

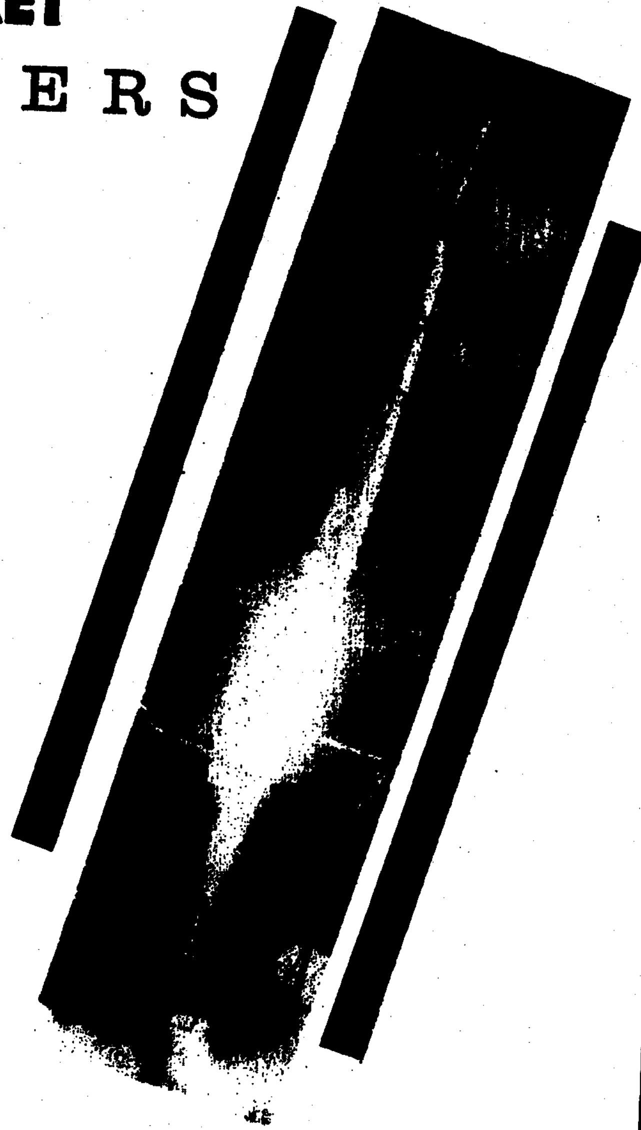
program boosters

SPACE PROGRAM BOOSTERS

SECRET

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.

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THOR

Prime contractor:
Douglas Aircraft Co.

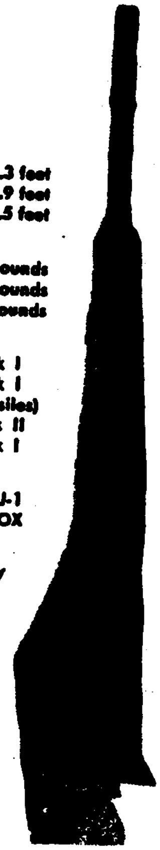
Engine manufacturer:
Rocketdyne Div., North American Aviation

Height	
DM-18	61.3 feet
DM-21	55.9 feet
DM-21A	60.5 feet
Weight (lift-off)	
DM-18	108,000 pounds
DM-21A	108,000 pounds
DM-21	107,720 pounds
Engine	
DM-18	MB-3 Block I
DM-21	MB-3 Block I (only 4 missiles)
	MB-3 Block II
DM-21A	MB-3 Block I
Fuel	
	RJ-1
	LOX

Guidance — Bell Telephone Laboratories or autopilot only

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 (used with an AGENA second stage), 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. The DM-21A, used with the ABLE-STAR second stage, has a larger transition section than DM-18/DM-21 and does not incorporate all the weight changes effective on the DM-21.

ATLAS

Prime contractor:
Convair

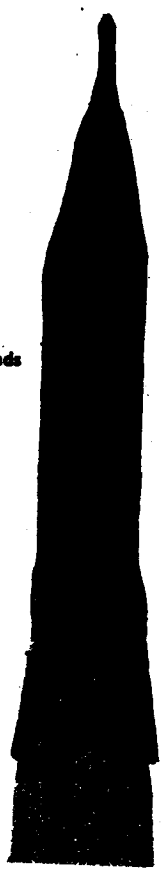
Engine manufacturer:
Rocketdyne Div., North American Aviation

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

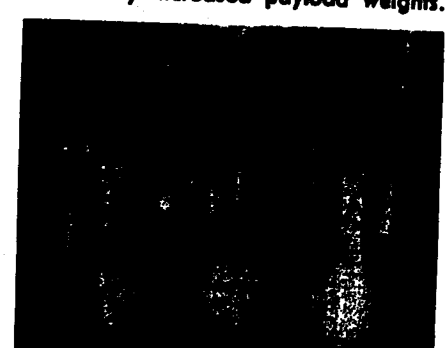
Guidance — Radio-inertial
General Electric (radar)
Burroughs Corp. (computer)

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.



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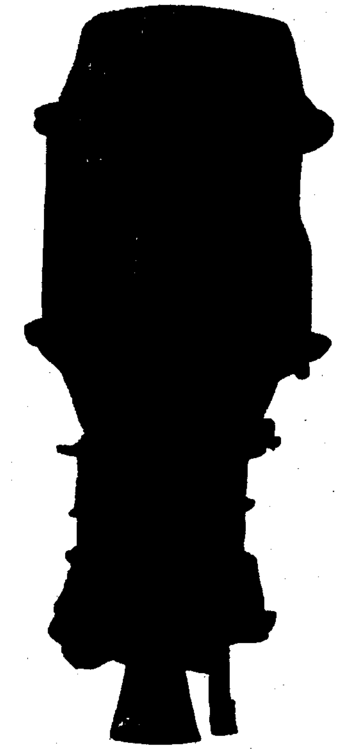
AGENA

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
Unsymmetrical Dimethyl Hydrazine

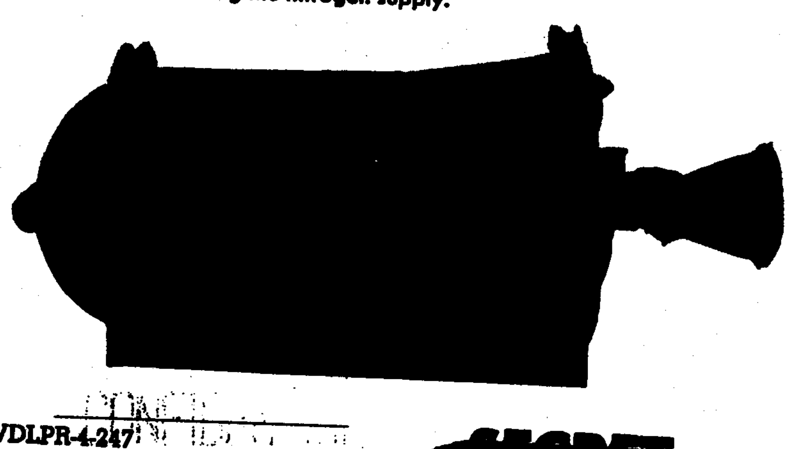
Oxidizer
Inhibited Red Fuming Nitric Acid

Guidance optical-inertial

Used as second stage for:
DISCOVERER
SAMOS
MIDAS
NASA/AGENA "B"

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 hydraulic actuators 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 ABLE Guidance System
Burroughs J-1 Computer

Used as second stage for:
TRANSIT 1B, 2A, 3A, 3B, 4A
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

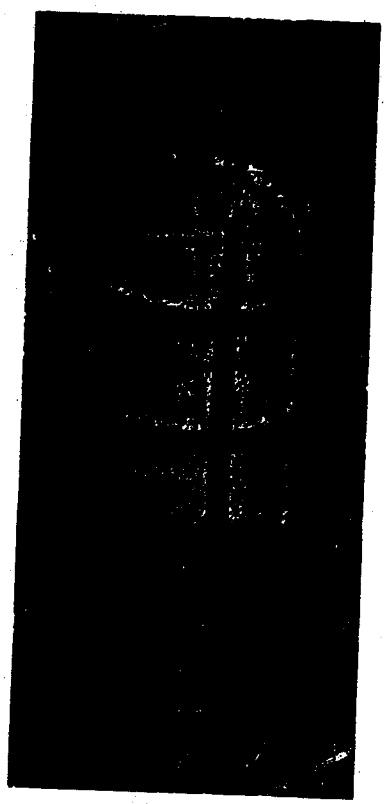
Fuel
Unsymmetrical Dimethyl Hydrazine

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

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



ABL 248 Vehicle

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	C DM-21A
Weight—dry	6,727	6,590	6,950
Fuel	33,500	33,500	33,500
Oxidizer	68,000	68,000	68,000
TOTAL WEIGHT	108,227	108,090	108,450
Thrust-lbs., S.L.	152,000	167,000	152,000
Spec. Imp.-sec., S.L.	247.0	247.8	247.0
Burn Time—sec.	163.0	152.0	163.0

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

FIRST 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.*

AGENA	E "A"	F "B"	G
Engine Model	YLR81-Ba-5	XLR81-Ba7(4)	XLR81-Ba-9(4)
(1)Weight—inert	1,262	1,328	1,346
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
(2)TOTAL 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	240(4)	240(4)

SECOND STAGE

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

SECOND ↔ STAGE — THIRD STAGE

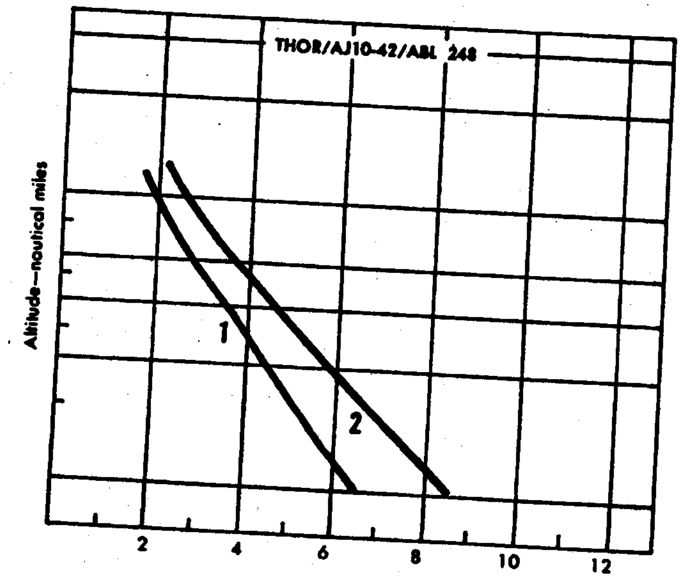
Program Vehicle Combinations

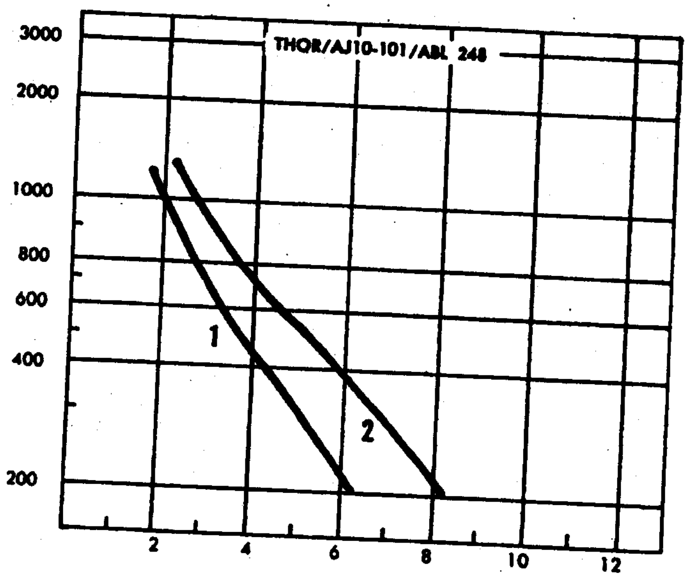
DISCOVERER (1 thru 15) . . . . . . A-E
DISCOVERER (16 thru 19) . . . . . A-F
DISCOVERER (20 and subs) . . . . B-G
COMM. SATELLITE . . . . D-F
COMM. SATELLITE . . . . D-G

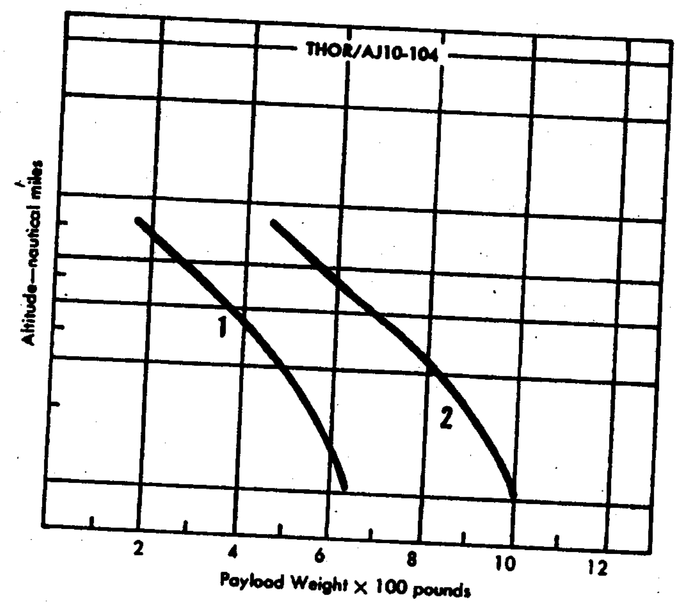
MIDAS (1 and 2) . . . . D-E
MIDAS (3 and subs) . . . . D-G
SAMOS (1 thru 3) . . . . D-E
SAMOS (4 and subs) . . . . D-G
ABLE-1, -3 and -4 . . . . A-J-L

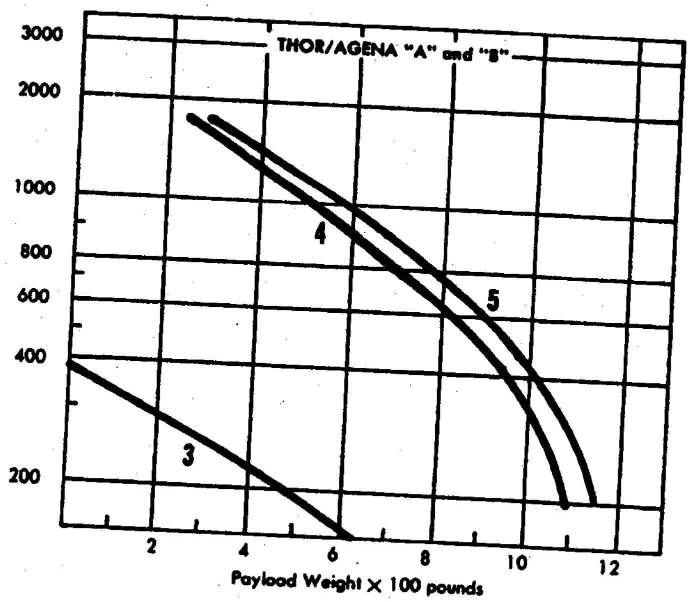
ABLE-4 and -5 . . . . D-J-L
TRANSIT 1A . . . . A-H-L
TRANSIT 1B, 2A, 3A, 3B, 4A . . . C-K
COURIER . . . . C-K
TIROS . . . . A-H-L

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)

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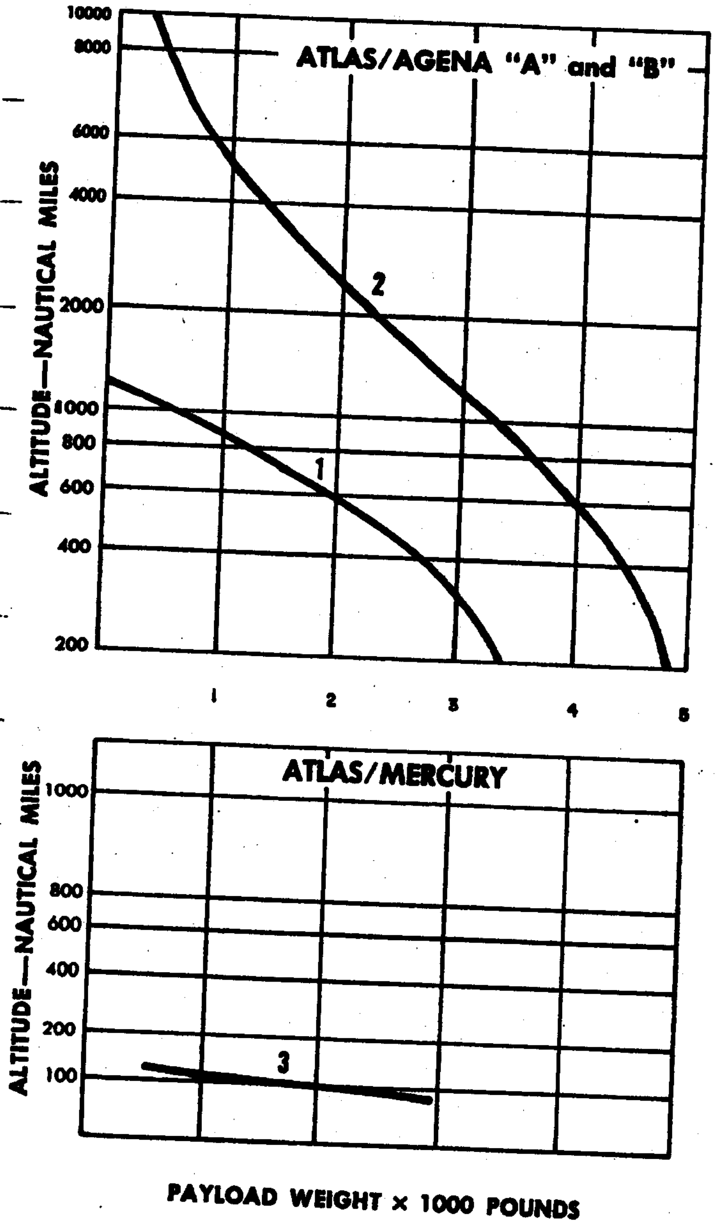
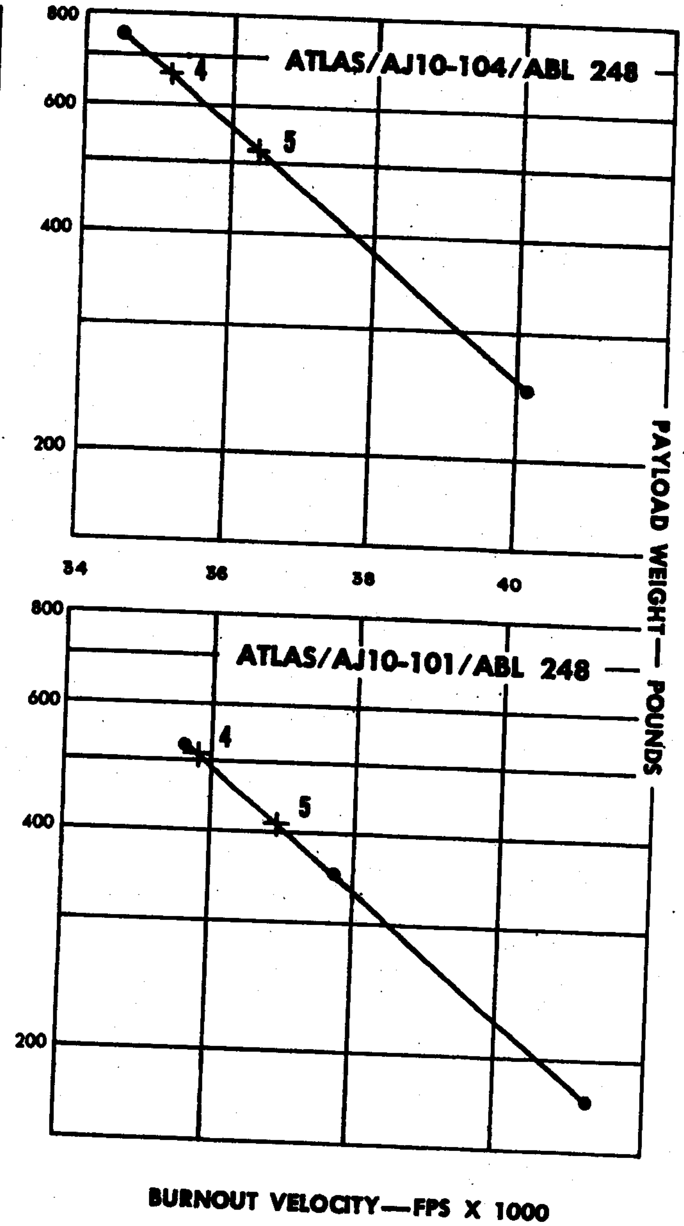
Performance Graphs — ATLAS BOOSTED





1. AGENA "A"— Polar Orbit
2. AGENA "B"— Polar Orbit
3. AMR—90 degrees

4. Lunar Probe
5. Venus Probe

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