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a foreword to...

SPACE

WDAT 60-4744

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

WDLPM-4

17 October 1960

FOREWORD

This report includes information on the three space vehicles launched by the Air Force in September. DISCOVERER XV was launched from Vandenberg Air Force Base on 13 September. At the Atlantic Missile Range a Project 609A Blue Scout, Jr., vehicle was flown on 21 September and the ABLE-5 Lunar Probe vehicle was launched on 25 September. In addition, preliminary flight information is given on the 4 October launch and highly successful orbital performance of COURIER 1B. The SAMOS section has been deleted as of this issue. The program has been placed directly under the Secretary of the Air Force and is no longer an official AFBMD responsibility.

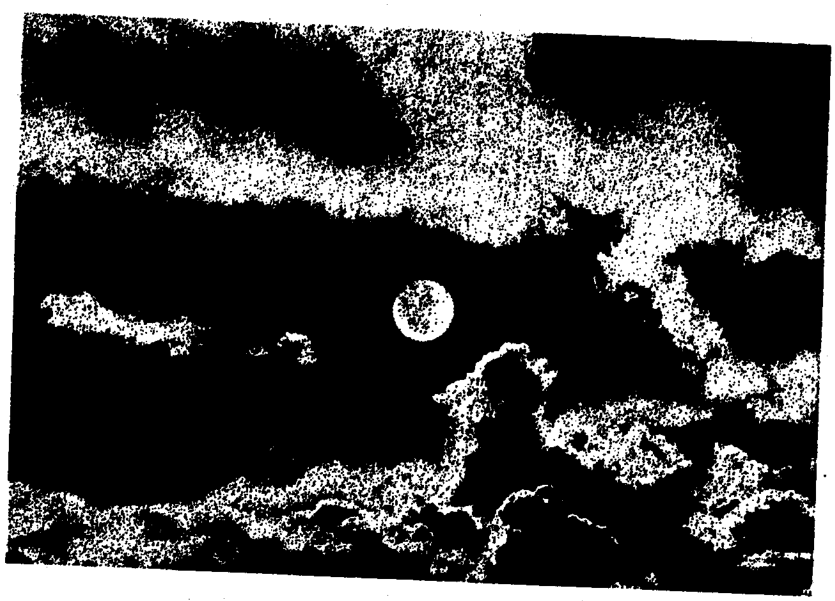
Henry B. Kieburman Jr.
Col USAF

O. J. RITLAND
Major General, USAF
Commander

SECRET

SATELLITE

systems



SATELLITE SYSTEMS

DISCOVERER
MIDAS
ADVENT

Discoverer

The DISCOVERER Program consists of the design, development and flight testing of 37 two-stage vehicles, using the THOR IRBM as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Project's Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

PROGRAM OBJECTIVES

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

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

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

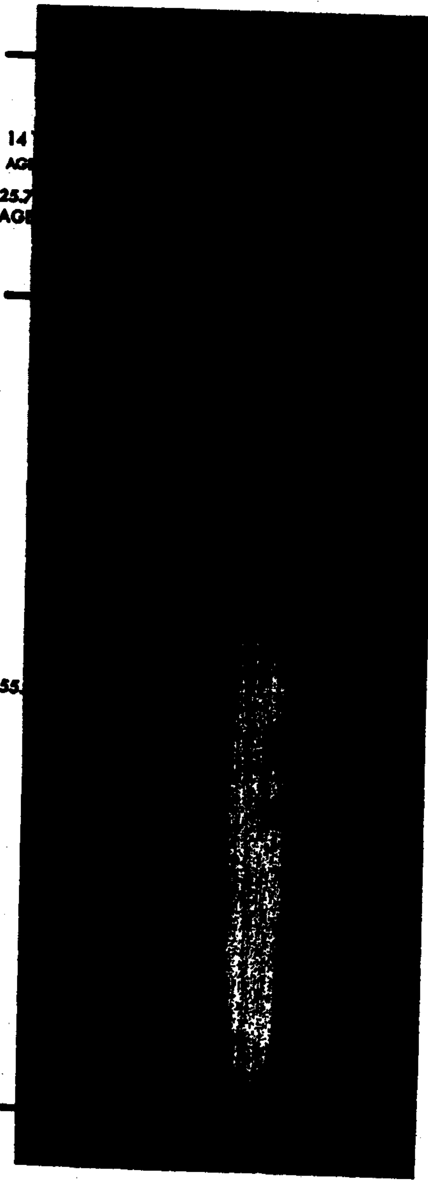
(e) Testing of ground support equipment and development of personnel proficiency.

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

PROGRAM SUMMARY

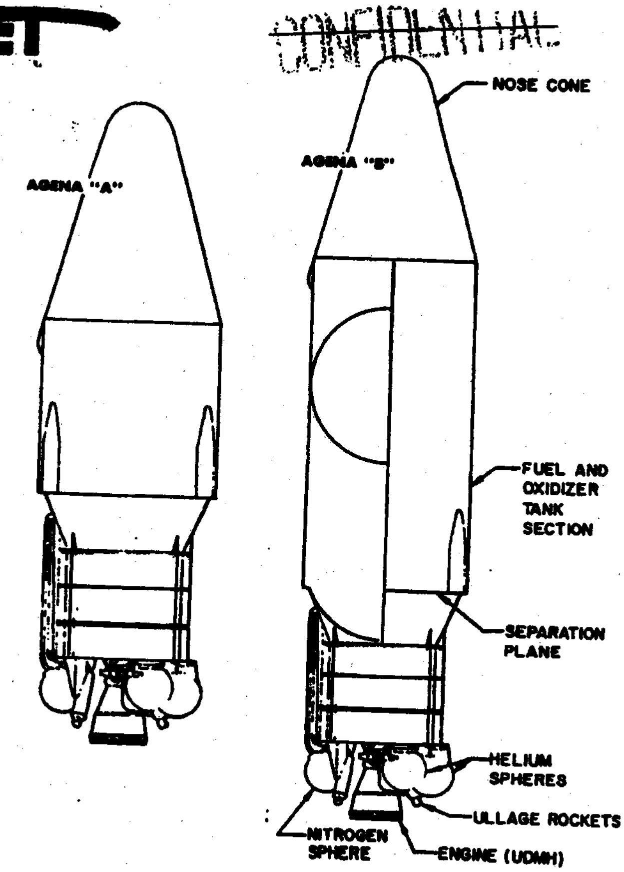
Early launches confirmed vehicle flight and satellite orbit capabilities, developed system reliability, and established ground support, tracking and data acquisition requirements. Later in the program, biomedical and advanced engineering payloads will be flight tested to obtain support data for more advanced space systems programs. DISCOVERER vehicles are launched from Vandenberg Air Force Base, with overall operational control exercised by the Satellite Test Center, 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	167,000
Spec. Imp., sec. (S.L.)		247.8	248.3
Burn Time, sec.		163	148

Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and recovery capability for the payload capsule (Figure 4). An impact area has been established near the Hawaiian Islands, and a recovery force activated. Techniques have been developed for aerial recovery by C-119 aircraft and for sea recovery by Navy surface vessels. The recovery phase of the program has provided advances in re-entry vehicle technology. This information will be used in support of more advanced projects, including the return of a manned satellite from orbit.



FLIGHT VEHICLE

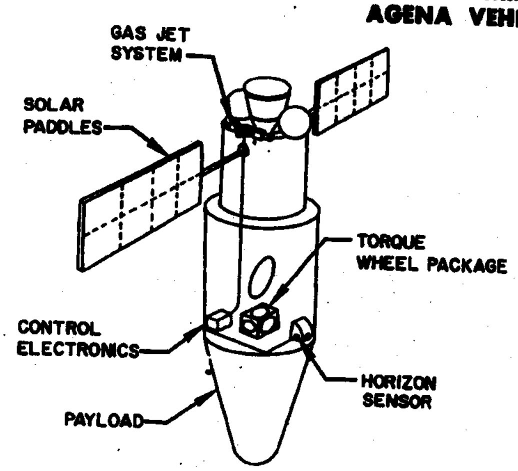
The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page A-5. Specifications for the two THOR configurations and three AGENA configurations used are given on page A-1.

AGENA VEHICLE DEVELOPMENT

The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. Basic design was based on use of the ATLAS ICBM as the first stage. ATLAS trajectory characteristics and the stringent eccentricity requirements of the advanced programs led to the selection of a guidance system suited to achieving orbital injection in a horizontal attitude. As a result, an optical inertial system was developed for vehicle guidance and a gas jet system for orbital attitude control. An urgent need for attaining higher altitude orbits resulted in development of the AGENA "B" versions. The YLR81 Ba-5 version of the LR81-Ba-3 engine (Bell Hustler engine developed for B-58 aircraft) is used on AGENA "A" vehicles. The YLR81-Ba-5 version of this engine was developed to provide increased performance through the use of unsymmetrical di-methyl hydrazine (UDMH) fuel instead of JP-4.

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

SAMOS and MIDAS AGENA VEHICLE

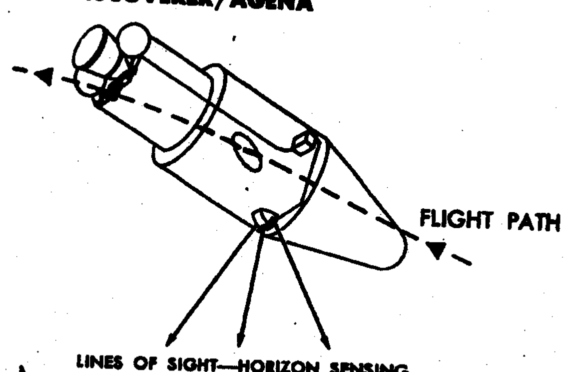


DISCOVERER/AGENA

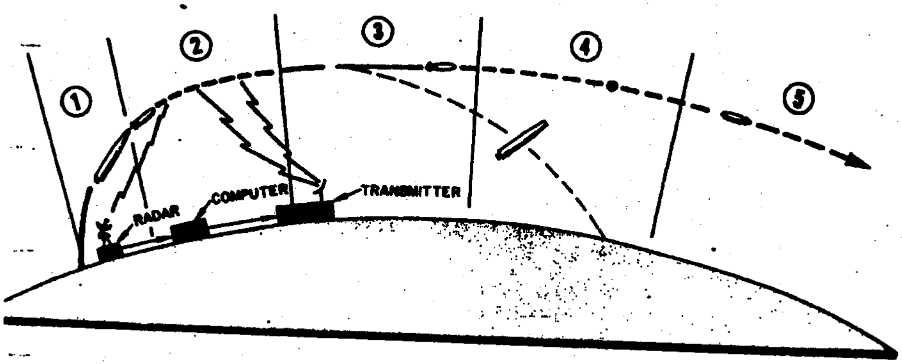
PERFORMANCE CAPABILITIES

ALTITUDE
200–20,000 MILES

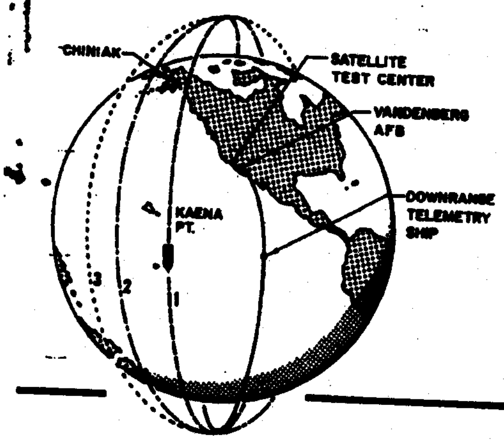
ATTITUDE
ROLL – 0.1 DEGREE
PITCH – 0.1 DEGREE
YAW – 1 DEGREE



Powered Flight Trajectory

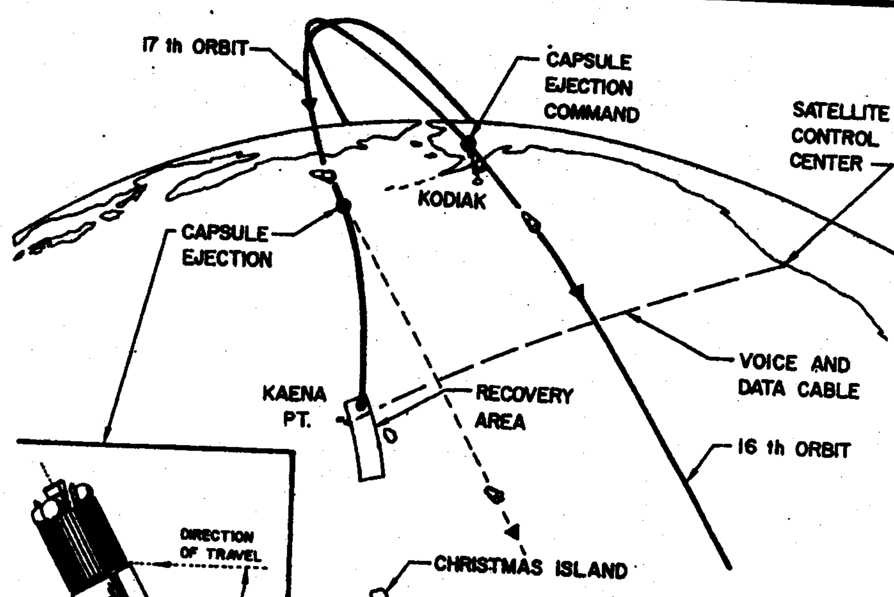


1. **First Stage Powered Flight**—2.5 minutes duration, 78 n.m. downrange, guided by programmed auto pilot.
2. **Coast Period**—2.4 minutes duration, to 380 n.m. downrange; altitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity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



Orbital Trajectory

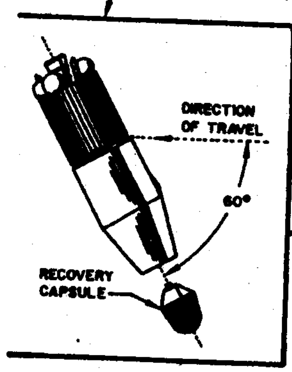
Schematic presentation of orbital trajectory following launch from Vandenberg Air Force Base. Functions performed by each station and a listing of equipment used by each station, is given on page A-4.



CAPSULE RECOVERY SEQUENCE

RECOVERY CAPABILITY

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



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

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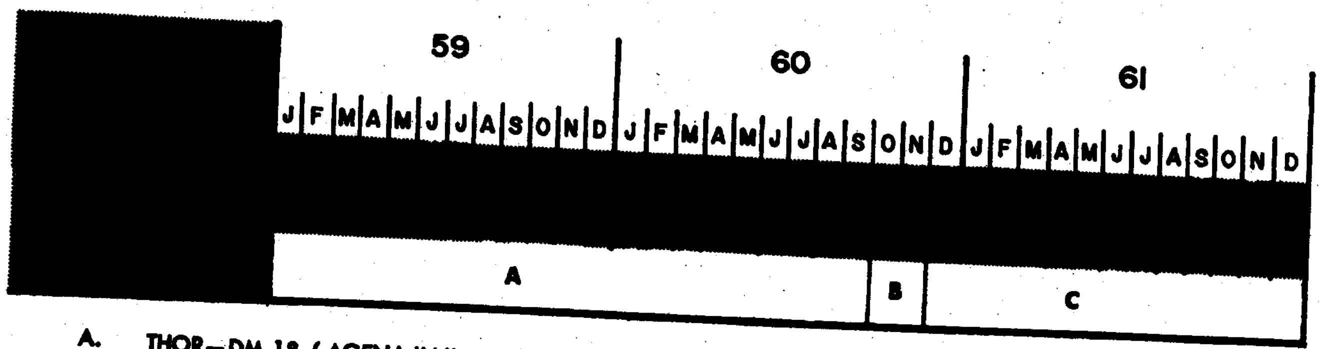
GROUND SUPPORT FACILITIES

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

***Equipment**

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



A. THOR—DM-18 / AGENA "A"

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

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

● Attained orbit successfully.

△ Failed to attain orbit.

Flight History

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

MONTHLY PROGRESS—DISCOVERER Program
Flight Test Progress

DISCOVERER XV

• DISCOVERER XV was launched from Vandenberg Air Force Base at 1515 PDT on 13 September and was successfully injected into polar orbit. Two-thirds of the satellites launched in the DISCOVERER Program have attained orbit. THOR booster trajectory was satisfactory; AGENA performance was nominal. Propellant exhaustion caused shutdown, rather than integrator command. A comparison of programmed and actual orbital parameters is shown in Table I.

PARAMETER	NOMINAL	ACTUAL
Azimuth, degree	172.0	175.2
Perigee, statute miles	120	129
Apogee, statute miles	410	478
Injection Angle	0	−0.2
Eccentricity	0.0371	0.04
Period, minutes	93.44	94.2

TABLE I. DISCOVERER XV Programmed Orbital Parameters

• Data received on the first pass over Kodiak and Hawaii indicated that the satellite was stable and in correct attitude but that control gas consumption was excessive. The capsule was ejected on the 17th orbit but, because of a loss of control gas, the pitch-down prior to ejection was not accomplished. As a result, the capsule impacted about 1,000 miles south of the impact point predicted prior to capsule ejection. Subsequent analysis indicates that the roll rate gyro was not properly restraining the rate of satellite roll movements to the proper frequency. This caused the satellite to roll between limits faster than normal and resulted in higher than normal control gas expenditure.

• The capsule descent was tracked by the Hawaiian tracking station until re-entry; a computer run of this data resulted in a revised impact point prediction. Aircraft and the recovery ship "Dalton Victory" were dispatched to the impact area. The first aircraft to reach the area located the capsule by radio beacon at 2105 PDT and a second aircraft sighted it thirty minutes later. Marker beacons, strobe lights, smoke bombs and aluminum dye were dropped to mark the area. On the morning of the 15th, a Coast Guard amphibian arrived but did not land because of rough seas. Because of deteriorating weather and sea conditions, a plan to drop parachutists and a raft was abandoned.

• At 1115 PDT on 15 September electronic contact was lost. Fifteen minutes later, the aircraft lost sight of the capsule which was then listing and riding low in the water. The capsule was not seen again although the search continued throughout 15 and 16 September.

DISCOVERER XVI

• DISCOVERER XVI is scheduled for launch from Vandenberg Air Force Base in October. This will be the first AGENA "B" vehicle to be launched. Vehicle subsystem and system checks were completed during September and the vehicle has been installed on the launch pad. The AGENA "B" is an improved version of the AGENA "A" containing integral propellant tanks which form part of the satellite skin and having double the propellant capacity.

• The increased payload capability of the AGENA "B" will permit use of extra batteries and control gas required for two, three and four day intervals between launch and capsule recovery. The recoverable payload is similar to those flown on DISCOVERER XIV and XV. The ascent parameters for AGENA "B" DISCOVERER satellites are markedly different from previous DISCOVERER vehicles. A comparison of predicted parameters for DISCOVERER XV and DISCOVERER XVI are shown in Table II.

	DISCOVERER XV (AGENA "A")	DISCOVERER XVI (AGENA "B")
ASCENT PARAMETERS		
THOR Burnout Time, seconds from liftoff	163	163
THOR Velocity at Burnout, fps	13,660	10,610
AGENA Ignition Time, seconds from liftoff	269	237
AGENA Burn Time, seconds	117	240
Injection Velocity, fps	26,032	25,964
ORBITAL PARAMETERS		
Apogee, statute miles	410	426
Perigee, statute miles	120	130
Eccentricity	0.0371	0.035
Inclination Angle, degree	79.63	81.83
Period, minutes	93.44	93.5

TABLE II. Comparison of Ascent and Orbital Parameters for AGENA "A" and AGENA "B" Satellites

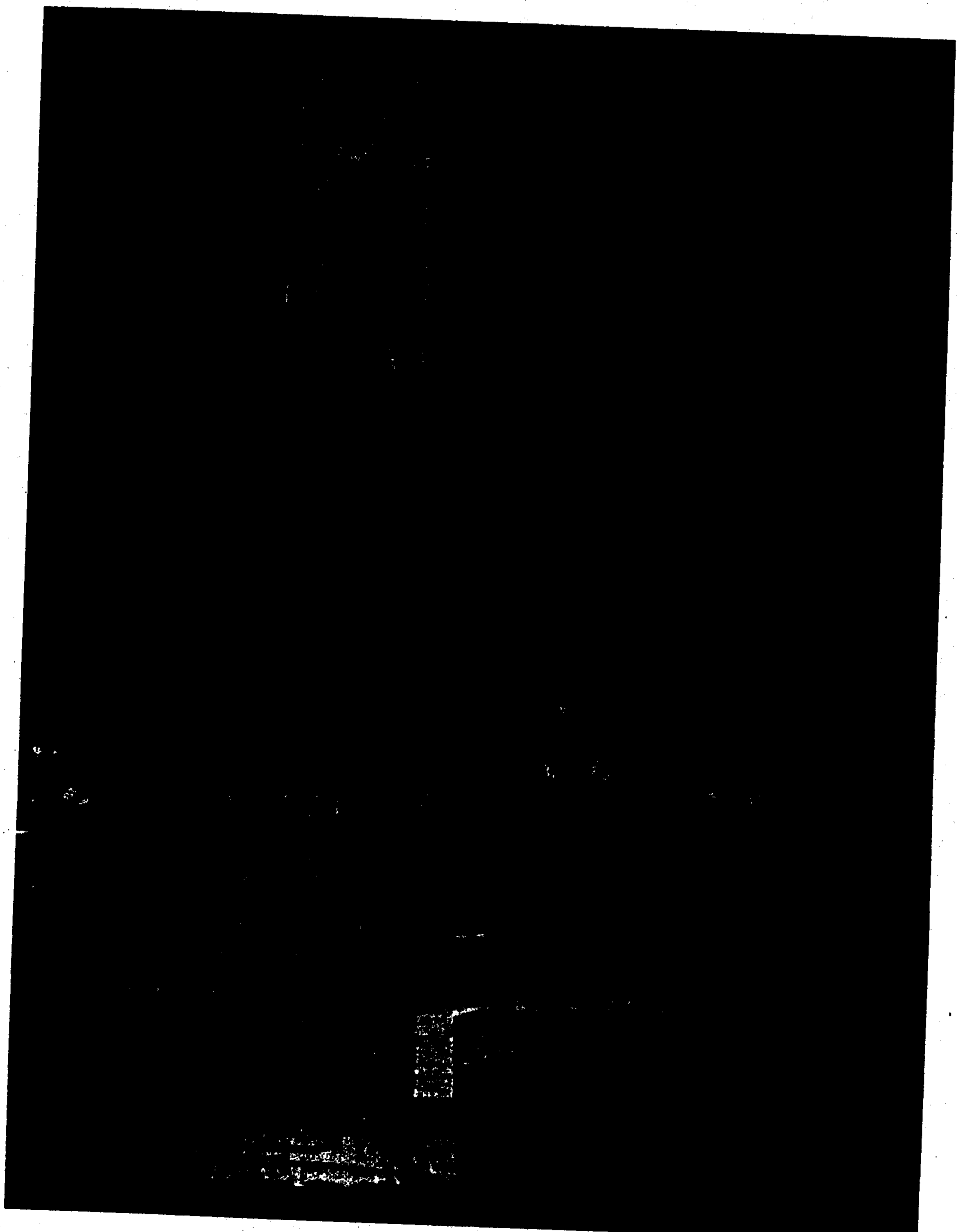


Figure 1. DISCOVERER XV prior to launch on 13 September. The transporter shown in front of the THOR booster is lowered for launch. The missile shelter is shown in the right background. The two nitrogen storage trailers and the hydro-pneumatic trailer are shown on the right.

Technical Progress

Second Stage Vehicles

- The results of an investigation into system and equipment performance on DISCOVERER XV were presented on 20 September. The presentation included analysis of the various problem areas encountered; action taken to improve test procedures, inspections and equipment specifications; and action to incorporate improvements in DISCOVERER XVI.

- The XLR-81Ba-9 engine (serial No. 307) was fitted with a new thrust chamber and subjected to a full duration calibration run. The 240 second firing was completed without appreciable nozzle throat erosion, using a titanium uncooled extension which had previously completed a five day humidity test. The nozzle extension was in excellent condition following the firing. This test completed the Preliminary Flight Rating Test for this engine which is now being prepared for re-acceptance inspection prior to shipment to Arnold Engineering Development Center for reliability testing.

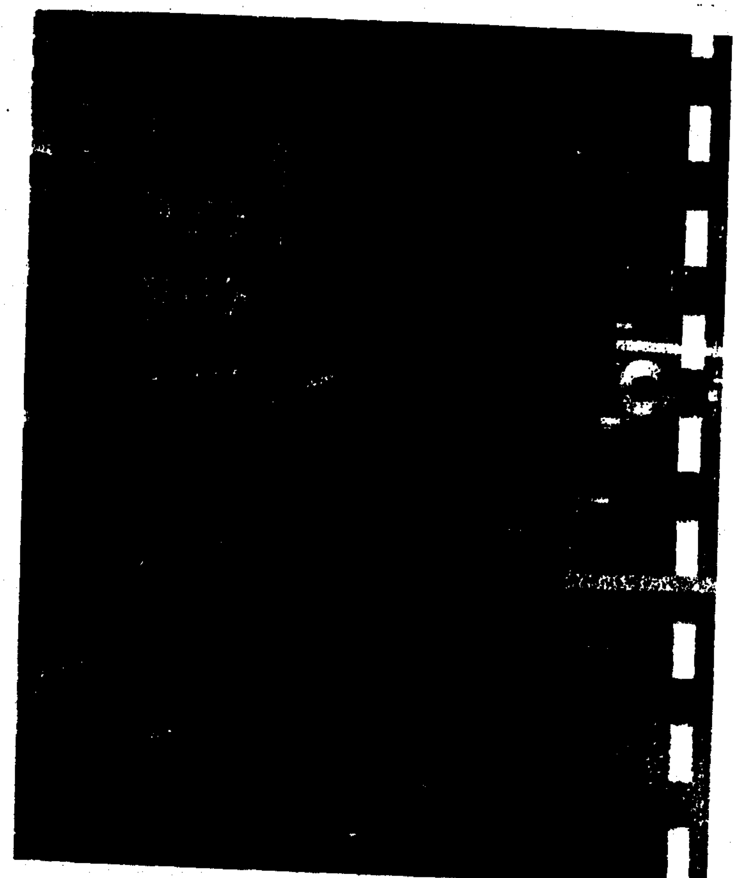
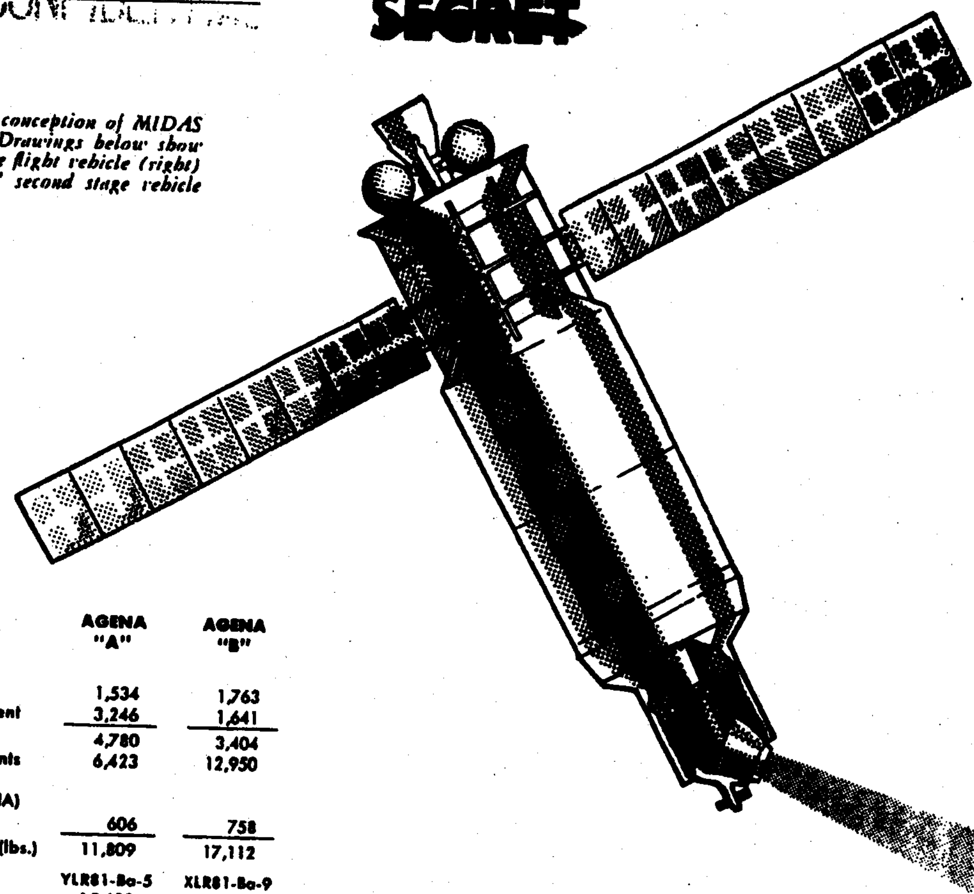


Figure 2. Air Force technicians adjusting electronic checkout equipment during flight control checkout of an AGENA vehicle. This activity is taking place in the Vandenberg Air Force Base missile assembly building.

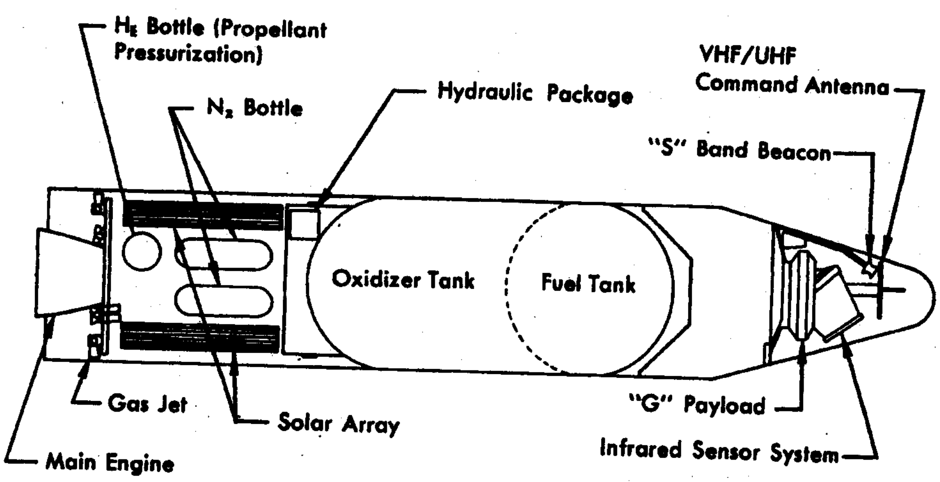
Figure 3. Change-over from AGENA "A" to AGENA "B" in the missile assembly building at Vandenberg Air Force Base. The AGENA "A", on the right, is DISCOVERER XV which was launched on 13 September. One more AGENA "A" remains to be flown. On the left is the AGENA "B" vehicle scheduled for launch in October as DISCOVERER XVI.

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



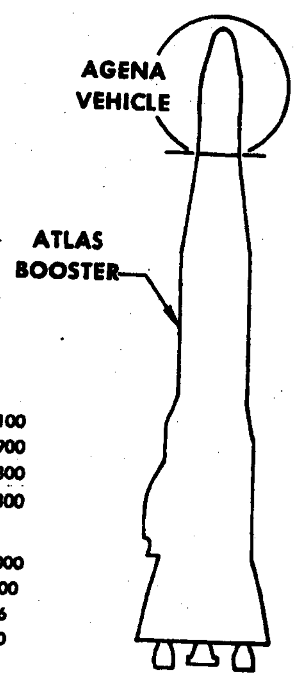
M i d a s

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



MIDAS, Configuration II, AGENA "B" Satellite

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



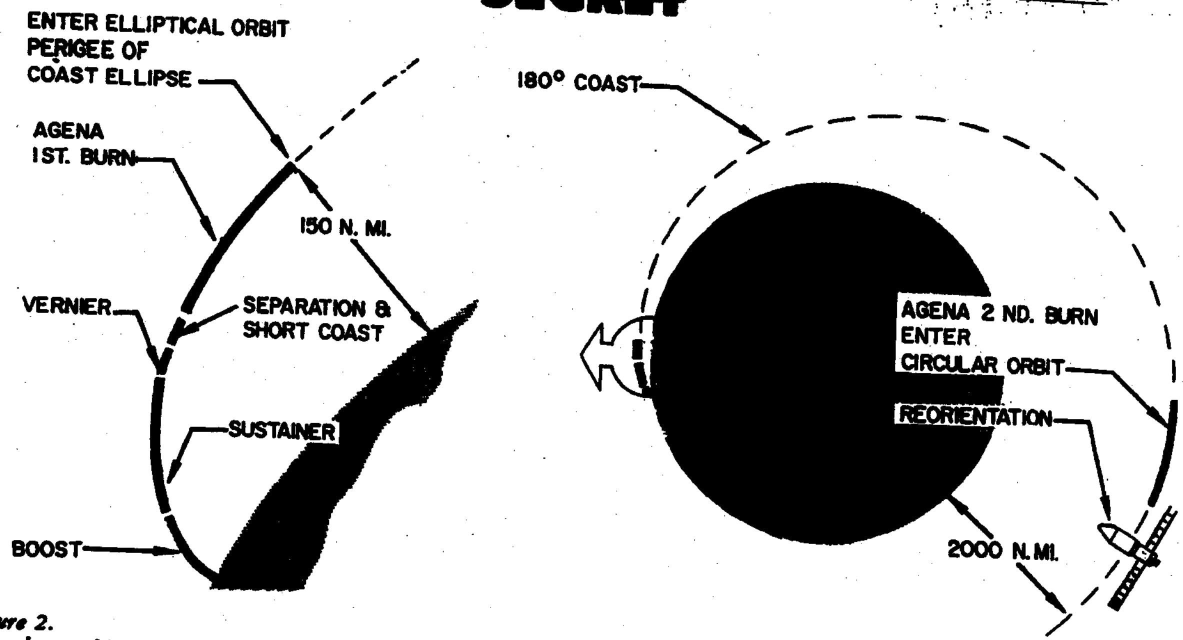


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. From boost through separation guidance and control is provided by the ATLAS radio inertial system. The AGENA inertial guidance system, with horizon scanner, provides attitude, velocity and directional control to establish the orbit and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

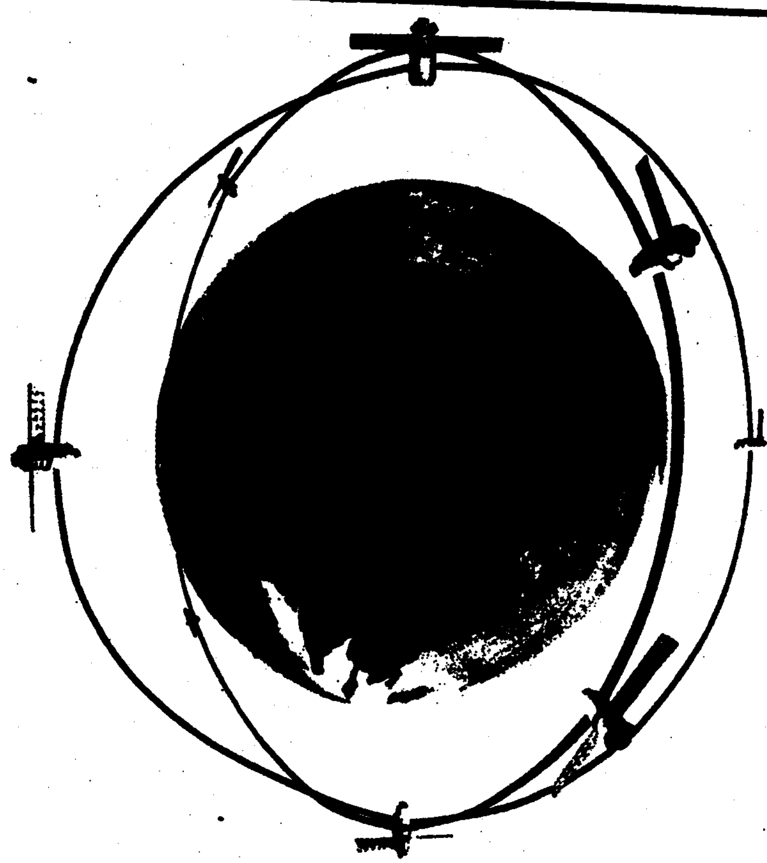
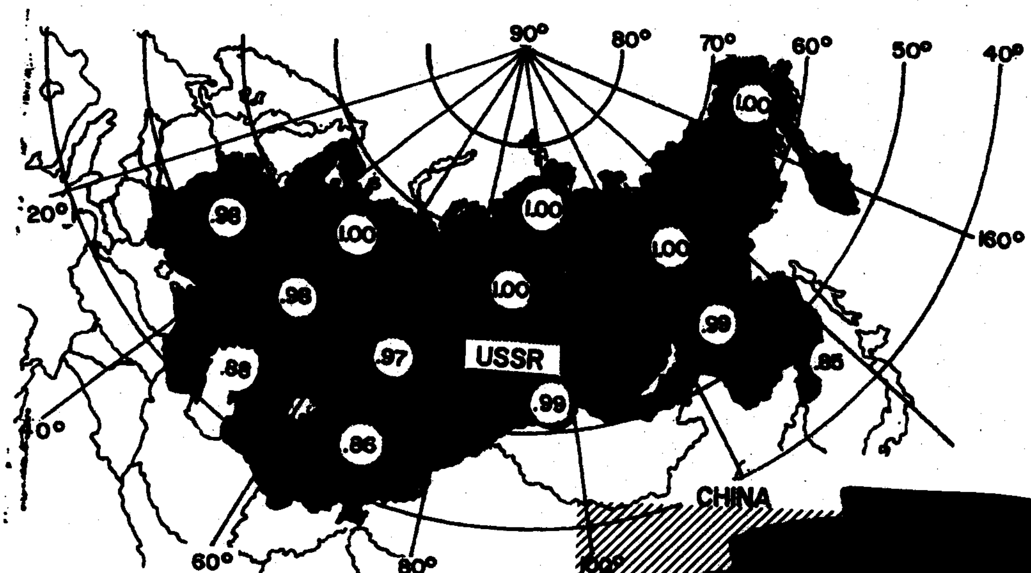


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

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



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

[redacted]

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

[redacted]

TECHNICAL HISTORY

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

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

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

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

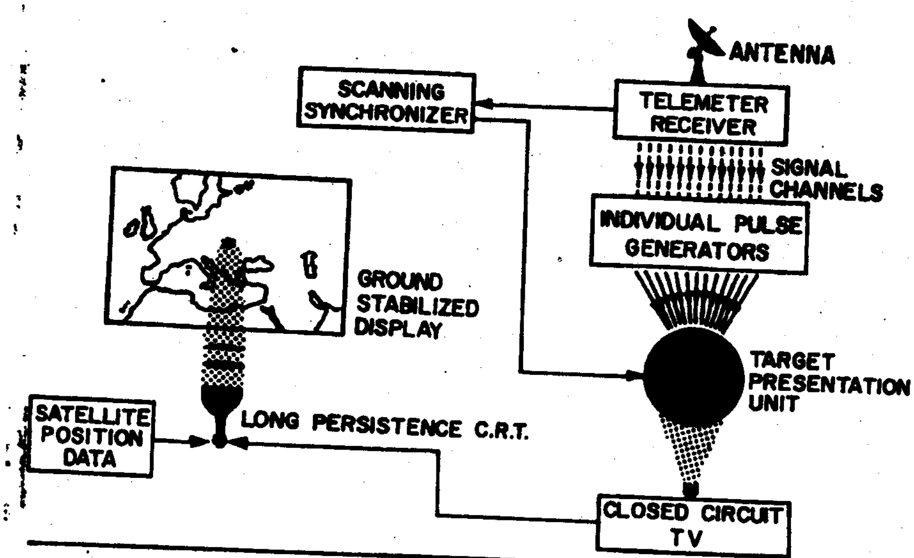
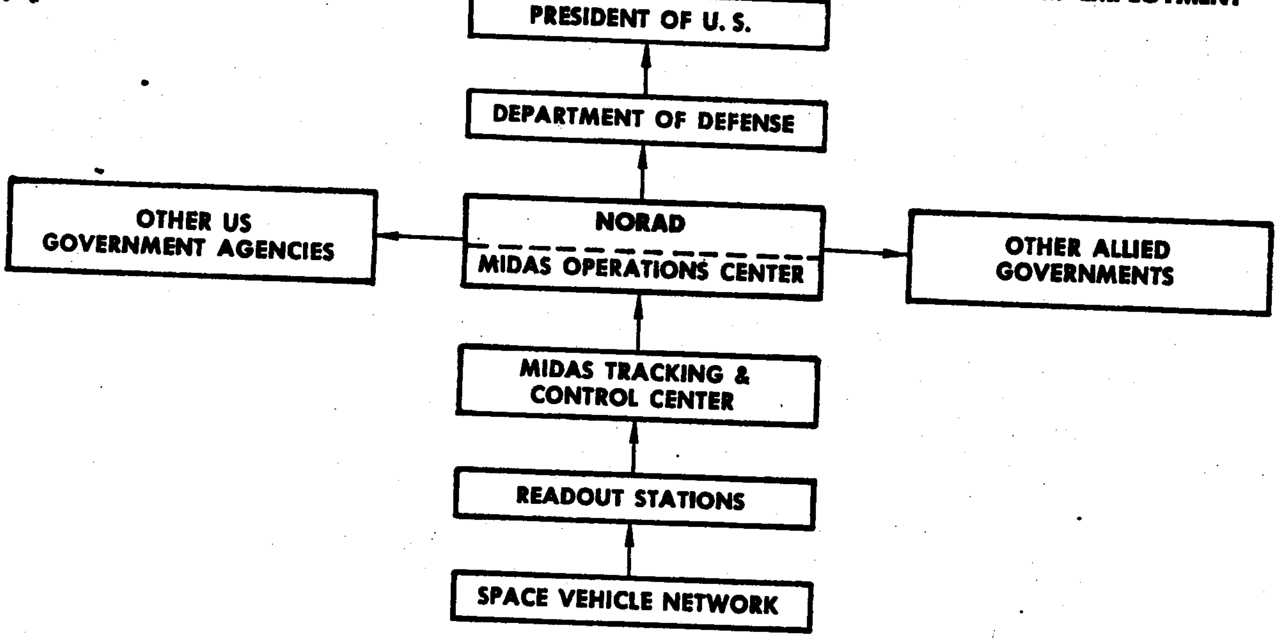


Figure 5.
Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies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

MIDAS ALARM EMPLOYMENT



CONCEPT

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

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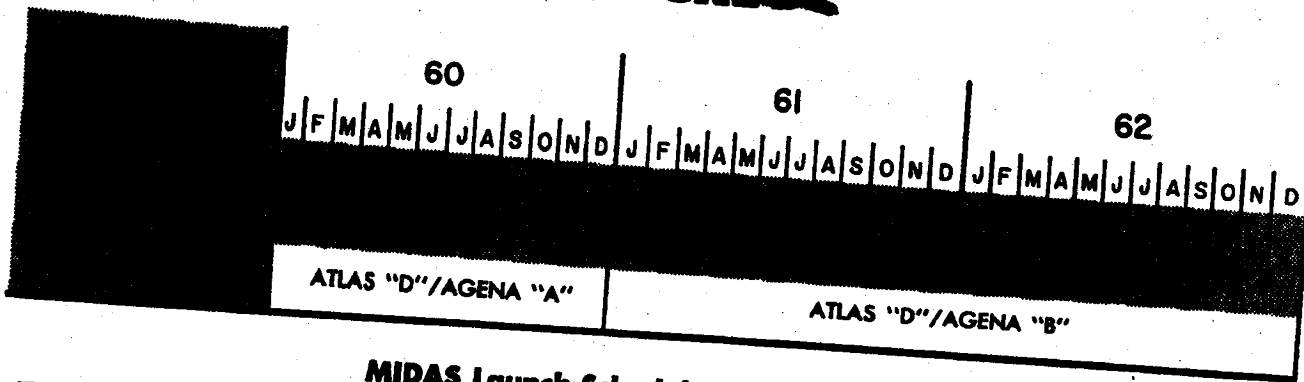


MIDAS Launch Schedule

Facility	*Equipment**	*Flight Function*
Satellite Test Center	ABC	Operations control center of the system during the R&D program. Directs tracking station operations, controls satellite programming and communication system utilization. Receives and stores key vehicle and station data, determines vehicles ephemerides and generates acquisition and tracking data to tracking stations. Analyzes systems operation and telemetry and payload data.
Vandenberg Air Force Base (tracking and data acquisition station)	ABCEFGHIJKLMPTU	Provides launch and ascent tracking, receives and records telemetry data and trajectory measurements. Gathers payload data, telemetry and tracking data and transmits this data to the Satellite Test Center.
Telemetry ships	IKMS	Ascent tracking and telemetry data reception through AGENA first burn period.
Vandenberg AFB	NO	Provides ground radio guidance system for booster guidance during the launch phase.
Northeast Station (New Boston, New Hampshire)	CDEFHMPQR	Provides orbital tracking. Gathers payload data, telemetry and tracking data and transmits this data to the Satellite Test Center.
Southeast Africa Station	JKM	To receive and record telemetry data and provide limited tracking during the AGENA second burn period.
Kaena Point, Oahu, Hawaii	HIKLMTU	Gathers supplemental Verlort tracking data during orbital passes.
Kodiak, Alaska	HIKLMTU	Gathers supplemental Verlort tracking data during orbital passes.
Point Mugu	HI	Ascent tracking for range safety; backup function.
Point Arguello	V	Mates vehicles, performs final system checkout, prepares vehicle for launch and launches vehicle.

**Equipment*

A. Model 1604 Computer
B. Ground Presentation Equipment
C. Data Distribution Equipment (PICE)
D. Data Conversion Equipment
E. UHF Tracking Equipment
F. UHF Telemetry and Data Acquisition Equipment
G. UHF Command Antenna
H. VERLORT (Mod II) Radar
I. Tri-helix Antenna
J. TLM-18 Telemetry Antenna
K. Telemetry Receiving and Recording Equipment
L. Plot Boards for Radar and TLM-18 Tracking Data
M. Doppler Data Gathering Equipment
N. AN/GQR-2 (XXA-2) Tracking and Monopulse Radar
O. AN/GRS-2 (XAA-2) Rate Measuring System
P. Timing (WWV) Equipment
Q. VHF FM/FM Data Acquisition Equipment
R. VHF PAM/FM Data Acquisition Equipment
S. High Frequency Radio Communications and Teletype Circuits
T. Acquisition Programmer for pre-acquisition Direction of Antennas
U. Conversion Equipment for Teletype Transmission of Radar, TLM-18 and Doppler Tracking Data in Binary Format
V. Complete Launch Facilities

GROUND SUPPORT FACILITIES

MONTHLY PROGRESS—MIDAS Program

Program Administration

- As a result of recent investigations by Space Technology Laboratories on the significance of the high energy tail of Van Allen protons, and their potential effect on long-life satellites, Lockheed has been requested to develop special instrumentation to be carried on MIDAS flights. Contrary to the present theory that the damage cross section is inversely proportional to energy, evidence has been found that solar photovoltaic cells may be degraded at a much higher rate by high energy protons, e.g., 700 MEV. A comprehensive program has been initiated to determine the sensitivity of selected components to high energy proton radiation and to determine the quantitative and qualitative characteristics of the Van Allen radiation at MIDAS flight altitudes.

Flight Test Progress

- The vehicle for the third MIDAS flight is currently in the systems test phase of checkout. This is the first MIDAS vehicle to have restart capability. Because of problems which developed in the horizon sensor and related checkout equipment, this vehicle is behind schedule. Based on delivery of a reworked horizon sensor on 15 October, it is scheduled to complete the systems test phase on 12 December. The scheduled launch date for this flight remains 28 February 1961.

Technical Progress

Second Stage Vehicles

- Assembly of the AGENA "B" vehicles for the fourth and fifth MIDAS flights is proceeding on schedule. The vehicle scheduled for the fourth MIDAS flight is now in final assembly.

Infrared Scanner Units

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

- The infrared detector payload scheduled to be carried on the third MIDAS flight has been delivered. Acceptance testing of this payload will be completed in early October. The second flight payload is scheduled for delivery on 15 October. Two more payloads, one for backup purposes, remain to be delivered.

- Temperature profile tests of the engineering test model of the Baird-Atomic configuration are in progress in the High Altitude Temperature Simulation Chamber.

Ground Support Equipment

- Delivery of the initial Baird-Atomic ground infrared data display equipment is scheduled for 15

Figure 6. A background radiometer of the type to be carried on DISCOVERER flights RM-1 and RM-2. The primary function of these flights will be to provide background radiation data for use in future MIDAS flights. The nitrogen spheres are part of the nitrogen-gas cooling system which cools the sensitive elements of the radiometer.

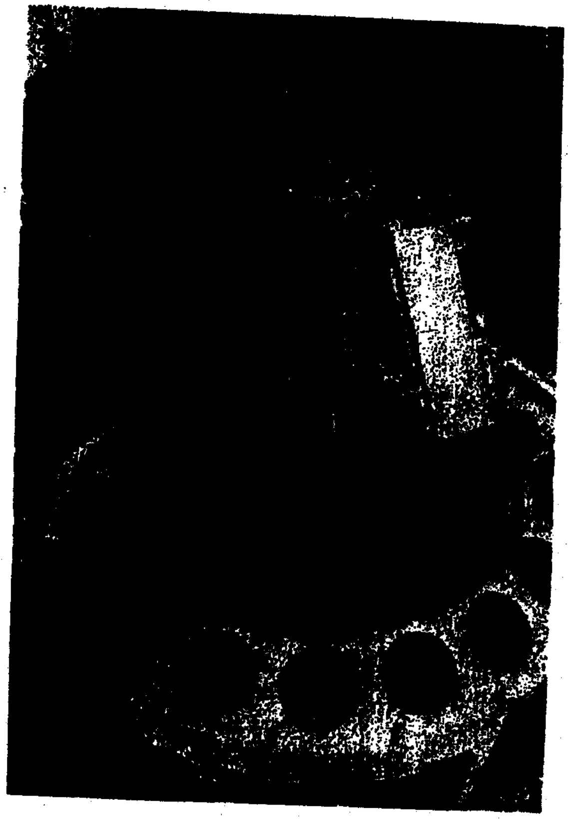
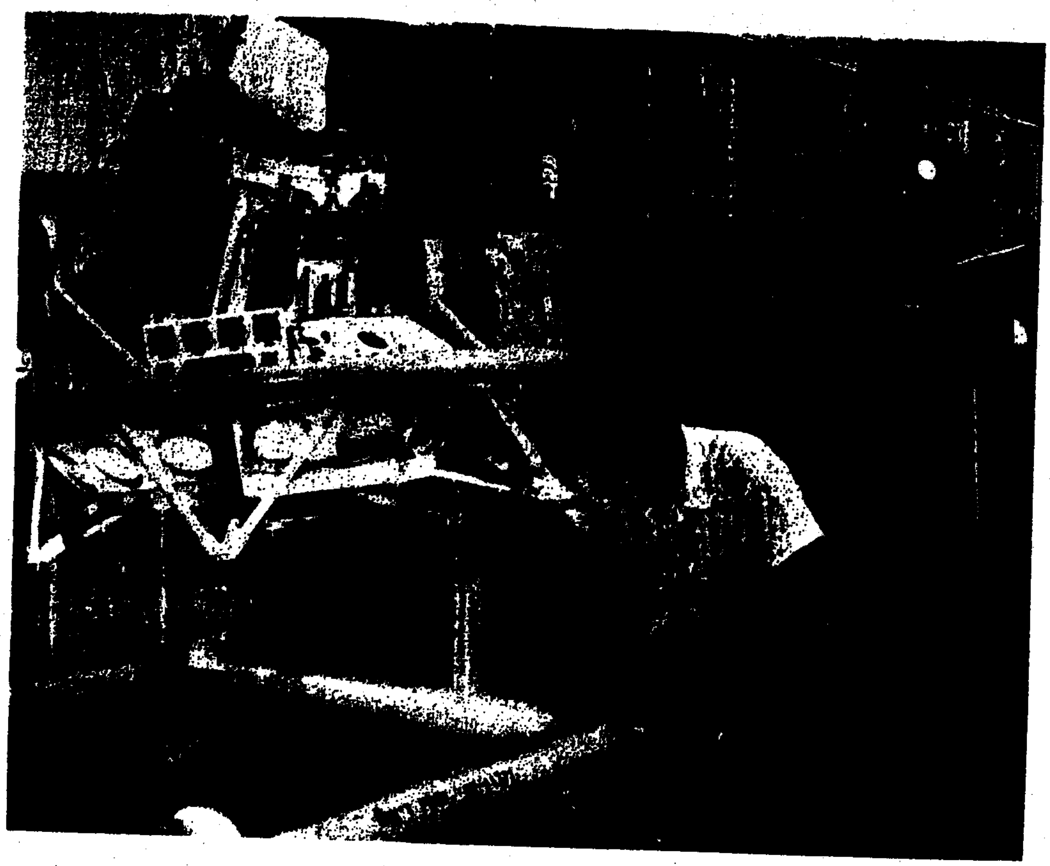


Figure 7. The Baird Atomic, Inc., infrared detector payload during checkout at the Lockheed Sunnyvale facility. This payload will be carried on the third MIDAS flight which is currently scheduled for February 1961. The payload checkout equipment is contained in the equipment racks shown on the background.



October. This equipment will be installed in the Satellite Test Center; a second unit will be installed in the Vandenberg Air Force Base Tracking station. The late delivery of the equipment for the Satellite Test Center will not affect the scheduled activation date. Some revision of the integration activity will be required; however, this will not affect the MIDAS launch schedule. Delays in delivering the second unit of ground station equipment, however, will cause some slippage in the Vandenberg Air Force Base tracking station activation date for support of MIDAS flights.

Facilities

- A detailed evaluation of launch pad requirements for the MIDAS operational phase has been accomplished. This study indicates the need for a three-pad launch complex during the establishment of the operational network, and a requirement for from two-to-three pads for maintaining the MIDAS satellite network once the buildup phase has been completed.

- Final acceptance of North Pacific station technical facilities at Donnelly Flats, Alaska, was accomplished on 29 September. The heated vehicle storage building at Fort Greely is scheduled for completion on 31 October. Completion of the combined dormitory and dining hall facility, except for exterior area grading, will be completed on 30 December. The Donnelly Dome microwave relay station is scheduled for completion on 15 December. Beneficial occupancy of the remaining North Pacific communications stations is programmed for 1 January 1961.

[redacted]

- All New Boston station support facilities located on Grenier Field, New Hampshire, were completed and accepted during the report period. Support facilities on the New Boston station are on schedule. Design of the data acquisition and processing building modification has been completed and a construction contract is presently being negotiated. Completion is scheduled on an incremental basis with final completion scheduled for 1 January 1961.

Figure 8. Over-all view of the MIDAS ground equipment currently installed in the Satellite Test Center. The drawer pulled out houses the oscillograph equipment. The equipment racks in the rear house the tape recorder installation.

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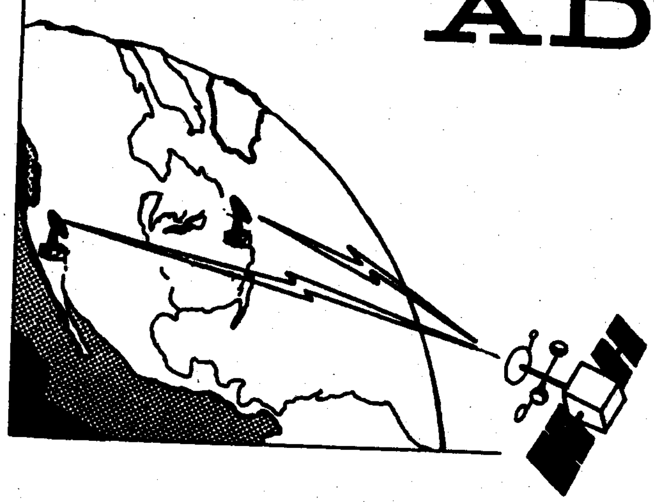
ADVENT



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.

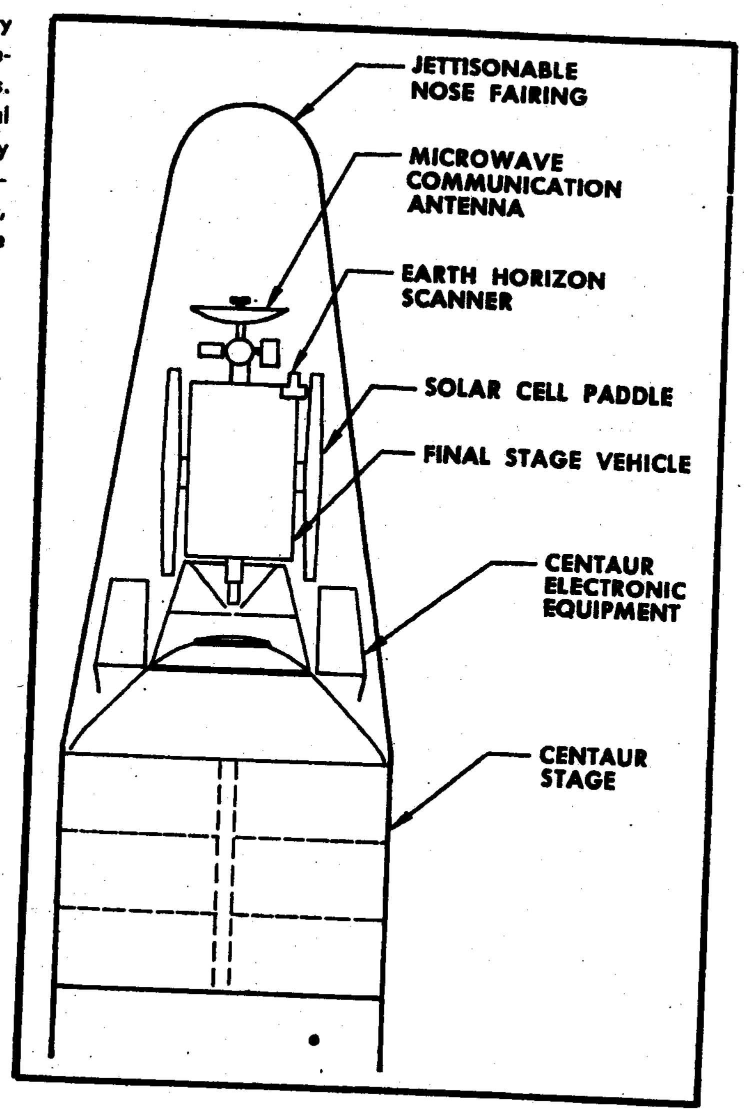


Figure 1. Proposed satellite with jettisonable fairing mounted on CENTAUR second stage.

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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.

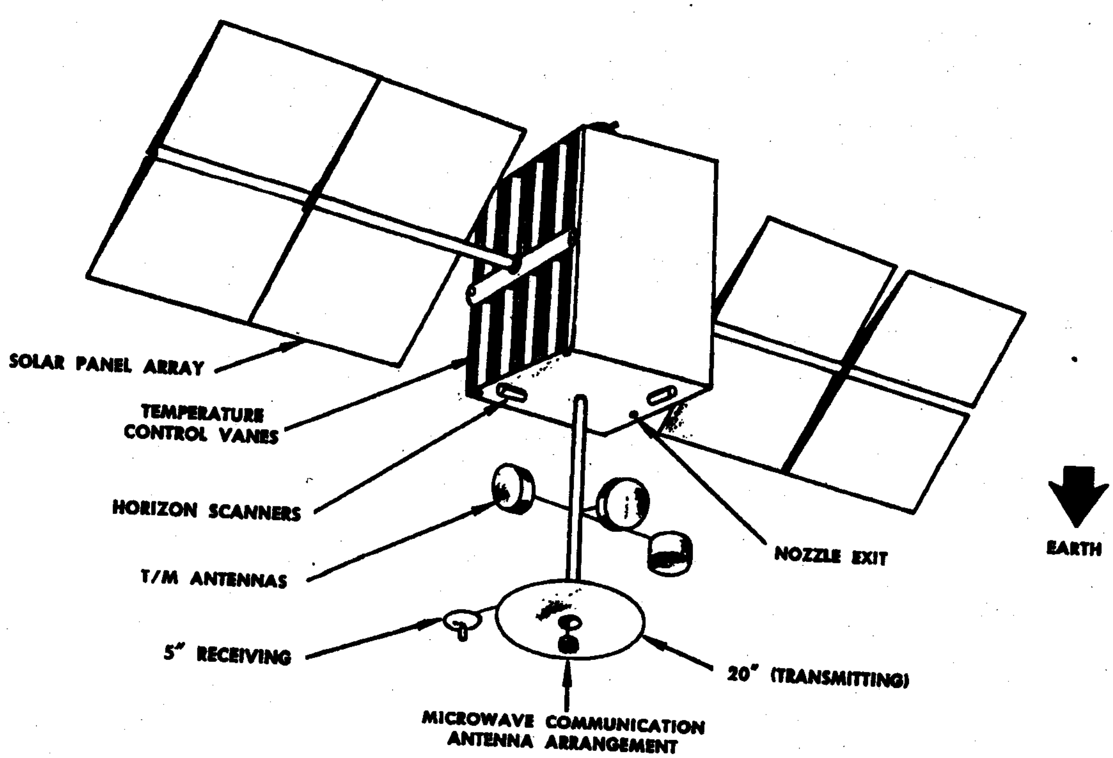

Figure 2. Initial design of final stage vehicle.

[redacted]

62												63												64					
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

[redacted]

ARMY	NASA	ARMY
ATLAS/AGENA "B"	ATLAS/CENTAUR	

ADVENT Launch Schedule

MONTHLY PROGRESS — ADVENT

Program Administration

The Secretary of Defense, by memorandum dated 15 September, assigned over-all management responsibility for the ADVENT Program to the Department of the Army. FY 1961 funds in the amount of $19,108,900, previously allocated under Amendments No. 9 and 10 to ARPA Order No. 54, have been withdrawn by ARPA in connection with the transfer of the program management to the Department of the Army.

Technical Progress

Communications Equipment

• Sylvania Electric Products submitted the design plan for the 60-foot automatic tracking antenna system for the ground terminal equipment. Approval of the plan, now being reviewed by Signal Corps Engineers, is expected during October.

• Technical coordination meetings have been held with the microwave communications equipment contractor for both the satellite and ground terminals. Consideration was given to ADVENT system design and system problems, satellite subsystem design and ground communications subsystem layout. The scope of the design plan to be submitted on 15 October was defined. It is the intent of USASRDL to work with the contractor on the plan so that rapid approval will be possible. A subcontract with Magnavox was approved for development of the sequence generator in connection with the anti-jamming equipment. Meetings have been held with Bendix, Sylvania and General Electric to discuss thermal and RF interferences.

• Contractual negotiations with Varian Associates for development of a high power, X-band, Klystron tube have been completed.

• Internal laboratory work is being continued to verify stage-by-stage and total chain performance of a proposed satellite borne design for the microwave communications equipment. An experimental, solid state, parametric configuration of an output mixer and low noise IF input stage has been developed as a possible replacement for the vacuum tube triode mixer. Tests indicate that this circuit possesses more than ample bandwidth, sufficient gain to drive a planar triode output stage and also provides hard limiting. An experimental model of a complete satellite repeater chain, meeting the requirements of bandwidth and sensitivities, has been tested. Work has begun on a laboratory set-up for determining some of the effects of jamming signals on repeater operation in terms of phase distortion and intermodulation products. Specific investigations of circuitry and component application have been initiated as a result of discussions with Bendix in connection with the design plan.

• Formal ARPA approval has been received for the selection of Fort Dix, New Jersey, and Camp Roberts, California, as the East and West Coast ground station sites for ADVENT. Soil borings have been completed at Fort Dix and will begin shortly on the West Coast.

Launch Vehicles

• The ATLAS/AGENA "B" Stage I and II work statements were approved by ARPA with qualifications stated in Amendment No. 10, dated 22 August, to ARPA Order No. 54. On the basis of work statements incorporating revisions directed by ARPA, a Purchase Request in the amount of $1.0 million was initiated for initial funding of three ATLAS boosters. Revised work statements for the AGENA second stage have been transmitted to Lockheed Aircraft Corporation with a request for submission of a detailed proposal. Following an evaluation of this proposal, the AGENA second stages will be procured.

- Work is continuing on the Stage I, Stage II and the rocket engine work statement essential for procurement of the booster vehicles required during the ATLAS/CENTAUR phase of the program.

Final Stage Vehicle

- A study of the reference problem for final orbit injection is in progress for a six-hour inclined orbit using the ATLAS/AGENA configuration. It appears at this point that the most significant problem is that of yaw drift during orbit correction. Restrictions effecting launch times have not yet been determined.

- Representatives of AFBMD, Space Technology Laboratories and General Electric met on 14, 15 and 16 September in Philadelphia and held an informal general program review on the over-all temperature control problems of the Final Stage Vehicle (FSV). Methods which have been investigated to meet the temperature control requirements were reviewed in detail as well as the back-up analysis substantiating the mechanization. The experimental test programs being performed in the temperature control area were reviewed and the proposed temperature control system evaluation and checkout tests were discussed.

- General Electric has given contractual authorization to Rocketdyne and Marquardt for Phase I studies of the FSV propulsion subsystem.

- Space Technology Laboratories' FSV preliminary design drawings were forwarded to General Electric for information. One of the main differences between the STL and GE concepts was the design of the propellant tanks. The STL two-tank concept allows a more efficient volume utilization of the FSV structure, but requires precise propellant metering from the two tanks. The GE configuration utilizes a tank of greater volume requiring a larger FSV basic structure. A meeting is planned to investigate in detail the center of gravity shift problems involved in the two configurations.

- Results of an STL study of a lithium azide system to produce pressurization and propellant gas for the FSV indicate that system complexity nullified the 18-pound weight saving obtainable by using this system.

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BOOSTER

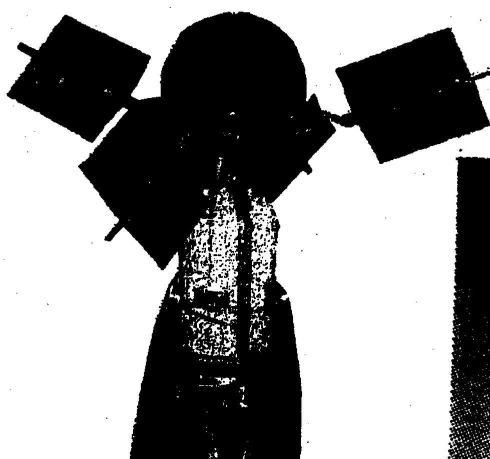
support programs

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

BOOSTER SUPPORT PROGRAMS

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.



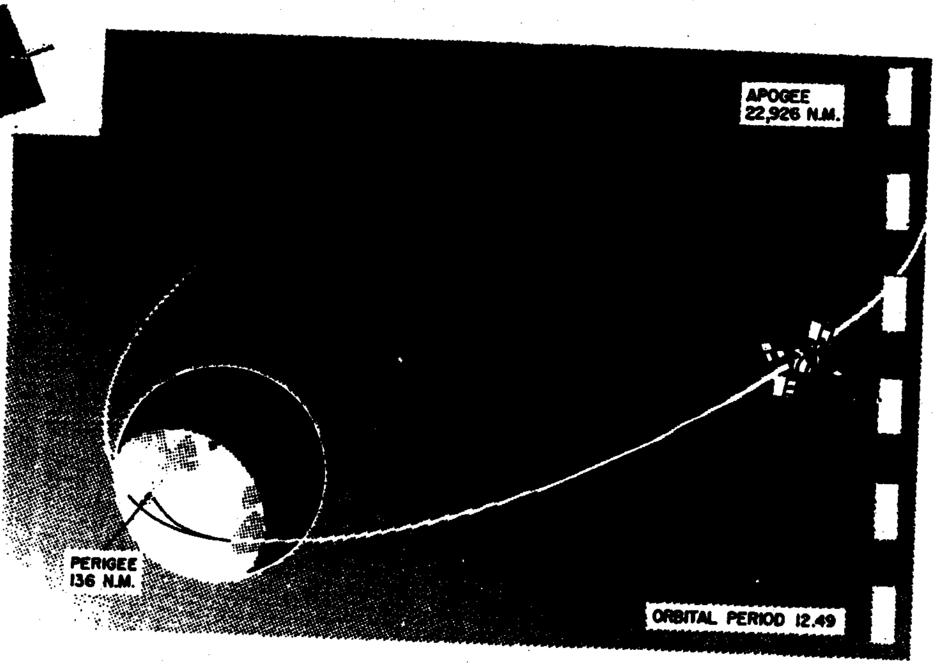
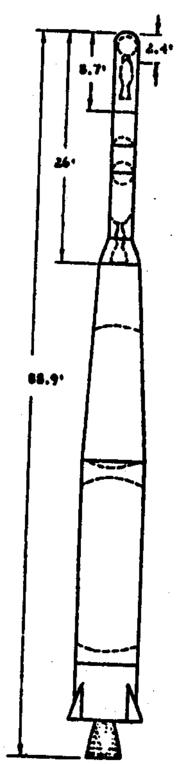


Figure 2. ABLE-3 third stage and payload (above) with solar paddles fully extended. Drawing of extremely elliptical orbit achieved by ABLE-3 (EXPLORER VI).



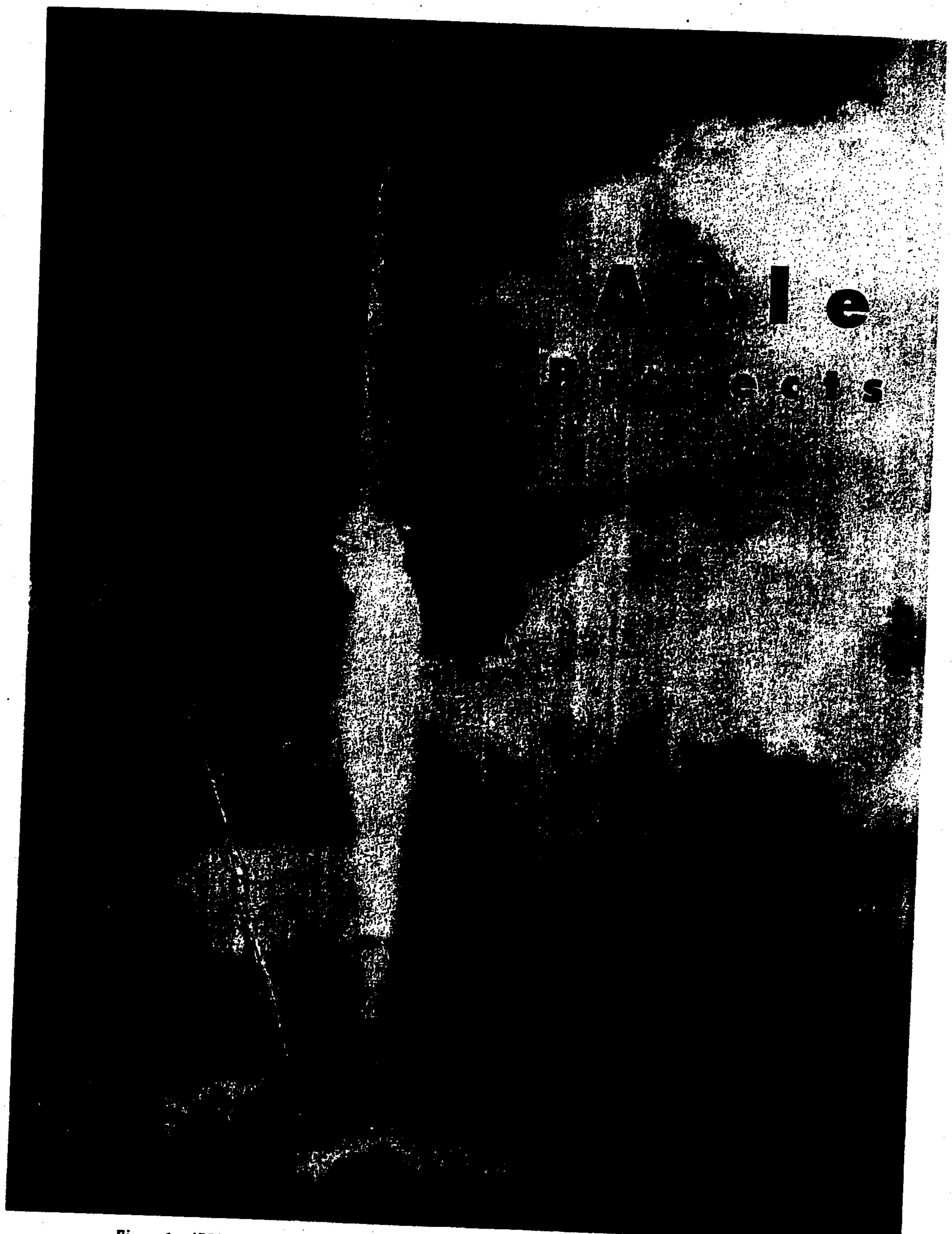
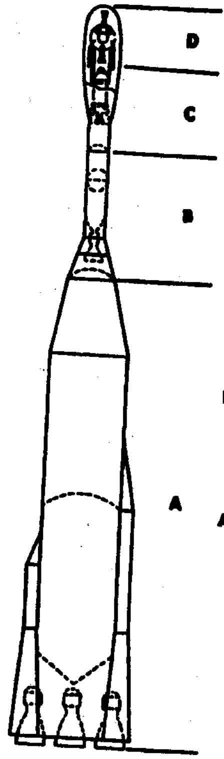


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.



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

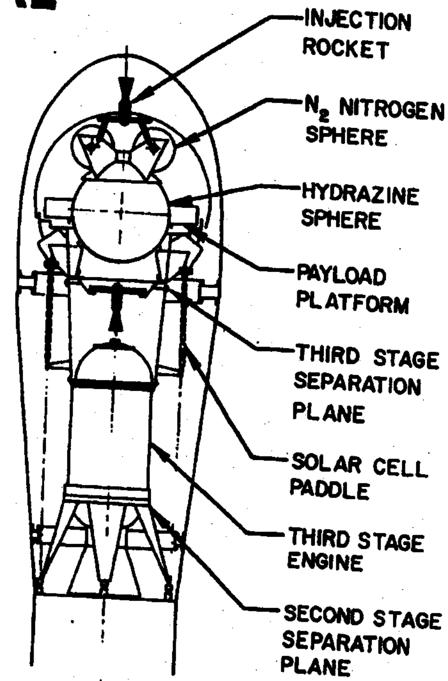
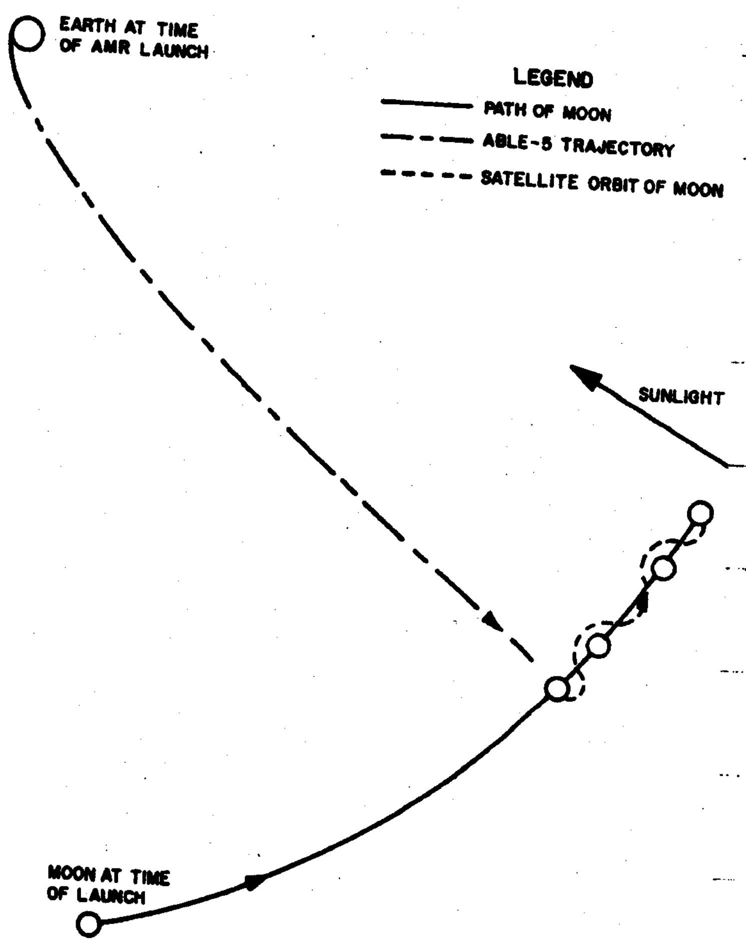


Figure 5. ABLE-5 vehicle configuration drawing and specification list. Third stage and payload configuration (right). Trajectory of ABLE-5 into lunar orbit is shown in drawing (below).

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.



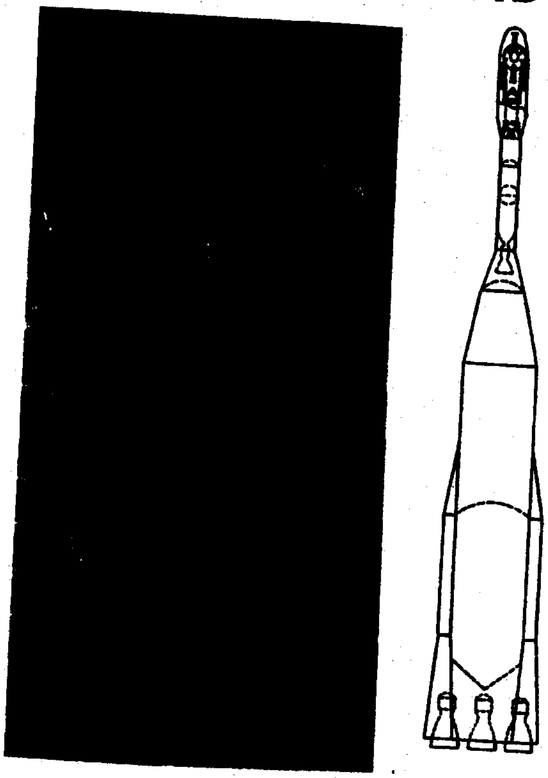


Figure 3. ABLE-4 ATLAS vehicle configuration drawing and photo of vehicle installed on Atlantic Missile Range launch stand 12.

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.

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.

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 1.)

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	0.25211 x 10^8 feet
Eccentricity	0.1899 degree
Orbital period	1,008 minutes
Apolune	4,937 nautical miles
Perilune	3,361 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).

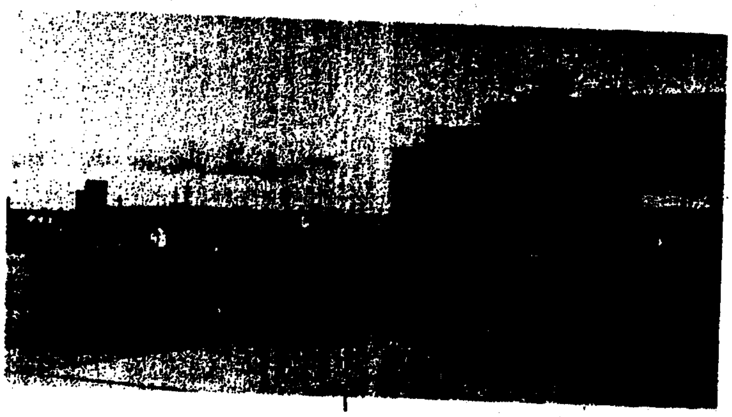
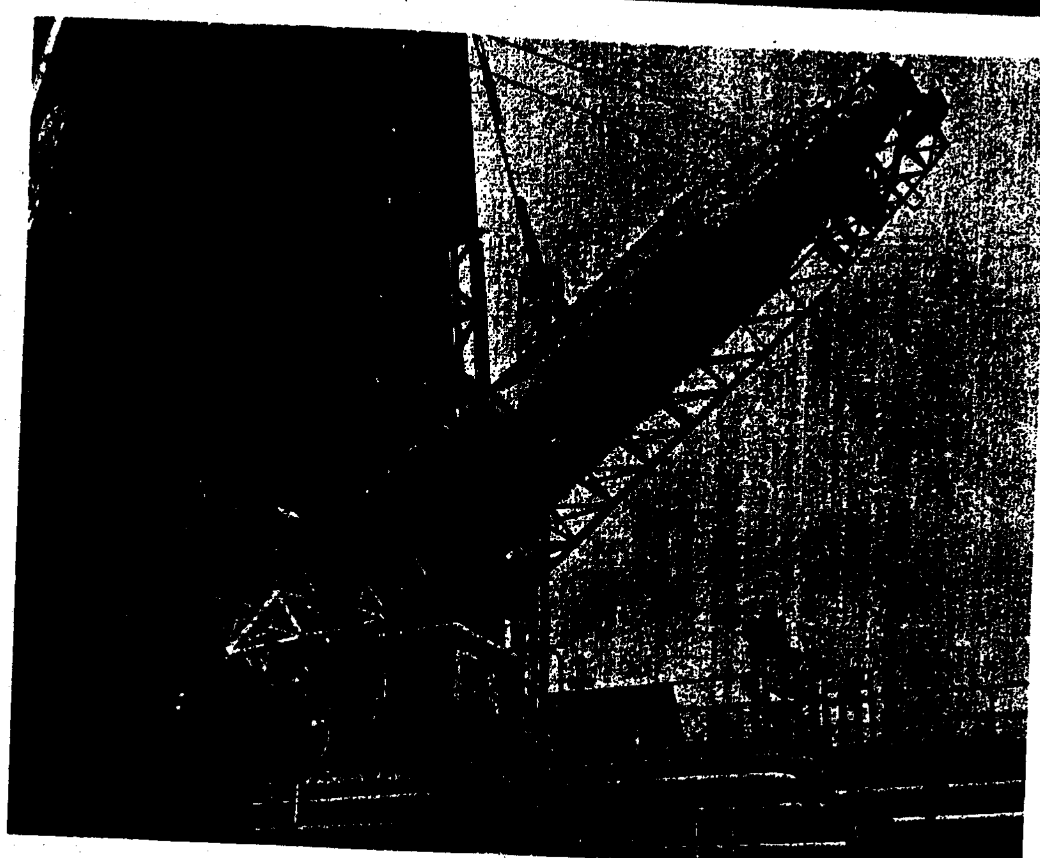


Figure 7. The ATLAS 80D booster (above) about to enter Atlantic Missile Range Hangar H prior to subsystem and system checks. The vehicle was delivered by C-133 from the west coast. Delivery of the booster (right) to the launch stand following lifting of the hurricane alert. Booster and transporter during erection on AMR Stand 12.



MONTHLY PROGRESS — ABLE-5

Program Administration

• A proposal for an alternate mission for the ABLE-5B vehicle was developed and forwarded to NASA for consideration. This alternate mission was designed to complement and increase the value of the ABLE-5A lunar orbital flight by placing the second satellite in an elliptical earth orbit which would permit simultaneous measurements to be made by two identical (ABLE-5A and 5B) vehicles. However, since this proposal was contingent upon the successful flight of ABLE-5A, it has been rejected.

• Negotiations have been conducted with Space Technology Laboratories for the reduction and analysis of PIONEER V data and for additional analysis and reduction of EXPLORER VI data recorded under weak signal conditions. The results of EXPLORER VI data reduction and analysis accomplished to date is being completed, with publication of final report scheduled for 1 October. Completion of the PIONEER V data reduction and analysis program and publication of results is scheduled for March 1961.

Flight Test Progress

ABLE-5A Flight

• The ABLE-5A vehicle was launched from Stand 12 at the Atlantic Missile Range on 25 September at 0713 PST. Countdown for the launch was initiated on 24 September, but the launch was postponed because of high winds and unfavorable weather in the launch area. The final countdown proceeded smoothly to liftoff, which was normal in all respects. The flight proceeded as planned through the completion of first stage operation. Performance of the ATLAS booster was excellent with all systems operating properly. ATLAS sustainer engine cutoff occurred at 271.7 seconds after liftoff and Stage I/Stage II separation occurred 1.5 seconds later. However, a malfunction occurred in the second stage propulsion system at ignition, and as a result, the objectives of the flight were not met.

• Second stage ignition was denoted by combustion chamber pressure fluctuations which occurred immediately after chamber pressure buildup. Chamber pressure then stabilized at 60-70 percent of the nominal value. The data also indicated an abnormally high rate of propellant depletion during second stage burning. Although the exact cause of the malfunction has not been definitely established, it is possible that propellant loss external to the combustion chamber may have occurred. This could have resulted in an improper fuel-oxidizer ratio with a consequent reduction in combustion chamber pressure and a reduction of second stage thrust. The reduced performance of the second stage prevented the attainment of orbital velocity.

• The other flight events apparently occurred as planned. Telemetry data received from the satellite vehicle indicated satisfactory performance of the

Figure 6. System checkout of second stage vehicle being performed in Atlantic Missile Range hangar. The ABLE vehicle shown mounted on the transporter uses the AJ10-101 propulsion system.

vehicle subsystems. Analysis of the telemetry data indicates that the first vernier firing of the hydrazine engine was accomplished. Due to the suborbital velocity of the satellite vehicle at the time of firing, the velocity gained did not significantly affect the ballistic trajectory, and the vehicle was destroyed upon re-entry into the atmosphere. Final details of the flight will not be known until complete analysis of the tape has been performed.

Pre-Launch Progress

• Following the correction of the ATLAS 80D contamination problem, the ABLE-5A booster was erected on 2 September. Preparations for the Flight Acceptance Composite Test (FACT) were interrupted because of Hurricane "Donna." The missile was removed from the stand on 10 September and returned on 11 September. The FACT was successfully completed on 14 September; a complete Firing Readiness Demonstration was completed on 17 September. The second stage vehicle successfully completed the Flight Systems Test on 7 September. After the lifting of the hurricane alert the stage was mated to the ATLAS booster and also completed the FACT on 14 September. The third stage was delivered to the Atlantic Missile Range on 14 September. Following the receiving inspection and static and dynamic balancing, it was mated to the second stage on 22 September. The satellite vehicle was delivered to AMR on 7 September and was attached to the third stage on 23 September.

Technical Progress

First Stage

• ATLAS 91D, the booster for the ABLE-5B flight, is proceeding on schedule for delivery to AMR on 14 October. After completing the receiving inspection and subsystem tests the booster will be erected on or before 14 November. The missile is currently in the final factory checkout phase. In addition to the normal tests, a thorough examination of all booster systems is being accomplished to preclude any possibility of contamination.

Second Stage

• The ABLE-5B second stage vehicle is progressing satisfactorily toward an AMR delivery date of 28 October. Electronic equipment has been installed and subsystem checkout is in progress.

• Vendor gyro deliveries were received in September alleviating the ABLE-5 second stage gyro shortage. This shortage has been a serious problem in second stage deliveries.

Third Stage

• Three ABL-X248-A9 engines were static tested in a simulated high altitude environment at Arnold Engineering Development Center to determine internal ballistic performance. Data obtained from these tests indicated that outgassing following propellant burnout was excessive. The thrust developed during this period was of sufficient duration and character to necessitate a change in payload separation equipment. A mechanical "Yo" de-spin device was developed and tested for installation on the third stage to re-orient the thrust vector and prevent possible interference between the third stage and the satellite vehicle after separation. A weight attached to a cord is installed at the Stage III/Stage IV interstage structure and deployed simultaneously with Stage IV separation. The momentum developed by the weight during deployment is used to de-spin the third stage and exert a couple to rotate the longitudinal axis of the third stage, assuring positive separation.

• The second flight engine was delivered to AMR on 14 September. However, the stage was found to weigh less than specifications permit and has been rejected. The replacement engine is scheduled for delivery before 8 November.

Figure 9. Installing "butterflies" on the ABLE-5A payload. These "butterflies" rotate in response to heat and expose more or less reflective surface, as required, to control payload temperatures. Antiseptic methods similar to those used in surgery are employed in assembling the ABLE-5A payload. These procedures are followed to prevent contamination in the unlikely event that the payload impacts on the moon.

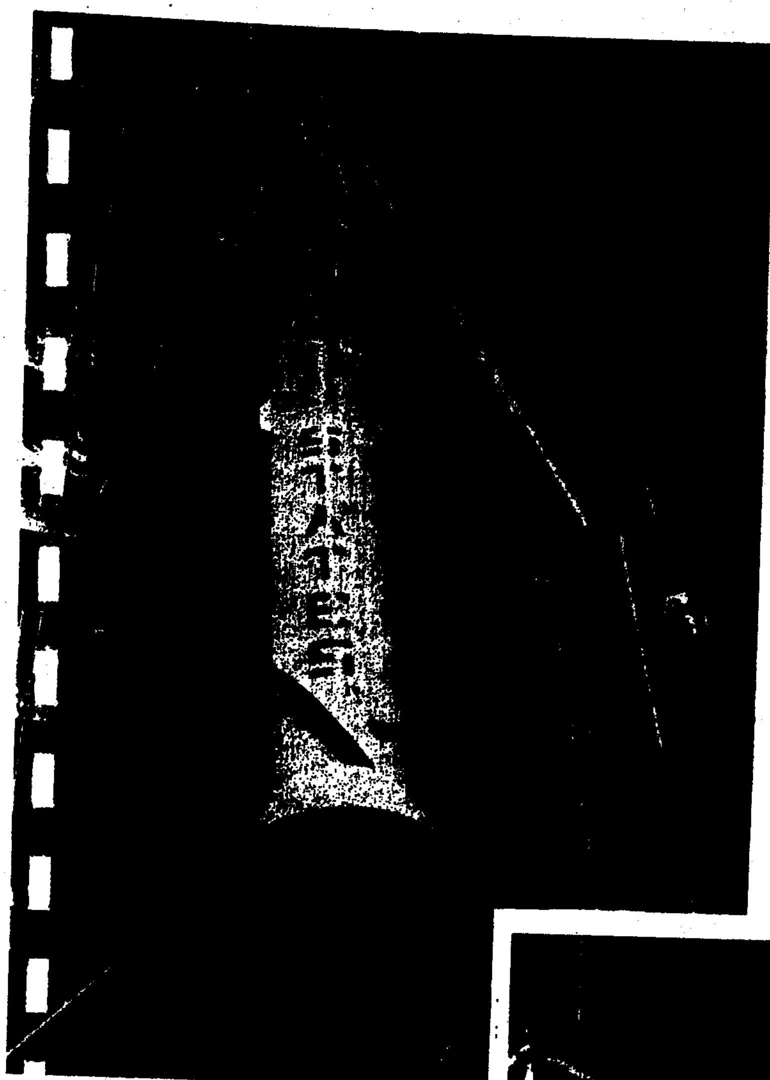
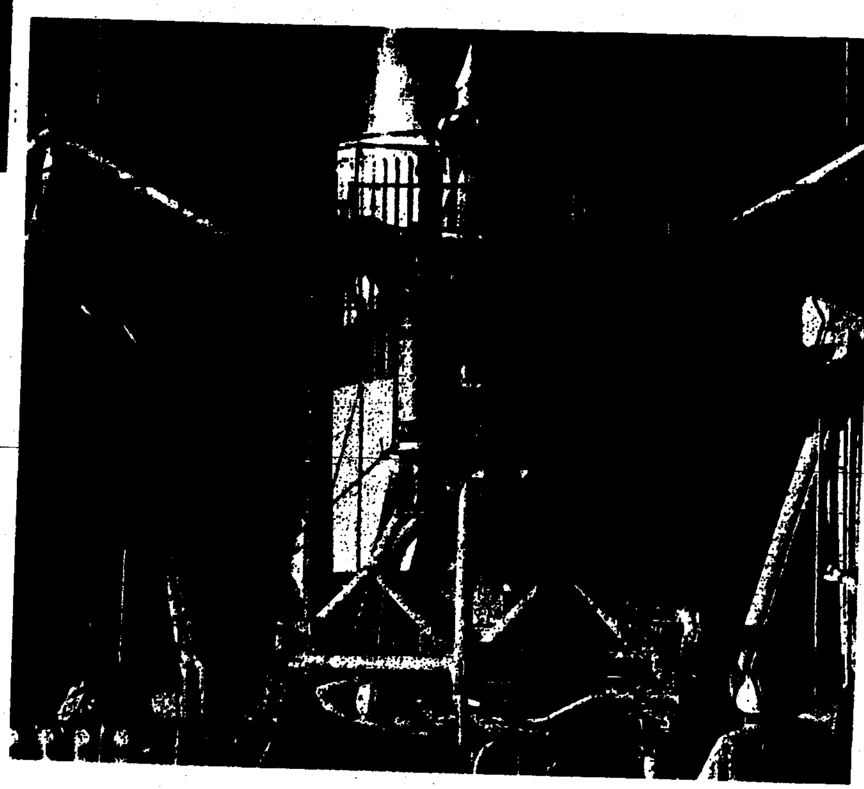
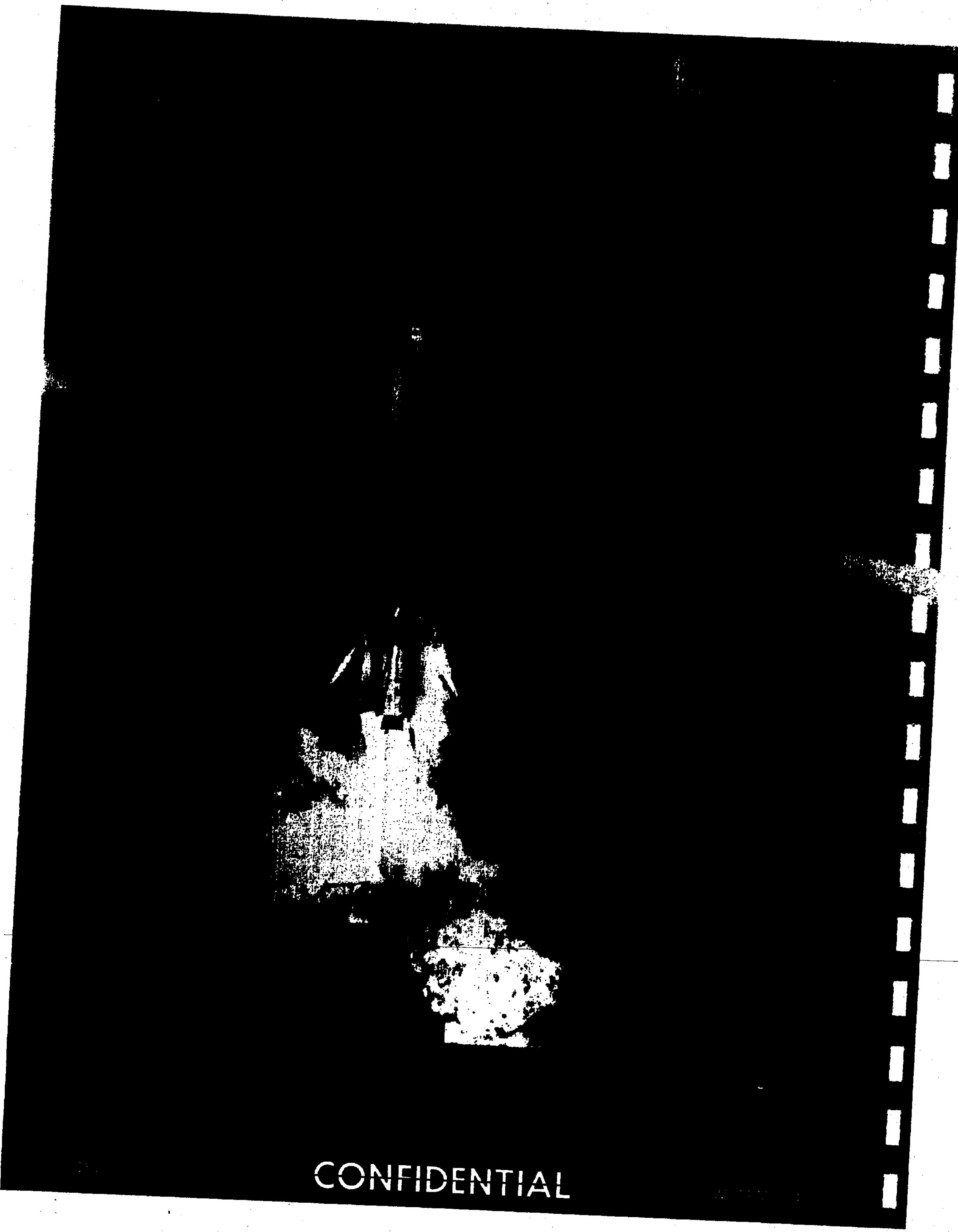


Figure 8. The second stage being raised into the gantry tower (left) and during mating with ATLAS 80D. The third stage ABL-248 being raised into position with the mighty booster in the background. The weight differential is approximately 130 tons.

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Satellite Vehicle

- Test and checkout of the ABLE-5B satellite vehicle was completed on 27 September. Initial magnetic field background and source checks were accomplished at the Fanselan facility located in Malibu, California, on 30 September. Vibration tests on the vehicle are scheduled to begin on 3 October. Following completion of the thermal vacuum environmental acceptance tests the vehicle will be delivered to AMR on 4 November.

Guidance and Control

- The Hughes Advanced Guidance System computer was delivered on 14 September following the completion of acceptance testing. Peripheral equipment installation and checkout was complete at the end of the report period.

Transit

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

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

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

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

C FIRST STAGE—THOR IRBM

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

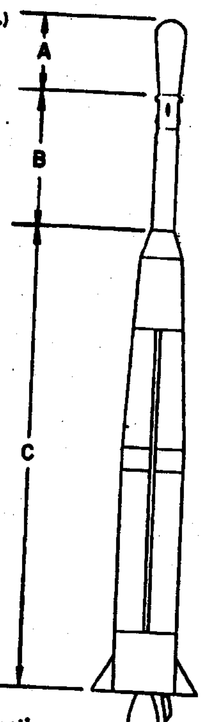
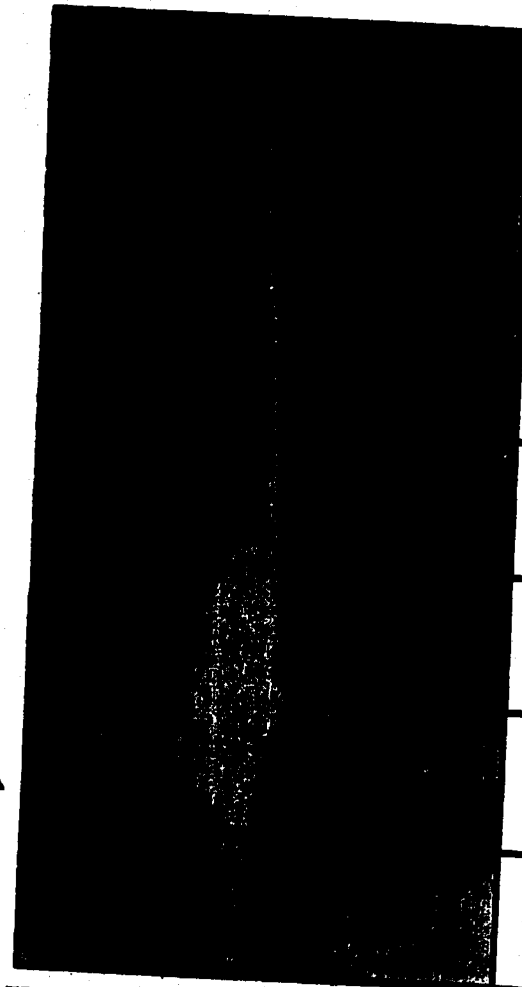


Figure 1. TRANSIT 1A three stage flight vehicle.



TRANSIT 1A launched from Atlantic Missile Range

The TRANSIT Program consists of the flight testing of six vehicles to place 200-270-pound satellite payloads into circular orbits of 400 to 500 nautical miles. The program is designed to provide extremely accurate, world-wide, all-weather navigational information for use by aircraft, surface and subsurface vessels, particularly in relation to POLARIS missile firings. The ARPA Order for TRANSIT 1A was initiated in September 1958 and amended in April 1959 to add TRANSIT 1B, 2A and 2B flights. The TRANSIT 3A and 3B flights were initiated by a Navy MIPR, dated 18 May 1960. Because of the successful TRANSIT 2A launch and excellent payload performance the Navy has elected to launch TRANSIT 3A rather than 2B. TRANSIT 2B was scheduled to carry the same type payload as was carried on the 2A flight.

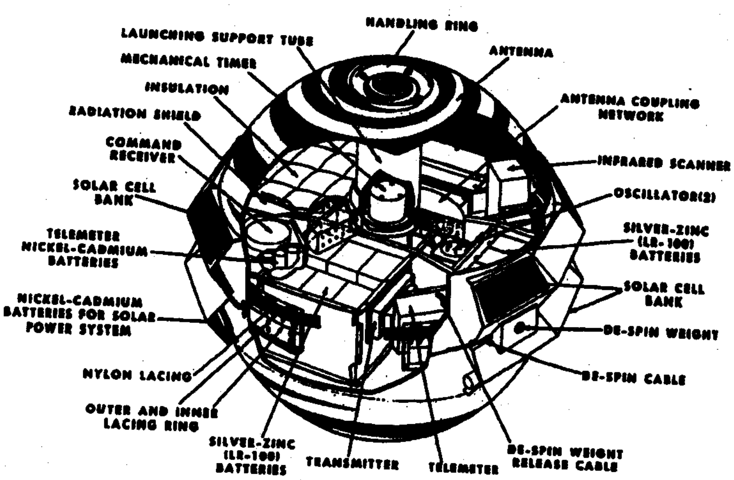
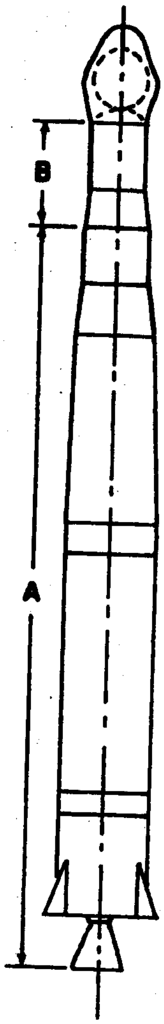


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV 1).

The program was originally authorized by ARPA Order No. 97-60, which assigned AFBMD responsibility for providing the booster vehicles, integrating payloads to the vehicles, and flight operations from launch through attainment of orbit. 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.



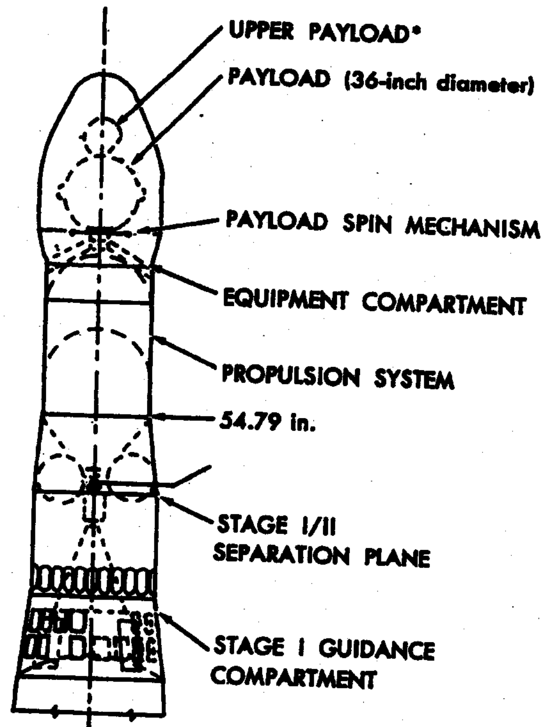
B. SECOND STAGE—ABLE-STAR (AJ10-104)

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

A. FIRST STAGE—THOR IRBM

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

—TRANSIT 1B, 2A, 3A and 3B



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

Program Objectives

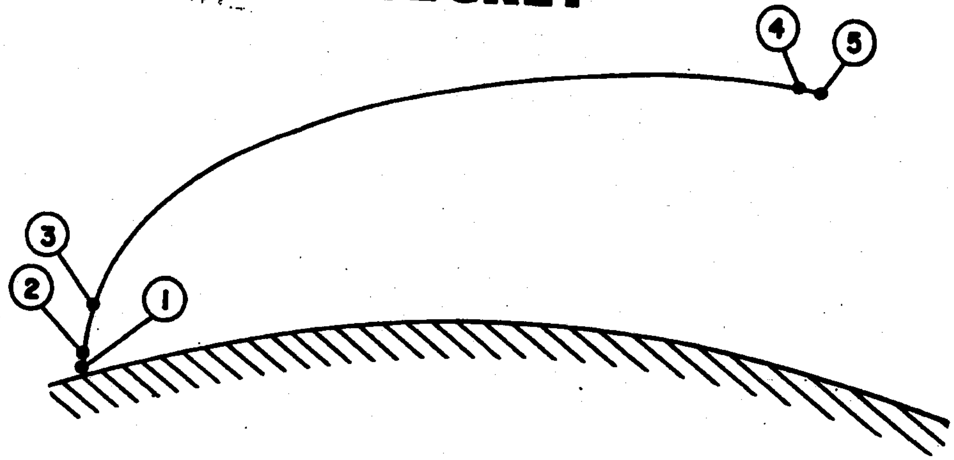
1. Provide accurate navigational reference information for POLARIS launches.
2. Precise determination of satellite position by measuring the doppler shift of satellite transmitted radio signals.
3. Investigate the refractive effect of the ionosphere on radio transmissions.
4. Acquire additional geodetic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

Flight Vehicles TRANSIT 1A consisted of three stages as shown in Figure 1. TRANSIT 1B, 2A, 3A and 3B are two-stage vehicles as shown above.

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

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

Payload Description The spherical payloads are approximately 36 inches in diameter and weigh between 200 and 270 pounds. Payload equipment includes four transmitters (on frequencies of 54, 108, 162 and 216 megacycles), two receivers, and a gate which permits the insertion of data only when the gate has been opened at a previously scheduled time. Power for the first five months will be supplied by batteries, recharged by solar cells located in a 12-inch band around the sphere. The TRANSIT 1B payload will also contain an infrared scanner which will operate for the first four days of orbit. On TRANSIT 2A a 20-inch sphere, mounted on top of the 36-inch sphere, will contain instrumentation for studying solar emissions. The payloads will be spin-stabilized in orbit.



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

FLIGHT TRAJECTORY—TRANSIT 1B and 2A

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

Ground Support Stations Tracking stations will be operated in Maryland, Texas, New Mexico, Washington and Newfoundland. First and second stage tracking and telemetry and second stage guidance will be provided by the Atlantic Missile Range. A mobile tracking and telemetry van was located in Germany for TRANSIT 1B and South America for TRANSIT 2A. The mobile tracking and telemetry van will be located in southeast Africa for TRANSITS 3A and 3B. These locations were selected as the closest sites possible to the orbit injection point.

MONTHLY PROGRESS — TRANSIT

Flight Test Progress

- The TRANSIT 3A launch scheduled for early November has been rescheduled to 29 November. This change was required because the COURIER 1B and ABLE-5B launches have created a launch schedule problem. The launch of TRANSIT 3B is scheduled for 21 February 1961 and TRANSIT 4A for May 1961.

- The mobile tracking station has been moved from Salisbury, Southern Rhodesia to Pretoria, Union of South Africa. The station was operating and successfully tracked the COURIER 1B flight.

- The ABLE-STAR vehicle for the TRANSIT 3A flight is currently undergoing final checkout prior to Air Force acceptance. The vehicle is scheduled to be shipped to the Atlantic Missile Range on 21 October. The THOR booster for this flight is undergoing subsystem checkout prior to being installed on the stand.

Courier

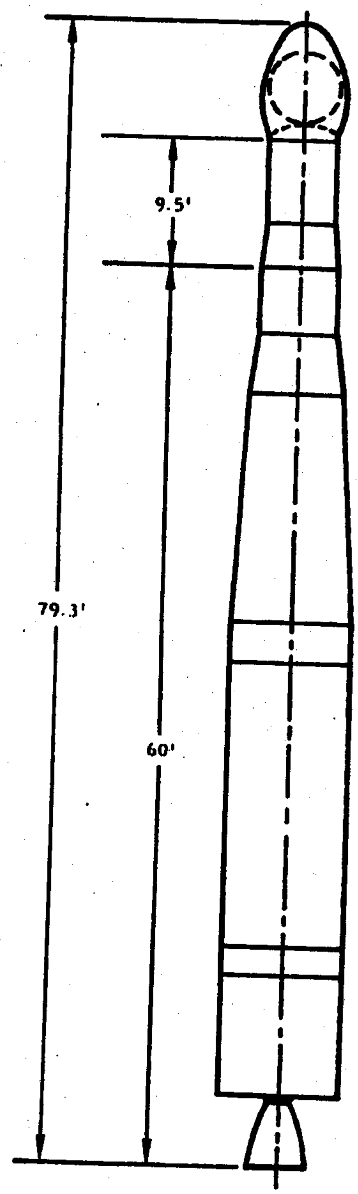
The ARPA COURIER Program consists of two flight vehicles to be launched from the Atlantic Missile Range. The program objective is to test delayed repeater communications between a satellite and ground stations. The program also will be used to determine the operating characteristics and capabilities of the ABLE-STAR (AJ10-104) second stage vehicle. The program is being conducted under ARPA Order No. 98-60 (Project Code No. 2200). AFBMD responsibility includes development of the launch vehicle, payload integration, launch, injection of payload into orbit, and verification of orbital parameters at injection. The Army Signal Research and Development Laboratory will design, develop and fabricate the payload, and will be responsible for world-wide ground station requirements. Primary payload contractor is Philco Corporation.

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

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

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

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



SECOND STAGE—ABLE-STAR (AJ10-104)

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

FIRST STAGE—THOR IRBM

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

MONTHLY PROGRESS—COURIER Program

Flight Test Progress

• The COURIER 1B satellite was launched from Atlantic Missile Range stand 17B at 0950 PST on 4 October. The countdown was interrupted twice 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

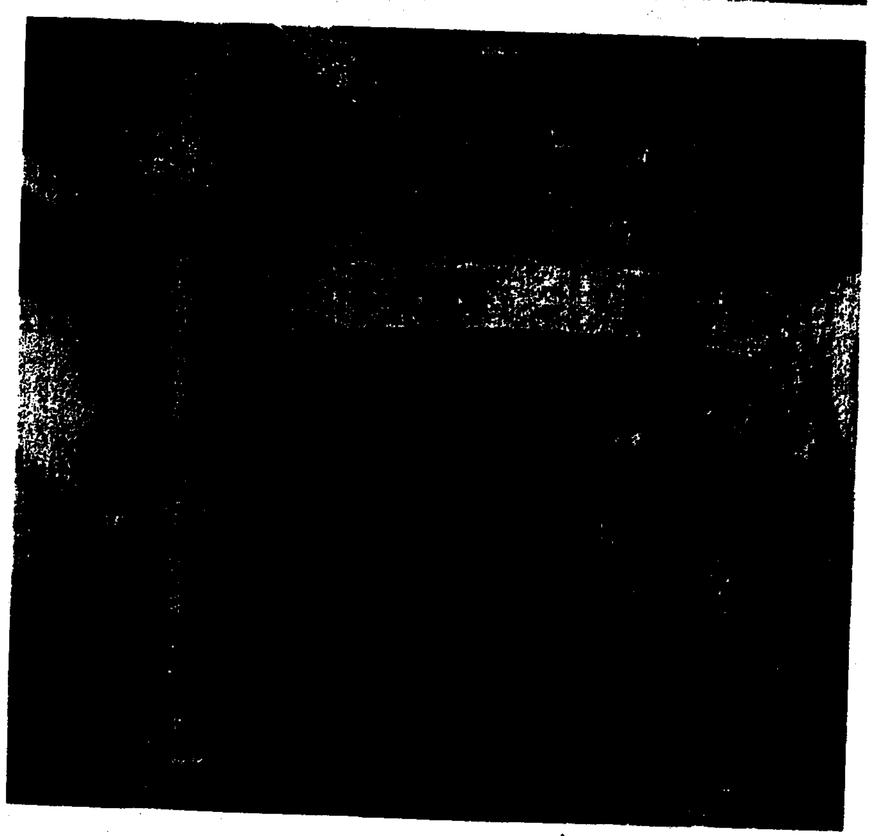


Figure 1. COURIER 1B payload being mated to the ABLE-STAR second stage (upper right). Half of the protective fairing is in place. The solar cell protective cover has not been removed from the upper half of the payload. The aluminum foil visible inside the fairing affords protection from the heat caused by the nose fairing radiation. The microwave antenna is visible inside the fairing on the payload equator. Preparing the payload for spin tests (lower). The solar cell hemi-spheres have been removed revealing the VHF 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. The COURIER 1B shown (opposite page) emerging from the cloud shrouded stand.

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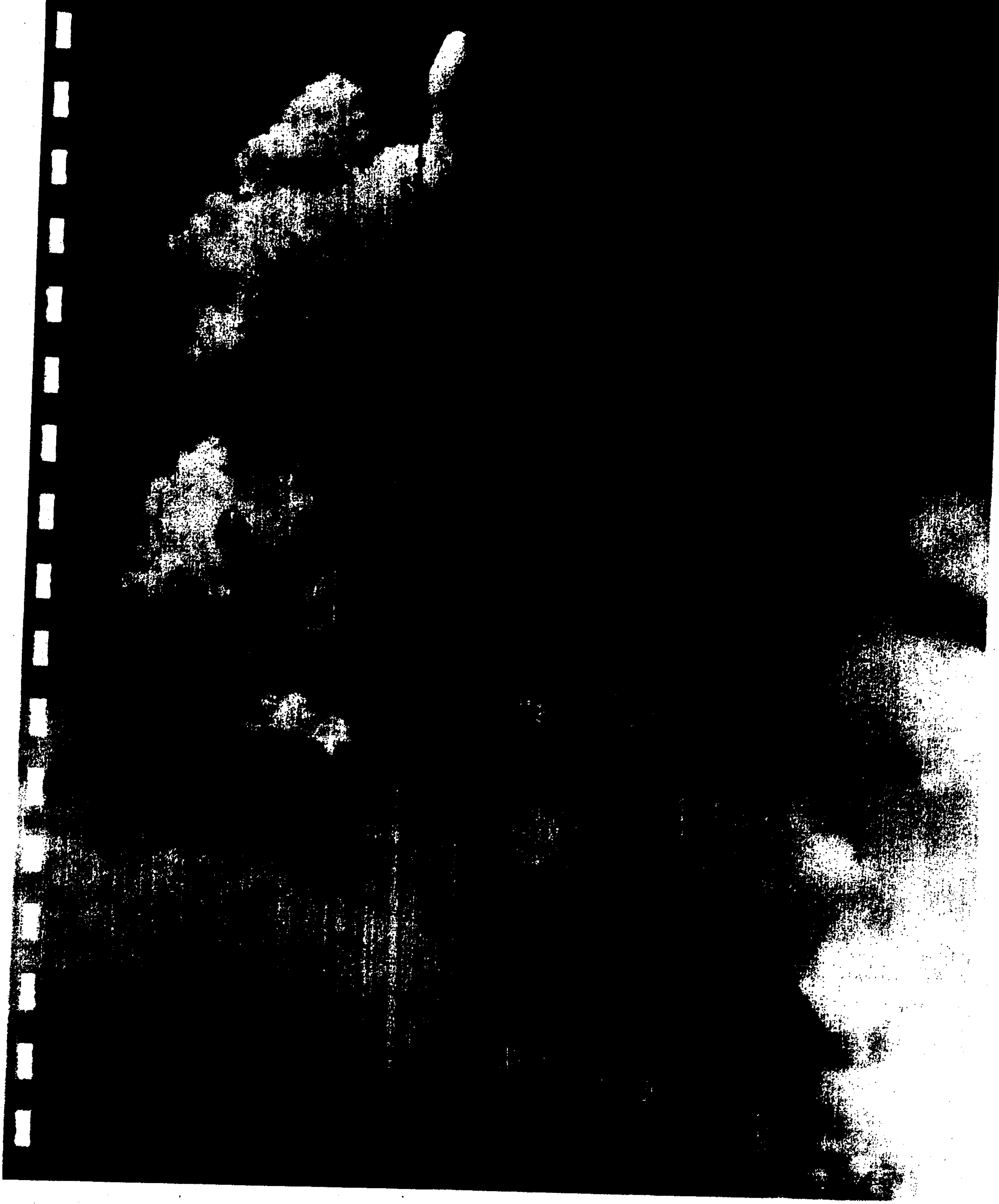


modification incorporated as a result of the COURIER 1A flight. Table I lists nominal and actual orbital parameters.

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 payload contractor reports that the payload is operating as well as or better than expected.

- Downrange tracking of the flight was excellent. The mobile tracking van at Pretoria, Union of South Africa was operated and successfully tracked the ABLE-STAR vehicle during the second burn period and injection into orbit.

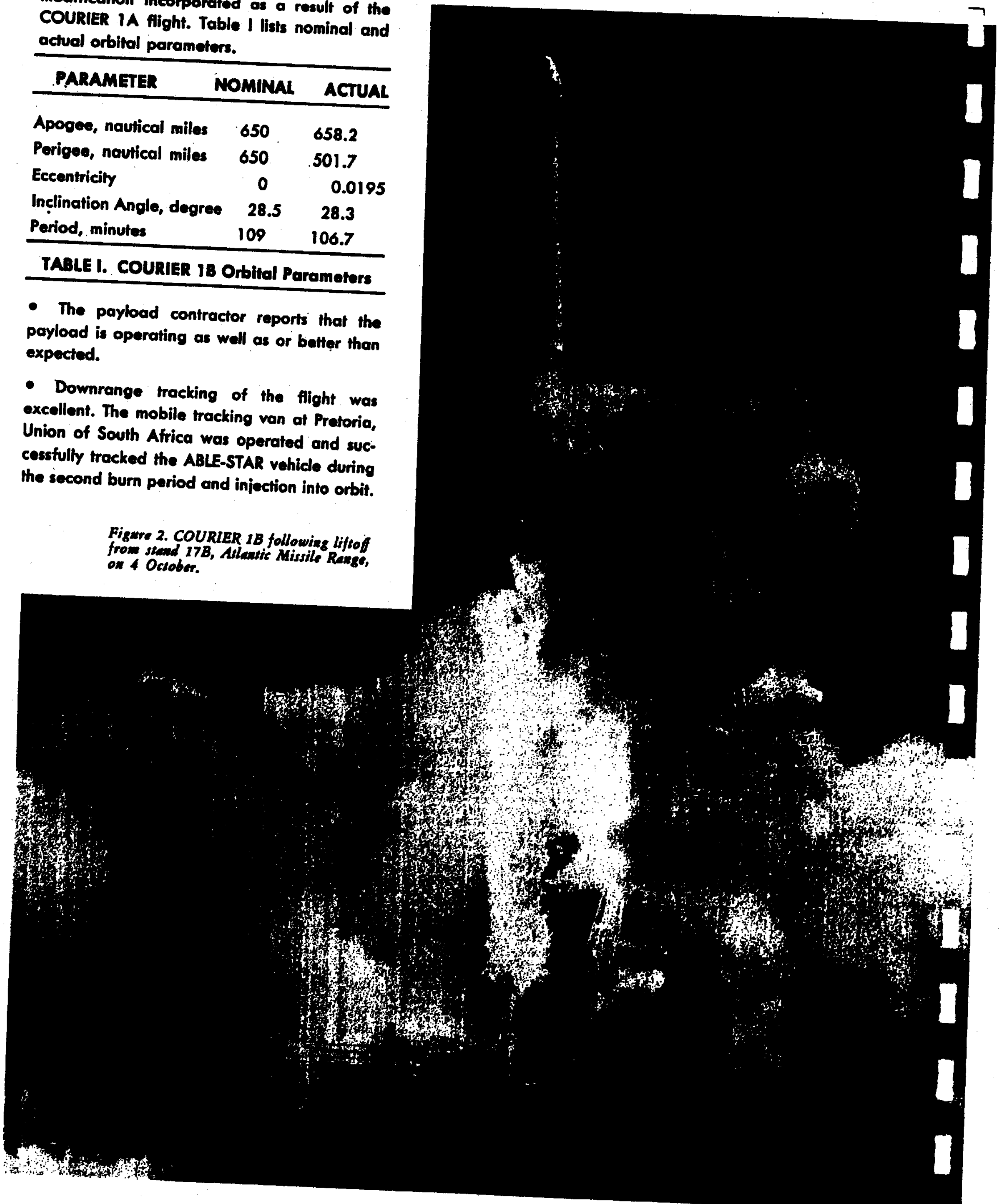
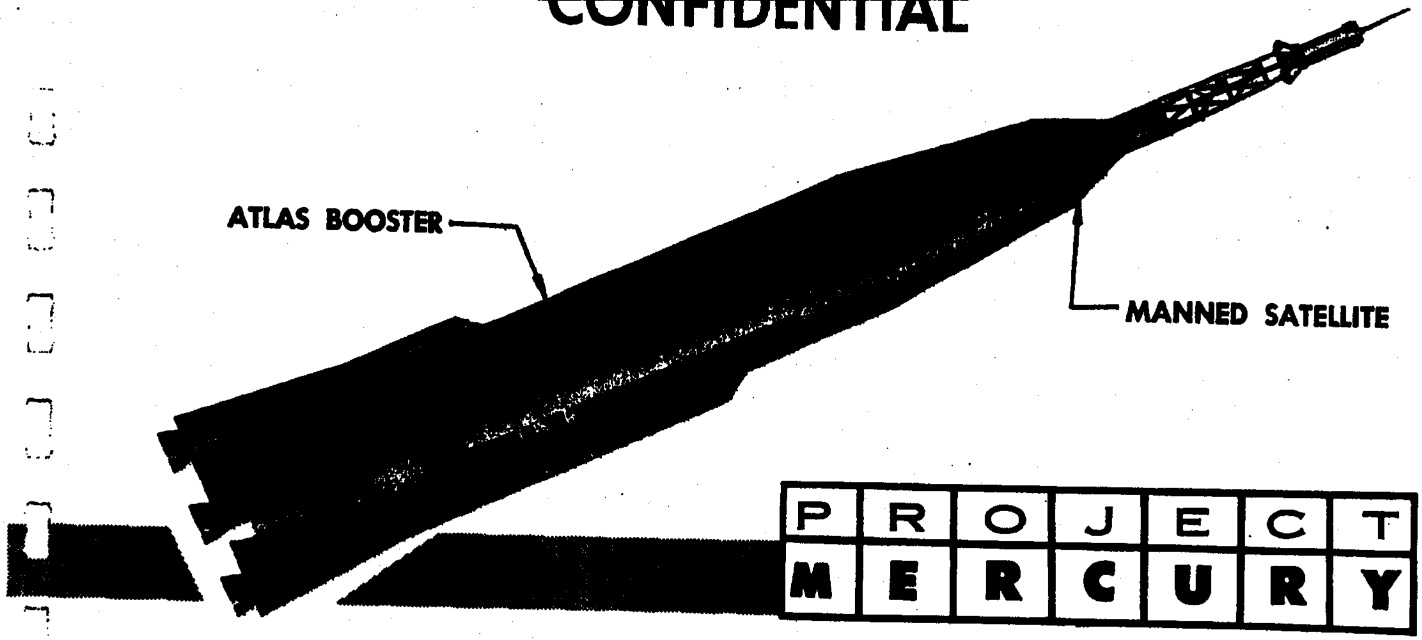
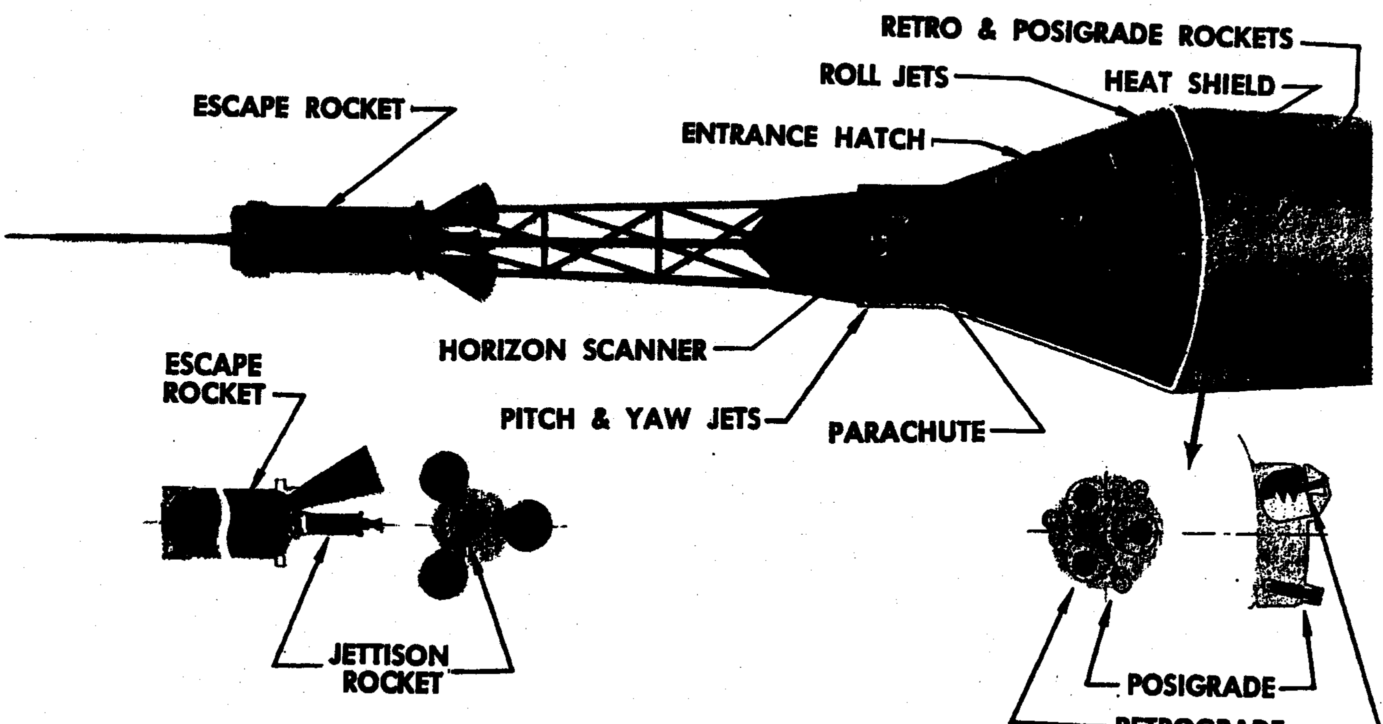


Figure 2. COURIER 1B following liftoff from stand 17B, Atlantic Missile Range, on 4 October.





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

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

Project MERCURY represents the transitional threshold between this nation's cumulative achievements in space research and the beginning of actual space travel by man. The primary program objective is to place a manned satellite into orbit about the earth, and to effect a controlled re-entry and successful recovery of the man and capsule (Figure 1). Unmanned ICBM trajectory and near-orbital flights, and unmanned orbiting flights will be used to verify the effectiveness and reliability of an extensive research program prior to manned orbital flights (Figure 2). The program will be conducted over a period of nearly two years. The initial R & D flight test was accomplished successfully in September 1959. The total program accomplishment is under the direction of NASA. The primary responsibility of AFBMD to date consists of: (a) providing 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: Space Technology Laboratories, systems engineering and technical direction; Convair-Astronautics, modified ATLAS boosters; GE/Burroughs, ATLAS guidance equipment; and Rocketdyne, engines. All of these companies also provide special studies and engineering efforts peculiar to meeting Project MERCURY requirements.

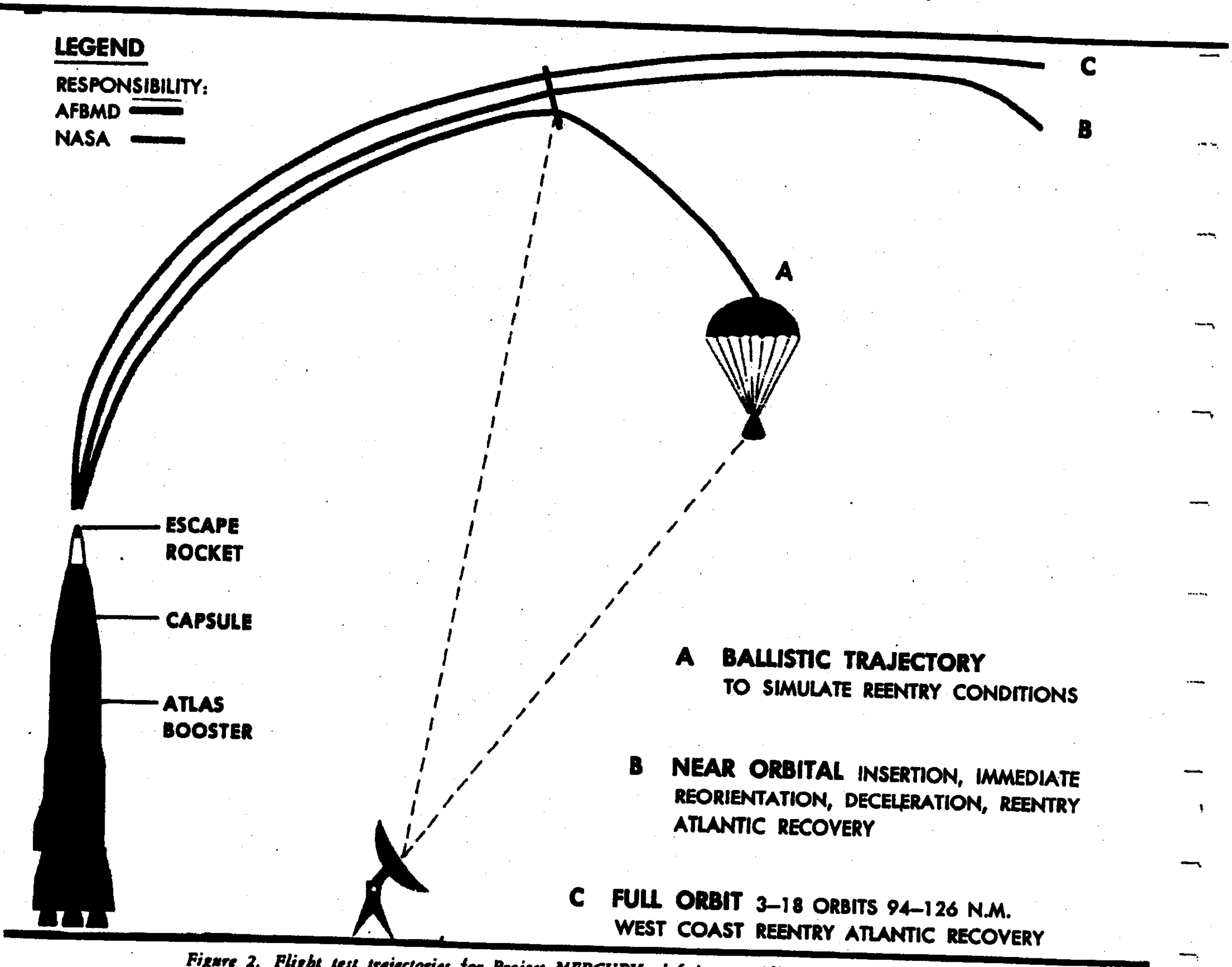


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.

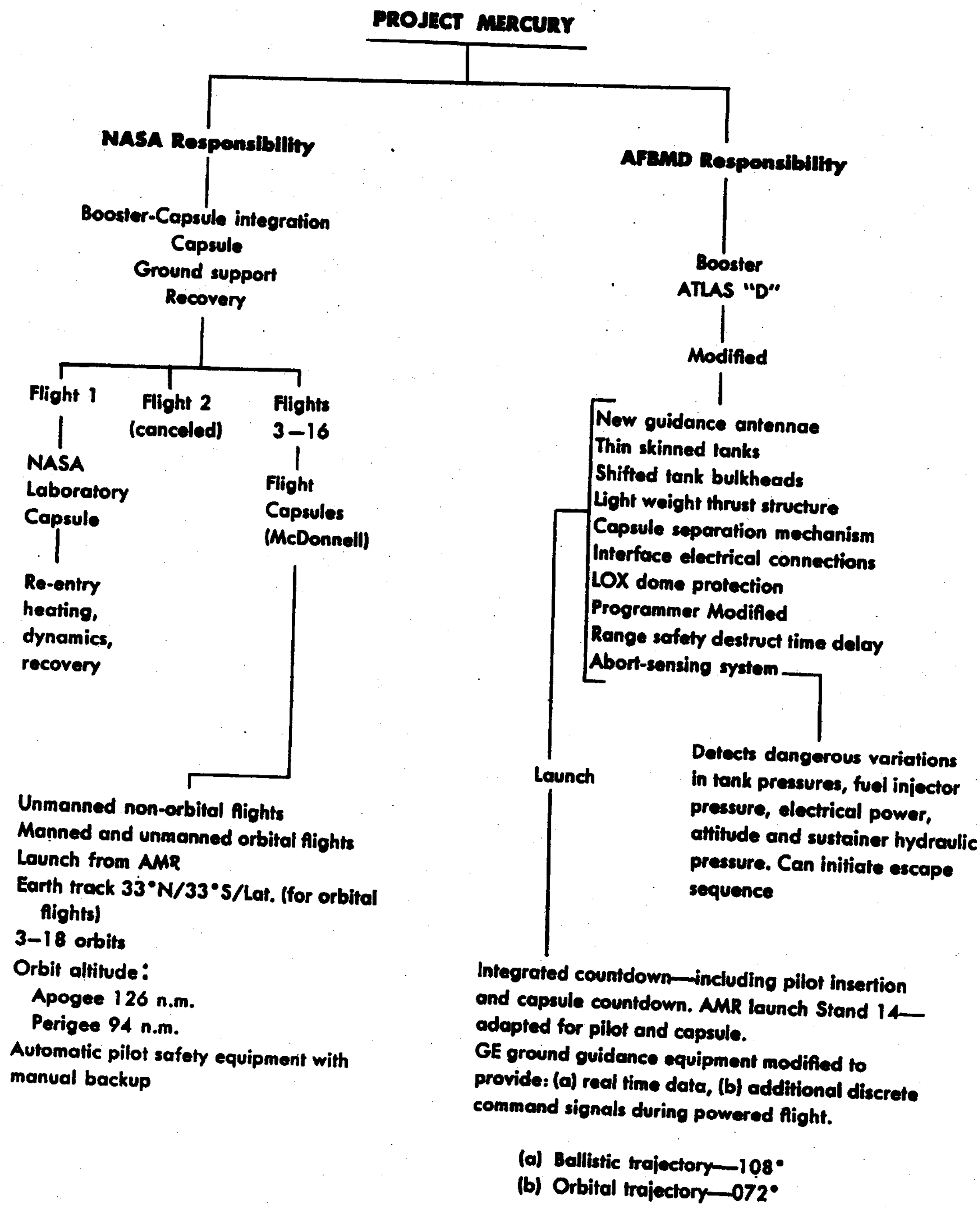


Table 1. Outline of NASA and AFBMD responsibilities in PROJECT MERCURY.

PROJECT MERCURY

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

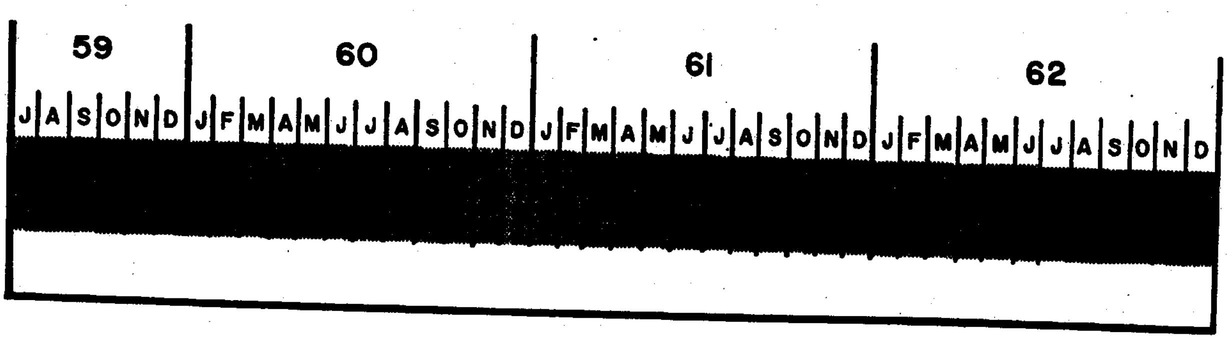
Design, engineering studies
Equipment modification
Hardware fabrication

Flight scheduling

Launch support
Trajectory data
Missile allocation

Provide 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

• Amendment No. 9 to NASA work order HS-36 requesting two additional ATLAS Series "D" boosters for Project MERCURY was received on 31 August. This request increased the program to 16 boosters/15 launches. The additional boosters have been incorporated into AFBMD allocation and launch schedules, and the 31 March MERCURY Development Plan will be amended to reflect the program increase.

• The MA-1 Malfunction Analysis Panel (which includes members of all agencies concerned with MERCURY/ATLAS flights) has been monitoring all MA-1 investigations and determining the precautionary modification action necessary for follow-on launches.

Flight Test Progress

• Continued investigations have not yet revealed the specific cause of the 29 July MA-1 (ATLAS booster 500) malfunction. One of the initial theories for the failure was eliminated during September when it was determined that the failure of the booster LOX boil-off valve assembly was subsequent to, and the result of, the over-all failure. It had been theorized that the failure of this valve was a possible cause since it was recovered near the capsule. Other early indications seemed to substantiate the belief that the valve had separated from the booster prior to the over-all failure.

• The trajectory pitch program will be revised to minimize the angle of attack during the period of high Q and thus reduce the vehicle bending loads. Because of the MA-1 flight analysis and these trajectory changes, it is anticipated that the MA-2 launch now scheduled for 1 November will be delayed at least two weeks.

• A walkout of over 450 workers occurred on 12 September at the Atlantic Missile Range. Early reports did not indicate that Project MERCURY Stand 14 had been affected by this walkout. It has not yet been determined whether the strike will have any effect on the present MERCURY launch schedules.

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

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

• ATLAS booster flight objectives for the MA-2 flight are:

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

Technical Progress

• A vibration test program will be accomplished at the McDonnell Aircraft facilities in St. Louis during the first week of October. These tests will use a full scale assembly composed of an ATLAS forward LOX dome, the adapter, and a portion of the capsule. These tests are designed to determine possible areas of failure caused by vibrational loads. During this same period a one-third scale model of the ATLAS forward LOX dome, the adapter, and capsule will be tested in the Arnold Engineering and Development Center wind tunnel. It is anticipated that the data gained from these experiments will be sufficient to determine the necessary modifications and/or configuration changes necessary to gain reasonable assurance for the success of follow-on MERCURY flights.

• Additional instrumentation requirements have been established for the MA-2 flight as a result of Malfunction Analysis Panel action. Additional instrumentation pickups for this flight will be located in the adapter and booster-capsule attach point areas. In order to handle the additional inputs generated by this instrumentation an extra telemetry package will be installed in the ATLAS booster.

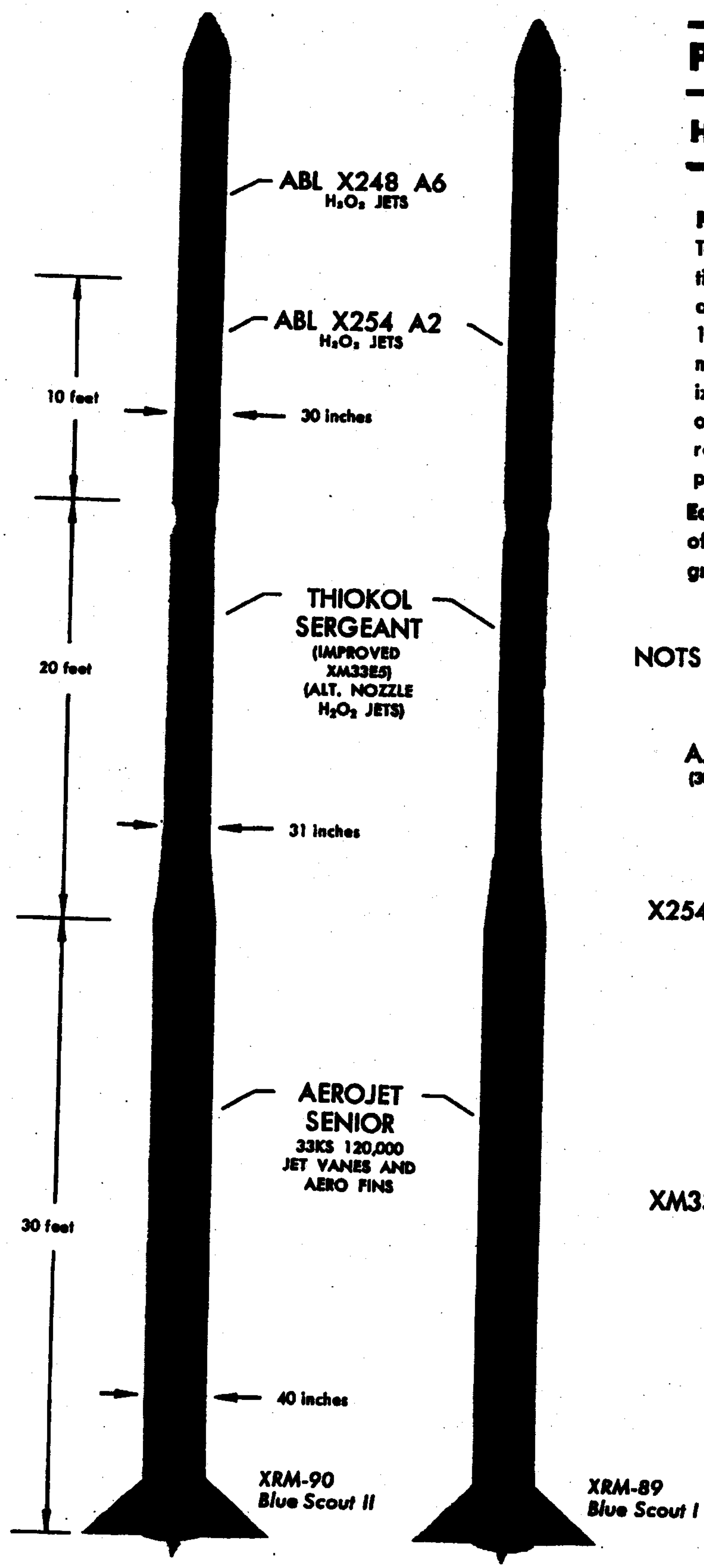
• The Factory Roll-Out Inspection for ATLAS 77D, the booster for the fourth MERCURY flight, was held on 23 and 26 September. The data review was completed on 23 September. An AFBMD inspection team meeting was held on the morning of 26 September to determine the status of inspection discrepancies. The joint AFBMD/Convair-Astronautics meeting was held in the afternoon, and the booster was accepted with a few non-operation shortages remaining.

PROJECT 609A

Hyper-Environment Test System

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

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



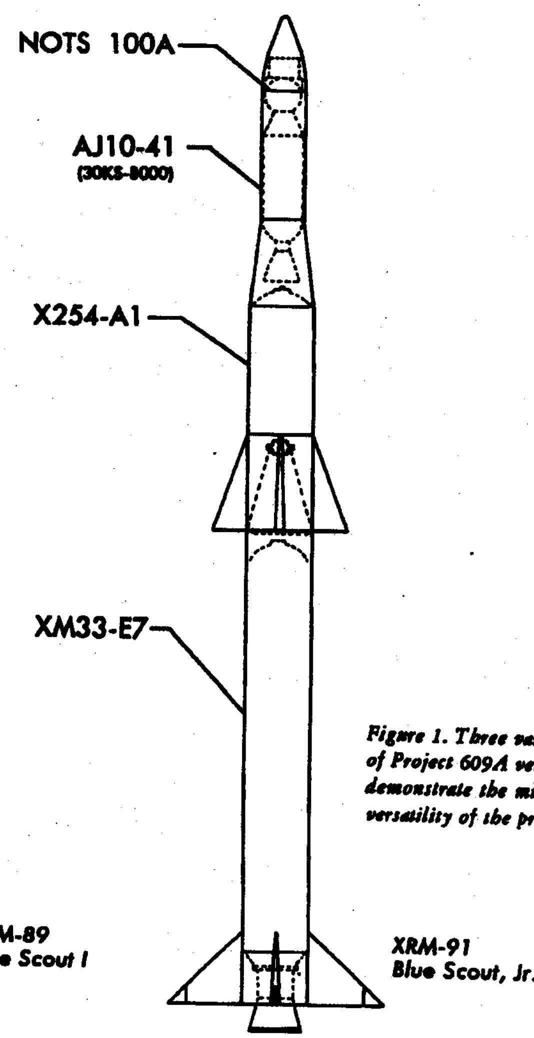


Figure 1. Three variations of Project 609A vehicle demonstrate the mission-versatility of the program.

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

Program Management—An abbreviated development plan, covering the R&D phase only, was approved on 9 January 1959. Funds in the amount of $11,500,000 have been made available for this R&D phase of the program only. A letter was issued assigning management responsibility to AFMBD, with emphasis on integrating the program with the scientific and military research experiments conducted on regularly scheduled ballistic missile flight tests (Piggyback Program). In June 1959, Aeronutronic Division of the Ford Motor Company was chosen through normal competitive bidding as the Payload, Test, and Systems Integration Contractor. Arrangements have been made for the procurement of vehicle components and associated support equipment, modified to meet Program 609A requirements, through NASA, rather than through the SCOUT Program contractors. Atlantic Missile Range facilities consisting of launch complex 18 will be made available to the Air Force for this program. A Project 609A division has been established within the 6555th Test Wing (Development) at AMR to supply Air Force technicians to participate in the assembly, checkout and launch operations of the R&D phase under the direction of the Payload and Test Contractor. An all-military operational capability will be developed from within this group.

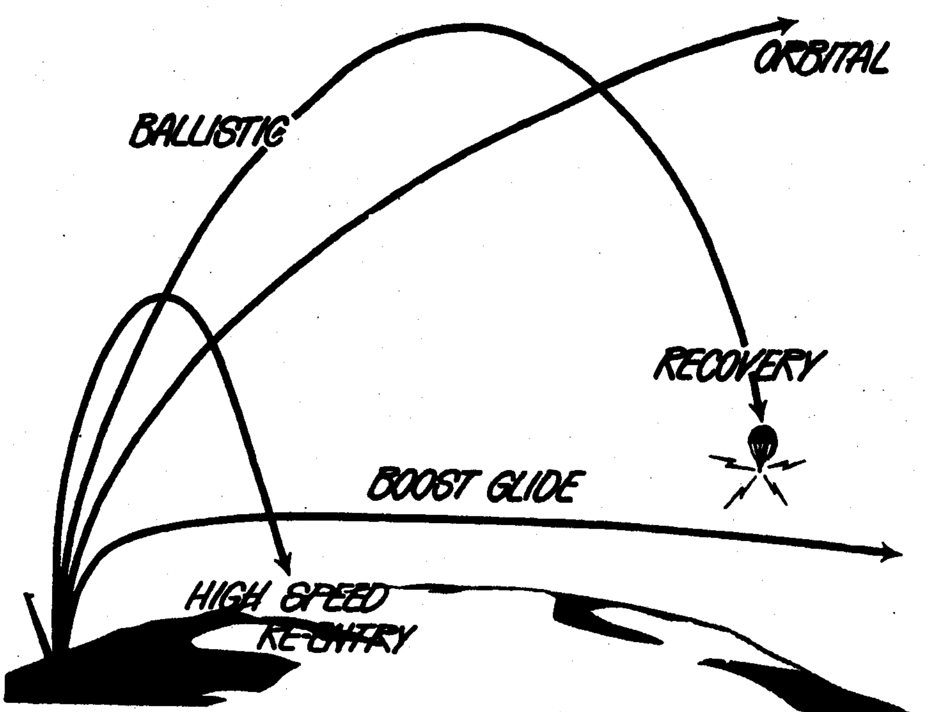
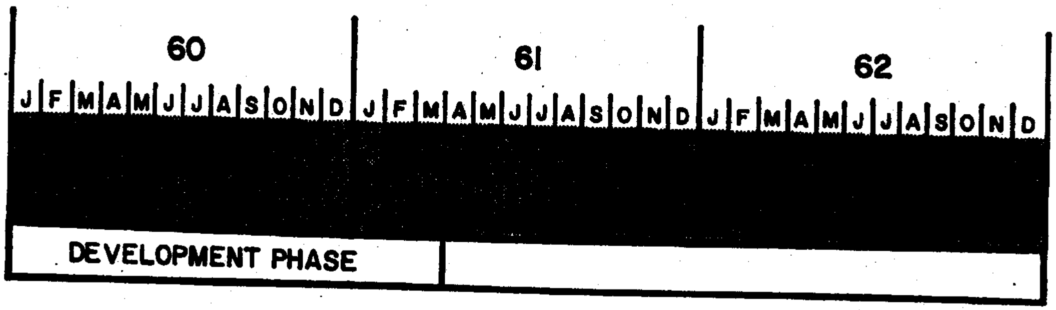


Figure 2. Four different trajectories possible using different arrangements of Project 609A stages.



MONTHLY PROGRESS — Project 609A

Program Administration

• Headquarters USAF has assigned type designation and proper names to Project 609A vehicles. Table I lists the old configuration designation together with the new type number and name.

Old Configuration	*Type Designation*	*Proper Name*
1-2-3	XRM-89	Blue Scout I
1-2-3-4	XRM-90	Blue Scout II
2-3-5-6	XRM-91	Blue Scout Jr.
1-2-3-4s	XRM-92	Scout

TABLE I. Old and New Project 609A Vehicle Designations

• Because the 609A Operational Program has not been funded, the DYNA SOAR Program has requested that two development phase vehicles be reallocated to support the DYNA SOAR Boost-glide test schedule for June and September 1961. This proposal is highly undesirable since it would increase costs and severely disrupt the development program. A partial or complete release of Operational Program funds will be recommended to Headquarters USAF to permit procurement of vehicles in support of the DYNA SOAR test program.

• The Test System 609A Development Plan dated 21 September 1960, submitted as a revision to the Development Plan dated 1 June, has been delivered to Headquarters ARDC. This revision reflects changes resulting from assignment of ARDC probe payload responsibility to the AFRD and includes the

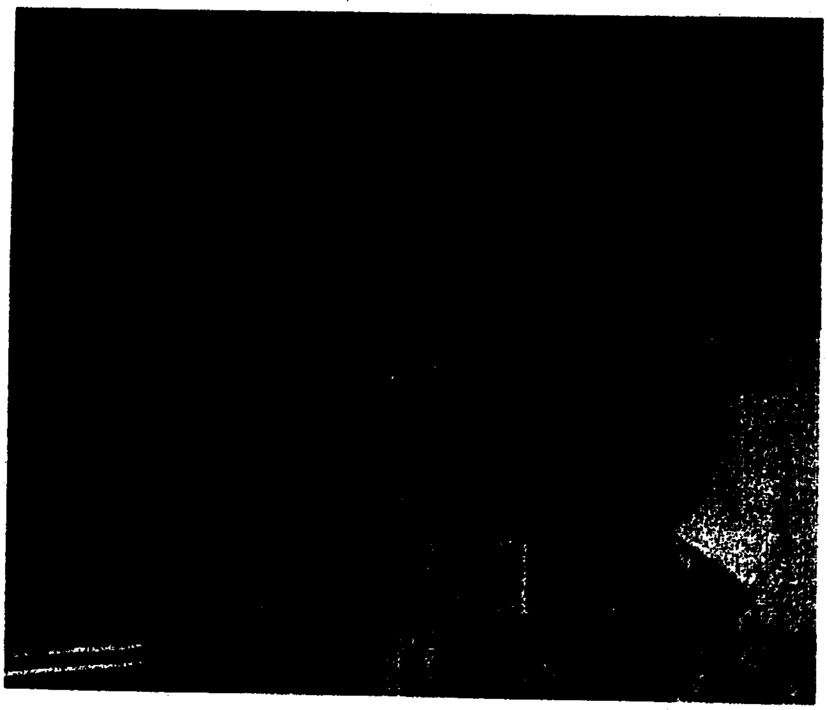
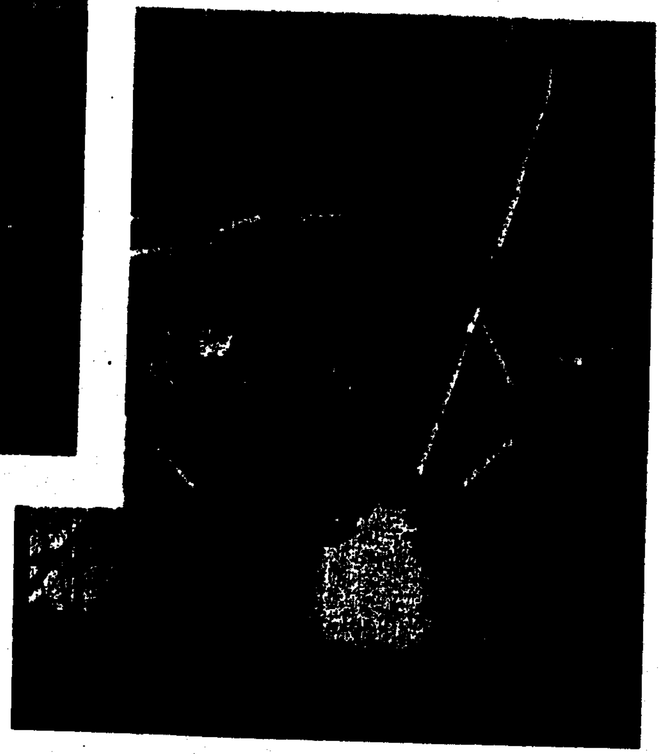


Figure 3. View inside Atlantic Missile Range launch complex 18 blockhouse prior to the 21 September launch. It is interesting to note the simplicity of the launch control panel. The solid propellant motors do not have the complex piping required for liquid propellants and consequently do not need all the propellant monitoring equipment. This is one of several reasons for the economy realized in the 609A Program.



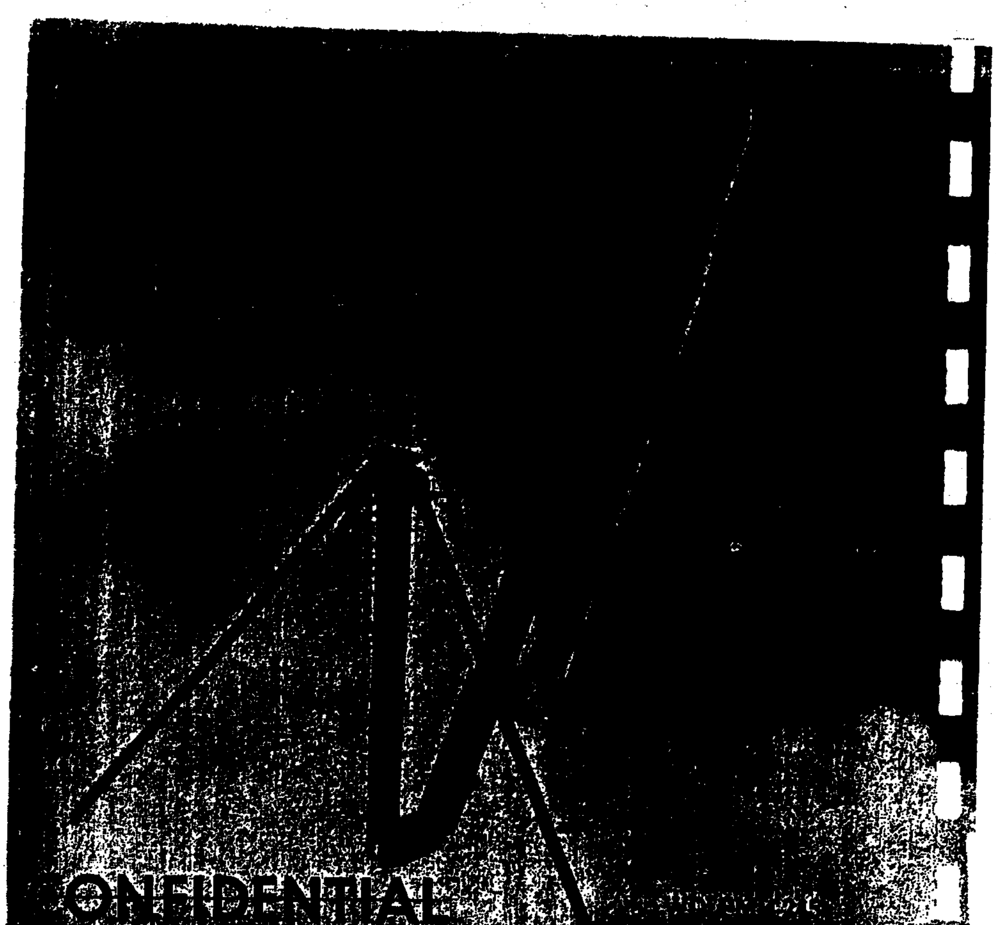


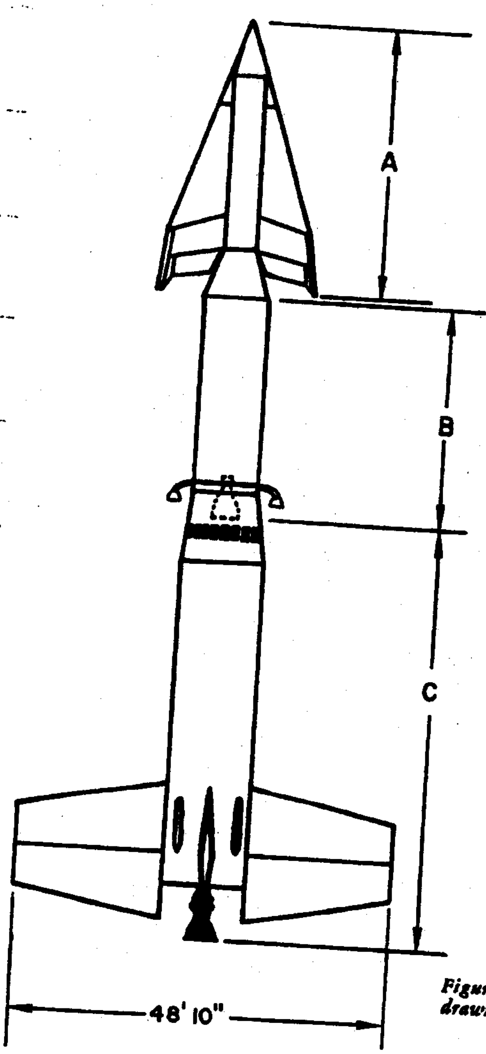
Figure 4. The first 609A launch in the development program. The series on this page shows the XRM-91 prior to ignition (top), the instant of first stage ignition (center), and the missile moving up the launch rail (lower) with the payload umbilical visible on the right of the second stage. The "Blue Scout, Jr." (opposite page) has cleared the launching rail and the spin stabilizing motors have just been ignited.

CONFIDENTIAL

DYNA SOAR

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

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



A. GLIDER

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

B. TITAN SECOND STAGE

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

C. TITAN FIRST STAGE

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

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

SECOND STAGE MODIFICATIONS

Ignition prior to Separation
Propellant Tanks Capacity Increased
Intertank Section Strengthened

FIRST STAGE MODIFICATIONS

Stabilizing Fins Added
Skirt Section and Intertank Section Modified and Strengthened

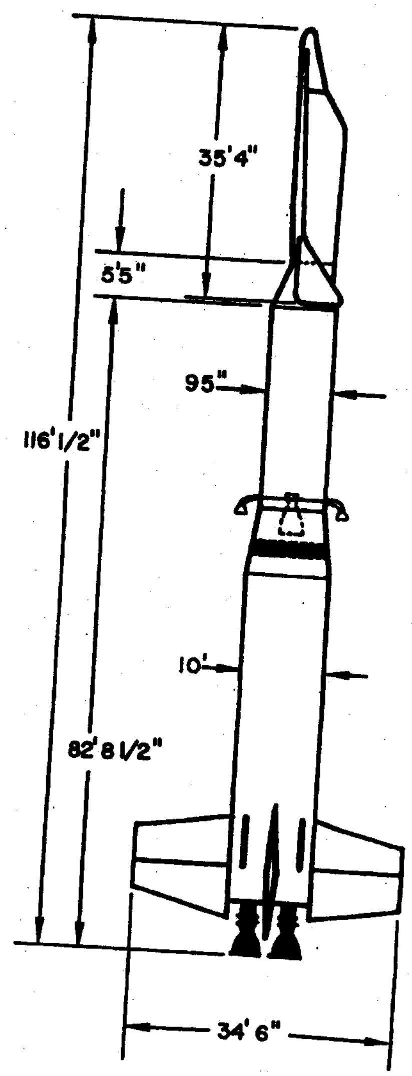
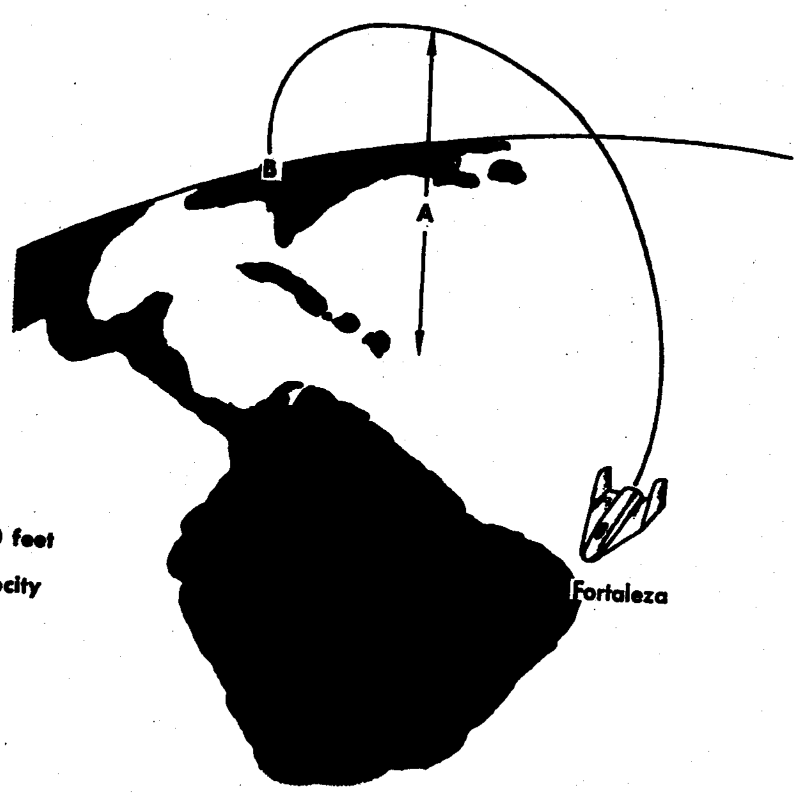


Figure 1. DYNA SOAR vehicle configuration drawing and specification list.

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.

FLIGHT ONE (Unmanned) TRAJECTORY



A. Altitude 250,000 feet

B. Boost Burnout Velocity 18,600 fps

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 techincal 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.
- The Martin Company submitted its DYNA SOAR launch facility report on 26 September. The DYNA SOAR Facilities Working Group has decided to use the gantry approach rather than the erector approach for Atlantic Missile Range launches.
- The Aerospace Corporation is providing technical supervision support to the booster portion of the DYNA SOAR Program. Space Technology Laboratories' efforts have been terminated.
- Program Evaluation Procedures (PEP) have been adapted as a technique of DYNA SOAR management. The system contractor and associate contractors are participating.
- The Martin Company has completed and submitted the following trade-off studies:

1. Second stage Propellant Load and Pressurization System on 26 August.
2. Structural Design and Criteria on 2 September.
3. Staging Techniques (including fire-in-the-hole) on 12 September.
4. Reliability and Safety on 15 September.
5. Booster-Glider Interface on 19 September.
6. Malfunction Detection and Warning System on 3 October.

revised funding requirements necessitated by the increased cost of the Development Test Program.

Flight Test Progress

• The first 609A vehicle, type XRM-91, was launched from the AMR at 0801 EST on 21 September. The countdown proceeded with no major holds and all flight events were normal until approximately eight seconds prior to fourth stage burnout. At this point, T plus 151 seconds, the telemetry failed and consequently the duration of the fourth stage burning is unknown. The trajectory was as planned and the 32.8 lb payload probably reached an altitude of 14,400 nautical miles. All of the payload test objectives (vehicle development objectives) appear to have been accomplished. The secondary objectives (payload objectives) were not accomplished.

Technical Progress

• Serious quality control and fabrication deficiencies have been discovered in the guidance system timer unit. The launch of the first guided vehicle scheduled for 21 October will be delayed. The Haydon Company is working on a three-shift basis and Minneapolis-Honeywell and Aeronutronic personnel are assisting in modification design and are monitoring the timer rework. There is a possibility that the delay will be less than ten days.

• The ABL-X254 rocket motor program for the first guided vehicle was found to be defective. The motor case developed a 360° crack, located along the forward attachment ring, during curing. A satisfactory modification to the motor case has been developed. The fabrication and delivery of a new motor could cause a schedule slippage, but the timer problem appears to be the critical item.

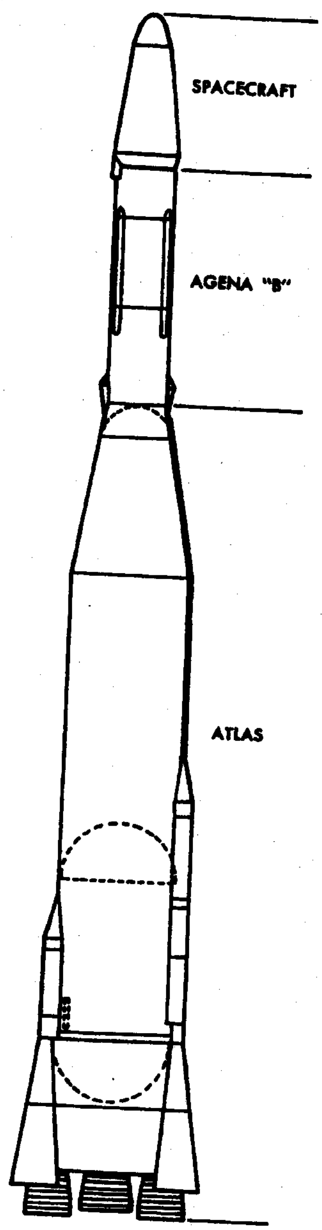
• A successful linear charge motor destruct test was accomplished at Edwards Air Force Base on a rejected ABL-X248 motor. The motor did not have a high order detonation as expected. The case split and the propellant burned rapidly. The test was required to demonstrate 609A guided vehicle destruct capability to AMR range safety.

Facilities

• Final design drawings for the two assembly and checkout buildings and the combined system test building were received from the architect-engineer. Following a final design review, scheduled for 11 October, plans and specifications for these buildings will be sent out to contractors for bids. Concept drawings for the payload carrier building and engine storage building also have been received.

Figure 5. The payload for the first 609A flight during checkout. An oscilloscope, a signal generator and other test equipment is visible beside and behind the payload. Three of the four payload antennas can be seen above the dark band.

NASA AGENA "B" PROGRAM



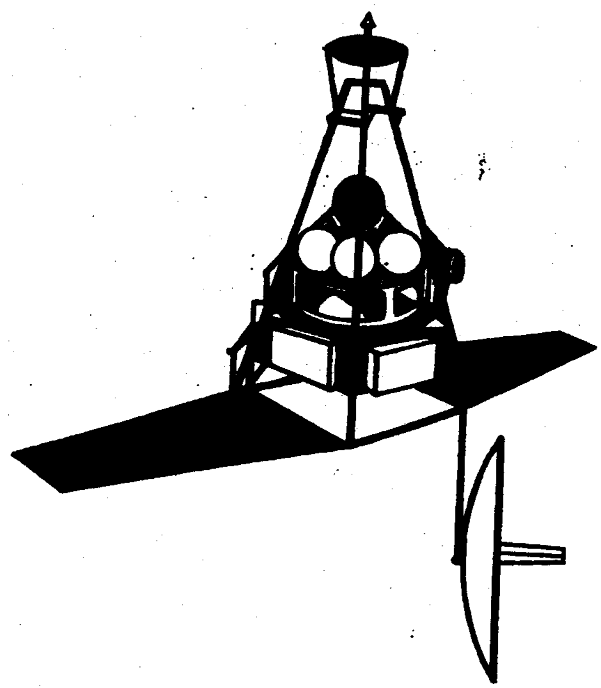
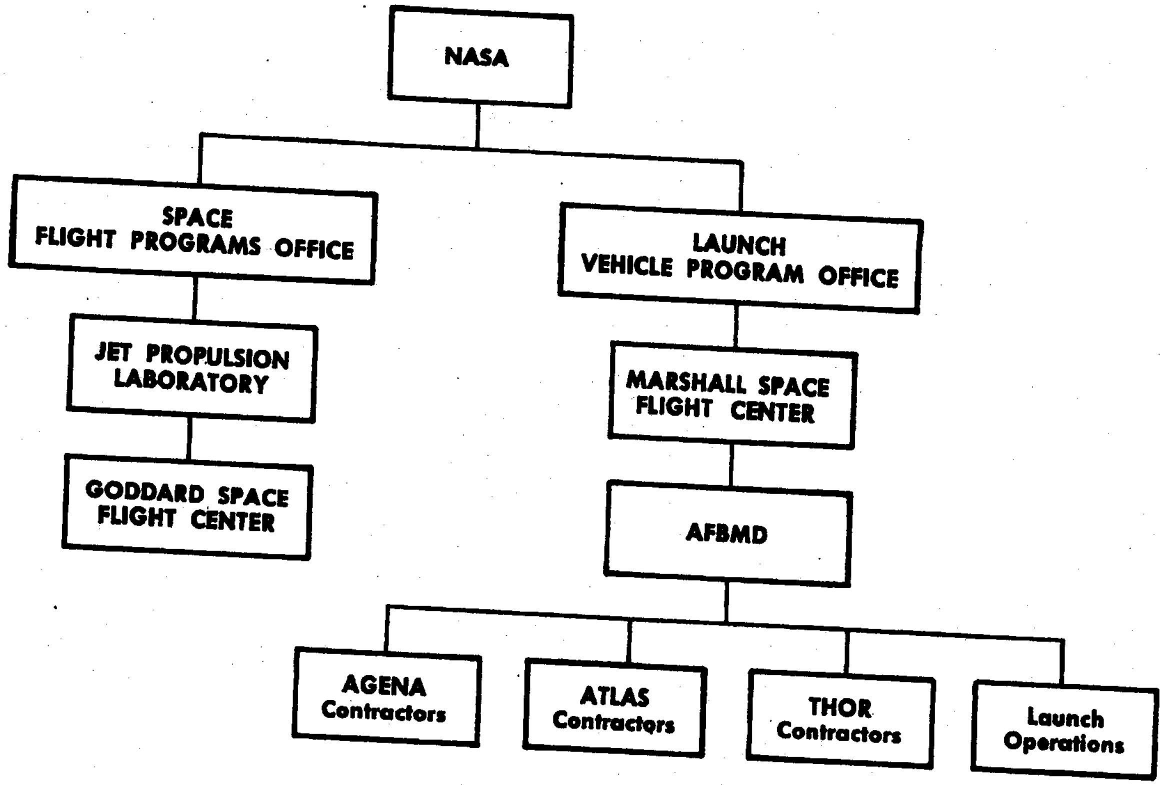


Figure 1. NASA AGENA "B" configuration for Ranger flights (left). Proposed Ranger lunar spacecraft (above) which will be launched from the Atlantic Missile Range.

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



NASA AGENA "B" Project Organization Chart

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

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

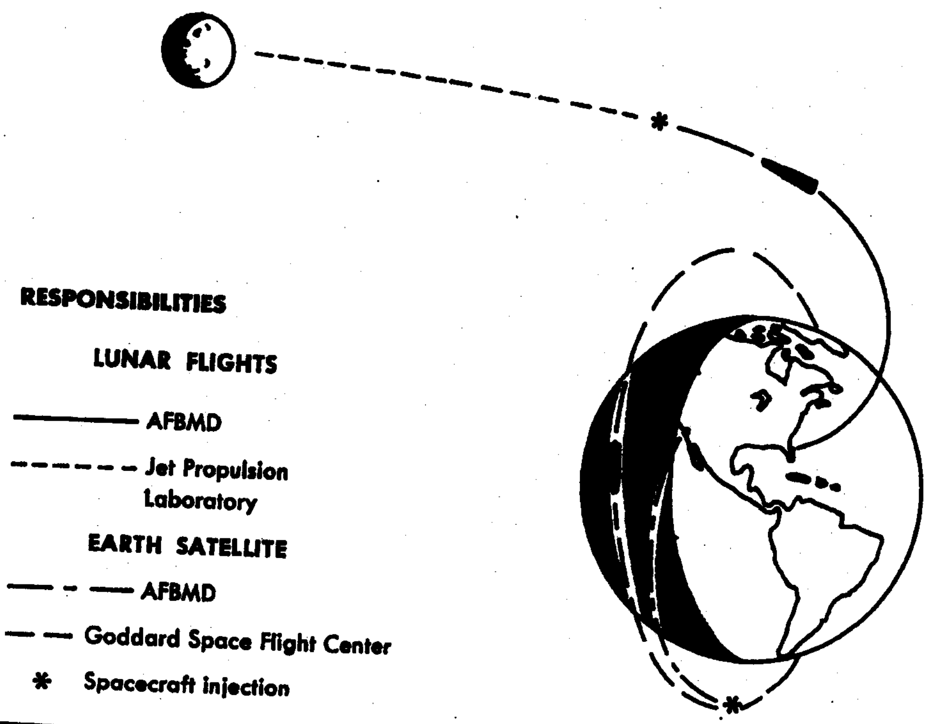
Note: Lunar flights will be launched from the Atlantic Missile Range; all others will be made from Vandenberg Air Force Base.

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

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

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

NASA AGENA "B" Program Flights



SPACE
defense programs

SAINT

SPACE DEFENSE PROGRAMS

SAINT

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

Program Objectives

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

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

Satellite Inspector Feasibility Demonstration

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

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

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

Satellite Inspector System

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

SPACE

program boosters

SPACE PROGRAM BOOSTERS

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 planping 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.

~~SECRET~~

~~CONFIDENTIAL~~

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

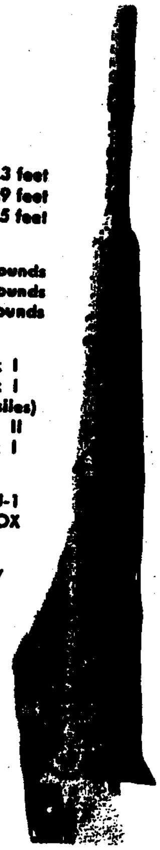
Weight (lift-off)
DM-18 — 108,000 pounds
DM-21 — 108,000 pounds
DM-21A — 107,720 pounds

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 second 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

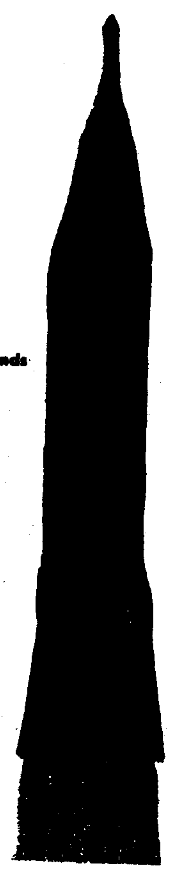
Weight — 261,206 pounds

Engine
Series D ATLAS — MA-2

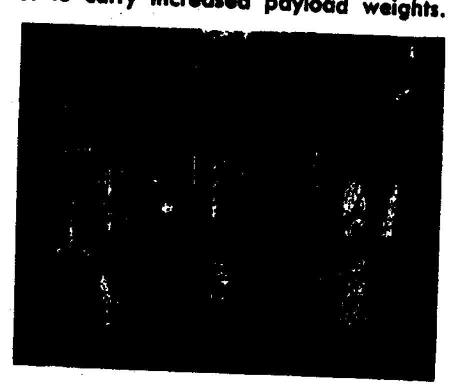
Fuel — JP-4
Oxidizer — LOX

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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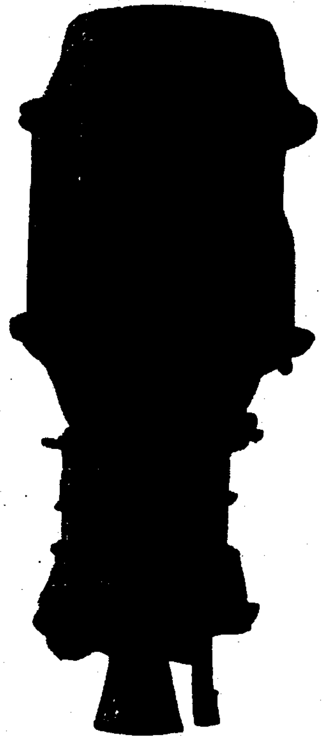
Although originally designed as the basic satellite vehicle for the Advanced Military Satellite Programs, flight testing of the AGENA was accelerated when the DISCOVERER program was created, using the THOR/AGENA combination. Because of its availability, the Bell Aircraft LR81-Ba-3 rocket engine was selected 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.



AGENA

Prime contractor:
Lockheed Missile and Space Division

Engine manufacturer:
Bell Aircraft Corp.
American Aviation

Length	
"A" version	14 feet
"B" version	19.5 feet*
	21 feet**
Diameter	60 inches
Weight	
"A" version	7,987 pounds
"B" version	14,800 pounds
Engine	
"A" version	YLR81-Ba-5
"B" version	XLR81-Ba-7*
	XLR81-Ba-9**

Fuel
Unsymmetrical Dimethyl Hydrazine

Oxidizer
Inhibited Red Fuming Nitric Acid

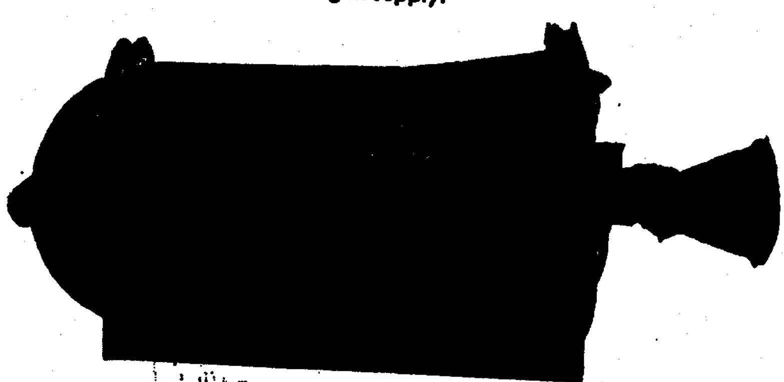
Guidance optical-inertial

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.

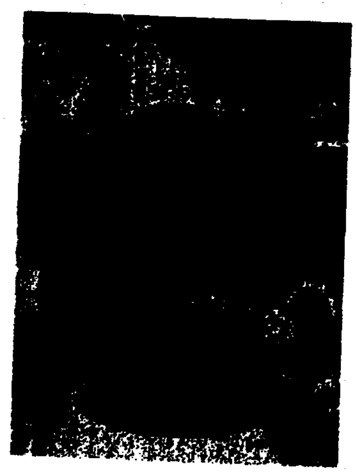
Contractor:
Aerojet-General Corp.

Height 18 feet 7 inches

Diameter 4 feet 8 inches

Weight
AJ10-42 4622 pounds
AJ10-101 4178 pounds

Fuel
Unsymmetrical Dimethyl Hydrazine



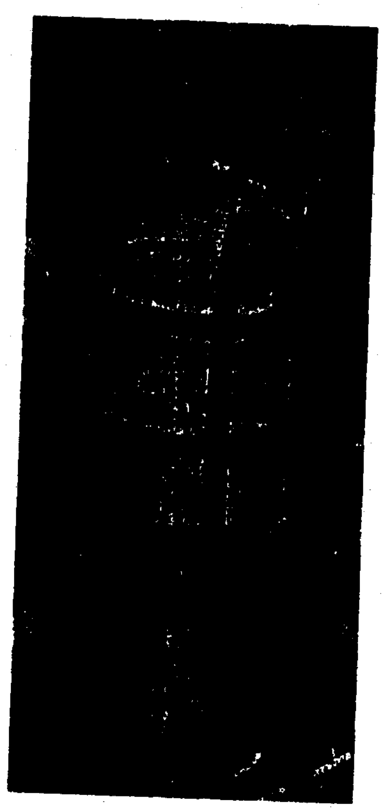
Oxidizer
Inhibited White Fuming Nitric Acid

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

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

ABL 248 Vehicle

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



Contractor:
Allegany Ballistic Laboratory

Height 4 feet 10 inches

Diameter 1 foot 6 inches

Weight 515 pounds

Fuel Solid

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

SECRET

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-Ba7④	XLR81-Ba-9④
①Weight—inert	1,262	1,328	1,346
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
②TOTAL WEIGHT	8,165	14,789	14,807
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn Time—sec.	120	240③	240③

SECOND STAGE

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

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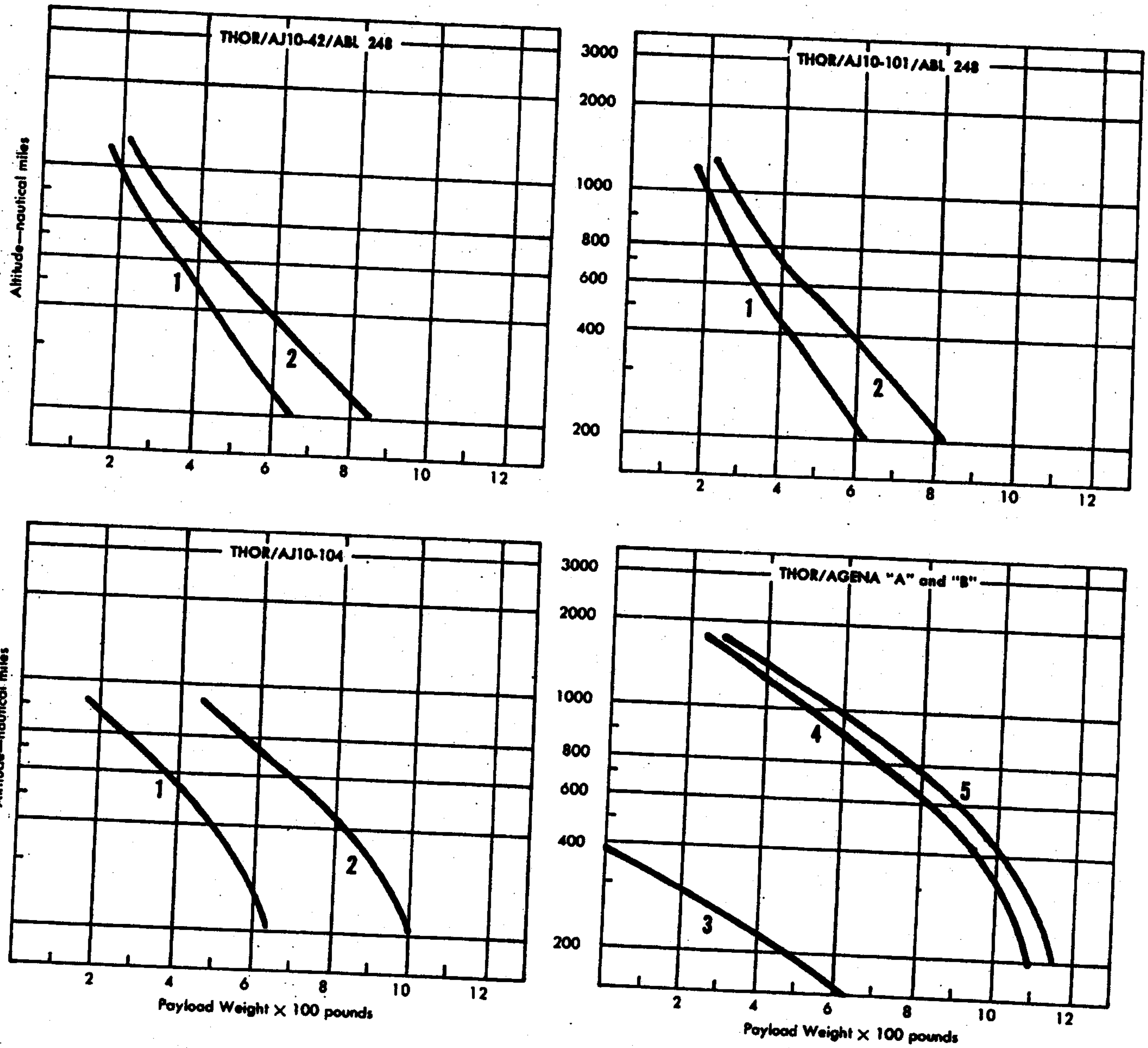
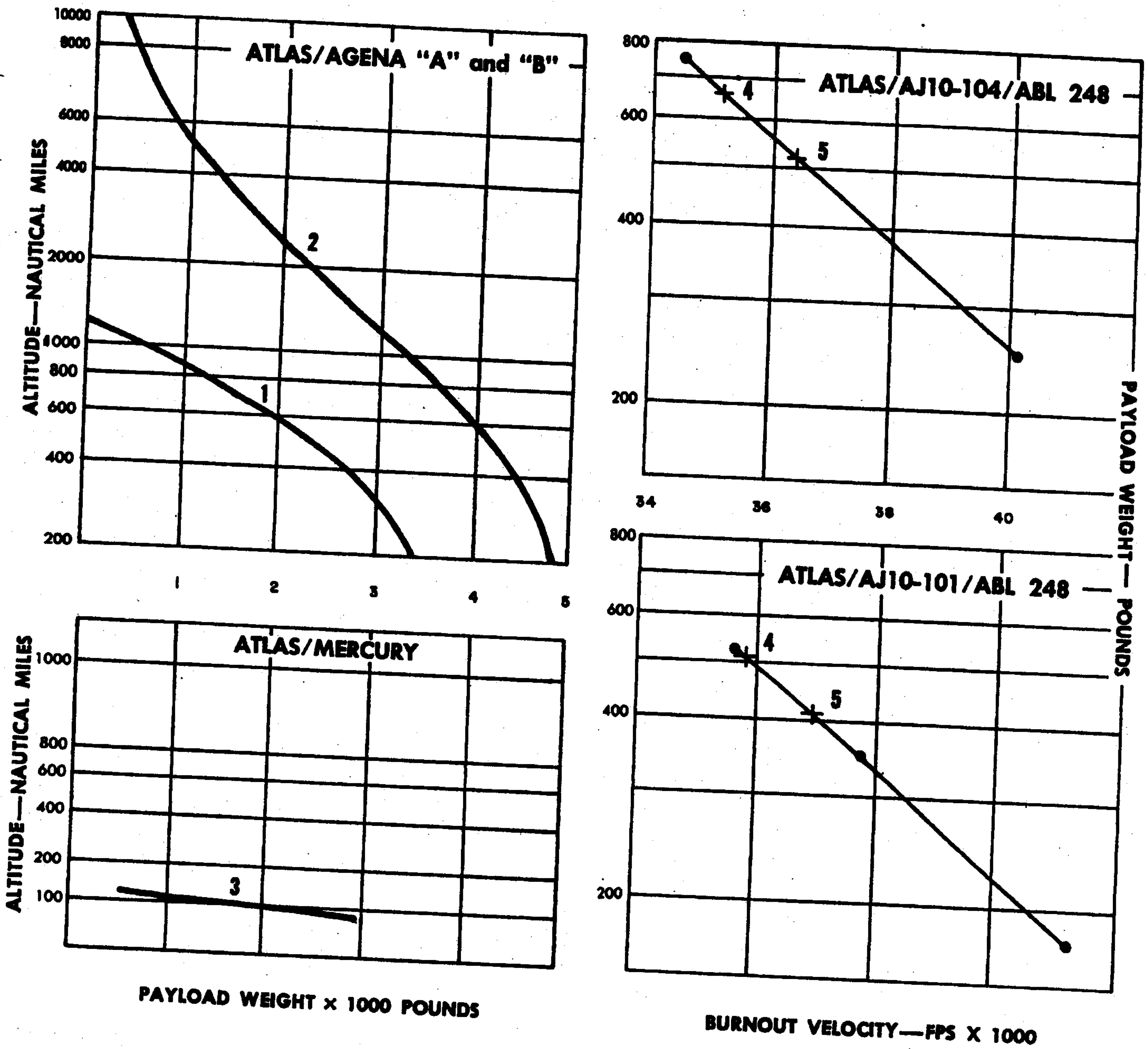
Performance Graphs — THOR BOOSTED



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

SECRET

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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