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JANUARY 1961

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FOREWORD

a foreword to...

SPACE

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

WDLPR-4

9 February 1961

Summary of AIR FORCE BALLISTIC MISSILE DIVISION Activities in Space JANUARY 1961

FOREWORD

This report includes information about: the DISCOVERER Engine Reliability Program, the data gathered by the MIDAS Radiometric Measurement flight and the successful Blue Scout I launch. The results of space radiation measurements conducted on 9 November are reported in the BIOASTRONAUTICS Section. VELA HOTEL information is included in the BOOSTER SUPPORT PROGRAMS Section.

Robert W. Hoffman Col USAF
for

O. J. RITLAND
Major General, USAF
Commander

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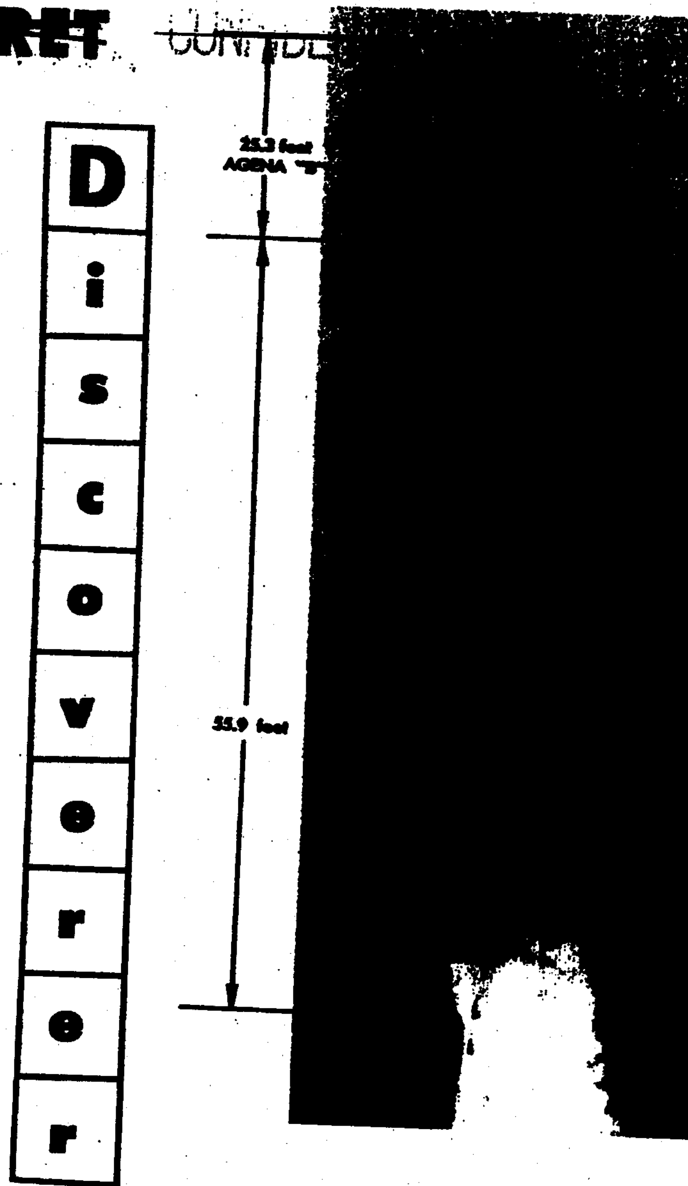
SATELLITE

systems

DISCOVERER
MIDAS
ADVENT

The DISCOVERER Program consists of the design, development and flight testing of 41 two-stage vehicles, using the Douglas DM-21 Space Booster as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Project's Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.



PROGRAM OBJECTIVES

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

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

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

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

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

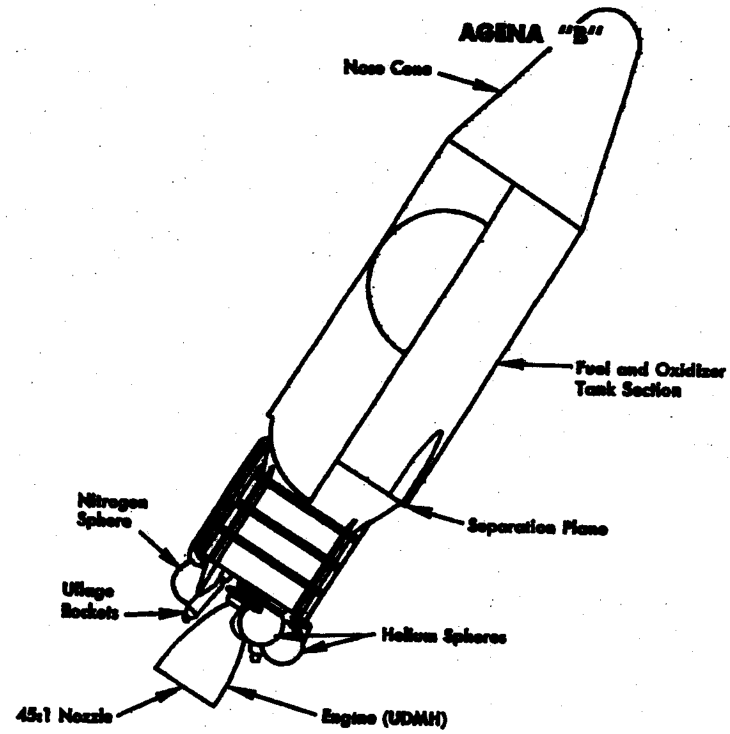
PROGRAM SUMMARY

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

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

SECOND STAGE	AGENA "B"	
Weight—		
Inert	1,328	1,346
Payload equipment	887	915
Orbital	2,215	2,261
Impulse propellants	12,950	12,950
Other	511	511
TOTAL WEIGHT	15,676	15,722
Engine Model	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	16,000
Spec. Imp.-sec., vac.	277	290
Burn time-sec.	240	240
BOOSTER	DM-21	
Weight—Dry	6,500	
Fuel	33,700	
Oxidizer (LOX)	68,200	
GROSS WEIGHT (lbs.)	108,400	
Engine	MB-3 Block 2	
Thrust, lbs. (S.L.)	169,000	
Spec. Imp., sec. (S.L.)	248.3	
Burn Time, sec.	148	

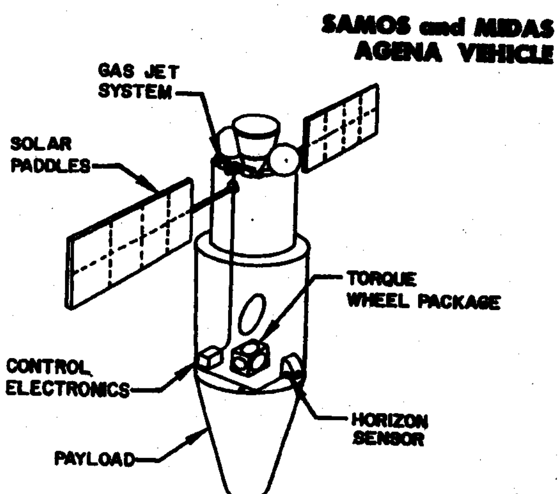
Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and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

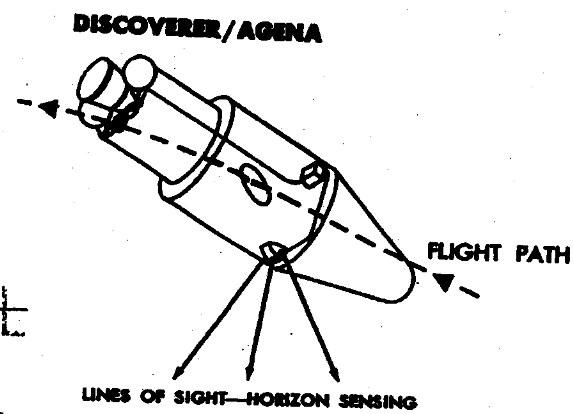


AGENA VEHICLE DEVELOPMENT

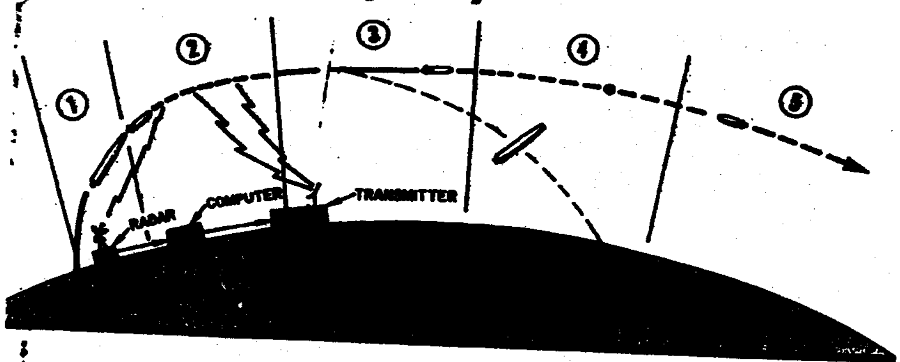
The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. The first AGENA satellites or "A" configuration employed the YLR-81Ba-5 engine which developed 15,600 pounds thrust at altitude. The development of an optical inertial system for vehicle stabilization and an attitude control system for orbit injection resulted from the advanced programs stringent eccentricity requirements.

By increasing the tank capacities on the AGENA "A" an improved performance capability was achieved. This new configuration or AGENA "B" used the Bell XLR-81Ba-7 engine and was first flown on DISCOVERER XVI. The latest AGENA "B" vehicles use the 16,000 pound thrust XLR-81Ba-9 engine which has a restart capability. This larger vehicle permits achieving higher injection altitudes with equivalent weight payloads and the restart provision permits orbital adjustment.

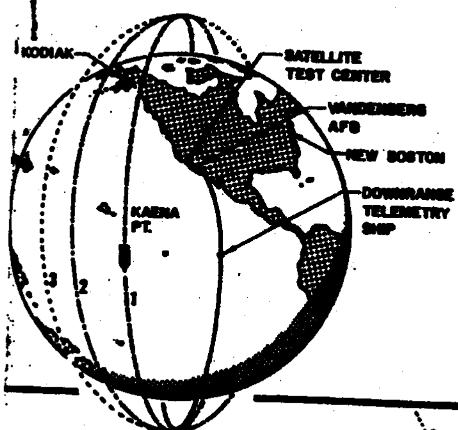




Powered Flight Trajectory

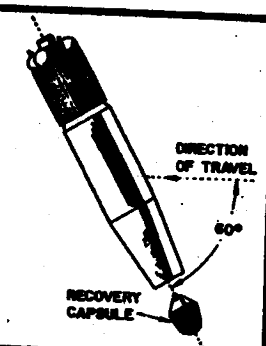


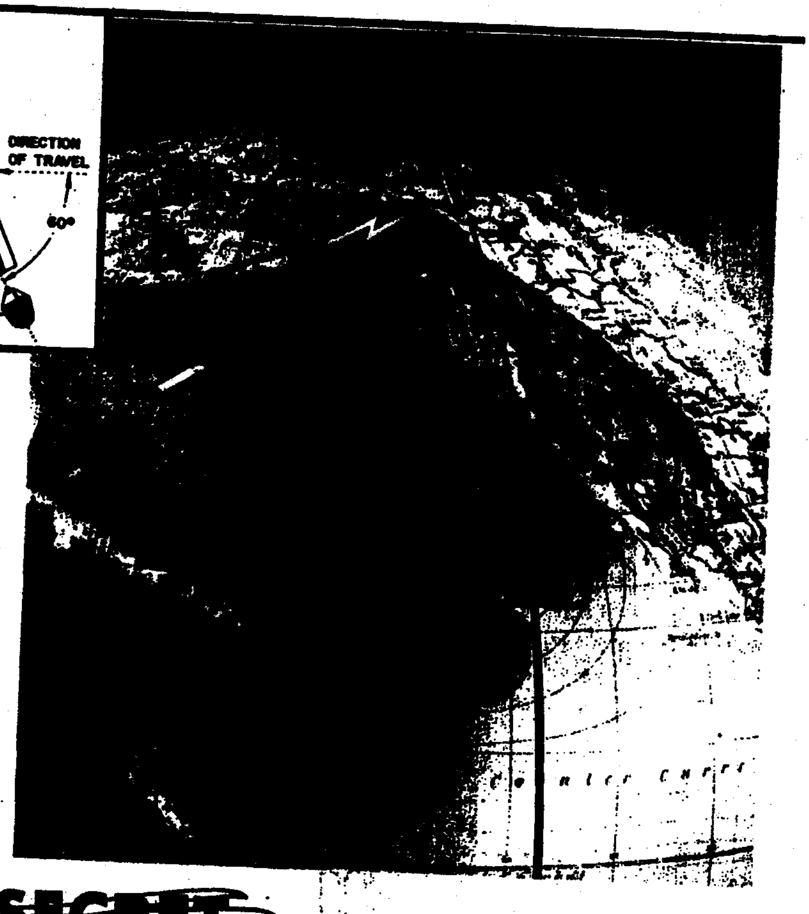
1. **First Stage Powered Flight** — 2.5 minutes duration, 78 n.m. downrange, guided by programmed autopilot and BTL guidance.
2. **Coast Period** — 2.4 minutes duration, to 380 n.m. downrange, attitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity to be gained commands.
3. **Second Stage Powered Flight** — Approximately four minutes or until injection velocity is attained. Pitch and yaw stabilization achieved by gimballing the engine and roll by gas reaction jets. Engine shutdown achieved by integrator accelerometer cutoff command.
4. **Vehicle Reorients to Nose Aft** — 2 minutes duration. 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 4.





RECOVERY CAPABILITY

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

CAPSULE RECOVERY SEQUENCE

- *The desired orbit for capsule ejection is selected and programmed into the vehicle prior to launch. If an alternate pass is desirable, an ejection command is sent to the satellite before this alternate re-entry pass. This command may be sent from any of the primary tracking stations listed on page A-4.*
- *The ejection sequence includes a pitch down maneuver, capsule separation, spin-up, retro-rocket firing, de-spin and re-entry. Following parachute deployment the aerial recovery force converges on the descending capsule and snags the parachute. The capsule contains a radio beacon and reflective chaff which is dispersed to aid in tracking.*
- *The recovery force consists of C-119, RC-121, WVII and JC-54 aircraft supplemented by 2 or 3 surface vessels that receive and record telemetry data. If it is necessary to retrieve the capsule from the sea, these ships are available.*

GROUND SUPPORT FACILITIES

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

†Primary Tracking Stations (have command capability)

***Equipment**

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

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

CO

LAUNCH SCHEDULE

Config.	Launches	Month	Year
A	●	J	1959
A	★	F	1959
A		M	1959
A	★	A	1959
A		M	1959
A	● ●	J	1959
A		J	1959
A	★ ★	A	1959
A		S	1959
A		O	1959
A	★ ★	N	1959
A		D	1959
A		J	1960
A	● ●	F	1960
A		M	1960
A	★	A	1960
A		M	1960
A	●	J	1960
A		J	1960
A	® ®	A	1960
A	★	S	1960
B	●	O	1960
B	®	N	1960
B	® ★	D	1960
C		J	1961
C	2	F	1961
C	1	M	1961
C	2	A	1961
C	2	M	1961
C	2	J	1961
C	2	J	1961
C	2	A	1961
C	2	S	1961
C	2	O	1961
C	2	N	1961
C	2	D	1961

★ Attained orbit successfully.

® Capsule recovered.

● Failed to attain orbit.

FLIGHT HISTORY

DISCOVERER No.	THOR No.	AGENA No.	Flight Date	Remarks
0	160	1019	21 January 1959	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	163	1022	28 February	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	170	1018	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	174	1020	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	179	1023	25 June	*Same as DISCOVERER III.*
V	192	1029	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	200	1028	19 August	*Same as DISCOVERER V.*
VII	206	1051	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	212	1050	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	218	1052	4 February 1960	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	223	1054	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer. Severe pitch oscillations caused by booster autopilot malfunction.*
XI	234	1055	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
XII	160	1053	29 June	*Launch, ascent, separation, coast and orbital stage ignition were successful. Failed to achieve orbit because of AGENA attitude during orbital stage boost.*
XIII	231	1057	10 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit. Capsule was recovered after a water impact with negligible damage. All objectives except the airborne recovery were successfully achieved.*
XIV	237	1056	18 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit and was successfully recovered by the airborne force. All objectives successfully achieved.*
XV	246	1058	13 September	*Attained orbit successfully. Ejection and recovery sequence completed. Capsule impact occurred south of the recovery forces; located but lost prior to being retrieved.*
XVI	253	1061	26 October	*Launch and ascent normal. AGENA failed to separate from booster and failed to attain orbit.*
XVII	297	1062	12 November	*Attained orbit successfully. Recovery capsule ejected on 31st orbit and aerial recovery was accomplished. All objectives were successfully achieved.*
XVIII	296	1103	7 December	*Attained orbit successfully. Recovery capsule ejected on 48th orbit and aerial recovery was accomplished. All objectives were successfully achieved.*
XIX	258	1101	20 December	*Attained orbit successfully. Non-recoverable, radiometric data gathering MIDAS support flight.*

VEHICLE CONFIGURATIONS

A. THOR—DM-18/AGENA "A"

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

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

Monthly Progress — DISCOVERER Program

Flight Test Progress

DISCOVERER XIX Flight Investigation

• DISCOVERER XIX was launched on 20 December carrying a radiometric payload (non-recoverable) in support of the MIDAS Program. Because of a loss of control gas, the satellite was unstable in attitude on orbit. Despite the satellite oscillations, sufficient data were obtained for evaluation of the payload operation. Gas expenditure through ascent and orbital injection was normal. Telemetry data shows a rapid loss of gas from engine cutoff until the satellite passed out of range of the telemetry ship. By the time of acquisition at Kodiak on the first pass, all gas in the storage bottles was gone.

• The nature of the malfunction, as determined from telemetered data, pointed to a failure in some portion of the equipment which controls gas valves one and three. The most probable point of failure was ascertained to be the output stage of the gas valve amplifier. A dynamic simulation on an analog computer confirmed this analysis. Tests were conducted on an identical amplifier and these tests narrowed the failure to a particular transistor in the amplifier.

Future Flights

• Two DISCOVERER launches were scheduled for January but both launches have been rescheduled for early in February. This resulted from the decision to delay the launch of SAMOS II from 20 January to 31 January. DISCOVERER XX was rescheduled to avoid possible interference during SAMOS orbital operations.

• DISCOVERER XX, scheduled for launch on 10 February, will carry a recoverable Advanced Engineering Test payload and will be used in the first attempt at a four-day recovery mission. One, two and three-day missions have been successfully accomplished on previous DISCOVERER flights. The nominal recovery pass will be number 63 on this flight. The orbital programmer, however, can be adjusted by command from the ground to permit recovery on pass 15, 17, 30, 32, 46, 48 or 61.

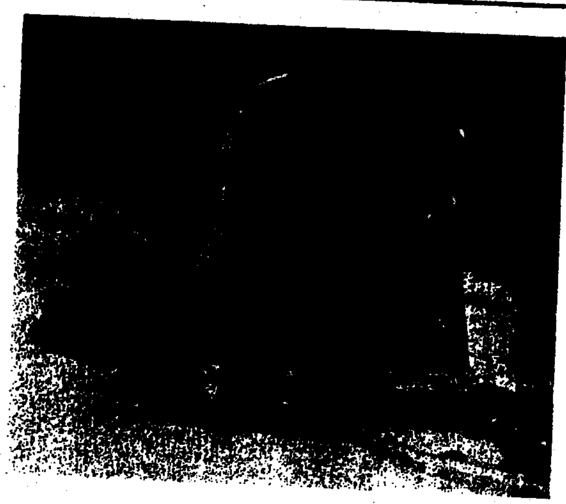


Figure 1. Radiometer for RM payload prior to installation in DISCOVERER vehicle. This unit is designed to obtain measurements of the earth's background infrared radiation and is being flown on DISCOVERER vehicles in support of the MIDAS Program. RM payload (right) is shown being lowered into a vacuum chamber at the Vandenberg Air Force Base Missile Assembly Building for a leak test of the nitrogen supply system.

• The DM-21 will carry a Bell Telephone Laboratories (BTL) guidance system for the first time on a DISCOVERER flight. It will be carried open-loop (not guiding) and performance data will be telemetered back for system evaluation. If performance of the guidance system is satisfactory, future DISCOVERER vehicles will be guided by the BTL system. The BTL guidance system, developed for TITAN I, provides very precise guidance.

• The rescheduling of DISCOVERER XX has caused the launch of DISCOVERER XXI to be delayed until mid-February. This flight will carry the second non-recoverable radiometric payload for the MIDAS program, to measure the earth's infrared radiation background.

• The first satellite (AGENA) engine re-start experiment will be conducted on DISCOVERER XXI. This first on-orbit test will be a one-second firing initiated by the orbital programmer while the satellite is over Kodiak on its first pass. The effect of reburn on the orbit will be minor. The experiment will require that the yaw-around from a nose-first to a tail-first attitude be delayed until the restart is completed. This usually occurs immediately after orbital injection.

Technical Progress

Second Stage Vehicles

• The Engine Reliability Program is on schedule at the Bell Aerosystems test facility. Twenty-six of forty scheduled firings have been completed. The phase involving evaluation of the effects of using fuels with high solid content was completed with no excessive skin temperatures being recorded.

• Ten starter assemblies were subjected to temperature and vacuum conditioning for thirty days and fired successfully. Two other assemblies were disassembled and one was found to have a cracked grain. Both units will be fired to determine the effect of the crack. These tests are part of the Thirty Day Coast Program which has the objective of developing the capability of restarting the engine after an extended coast period in space.

• The occasional speed fluctuations in the XLR-81Ba-9 engines have been corrected by installation of an acoustic damper in the gas generator. No speed fluctuations have occurred during acceptance testing of eight turbine pumps and six engines incorporating the acoustic damper. A 2 percent speed discrepancy between turbine pump acceptance tests and engine acceptance tests on production engines 323, 324 and reliability program engine 306 (all with acoustic dampers) has been attributed to servicing discrepancies.

• The causes for power level drop-offs occurring in Preliminary Flight Rating Tests on XLR-81Ba-9 engine serial number 306 have not been completely defined, but may be associated with the vertical firing position. Investigations of possible oxidizer pump housing etching and internal gas generator damage connected with vertical firing and an evaluation of the effect of these conditions on engine power level are being conducted.

Optical Tracking Light Experiments

• A meeting was held at the Smithsonian Astrophysical Observatory (SAO) on 9 January to discuss results and future plans of the DISCOVERER Optical Tracking Light Experiment. Although the Observatory has successfully photographed the AGENA vehicle on all orbiting flights since DISCOVERER XI (Figure 2), final data reduction has been insufficient to analyze the results completely. It was decided that the Observatory will complete the data reduction for DISCOVERER XVII and XVIII and forward it to Lockheed for comparison with other tracking systems (radar). Final plans for this experiment will be made following receipt of the Lockheed analysis.

Biomedical Test Program

• Results of the biopack specimens analysis carried in the recovered DISCOVERER XVIII capsule are included in the BIOASTRONAUTICS Section of this report.

Recovery Aircraft

• The JC-130B recovery aircraft should begin arriving at the 6594th Recovery and Control Group early in May with the last aircraft due to arrive on 15 June. At present one aircraft is at Edwards Air Force Base being used for pilot check out and one is at Wilmington, Delaware undergoing final tests of recovery equipment. Four other aircraft are being modified at Warner-Robbins Air Force Base.

Facilities

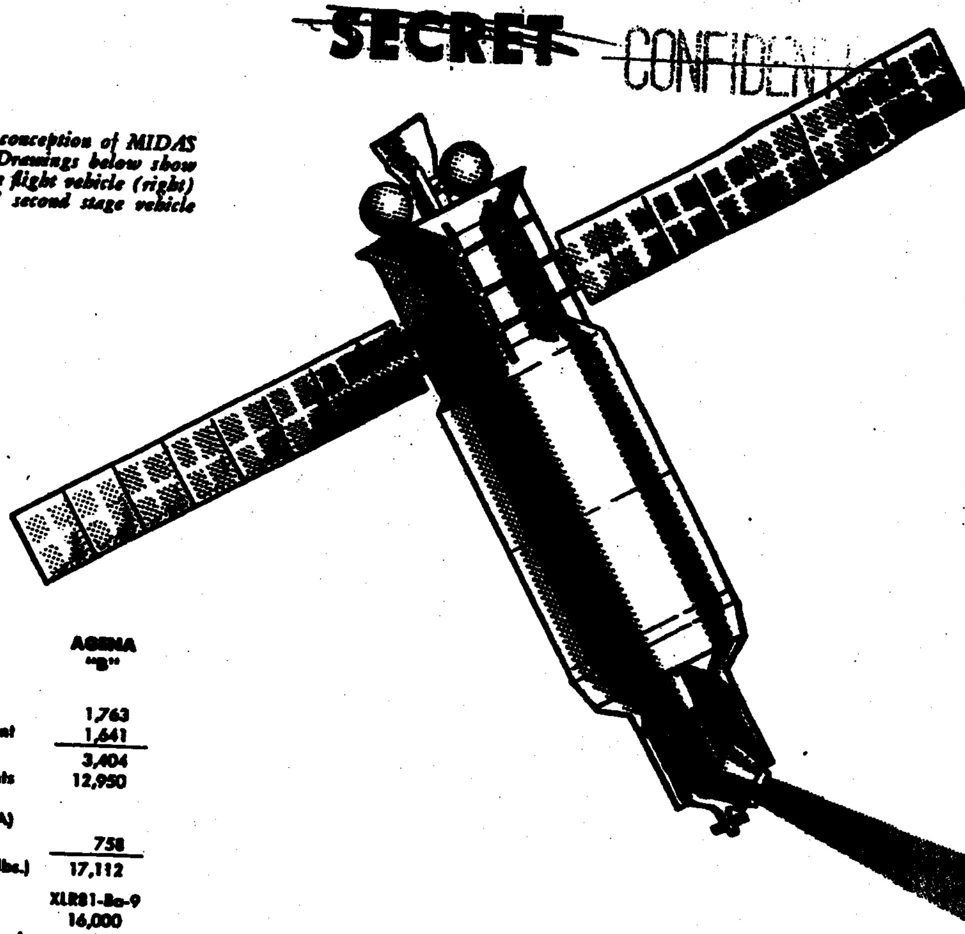
• Deliveries of AGENA launch control equipment for Vandenberg Air Force Base Complex 75-1, Pad 1 is approximately three weeks behind schedule. In an attempt to recover and adhere to the original modification completion date, AFBMD has directed

Figure 2. Optical tracking lights (left) as installed on DISCOVERER XI. Ground stations throughout the world were able to track this vehicle with powerful cameras. The lights have been carried on all subsequent DISCOVERER vehicles. The photometric sphere, shown on the right, is used to measure the intensity of optical tracking lights and the reflectance of various surfaces and to assist in the establishment of desired optical parameters.

Lockheed and Douglas to prepare an integrated revision to the installation and checkout plan which will permit AGENA Missile-On-Stand as presently scheduled. The revised schedule will result in earlier completion of items with available equipment and the simultaneous accomplishment of certain checkout functions. Review and approval of the revised installation and checkout plan is expected early in February. This revised plan provides for pad 1 activation to support a mid-May launch.

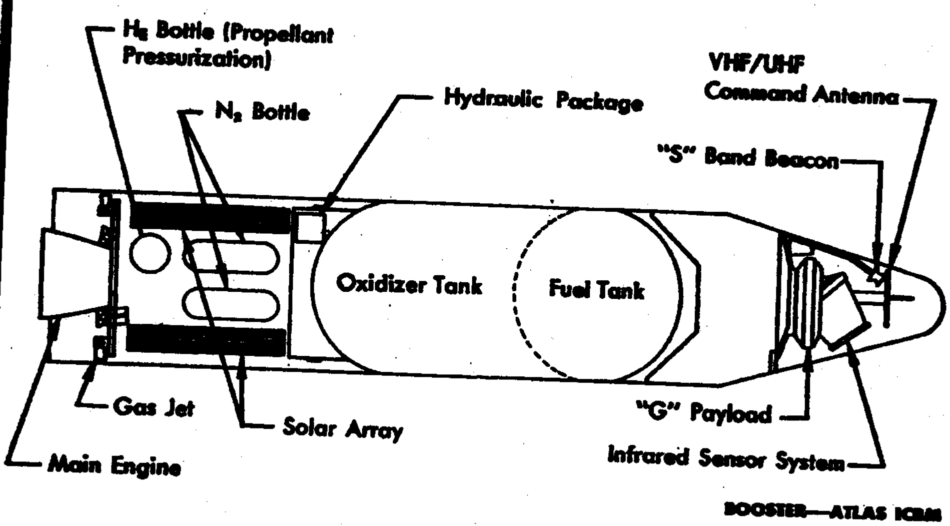
- Plans and schedules for conversion of Complex 75-3, at Vandenberg Air Force Base, to permanent propellant transfer systems and launch control modernization have been formulated by Lockheed and Douglas and approved by AFBMD. Design of facilities modification has been completed and some preliminary facility work is being accomplished on a non-interference basis. The new propellant transfer systems are scheduled for delivery to Vandenberg Air Force Base in February.

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).

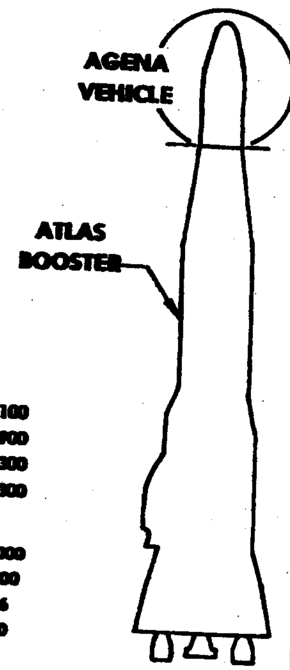


M i d a s

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



MIDAS, Configuration II, AGENA "B" Satellite



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

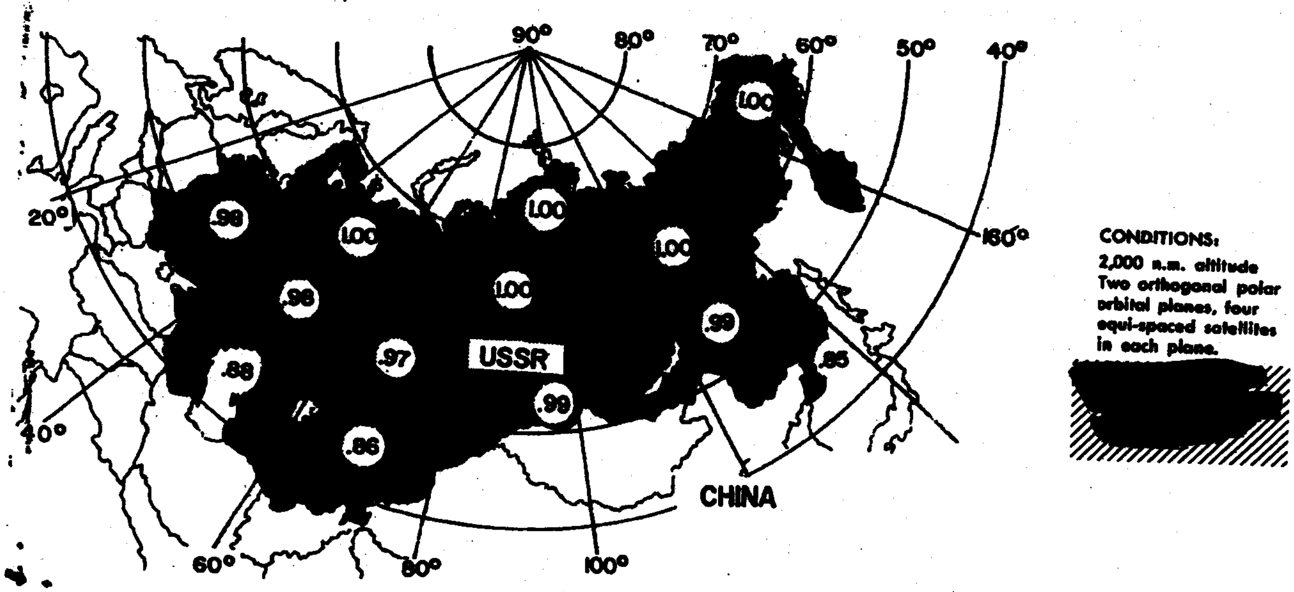
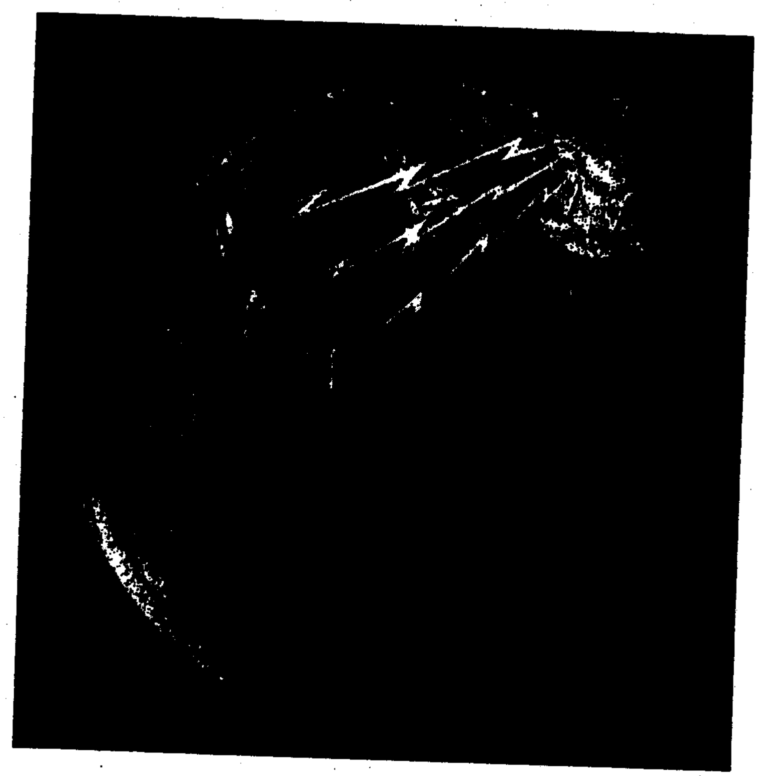


Figure 4.
Orbiting satellites detect infrared radiation emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveal approximately the number of missiles launched and launch location, direction of travel and burning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



TECHNICAL HISTORY

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

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

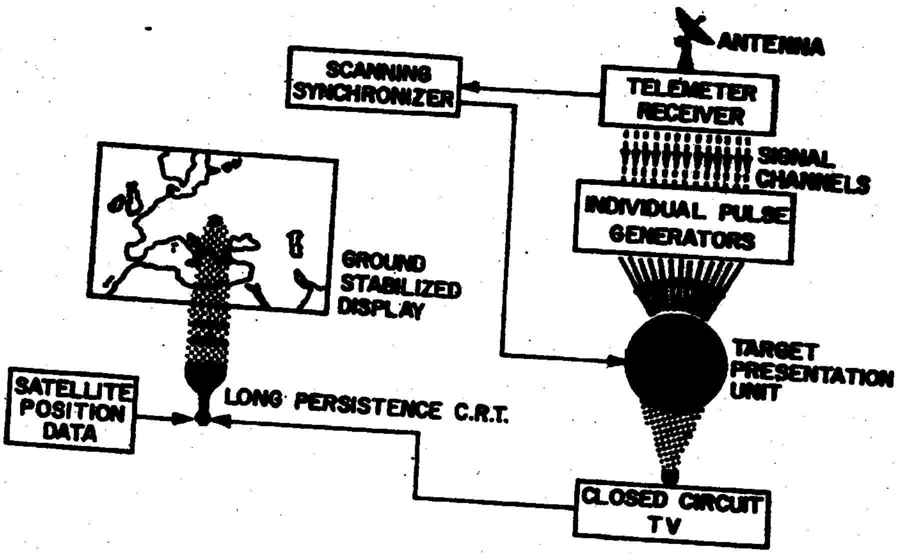
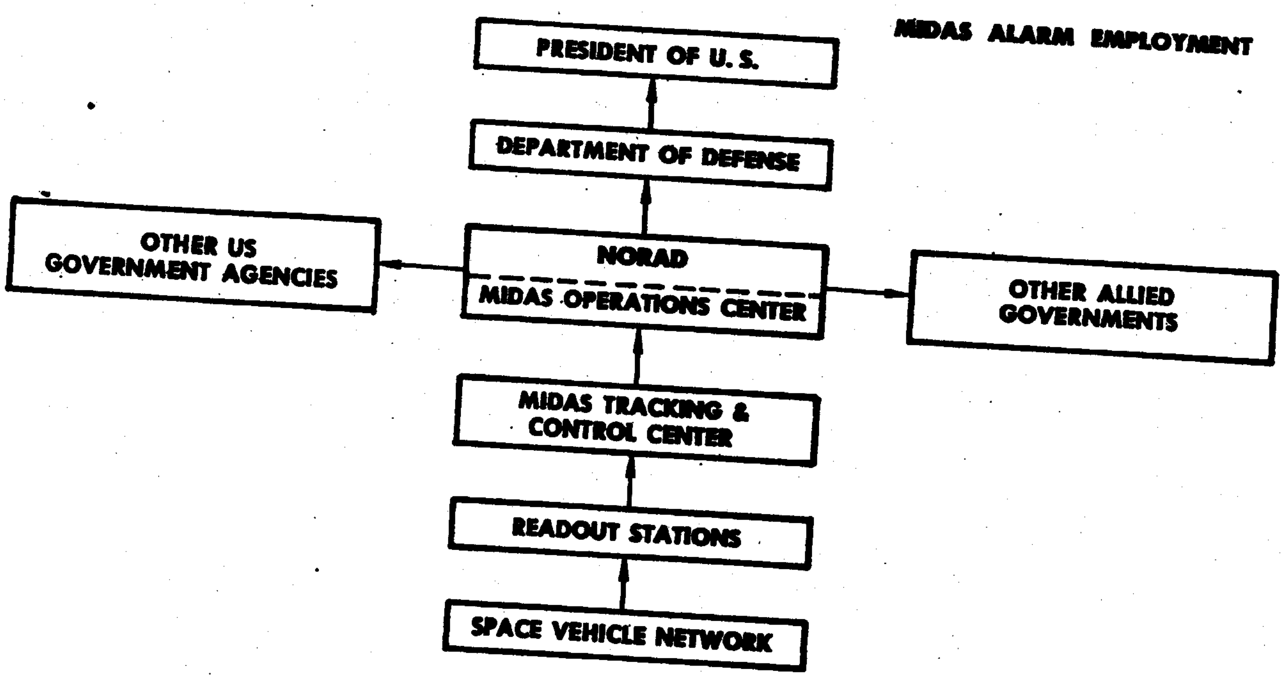


Figure 5.
Simplified version of ground presentation system (left) for display of infrared warning data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having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

MIDAS ALARM EMPLOYMENT



CONCEPT

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

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

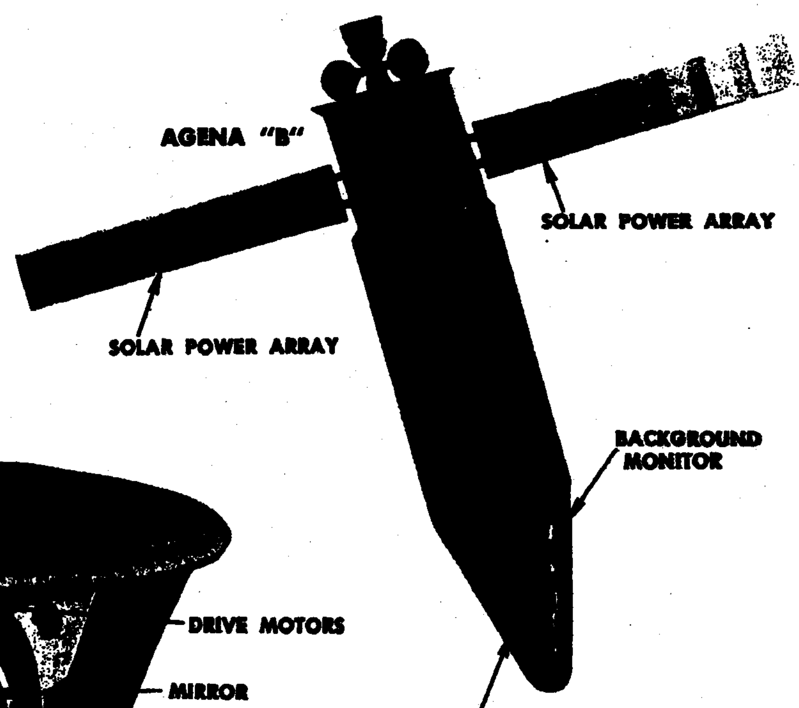
★ Attained orbit successfully ⬮ Failed to attain orbit

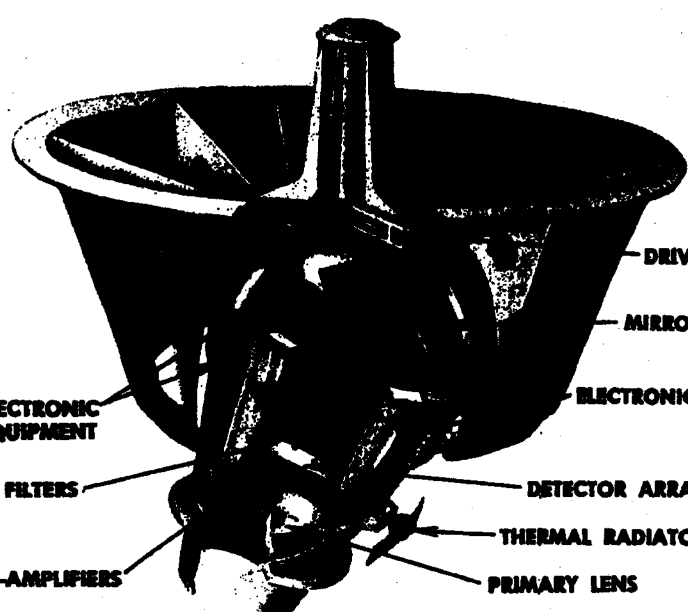
Flight History

MIDAS No.	Launch Date	ATLAS No.	AGENA No.	Remarks
I	26 February 1960	29D	1008	*Did not attain orbit because of a failure during ATLAS/AGENA separation.*
II	24 May 1960	45D	1007	*Highly successful. Performance with respect to programmed orbital parameters was outstanding. Useful infrared data were observed and recorded.*

MIDAS Infrared Detection Payload

Payload Operation: *Incident radiation passes through the primary lens, then is reflected by the mirror which brings the energy into sharp focus on the detector array. The filter is located in front of the detector array to exclude unwanted radiation. Preamplifiers are mounted in back of the detectors.*





MIDAS GROUND SUPPORT FACILITIES

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

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

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

**Equipment*

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

Monthly Progress — MIDAS Program

Program Administration

• A Headquarters USAF team, composed of members of the Weapons Board and Air Defense Panel, reviewed a revision of the MIDAS Development Plan at AFBMD on 20 January. The revised plan was prepared in response to the guidance received upon presentation of the 3 January Development Plan to the Air Force Ballistic Missile and Space Committee and Air Staff on 5-6 January. The Headquarters USAF team accepted the plan as modified and will present the new plan to the committee early in February.

• Representatives of Lockheed Missiles and Space Division (LMSD) and AFBMD met on 26 January and developed a basis for a projected MIDAS Program costing for the next five years. This possible projection of the program will be used for the annual cost study currently being compiled and scheduled for completion prior to the end of February. The cost study is being assembled and computed in such form that it may be used for inputs into the budget preparation of the actual program when finalized.

• Representatives from several contractors, Headquarters AFMTC, the 6555th Test Wing, and AFBMD met on 24-25 January to discuss the scope, policies and implementation details of the infrared measurement programs utilizing the KC-135 aircraft. The Aerojet-General Corporation has been placed under a six-month contract to install, modify and operate the target measurement equipment.

Flight Test Progress

Radiometric Measurement Flight (RM-1)

• The successful RM-1 flight (DISCOVERER XIX) on 20 December carried a radiometer designed to gather background infrared radiation information. Preliminary evaluation of the information indicates agreement with earlier data obtained from balloon-borne radiometric equipment in the 2.7-micron region with respect to structural content and average level. The 4.3 micron region is somewhat higher than had been anticipated from theoretical studies. A report on this initial evaluation is being prepared.

Future Flights

• The second radiometric measurement flight (RM-2) is scheduled for late February. A radiometer identical to RM-1 will be carried aboard this DISCOVERER XXI flight.

• The launch of MIDAS III has been rescheduled for 17 April. The General Electric horizon sensor and other equipment problems have prevented the completion of an acceptable systems test. If current sensor modifications and vehicle circuitry changes resolve the problem the April launch date can be met. However, if it is necessary to revert to the backup development system to solve the problem the launch will be delayed for an extended period. The contractors are expending every effort to resolve the problems and meet the launch date.

Technical Progress

Second Stage Vehicles

• The MIDAS IV vehicle, which has been rescheduled for launch late in May, is approximately 40 percent complete in the systems test phase. Transfer of the vehicle from systems test is scheduled for 28 March. The ATLAS booster for this flight is on schedule.

Infrared Scanners

Infrared scanners for MIDAS III, IV and V are being developed by Baird-Atomic, Inc., and for MIDAS VI, VII and VIII by Aerojet-General Corporation.

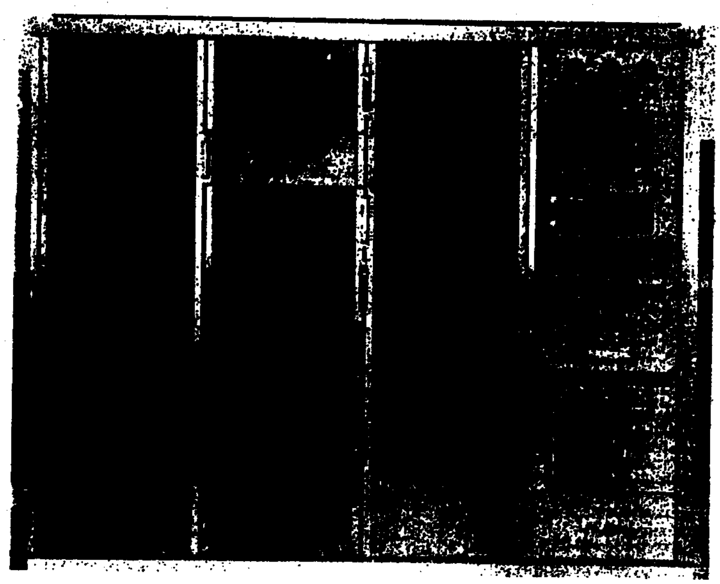
• Negotiations are in progress with Aerojet-General on their proposal for a Series IV infrared detection payload. The Series IV payload will be carried on MIDAS IX and subsequent.

Ground Support Equipment

• The ground display system manufactured by Baird-Atomic, to be used in support of MIDAS III, IV and V flights, was installed at the Vandenberg Tracking Station in early January. This equipment will provide a ground stabilized presentation of the payload readout. Similar equipment is being activated at the Satellite Test Center.

• Test equipment which will demonstrate the compatibility of the Series II payload and R-F link will be completed in mid-February. Field tests at Vandenberg Air Force Base will begin in early March.

Figure 6. The PICE terminal unit (above) shown during tests at Beckman Instruments, is scheduled for shipment to Vandenberg Air Force Base in late January. This unit serves as a tie-in between all station consoles, displays and PICE. Similar units are being built for installation at the Satellite Test Center and the new Boston Tracking Station. The High Speed Plotter (right) was designed by Lockheed to plot digital data coming from PICE units. It is capable of plotting ten curves and alphanumerical data simultaneously on sensitized paper contained in the magazine on the right of the unit. The unit plots at a paper drive speed of two inches per second with plot points .002 inches apart. This unit is complete and has been checked out with a simulated input and will be checked receiving inputs from a PICE unit. Acceptance testing is scheduled to start on 26 January.



- The Donnelly Flats communications requirements were finalized early in January. Philco was selected as the prime contractor and Western Electric as a subcontractor for the installation of equipment. This procedure will permit a better interface of all facilities.

Horizon Sensor Flight Test Program

- The U-2 Flight Test Program for initial tests of the General Electric Mod II MIDAS horizon sensor has been accomplished on a crash basis. To date, three flights have been made and data gathered on horizon sensor sensitivity is presently being analyzed. The results of this analysis will determine the extent of future flight testing.

Facilities

- Modifications to accommodate either a SAMOS or MIDAS configuration AGENA "B" at Point Arguello Complex #1, Pad 2, are progressing satisfactorily and should satisfy program need dates. The

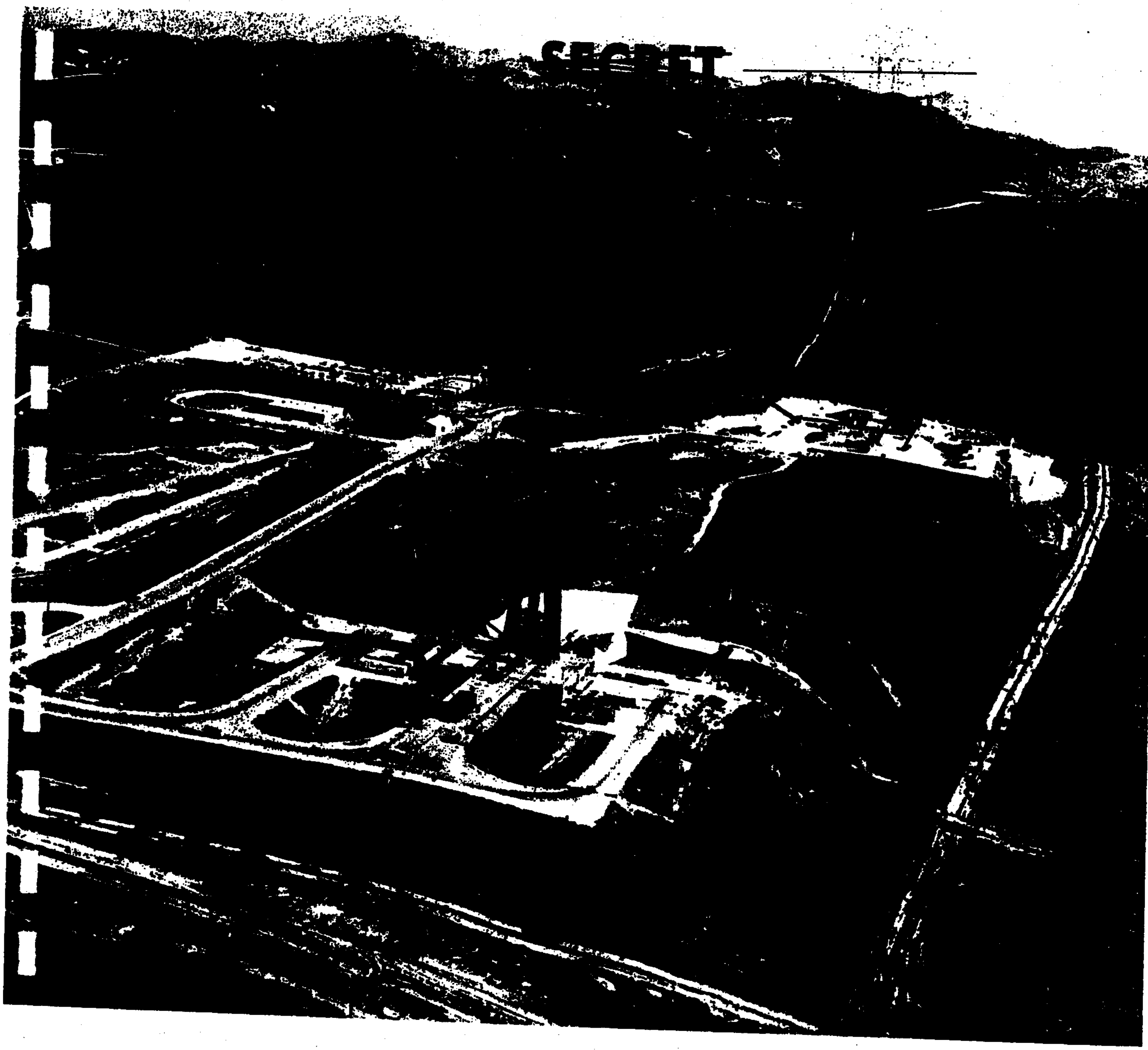


Figure 7. Point Arguello Complex Number 1, Stands 1 and 2. Two ATLAS boosters are on stand, one is MIDAS III and the other is SAMOS II. The blockhouse which monitors both stands is located to the left of and behind the stand in the foreground.

checkout equipment modifications within the Vandenberg Air Force Base missile assembly building are proceeding on schedule and will meet the MIDAS satellite vehicle schedule.

• A preliminary integrated milestone schedule has been prepared regarding the acceleration in the construction and activation of Pt. Arguello Complex No. 2. This schedule will be adjusted and approved by the SAMOS and MIDAS Programs to indicate the degree to which they are prepared to support the increased costs. A proposed Lockheed work statement has been reviewed and a proposed Convair Astronautics work statement is under review at this time.

• Design of the Ottumwa, Iowa, MIDAS Tracking and Control Center was authorized by Headquarters USAF on 27 January. Design criteria will be available early in March. Rehabilitation of storm damaged buildings has been completed and the buildings were accepted on 20 January. The central

Figure 8. Aerial view of the support facilities for the Ottumwa Tracking and Data Acquisition Station technical facilities. This station is located approximately 70 miles south-east of Des Moines. These photos were taken before a severe windstorm which damaged the roofs of some of the buildings. The rehabilitation of these storm-damaged buildings has been completed. The photographs (opposite page) show closeups of some of the Ottumwa buildings that were included in the rehabilitation program.

heating plant will be operational early in February.

- An architect-engineer has been selected to design a technical support building at the New Boston, New Hampshire tracking station. Criteria for the facility has been received from the 6594th Test Wing (Satellite). Final inspection of the general purpose and dining hall buildings was completed on 12 January. Final acceptance was deferred pending correction of several construction deficiencies.

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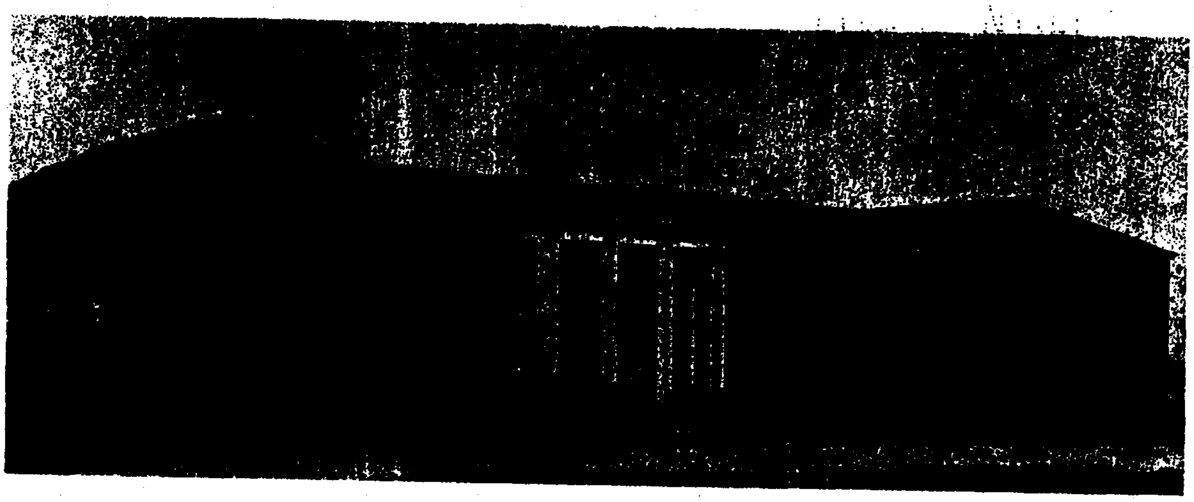
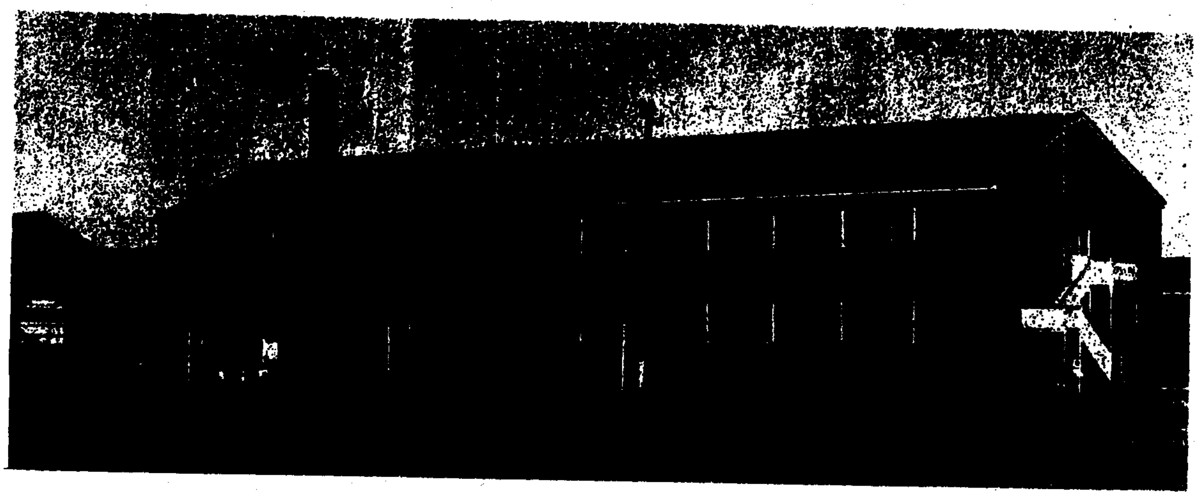
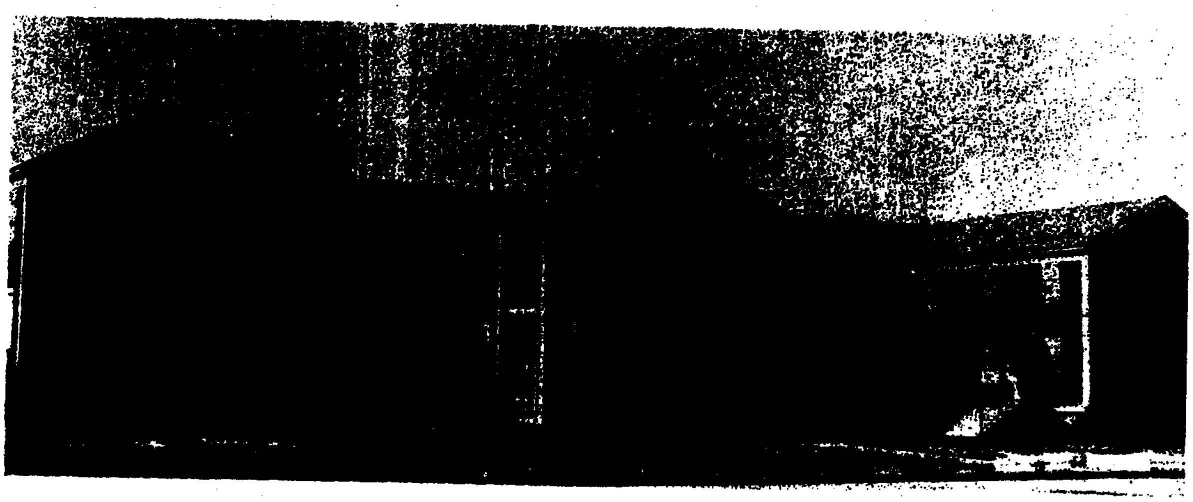


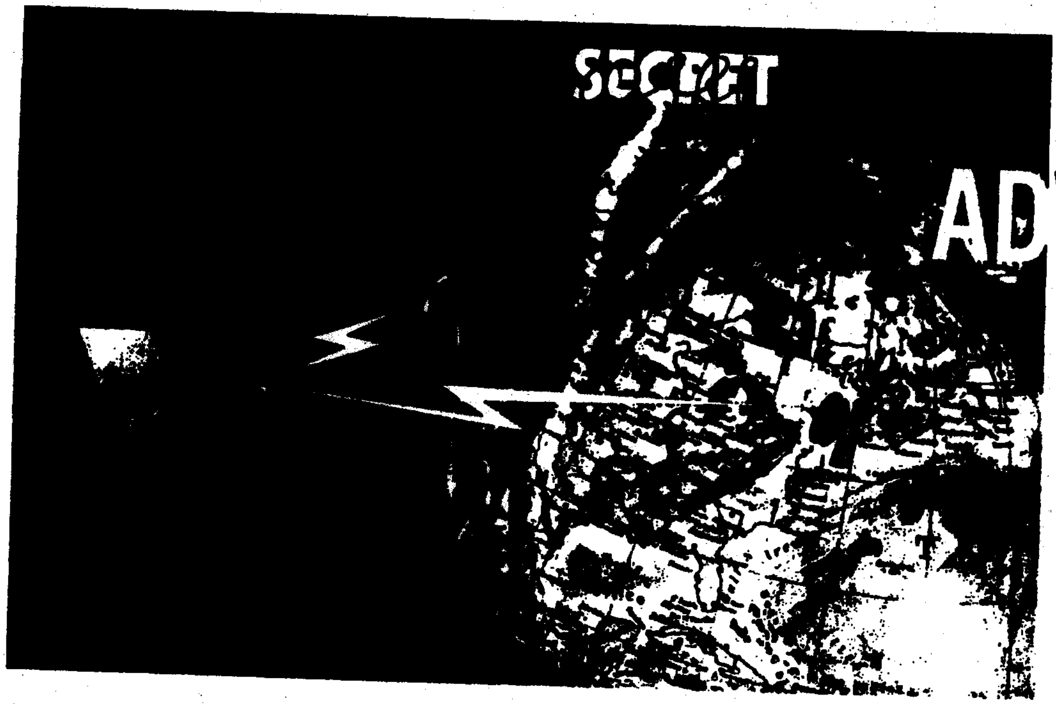
Administration Headquarters Building



Barracks Buildings



Bachelor Officer's Quarters Building



ADVENT

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

PROGRAM HISTORY

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

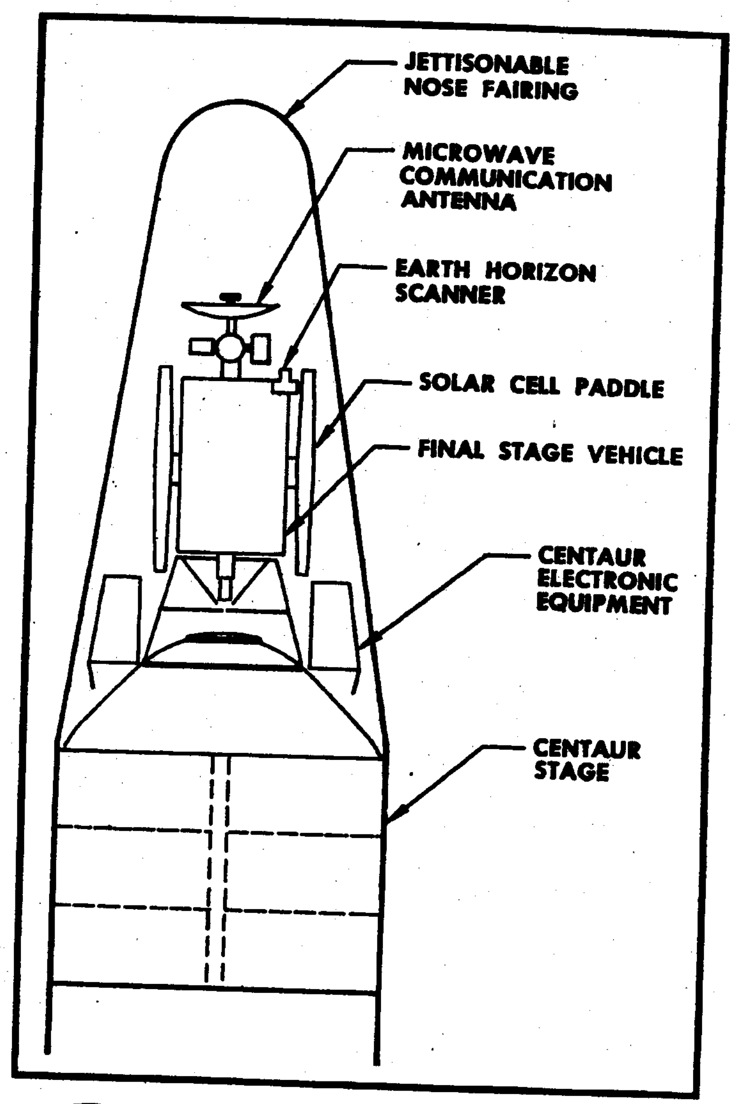


Figure 1. Proposed satellite with jettisonable fairing mounted on CENTAUR second stage.

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

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

PROGRAM OBJECTIVES

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

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

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

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

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

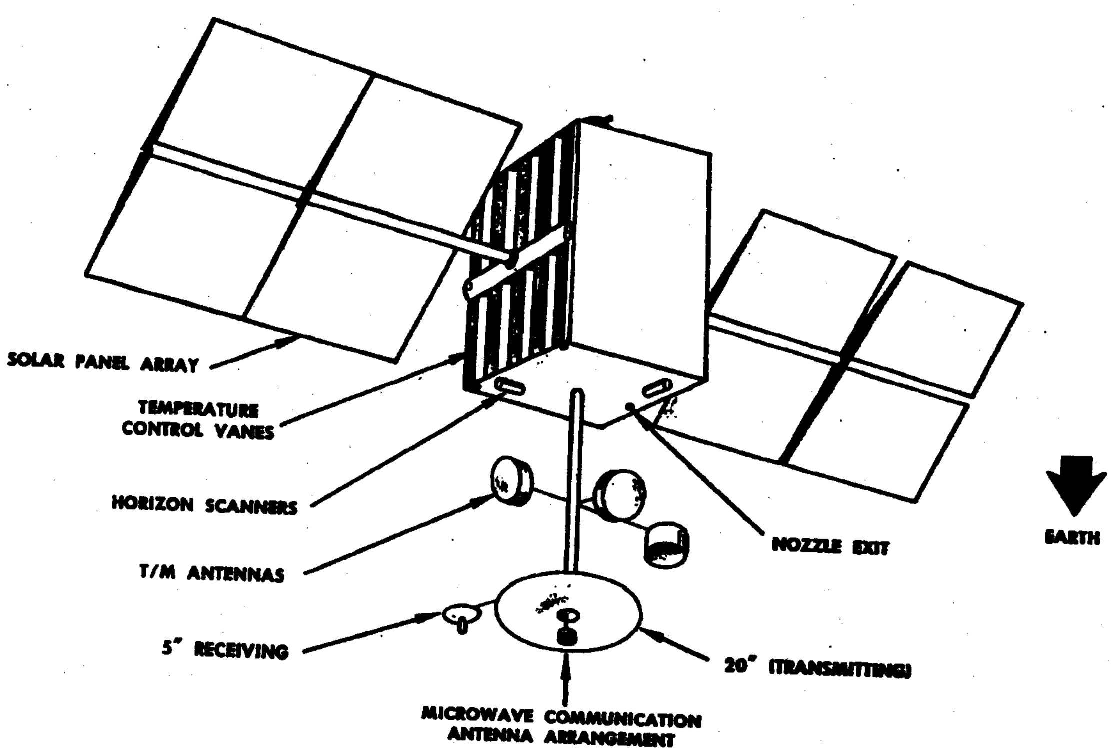
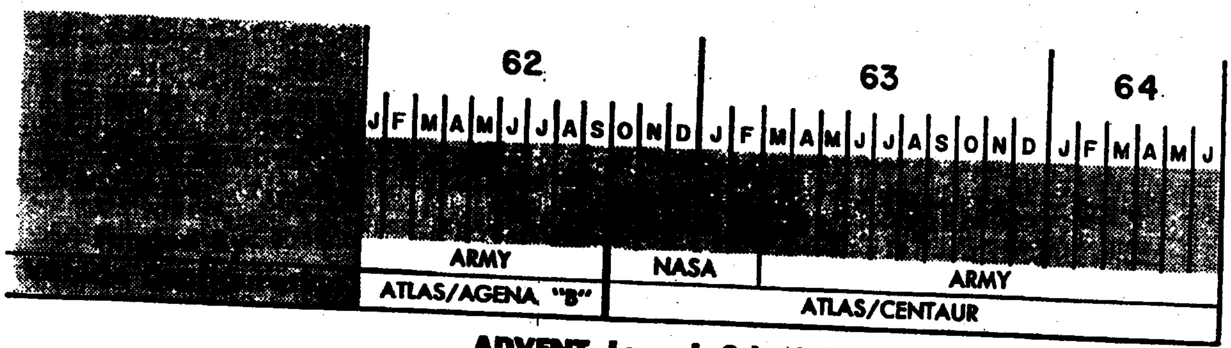


Figure 2. Initial design of final stage vehicle.



ADVENT Launch Schedule

Monthly Progress — ADVENT Program

Program Administration

• The first meeting of the ADVENT Technical Steering Committee was held at Fort Monmouth on 18-20 January. This committee is chaired by USAAMA and consists of the ADVENT Project Directors of AFBMD, BuShips, and USASRDL. Status reports were given on major subsystems of the ADVENT Project. The conclusion was that all major aspects of the program are on schedule and technical objectives are being met. Funding problems are causing some concern.

Technical Progress

Launch Vehicles

• Lockheed Missiles and Space Division (LMSD) has submitted a revised Technical Proposal and a Preliminary Program Plan for the AGENA vehicles to be used in the ADVENT Phase I launches. Technical review of the revised proposal has been completed by both AFBMD and Aerospace. Technical review of the Preliminary Program Plan is now in process. Negotiation of the work statement to be used for procurement of these AGENA vehicles will be held at AFBMD during the week of 13 February. The AGENA Configuration Review meeting will be held at LMSD on 10 February.

• A Preliminary Program Plan for the Phase II CENTAUR vehicles has been received from Convair Astronautics and is being reviewed by AFBMD and Aerospace. The Convair CENTAUR launch vehicle proposal is scheduled for submittal to AFBMD on 15 February. Preparation of proposals for the ATLAS boosters and for the Assembly and Test Operator contractor for the Phase III launches is also underway at Convair. These proposals are scheduled for submission in March; Convair indicates that preparation of all proposals is proceeding on schedule.

• A review of the Pratt and Whitney (P&W) proposal for the CENTAUR LR-119 engines has revealed that the data submitted is inadequate for a thorough evaluation of the proposed effort. A detailed description of the type of data required has been forwarded to the BMC procurement office for transmittal to P&W. Pending receipt of the additional data, processing of the complete proposal has been suspended. To insure that program schedules are not compromised, P&W has been requested to submit an abbreviated proposal covering only the long lead time tasks for which immediate contractual coverage is required. It may be necessary to utilize a letter contract for procurement of such long lead time items.

• At the January CENTAUR Management Committee meeting AFBMD indicated a need for increased CENTAUR performance to accomplish the ADVENT mission. The Convair proposal for lengthened fuel and oxidizer tanks was discussed. A proposal was made that NASA purchase this larger CENTAUR configuration for the last two development flights which are programmed to carry ADVENT final stage vehicles. A firm recommendation for purchase of the larger CENTAUR will be made to NASA at the February meeting.

Final Stage Vehicle

• Representatives of the final stage vehicle contractor and the second stage vehicle contractor attended the third monthly interface meeting on 5 and 6 January. Subsequent meetings will be called on an "as required" basis. The monthly meetings proved very effective in identifying interface problems and in arriving at solutions of such problems. Preliminary final stage vehicle/second stage interface specifications and subsystem integration plans are nearing completion.

• At the January Technical Direction Meeting, General Electric indicated they were having difficulties in meeting the schedule for the first orbit test vehicle. This is being pursued from the standpoint of:

1. An appraisal of the General Electric Company's present state of contract progress.

2. Possible means of meeting present contract commitments.

• AFBMD is evaluating the General Electric decision to proceed with Marquardt ($N_2H_4 - N_2O_4$) bi-propellant propulsion system. General Electric is continuing the mono-propellant ignition studies.

Tracking Telemetry and Command

• The review by AFBMD of the preliminary ADVENT Orbital Program Requirements Document has been completed. Distribution to all interested agencies and contractors has been initiated.

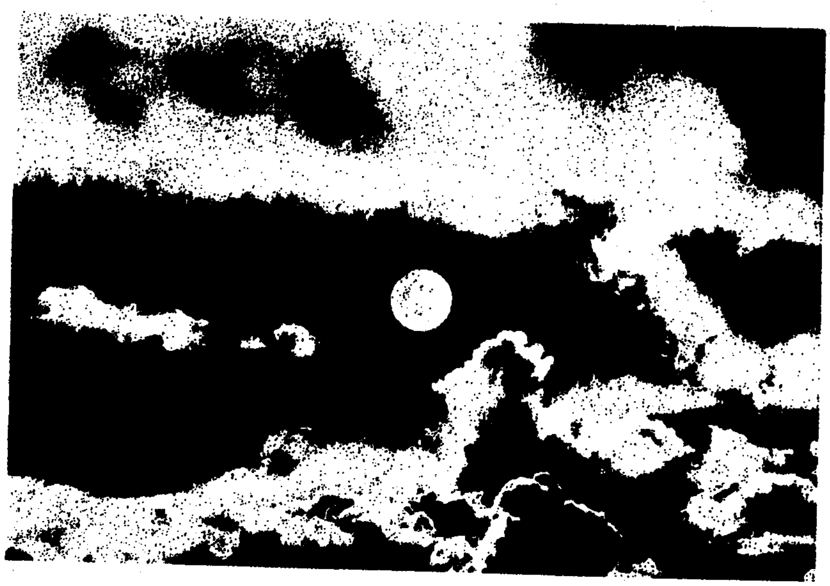
• The U.S. Army ADVENT Management Agency (USAAMA) directed AFBMD on 18 January to discontinue plans for the ADVENT Tracking, Telemetry and Command (TTC) Station at the existing Vandenberg Air Force Base tracking station. The USAAMA plans provide for a TTC station at the communications ground station site to be developed at Camp Roberts, California.

Facilities

• Initial estimates of launch support facility requirements have been submitted by General Electric, Bendix, USASRDL and USAAMA. Similar estimates for Phase I, ATLAS/AGENA launches, are being prepared by Convair and Lockheed. The GE/Bendix consolidated requirements are being reviewed and coordinated by the 6555th Test Wing, Patrick Air Force Base and the Atlantic Missile Range (AMR). On 27 January, representatives of AFBMD, 6555th Test Wing, and AMR met to discuss the ADVENT Program launch support requirements. Range recommendations for revision of initial requirements are now being reviewed and coordinated with affected associate contractors.

BOOSTER

support programs



ABLE
TRANSIT
MERCURY
609A
DYNA SOAR
NASA AGENA "B"
VELA HOTEL

BOOSTER SUPPORT PROGRAMS

Able Projects

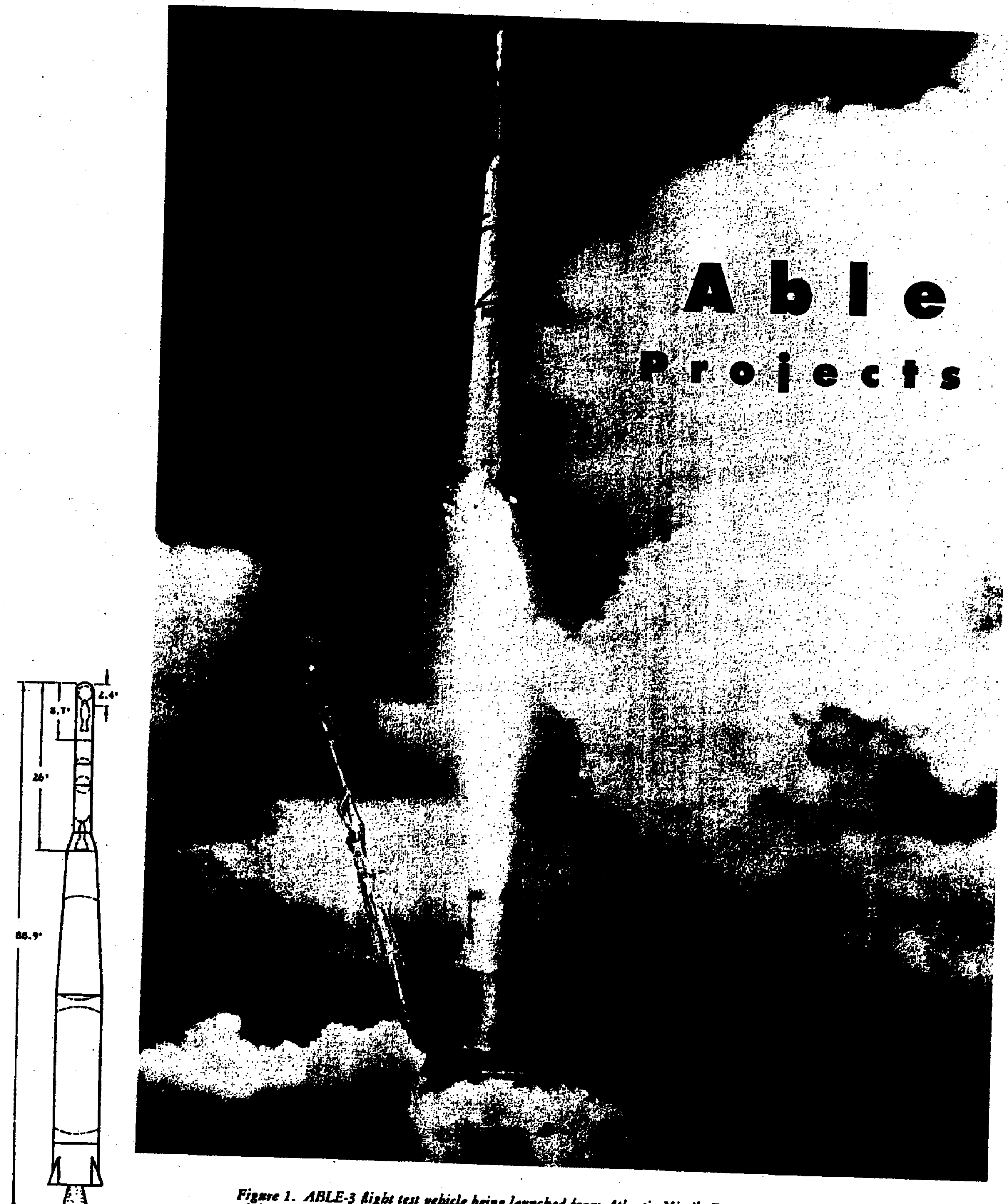
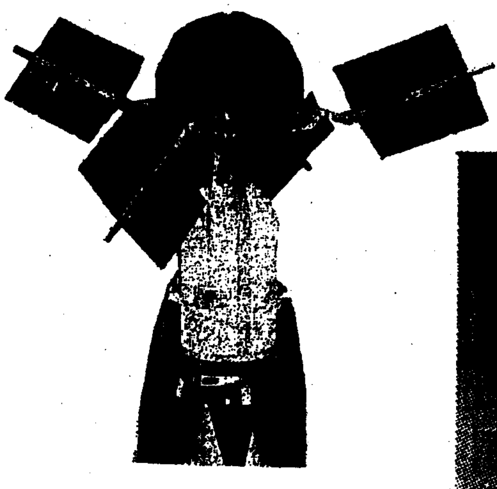


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.

The ABLE series of space probes was initiated with 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, and other military and NASA centers assisting in tracking and telemetry according to the specific requirements of each mission. The ABLE-4 program led to the development of a space booster utilizing the ATLAS ICBM as the first stage, providing a greatly increased payload capacity. A hydrazine engine with multi-start capability was developed for the ATLAS boosted vehicles to permit mid-course vernier control and to provide controlled thrust to inject the vehicle into orbit about another planet. Under the ABLE-3 and 4 programs, a solar cell power supply system was developed and extensive original design of satellite vehicle command, telemetry, and communication equipment was accomplished.

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



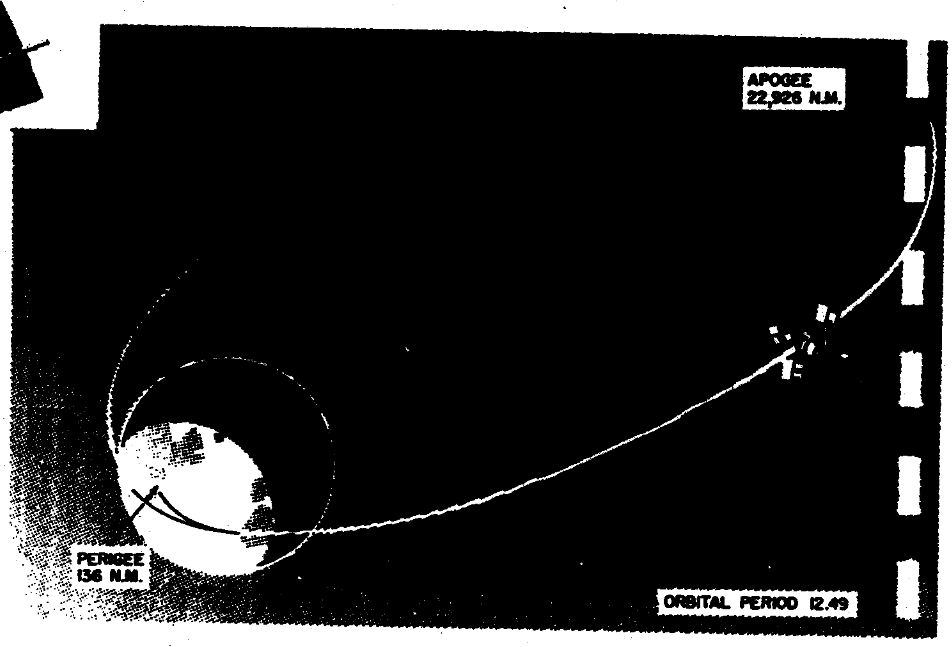


Figure 2. ABLE-3 third stage and payload (above) with solar paddles fully extended. Drawing of extremely elliptical orbit achieved by ABLE-3 (EXPLORER VI).

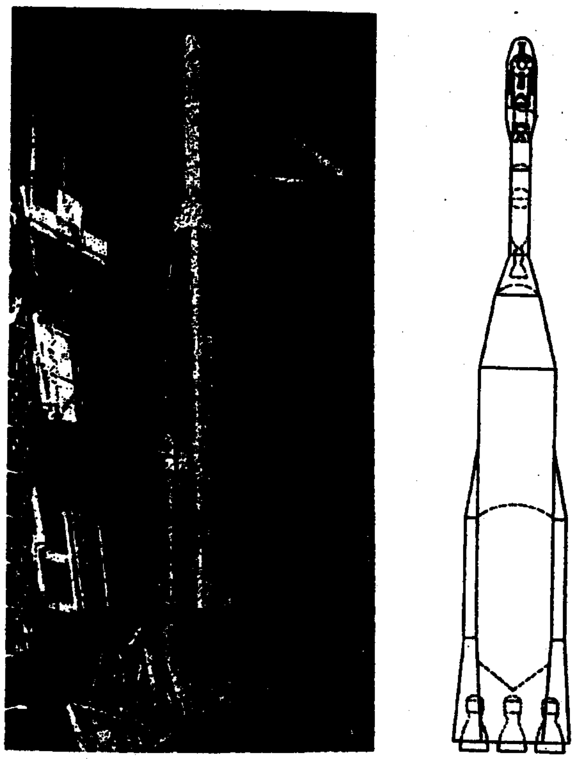


Figure 3. ABLE-4 ATLAS vehicle configuration drawing and photo of vehicle installed on Atlantic Missile Range launch stand 12.

ABLE-3 — This four stage flight vehicle was launched from the Atlantic Missile Range on 7 August 1959. The vehicle consisted of a THOR booster, a second stage using the AJ10-101A rocket engine, a third stage powered by the ABL-248-A3 engine, and a fourth stage consisting of the payload and an injection rocket. In addition to carrying a highly sophisticated payload, the ABLE-3 (EXPLORER VI) flight was used to demonstrate the validity of the ABLE-4 vehicle and component configurations. All phases of the launching were successful and the advanced scientific observatory satellite was placed in an extremely elliptical geocentric orbit. Trajectory and orbit were essentially as predicted with deviations in apogee and perigee well within the range of expected values. The payload was the most sophisticated to have been placed in orbit by this nation at the time and contained provisions for conducting 13 experiments in space environment and propagation. A wealth of valuable data was obtained from satellite telemetry until the last transmission was received on 6 October. Among the significant achievements of EXPLORER VI were:

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

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

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

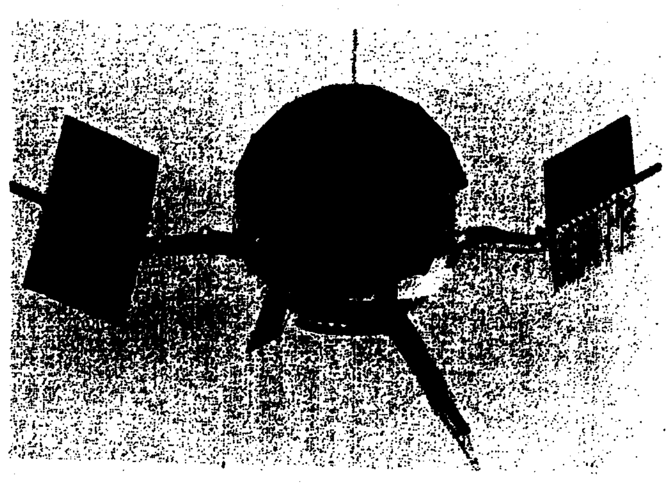
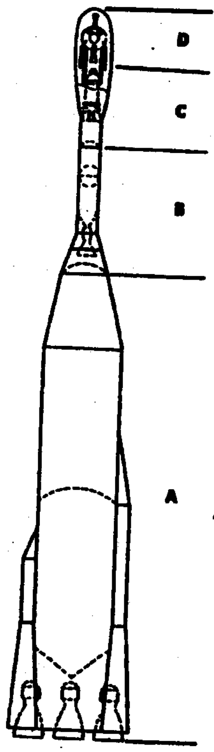


Figure 4. PIONEER V satellite vehicle shown in orbital flight position. This solar satellite was launched from the Atlantic Missile Range on 11 March 1960.



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

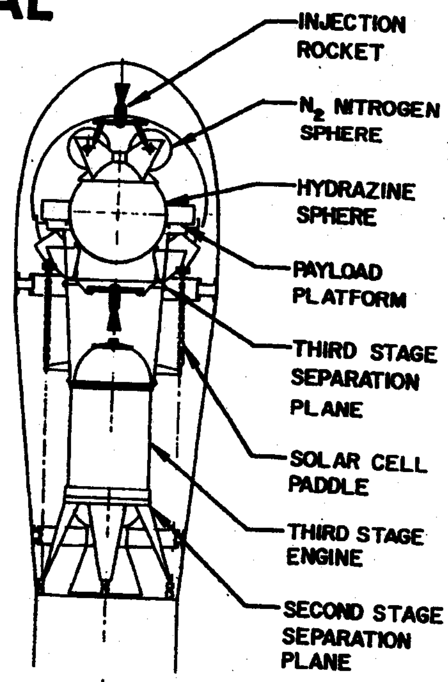
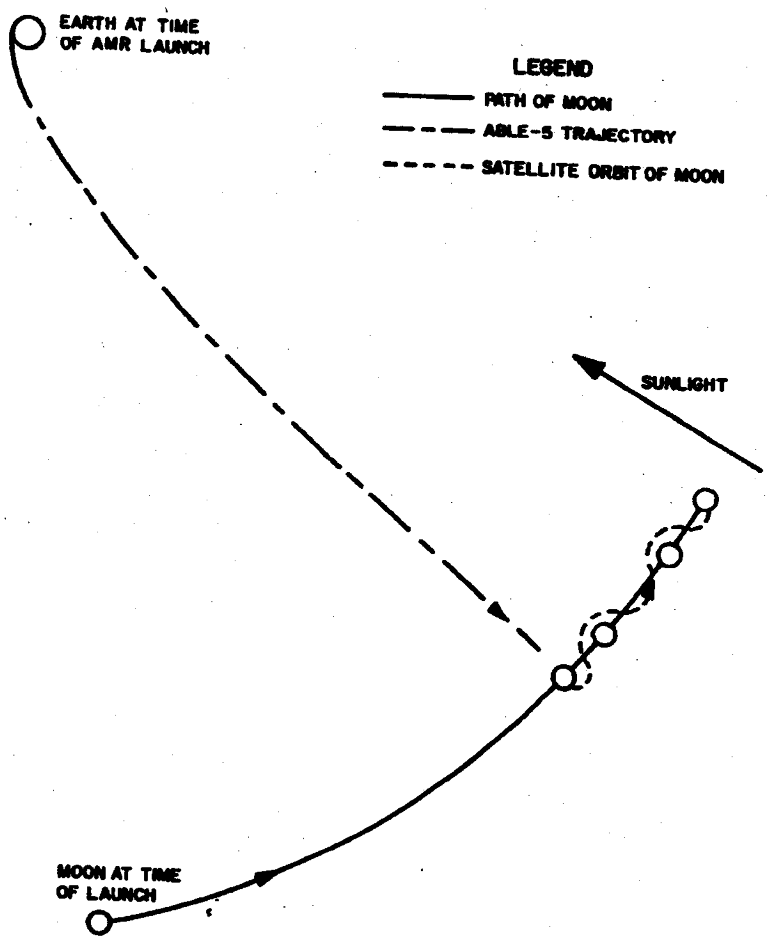


Figure 5. ABLE-5 vehicle configuration drawing and specification list. Third stage and payload configuration (right). Trajectory of ABLE-5 into lunar orbit is shown in drawing (below).

second. The payload was designed to investigate space environment and propagation effects and to transmit crude television images of the far side of the moon. This was the first flight in which an ATLAS ICBM was used as the booster for a multi-stage space flight.

ABLE-4 THOR—This vehicle was launched on 11 March from the Atlantic Missile Range and succeeded in placing the PIONEER V satellite into a solar orbit. At its closest approach to the sun, the satellite will pass near the orbit of Venus, and return to intersect the orbit of earth at its greatest distance from the sun. The vehicle consisted of a THOR first stage, ABLE second stage with AJ10-101 liquid fueled propulsion system and an STL guidance system, and an ABL-248A-3, solid fuel third stage. The 95 pound payload contains instrumentation for conducting scientific experiments related to magnetic field and radiation phenomena in deep outer space. At 0733 hours EST, on 26 June, the last radio signal was received from PIONEER V. The transmitter has been operated throughout the three and one-half month period and has demonstrated that, except for the batteries, the communications link could have been maintained for a distance significantly greater than the 50 to 60 million miles originally estimated. At the time of the last transmission the vehicle was 22,462,000 miles from earth.



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

1. An interplanetary magnetic field exists with a steady magnitude of more than one Gamma and a peak of up to ten Gamma. This field fluctuates in a manner that is connected to solar flare activity.
2. The planar angle of the interplanetary magnetic field forms a large angle (about 90 degrees) with the plane of the elliptic.
3. The exospheric ring current of 25,000 miles diameter encircles the earth as a giant doughnut at a distance of 40,000 miles from earth. The five million ampere current moves westward around the earth.
4. The geophysical magnetic field extends at times to 65,000 miles and this field oscillates in intensity in the outermost exosphere.
5. The sudden decrease in galactic cosmic rays (the Forbush decrease) always associated with large solar flares does not depend on the presence of the earth's magnetic field. This unexpected discovery will require formulation of a new theory to explain the Forbush decrease.
6. Penetration radiation in space is not limited to the Van Allen belts. At least during periods of solor 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 2,500 nautical miles and perilune of 1,400 nautical miles.
2. Maintain adequate earth-satellite communications and establish communications parameters for future space probes.
3. Demonstrate effective guidance system performance, particularly for the satellite vehicle.
4. Successful conduct of payload experiments.

***Program Vehicle** (Figure 5.)*

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

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

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

Fourth Stage (Satellite Vehicle)—Space Technology Laboratories designed, incorporating an injection rocket capable of being restarted four times to increase payload velocity and two times to decrease payload velocity. The satellite also contains a telemetry system (capable of continuous operation), four solar cell paddles, and scientific equipment for conducting the experiments. Satellite vehicle weight is 380 pounds.

Launch and Powered Flight

These vehicles will be launched from the Atlantic Missile Range on a true azimuth of 98.0 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 of ABLE-5A was programmed to occur 23,971,428 feet from the center of the earth at an inertial velocity of 34,051 ft./sec. Final burnout for ABLE-5B was programmed to occur 23,927,683 feet from the center of the earth at an inertial velocity of 33,901 ft./sec.

Orbital Characteristics — ABLE-5A

Major Axis	0.3470×10^{8} feet
Eccentricity	0.190
Orbital period	575 minutes
Apolune	2,460 nautical miles
Perilune	1,380 nautical miles
Duration of eclipses	less than 90 minutes

Orbital Characteristics — ABLE-5B

Major Axis	0.33388×10^{8} feet
Eccentricity	0.1854
Orbital period	543 minutes
Apolune	2,318 nautical miles
Perilune	1,300 nautical miles
Duration of eclipses	less than 90 minutes

Payload Experiment

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

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

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

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

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

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

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

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

Solid State Detector — (carried on ABLE-5B in addition to the above experiments) measure the flux of protons of energies from 0.5 to 9 MEV.

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. Central control and data collection for the flight will be accomplished at the Span Center at Los Angeles.

ABLE-5A — The vehicle configuration and trajectory for this flight are given in Figure 5. The unsuccessful launch of the ABLE-5A vehicle occurred on 25 September at 0713 PST. The launch had been postponed for one day because of high winds and unfavorable weather in the launch area. The countdown was normal and 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 271.7 seconds after liftoff and Stage I/II separation occurred 1.5 seconds later. However, a malfunction occurred at second stage ignition, causing a substantial loss in thrust and subsequent loss of control, and as a result, the objectives of this flight were not met.

ABLE-5B — Technical difficulties with the ground support equipment caused a one-day postponement of the flight. On 15 December, at 0110 PST, ABLE-5B was launched from the AMR. Powered flight appeared normal until approximately 67 seconds after liftoff. The flight test data indicate that all measured parameters were normal until T plus 66.7 seconds, when a transient was noted in the first and second stage axial accelerometers, followed by a decrease in booster liquid oxygen pressure. Film data show a change in flame pattern at this time, followed by structural failure of the combined vehicle, resulting in impact 8-12 miles off shore. Examination of recovered structure revealed no second stage propellant leakage or combustion. The cause of the malfunction has not been determined.

Monthly Progress — ABLE Program

ABLE 5B Flight Analysis

• Since the failure of ABLE 5B approximately 67 seconds after liftoff on 15 December the ATLAS/ABLE-5B Review Group, which consists of representatives from Aerospace, STL, Aerojet, Rocketdyne, Convair, NASA and AFBMD, has been conducting a flight analysis. This group has been charged specifically with the task of analyzing and evaluating data and conducting tests to determine mode and mechanism of failure of the ATLAS/ABLE-5B flight. The program established to accomplish this task is being conducted in three phases:

Phase I — Consists of the collection, calibration, and analysis of all data to provide a common time basis, establish data validity, and determine the mode of vehicle failure.

Phase II — Consists of analysis and evaluation of data to identify the mechanism(s) which could have caused the mode of failure as established in Phase I.

Phase III — Consists of test programs designed to prove the validity of the hypotheses relative to the mechanism(s) identified in Phase II.

• Portions of the second stage, Stage I/II interstage structure, and ATLAS engine section were recovered through salvage operations. Analysis of telemetry records, films, and this hardware indicates that flight was normal from liftoff to approximately 67 seconds, when a major failure of the ATLAS liquid oxygen tank occurred. This resulted in the loss of the upper stages which subsequently broke up because of airloading and/or collision with other parts of the ATLAS. A portion of the tank was retained containing enough liquid oxygen to enable the ATLAS to fly for seven seconds after the initial incident, with the first three and one-half seconds exhibiting approximately normal operation of the ATLAS propulsion system.

• The Review Group has completed Phase I and is in the process of completing Phase II of the program. Conclusions which have been reached to date must be considered tentative until Phase III is completed. Two hypotheses have been retained wherein the mechanism of failure can be explained. These are: a failure of the ATLAS liquid oxygen tank as the first incident; or the loss of a portion of the upper stages as the first incident which subsequently struck the ATLAS liquid oxygen tank, causing it to fail. In order to determine which of these events is most likely to have occurred, Phase III will be conducted. At the conclusion of Phase III a final report will be issued.

Transit

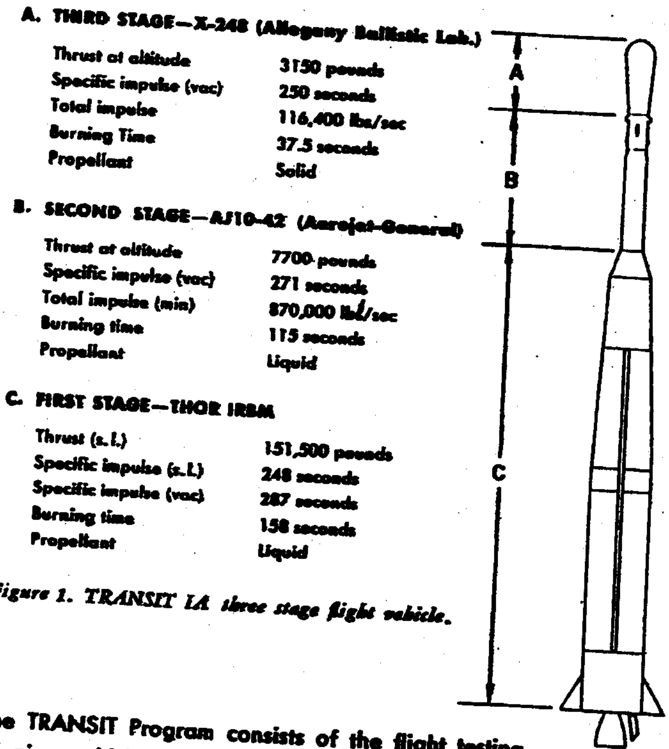


Figure 1. TRANSIT 1A three stage flight vehicle.

TRANSIT 3A launched from Atlantic Missile Range

The TRANSIT Program consists of the flight testing of nine vehicles to place 200-270-pound satellite payloads into circular orbits of 400 to 500 nautical miles. The program is designed to provide extremely accurate, world-wide, all-weather navigational information for use by aircraft, surface and subsurface vessels, particularly in relation to POLARIS missile firings. The ARPA Order for TRANSIT 1A was initiated in September 1958 and amended in April 1959 to add TRANSIT 1B, 2A and 2B flights. The TRANSIT 3A and 3B flights were initiated by a Navy MIPR, dated 18 May 1960. Because of the successful TRANSIT 2A launch and excellent payload performance the Navy has elected to launch TRANSIT 3A rather than 2B. TRANSIT 2B was scheduled to carry the same type payload as was carried on the 2A flight. Subsequently, the Navy initiated requests for TRANSIT 4A, 4B, 5A and 5B.

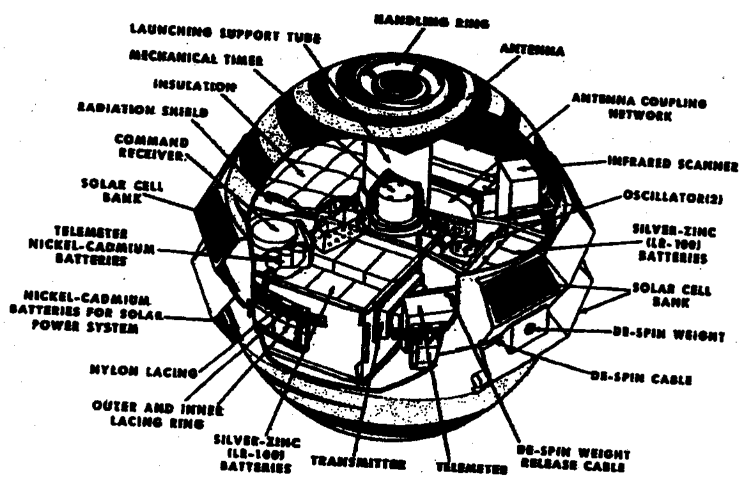
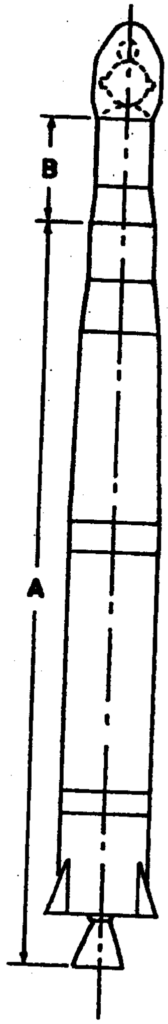


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV I).

The program was originally authorized by ARPA Order No. 97-60, which assigned AFBMD responsibility for providing the booster vehicles, integrating payloads to the vehicles, and flight operations from launch through attainment of orbit. 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 — ABLESTAR (AJ10-104)

Thrust at altitude	7752 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.)	245 seconds
Specific impulse (vac)	287 seconds
Burning time	158 seconds
Propellant	Liquid

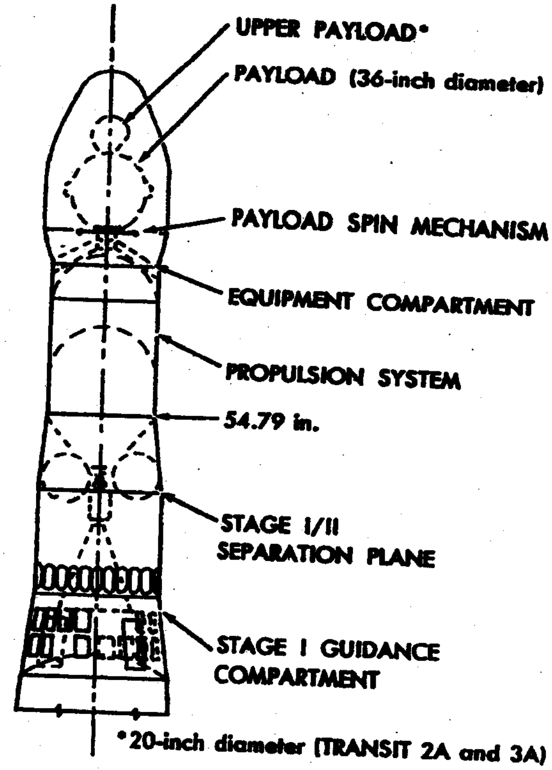


Figure 3. Two stage vehicle used for TRANSIT 1B and subsequent flights.

Program Objectives

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

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

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

Payload Description The TRANSIT payload is a spherical package with a bank of solar cells at the equator. The payload weight has increased with successive vehicles from 200 to 300 pounds for TRANSIT 3B. The payload contains four stable-frequency transmitters. Frequencies used on various flights are 54, 108, 162, 216, and 324 mc. Power is supplied by batteries and solar cells. Future plans call for a memory unit in the satellite which will receive orbital parameters transmitted from the ground, store them and read out on command from a user who will navigate with the aid of the satellite system. The TRANSIT 3B payload will contain a permanent magnet which will cause the satellite to be oriented along the lines of the earth's magnetic field after its spin rate has been reduced. Some of the TRANSIT payloads contained experiments from other agencies. Also, TRANSIT 2A and 3A carried GREB, a 21-inch sphere weighing about 40 pounds, which studied solar emissions. TRANSIT 3B will carry LOFTI, a 20-inch sphere weighing approximately 50 pounds which will study the attenuation of very low frequency radio transmission through the ionosphere.

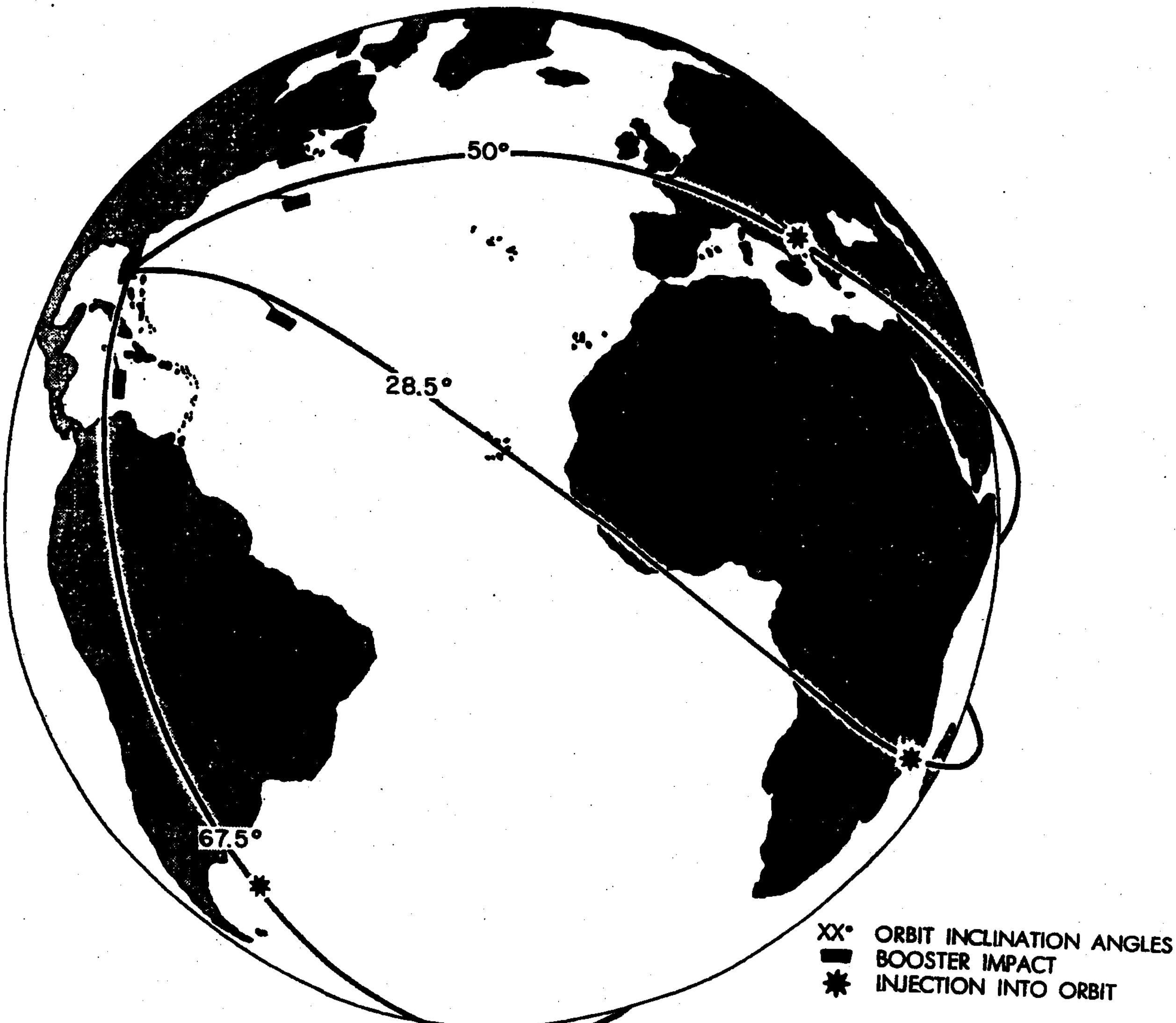
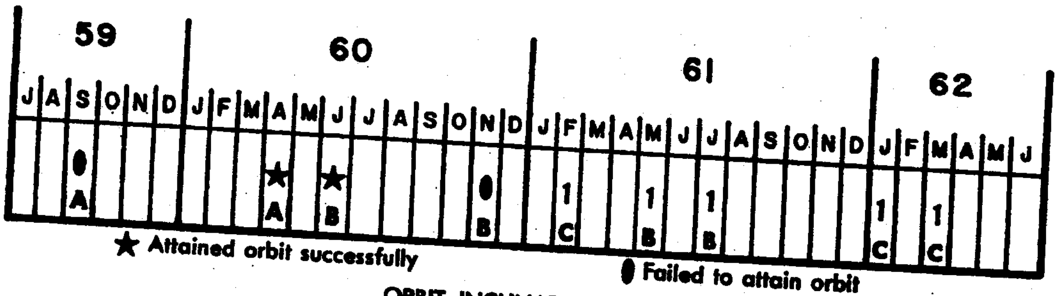


Figure 4. Typical TRANSIT launch trajectories showing flight path, booster impact areas, and orbital injection points.

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

Ground Support and Tracking Stations The Navy Bureau of Weapons payload contractor provides a system of payload tracking stations which obtain information for precise orbit determination. These stations are located in Maryland, Texas, New Mexico, Newfoundland and Brazil. First and second stage tracking and telemetry, and second stage guidance will be provided by the facilities of the Atlantic Missile Range. A mobile downrange tracking station will receive telemetry data and tracking information during the last portion of the second stage Ablestar coast, re-ignition and second burn, payload spin-up and payload injection periods. This station was located in Erding, Germany, for the TRANSIT 1B flight, Punta Arenas, Chile, for the TRANSIT 2A and 3A and will be in Pretoria, Union of South Africa for TRANSIT 3B.

Launch Schedule



ORBIT INCLINATION ANGLES

A. 50° B. 67.5 C. 28.5

FLIGHT HISTORY

TRANSIT No.	Launch Date	Thor No.	Ablestar No.	Remarks
1A	*17 September*	*136*		*The three-stage vehicle was launched from Stand 17A at the Atlantic Missile Range. The payload was not injected into orbit, because the third stage motor failed to ignite.*
1B	*13 April*	*257*	*002*	*The Thor Ablestar boosted satellite was launched from Stand 17B at AMR. The satellite was placed into orbit. The Ablestar second stage (on its first flight test) fired, shut off, coasted, and then restarted in space.*
2A	*22 June*	*281*	*003*	*A dual payload, consisting of TRANSIT 2A plus GREB (which studied solar emissions), was placed in orbit by the Thor Ablestar vehicle. A propellant slosh problem, discovered in the second stage, has been corrected.*
3A	*30 November*	*283*	*006*	*TRANSIT 3A failed to achieve orbit when the first stage Thor shut down prematurely, after a failure in the main engine cutoff circuitry. Staging occurred and the second stage performed nominally until it was cut off and destroyed by Range Safety.*

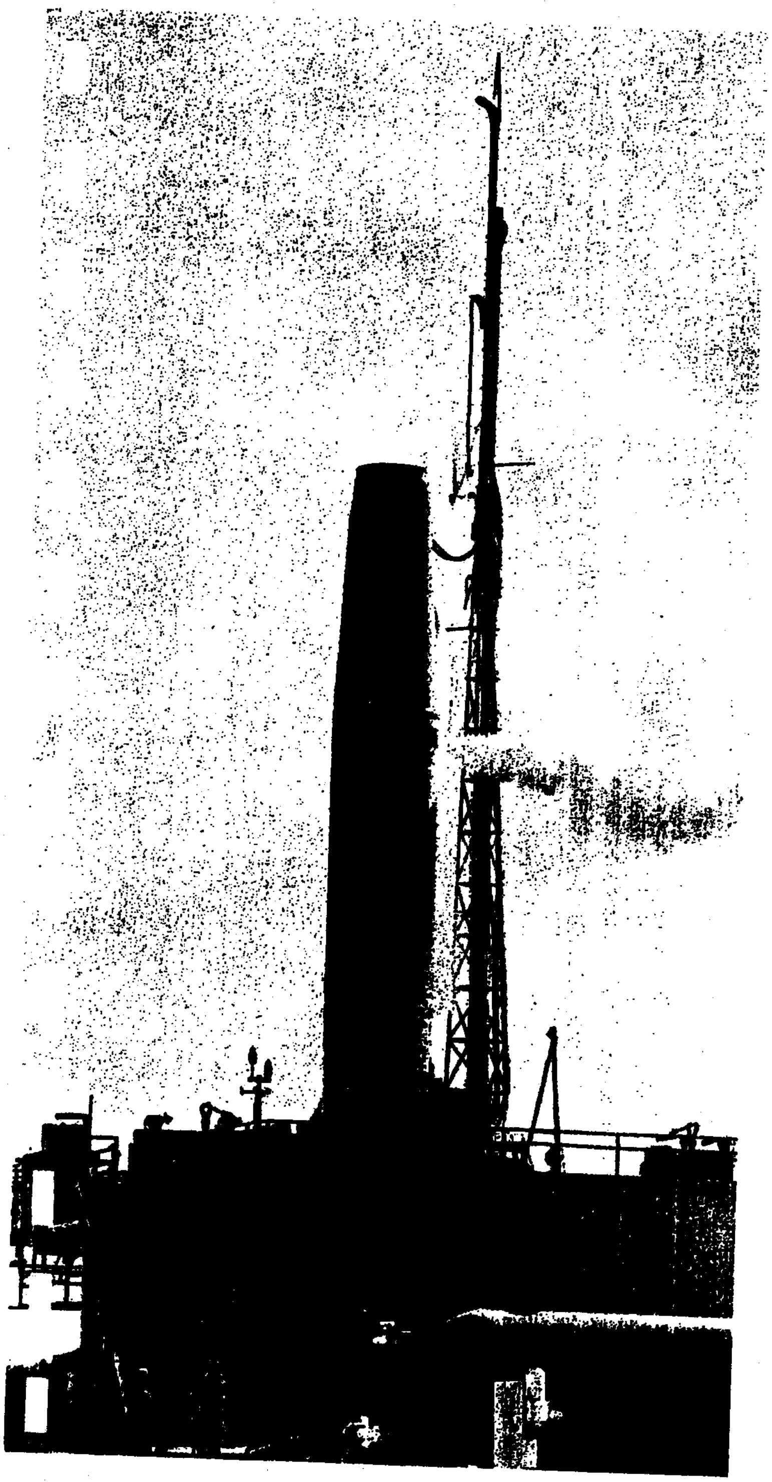


Figure 5. THOR 313, booster for TRANSIT 3B, during a liquid oxygen fill check at the Atlantic Missile Range. Frost is just beginning to accumulate on the valves and piping between the LOX supply tank in the foreground and the missile. The supply tank is a Dewar container (vacuum bottle) and does not frost over in spite of the −297° F temperature of the liquid oxygen.

Monthly Progress — TRANSIT Program

Program Administration

- With the launch of TRANSIT 3A, Space Technology Laboratories role as the Systems Engineering and Technical Direction Contractor for the TRANSIT Program ended. The Aerospace Corporation will assume the task of providing systems engineering and technical supervision for TRANSIT 3B and subsequent flights.

- The Space Technology Laboratories Ground Guidance System will be used on TRANSITS 3B and 4A. Bell Telephone Laboratories will provide the guidance system for TRANSIT 4B and subsequent vehicles.

- The mobile downrange tracking station was turned over to the Atlantic Missile Range (AMR) in early January and shipped to Pretoria, Union of South Africa on 11 January. The station has recently been overhauled and AMR personnel have been trained to operate this station's equipment. This station will be manned and operated by an AMR crew.

- There was a conflict of launch dates between the TRANSIT 3B and the NASA DELTA 4. AFBMD and NASA have resolved the problem by rescheduling the DELTA 4 and retaining the 21 February TRANSIT 3B launch date.

Technical Progress

- The failure of TRANSIT 3A on 30 November has been investigated. However, the exact mode of failure could not be determined. That a failure in the Thor main engine cutoff (MECO) circuit occurred is known, but the exact item which failed or how it failed is unknown. For TRANSIT 3B the DISCOVERER MECO circuitry will be incorporated into the Thor booster No. 313.

TRANSIT 3B Satellite Experiments

TRANSIT Payload

Refractive Index Correction — Experiments to confirm theoretical mathematical relationship between frequency and refractive index of the ionosphere.

Navigation — After determining the orbit of the satellite, the Doppler shift technique will be used to make navigation fixes on the earth.

Geodesy — Determine the shape of the earth by analyzing the shape of the satellites orbit.

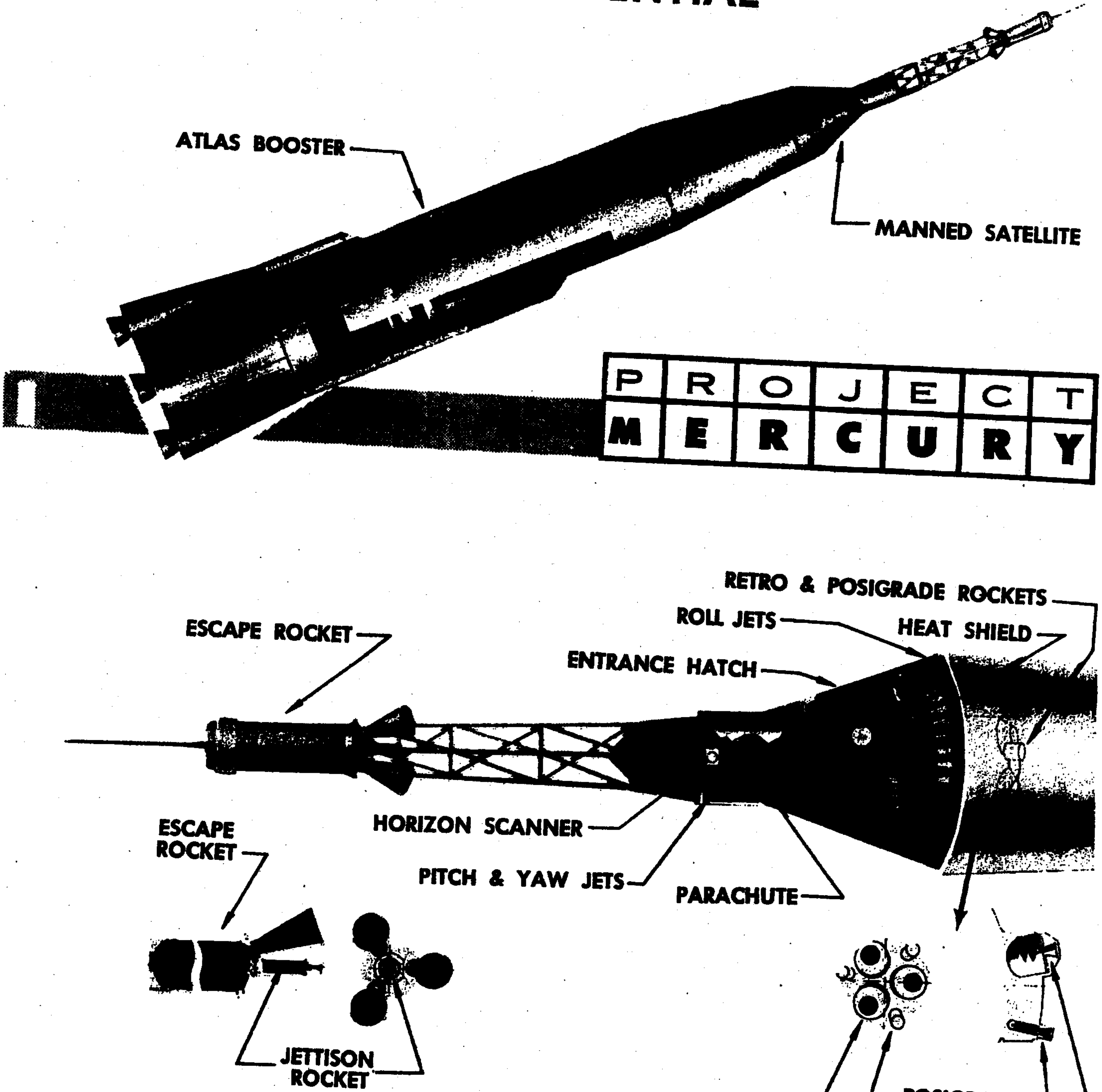
Injection Memory — The satellite will receive, store, and periodically readout TRANSIT orbital parameters on command.

LOFTI Payload

- Very low frequency radio signals (18kc) will be sent through the ionosphere to LOFTI from ground stations. Data on the signal strength and quality will be telemetered back to earth. The LOFTI payload is contained in the small upper sphere. (See figure 3)

SECOR Experiment

- The Army Map service will use a satellite-borne transponder to obtain accurate base points for mapping. This transponder is located within the TRANSIT payload.



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

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

Project MERCURY represents the transitional threshold between this nation's cumulative achievements in space research and the beginning of actual space travel by man. The primary program objective is to place a manned satellite into orbit about the earth, and to effect a controlled re-entry and successful recovery of the man and capsule (Figure 1). Unmanned ICBM trajectory and near-orbital flights, and unmanned orbiting flights will be used to verify the effectiveness and reliability of an extensive research program prior to manned orbital flights (Figure 2). The program will be conducted over a period of nearly two years. The initial R & D flight test was accomplished successfully in September 1959. The total program accomplishment is under the direction of NASA. The primary responsibility of AFBMD to date consists of: (a) providing 16 ATLAS boosters modified in accordance with program objectives and pilot safety factors, and (b) determination of trajectories and the launching and control of vehicles through injection into orbit. The division of responsibilities for this program is given in Table 1. Specific details of AFBMD support are given in Table 2.

Major contractors participating in the AFBMD portion of this program include: Aerospace Corporation, systems engineering and technical direction; Convair-Astronautics, modified ATLAS boosters; GE/Burroughs, ATLAS guidance equipment; and Rocketdyne, engines. All of these companies also provide special studies and engineering efforts peculiar to meeting Project MERCURY requirements.

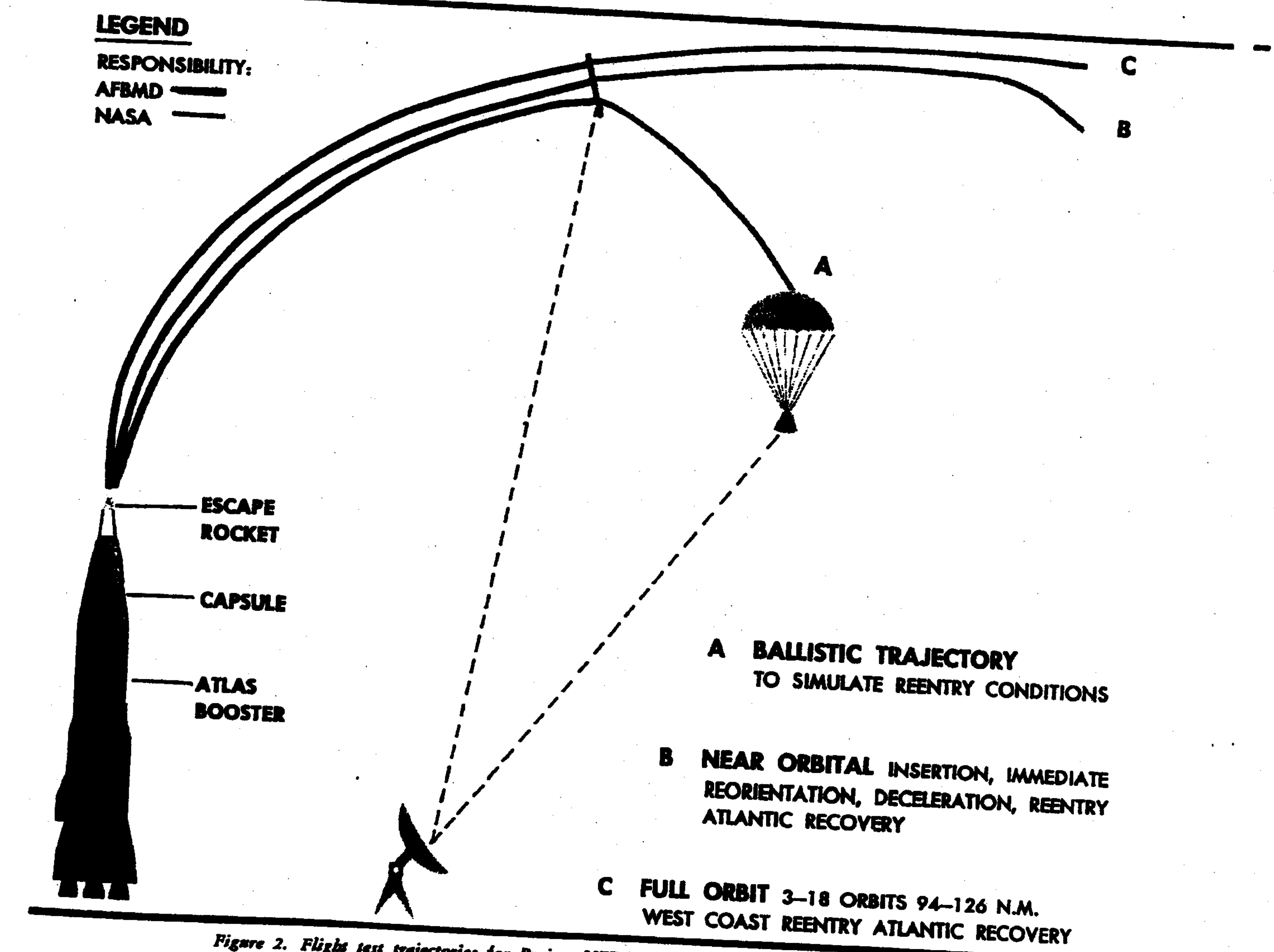


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.

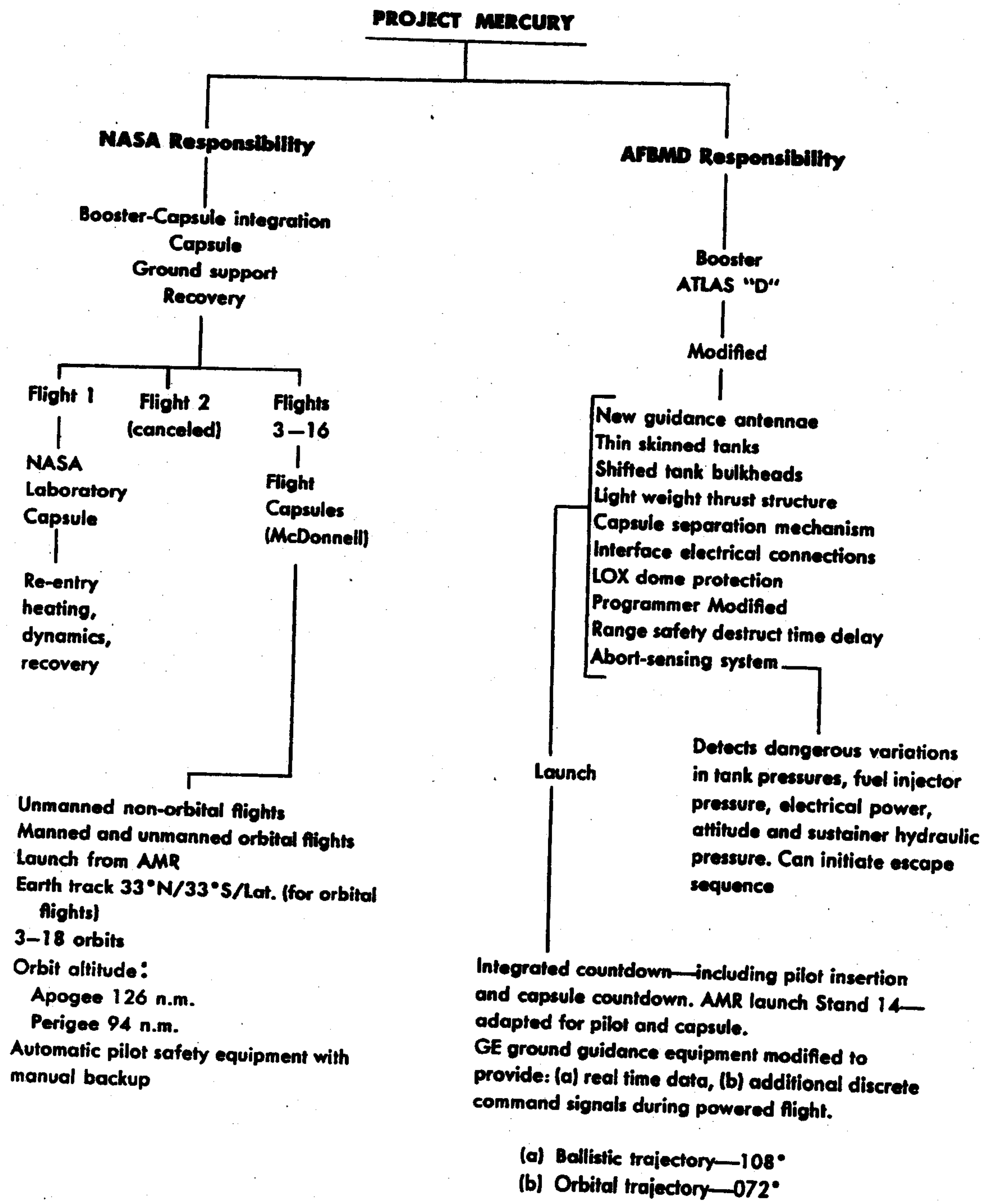


Table 1. Outline of NASA and AFBMD responsibilities in PROJECT MERCURY.

PROJECT MERCURY

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

Design, engineering studies
Equipment modification
Hardware fabrication

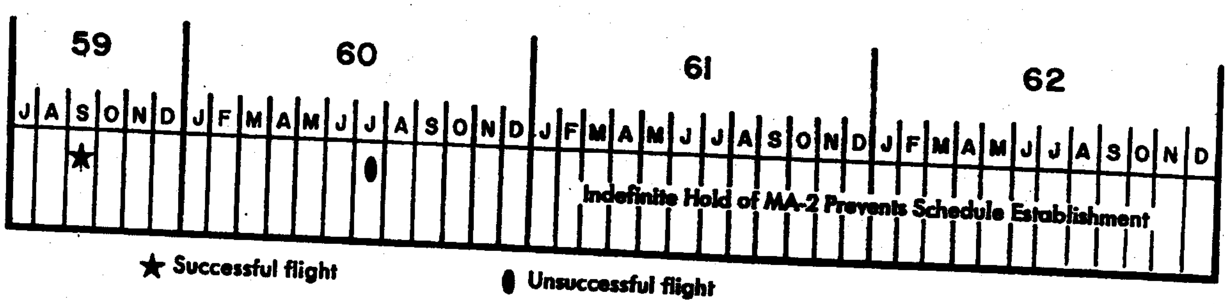
Flight scheduling

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.

Launch Schedule



Flight History

MERCURY Flight	Launch Date	ATLAS No.	Remarks
Big Joe I	9 September	10D	*Flight test objectives were achieved to such a high degree that a second, similar flight was cancelled. The capsule was recovered intact.*
MA-1	29 July	50D	*After one minute of normal flight guidance, rate, track lock, and telemetry were lost and the vehicle was destroyed. The Malfunction Analysis Panel could not determine the exact cause of the failure. However, it was established that the booster LOX boil-off valve did not cause the malfunction.*

Monthly Progress — MERCURY Program

Program Administration

• Based upon recommendations from AFBMD, Aerospace Corporation, and Convair Astronautics, NASA Space Task Group (STG) authorized the production of all future MERCURY boosters (starting with 109D) in the thick skin configuration. Additionally, the Space Task Group (STG) authorized the engineering and tooling for modification to thick skin those boosters committed to production in the thin skin configuration and one delivered booster (77D) will require modification to the thick skin configuration. Receipt of authorization to begin actual modification is anticipated by 1 February.

• As a result of MA-1 and ATLAS/ABLE-5B flight investigations, NASA (STG) proposed the installation of a restraining band on the forward portion of the booster liquid oxygen tank to reduce skin stress discontinuities on ATLAS 67D (MA-2). Testing and analyses for this field modification have been conducted by Convair Astronautics under the technical direction of AFBMD/Aerospace. Final decision of launch of MA-2 is expected in early February. The launch of this modified booster could be accomplished by mid-February. If a decision is made not to launch 67D as modified, the MA-2 capsule will be boosted by ATLAS 100D. Production of this booster in the thick skin configuration has been accelerated. If ATLAS 100D is used as the MA-2 booster, the launch, even under accelerated conditions, could not occur before late March.

• AFBMD is selecting the best performing rocket engines for use as ATLAS/MERCURY boosters. An investigation has been initiated to explore the possibility of reviewing engine data on a progressive basis to allow making selections prior to engine designation.

Flight Test Progress

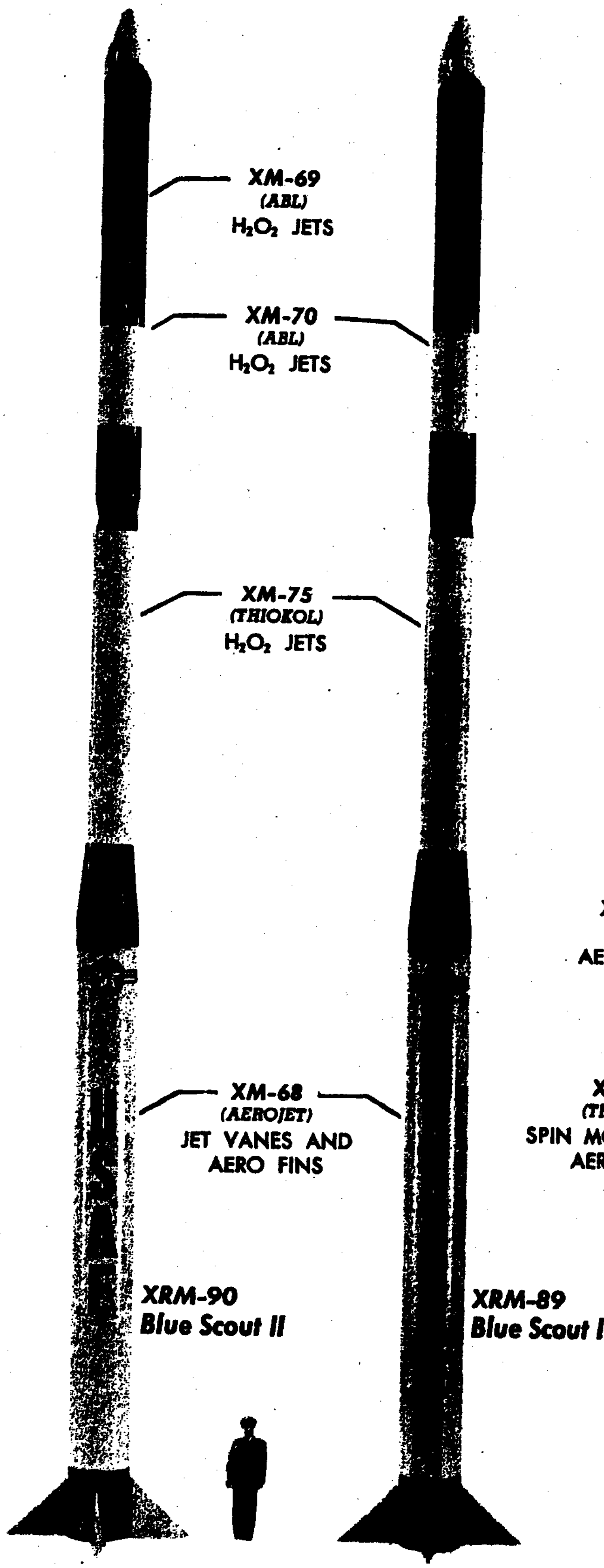
• ATLAS 67D, which completed the Flight Readiness Firing on 19 November, continues to remain erected on Atlantic Missile Range Stand 14 pending the decision on the MA-2 launch. The inspection program, inaugurated to protect critical components and electrical connectors which are prone to corrosion, has been continued throughout this period.

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



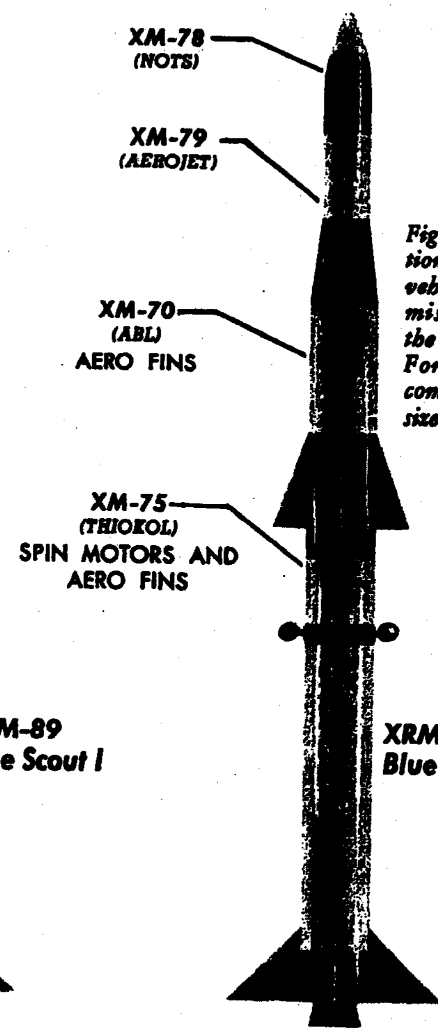


Figure 1. Three variations of Project 609A vehicles demonstrate the mission versatility of the program. The Air Force officer permits comparison of vehicle sizes.

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

Program Management—An abbreviated development plan, covering the R&D phase only, was approved on 9 January 1959. Funds in the amount of $12,651,000 have been made available for this R&D phase of the program only. A letter was issued assigning management responsibility to AFMBD, with emphasis on integrating the program with the scientific and military research experiments conducted on regularly scheduled ballistic missile flight tests (Piggyback Program). In June 1959, Aeronutronic Division of the Ford Motor Company was chosen through normal competitive bidding as the Payload, Test, and Systems Integration Contractor. Arrangements have been made for the procurement of vehicle components and associated support equipment, modified to meet Program 609A requirements, through NASA, rather than through the SCOUT Program contractors. Atlantic Missile Range facilities consisting of launch complex 18 will be made available to the Air Force for this program. A Project 609A division has been established within the 6555th Test Wing (Development) at AMR to supply Air Force technicians to participate in the assembly, checkout and launch operations of the R&D phase under the direction of the Payload and Test Contractor. An all-military operational capability will be developed from within this group.

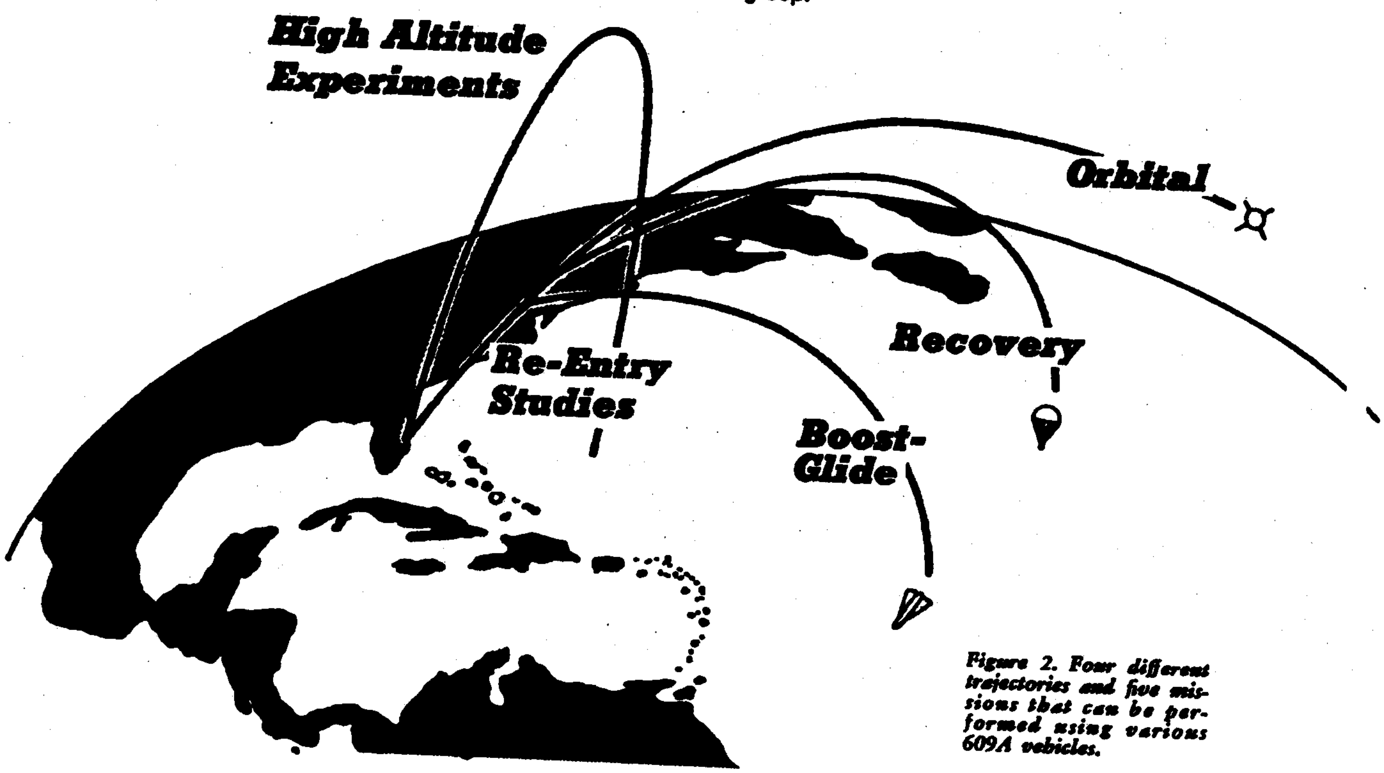
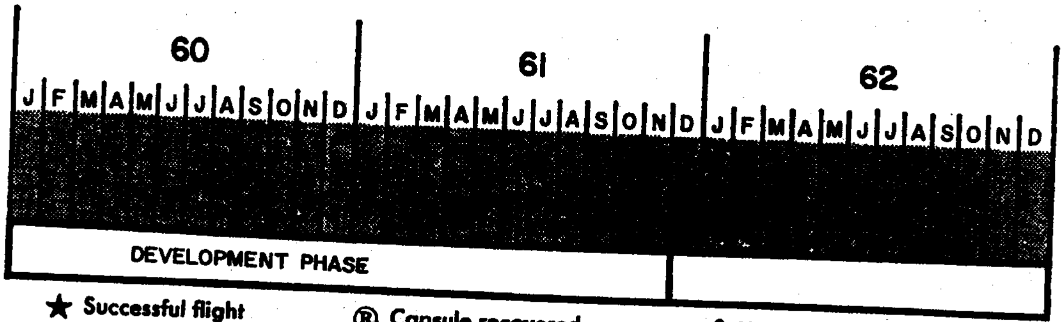


Figure 2. Four different trajectories and five missions that can be performed using various 609A vehicles.

Launch Schedule



★ Successful flight   Ⓡ Capsule recovered   ▮ Unsuccessful flight

Flight History

609A Flight	Launch Date	Type of Flight*	Type Designation	Remarks
D1	21 September	A	XRM-91	*Telemetry was lost prior to fourth stage burnout. The trajectory to this point was as planned and the payload probably reached an altitude of 14,000 n.m. All of the primary (vehicle) objectives were accomplished; none of the secondary (payload) objectives were achieved.*
D2	8 November	A	XRM-91	*A second stage motor failure occurred at T plus 60 seconds. The vehicle impacted approximately 240 n.m. downrange.*
D3	7 January	A&C	XRM-89	*The 392-pound payload was successfully launched to an apogee of 960 nautical miles and a range of 1025 nautical miles (175 nautical miles short of that programmed). The recovery capsule survived re-entry but was not recovered. Except for this, all primary objectives were achieved as were the majority of secondary objectives.*

*Type of Flight   A — High Altitude Experiments   B — Re-Entry Study   C — Recovery   D — Orbital   E — Boost-Glide

Monthly Progress — Project 609A

Flight Test Progress

• The third vehicle in the 609A Program was successfully launched from the Atlantic Missile Range on a probe trajectory at 1234 hours EST, 7 January. The vehicle was a guided Blue Scout I carrying a 392 pound payload containing eight ARDC experiments. The vehicle carried a 90 pound recovery system capsule. Analysis of telemetry data indicates that the third stage heat shield did not eject at third stage ignition as programmed, and that the second and third stage motors performance was slightly lower than anticipated. The resulting trajectory was approximately 60 NM higher in altitude and 175 NM shorter in range than planned. The search aircraft located the recovery system capsule shortly after impact. However, the recovery ship arrived approximately 17 hours after impact and was unable to locate the capsule. The capsule's recovery aids (beacon and flashing light) were no longer functioning. Useful data was obtained from all but two of the eight experiments comprising the payload. The guidance system, telemetry system and other booster components functioned as planned.

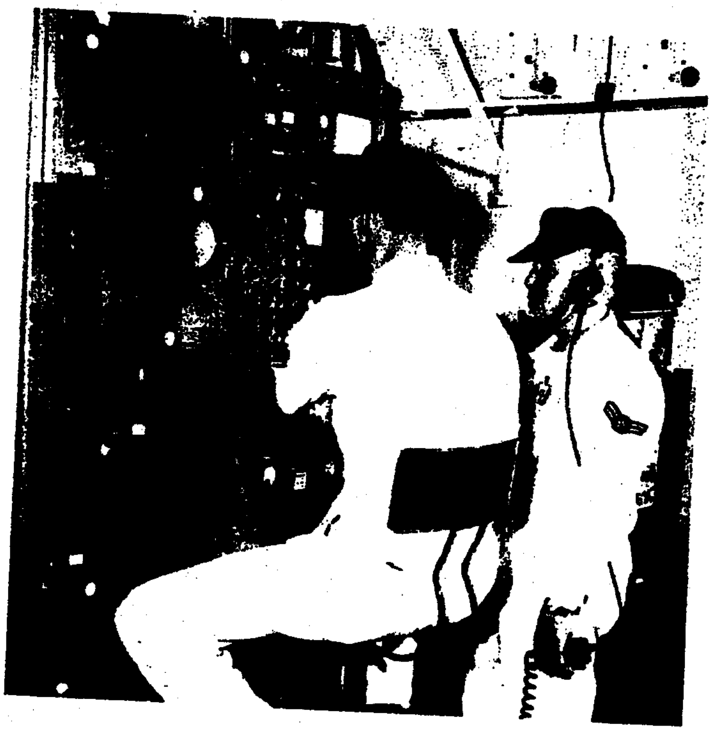
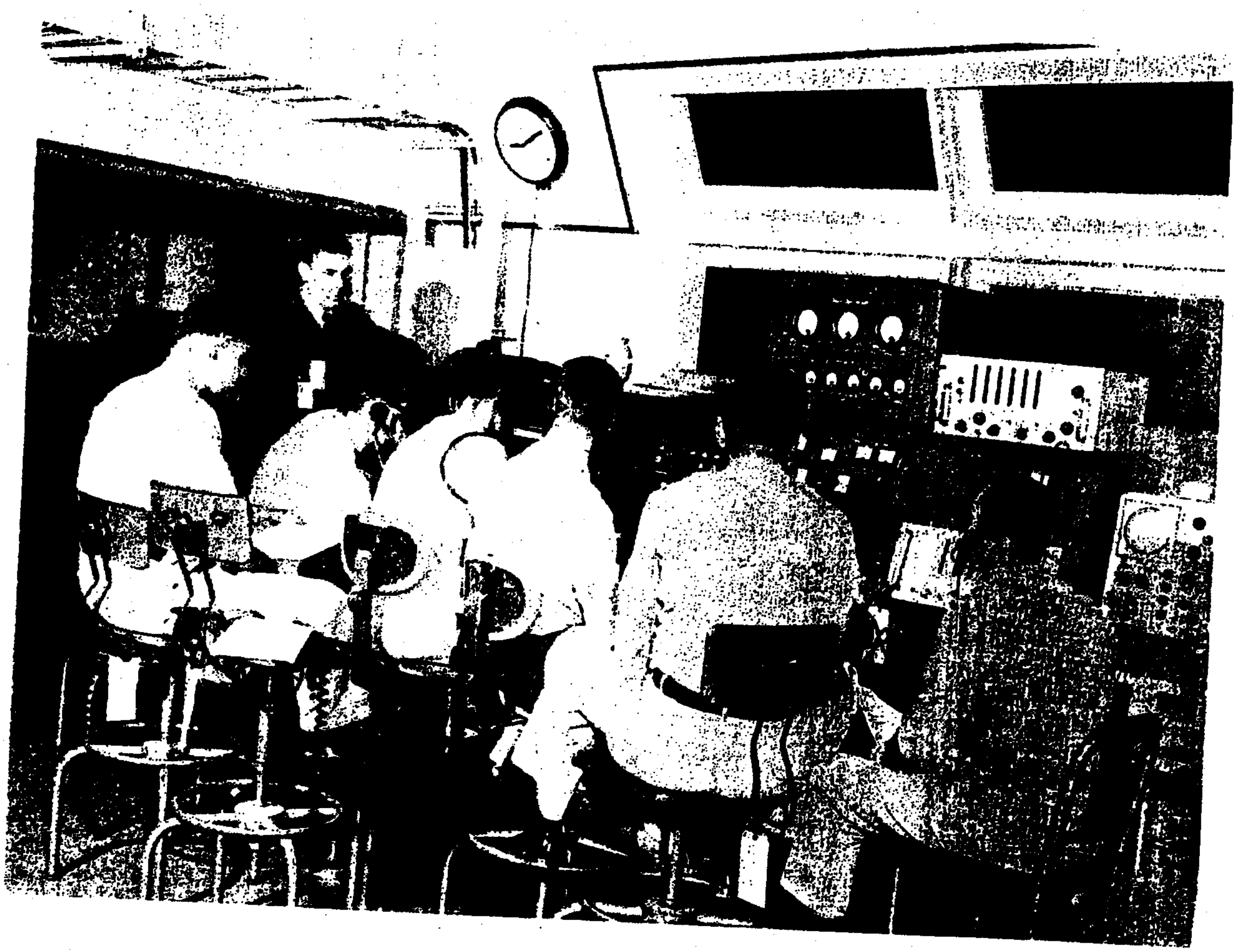


Figure 3. Air Force technicians (left) during prelaunch checkout of the XRM-89 vehicle. Air Force Officers and Aeroneutronic engineers at the launch console of Atlantic Missile Range launch complex 18. The windows in the blockhouse provide a view of the launch pad. The less complex launch monitoring equipment is only one of several reasons for the economy realized in the 609A Program. Blue Scout I, the third 609A vehicle launched, following lift-off from the Atlantic Missile Range on 7 January.

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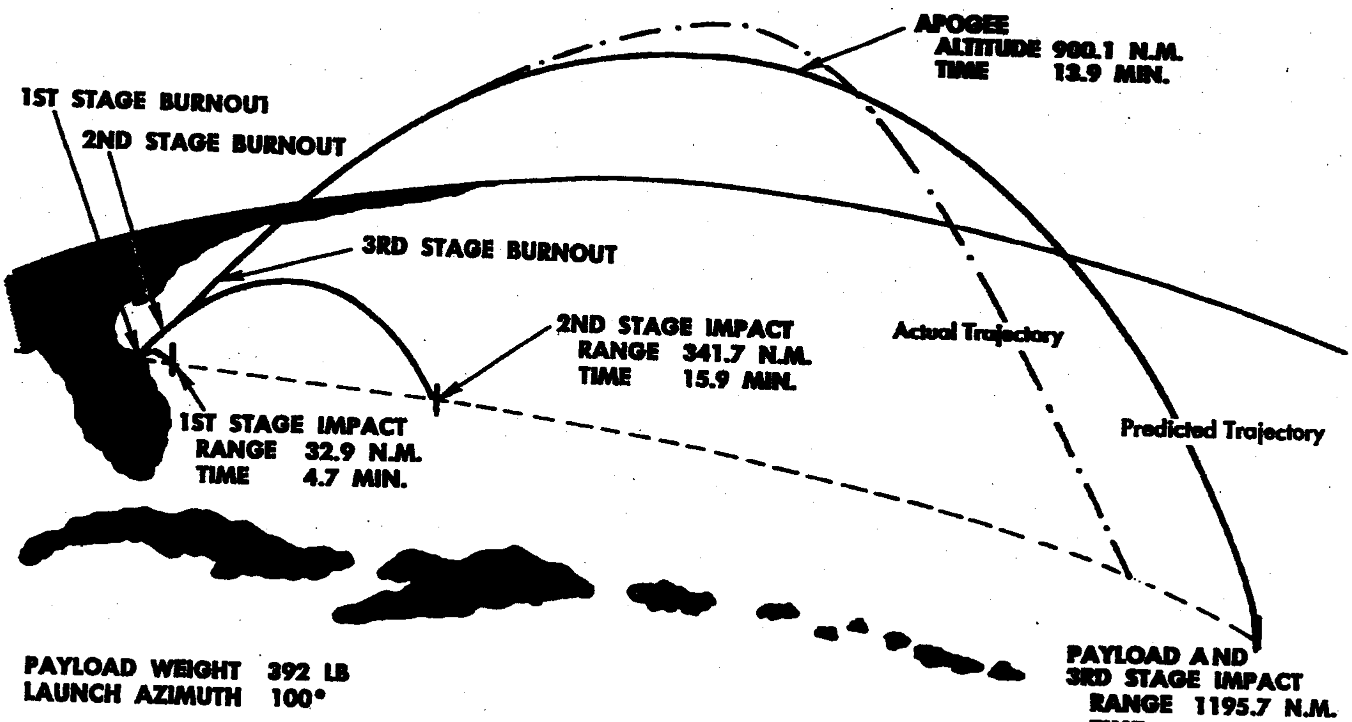


Figure 4. Comparison of predicted and actual trajectories for the third 609A flight. The payload attained an altitude approximately 60 nautical miles higher and impacted approximately 175 nautical miles short of the predicted impact point.

- The fourth 609A flight (D-4) is scheduled for launch on 28 February. The XRM-90 vehicle will be used for this flight. Assembly and checkout of the vehicle at the Atlantic Missile Range is proceeding on schedule. A combined systems test will be conducted on 16 February; the vehicle will be installed on the pad on 21 February; a dry run will be made on 24 February and the vehicle will be launched four days later.

CONFIDENTIAL

DYNA SOAR

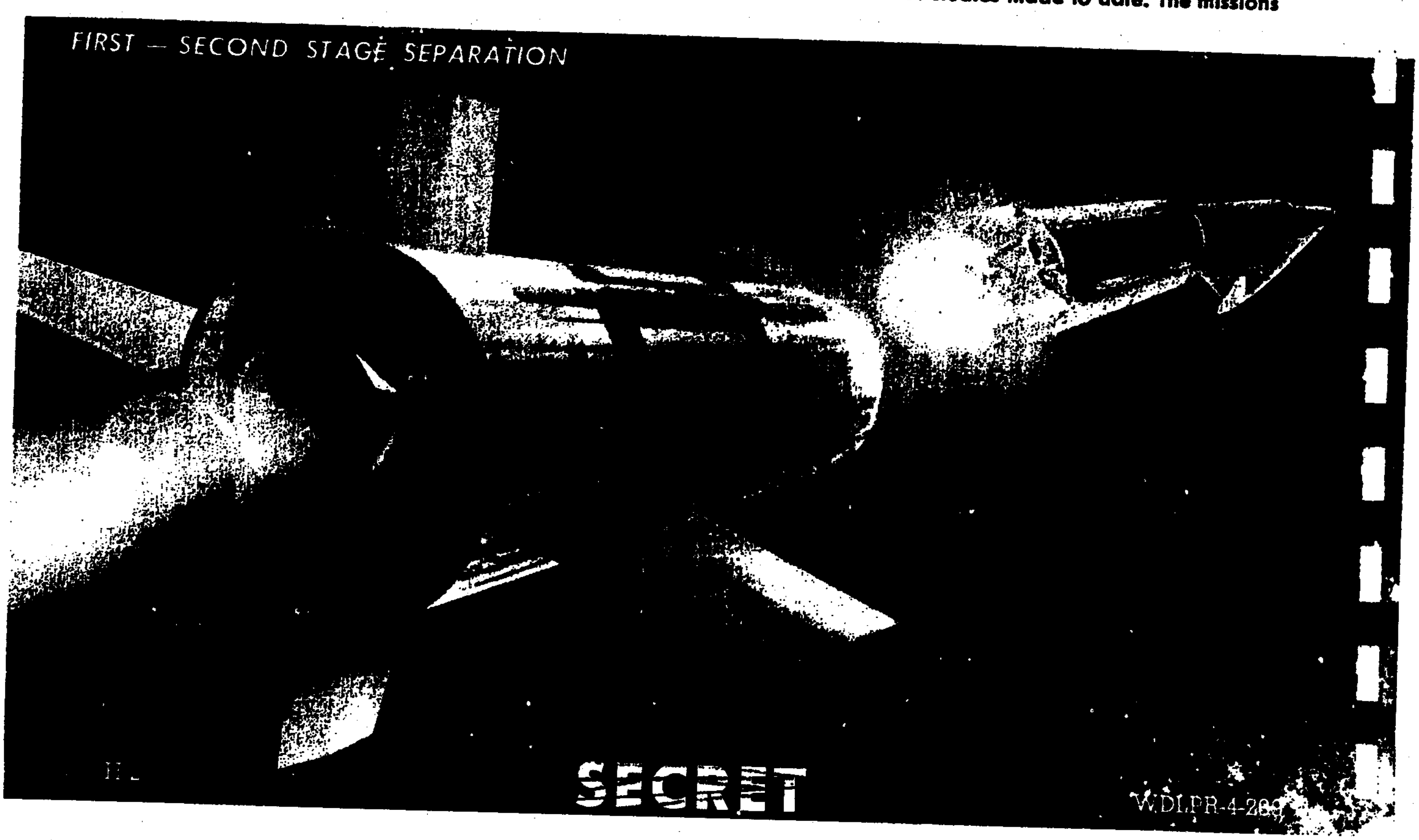
WDLPR-4-265

CONFIDENTIAL

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.

During the period covering program go-ahead to the end of CY 1960, efforts on the program were concentrated on design refinements to TITAN I and possible increased booster performance to accomplish program objectives. Studies on booster capabilities revealed many favorable factors on cost, time and expanded objectives by use of the XSM-68B (TITAN II) as the booster. Results of these studies were presented to Headquarters USAF and the Department of Defense. Headquarters USAF directed use of TITAN II as the SYSTEM 620 DYNA SOAR Step I Booster. Formal direction to use TITAN II was received by AFBMD/BMC from WADD/ASC on 13 January 1961.

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 II ICBM will boost the glider into hypersonic flight at velocities up to 22,000 ft/sec and permit conventional landing at a predetermined site. In Step II the glider will be tested, using a more powerful booster to 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 22,000 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 twenty air-launched, manned flights with the glider being dropped from a B-52. Sixteen booster-launched flights will follow; flights 1 and 2 are designated as unmanned flights. If all significant flight objectives are achieved, the third flight will be manned. Flights 3 and 4 have been programmed as backup flights in the event that flights 1 and/or 2 do not achieve program objectives. The frequency is five launches at two-month intervals and eleven launches at six-week intervals. The range from Wendover AFB, Utah, to Edwards AFB is adequately instrumented for the tracking and telemetry required during the air-launched tests of the DYNA SOAR glider. Instrumentation sites for the AMR launches will be located at Cape Canaveral, San Salvador, Mayaguana, Antigua, Santa Lucia, and Fortaleza. Instrumentation, tracking, and recovery ships will be provided to supply additional support for the AMR launches. Landing facilities will be provided at Fortaleza, Brazil; Santa Lucia, Lesser Antilles; and Mayaguana, Bahama Islands.

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

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

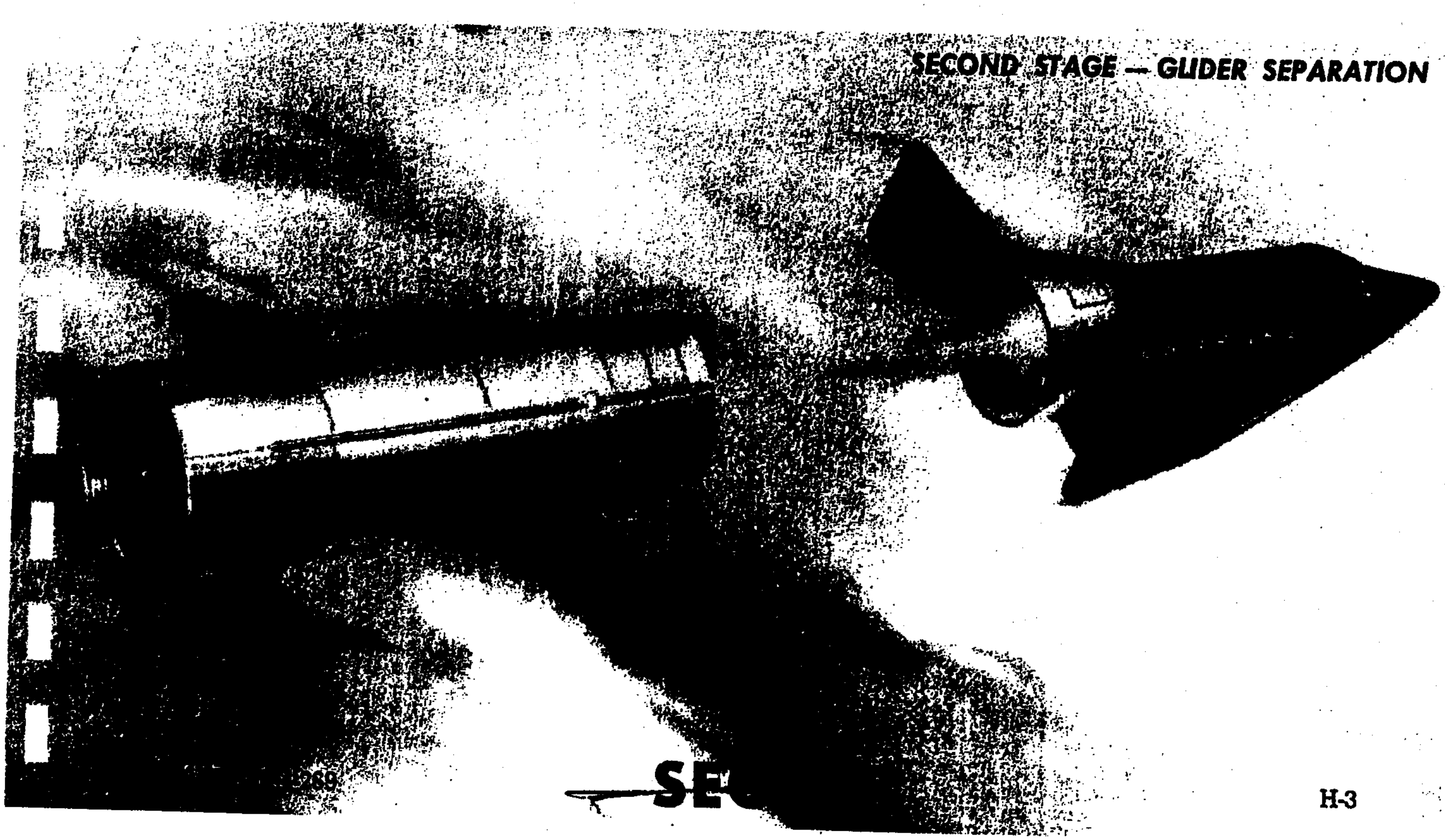
Technical Approach—AFBMD's technical approach to meet the objectives of the program are:

1. Modifying a TITAN II ICBM by adding stabilizing fins; strengthening the holddown and skirt area, intertank and interstage sections; redesigning the guidance bay; incorporating a malfunction detection system.

2. Modifying the XLR 87-AJ-5 and XLR 91-AJ-5 rocket engines to obtain structural compatibility with the modified booster; include malfunction detection system shutdown and fail safe systems.

3. Modification of an AMR launch pad.

4. Provide an integrated launch countdown.



SECOND STAGE — GLIDER SEPARATION

Monthly Progress — DYNA SOAR Program

Program Administration

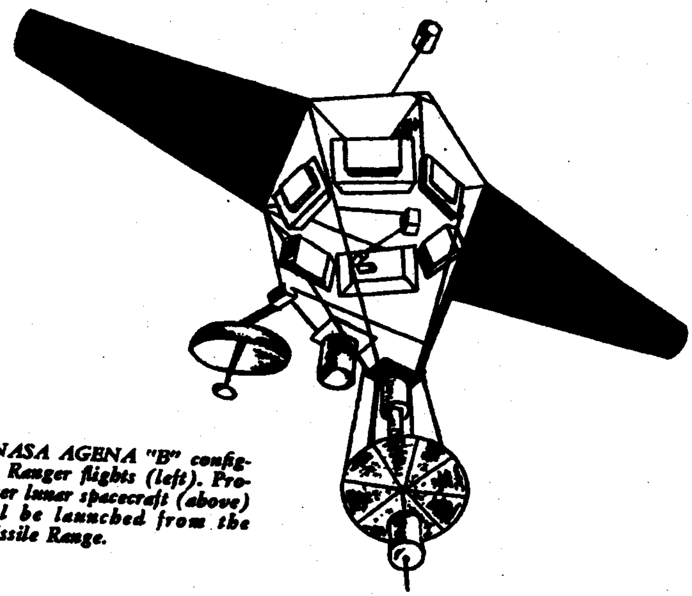
- By authority of System Program Office message, WWZR-13-1-1012, the Step I DYNA SOAR booster has been changed from the TITAN I to the TITAN II. Development efforts which are related solely to the TITAN I and which are not applicable to the Step I Program using TITAN II have been stopped and/or re-oriented. A task force approach is being used to assess the impact of this redirection.

- The DYNA SOAR System Program Office has reviewed the results of the DYNA SOAR testing trade study. The direction was given on 12 January that dynamic and compatibility tests-glider/booster-would be conducted at the Martin Company, Baltimore, Maryland. Test responsibilities will be assigned at a later date.

- The second meeting of the DYNA SOAR Program Evaluation Procedures (PEP) Task Group was held at WADD on 17-18 January. The PEP implementation procedures and requirements were defined with respect to the designation of TITAN II as the new booster. A discussion was held on standard numbering and reporting procedures including all aspects of analysis and evaluation activities.

- The first Management Council Meeting on DYNA SOAR was held at the System Program Office (WADD) on 26 January. Membership of this council is composed of project managers from participating agencies, both government and industry. Its purpose is to provide a means of periodically bringing all key program managers abreast of the general program status and to provide a means for mutually dealing with major program management problems.

NASA AGENA "B" PROGRAM



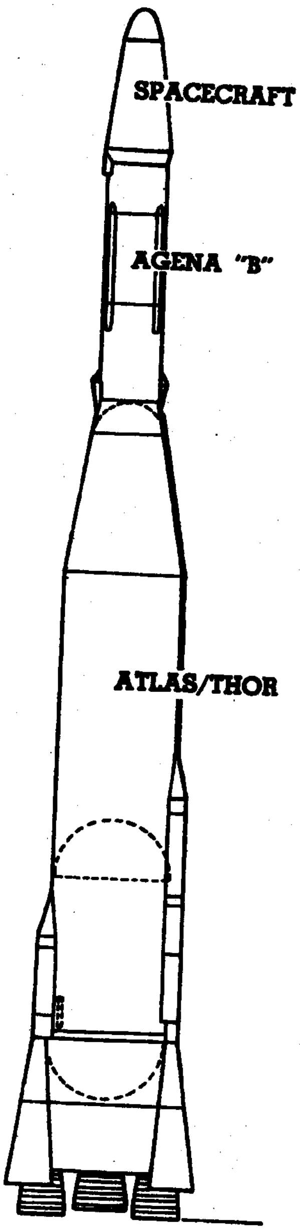


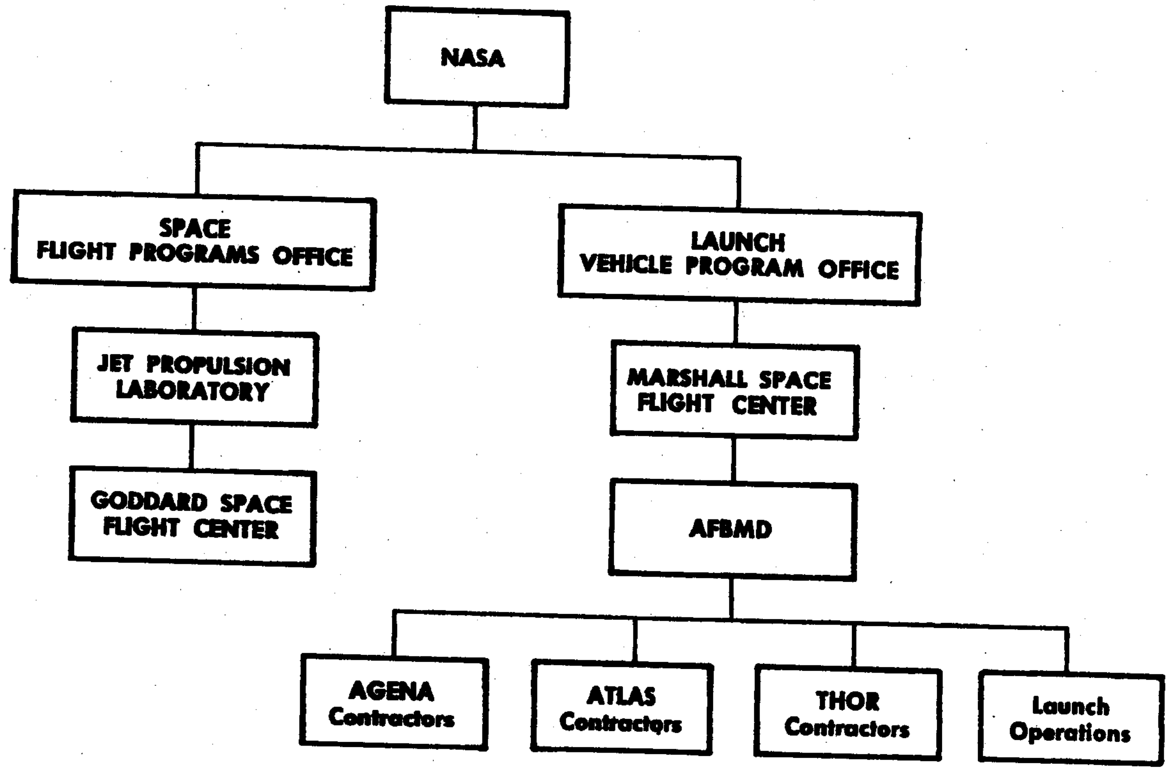
Figure 1. NASA AGENA "B" configuration for Ranger flights (left). Proposed Ranger lunar spacecraft (above) which will be launched from the Atlantic Missile Range.

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

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

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

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



NASA AGENA "B" Project Organization Chart

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

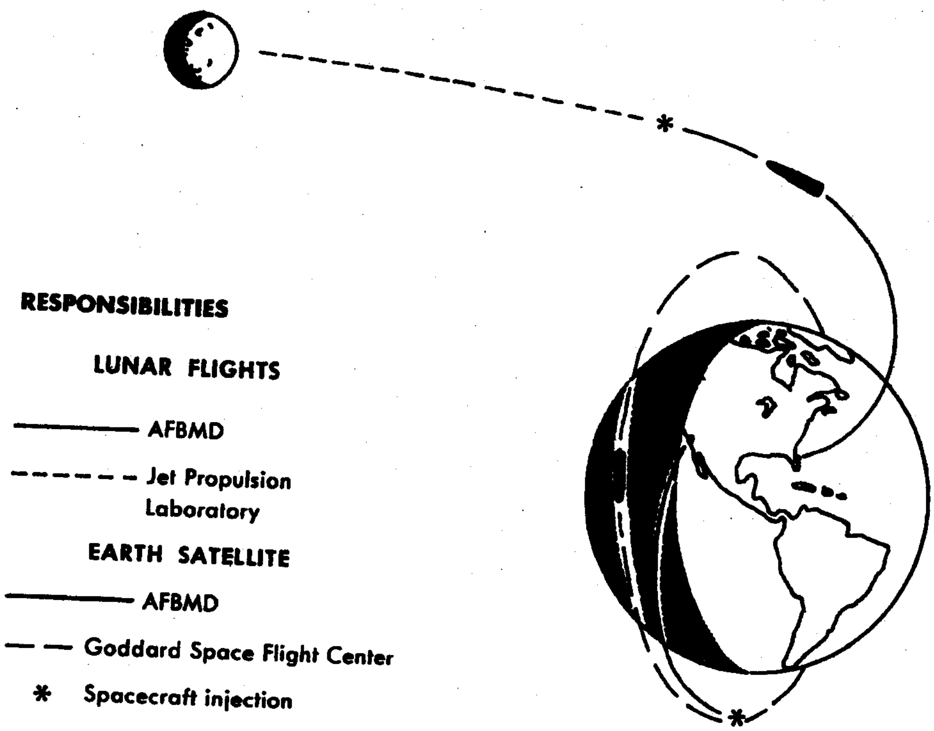
Program Status — AFBMD has taken the following action to support the NASA AGENA "B" Program:

1. Awarded Lockheed Missile and Space Division a contract (letter Contract -592 dated 12 April 1960) for the procurement of modified AGENA "B" second stage vehicles, jettisonable spacecraft shrouds, overall systems engineering and vehicle launch.

2. Issued a contract change notice to Convair Astronautics for five modified ATLAS "D" boosters to support the lunar flights.

3. Allocated eight THOR boosters to NASA.

NASA AGENA "B" Program Flights



Monthly Progress — NASA AGENA "B" Program

Program Administration

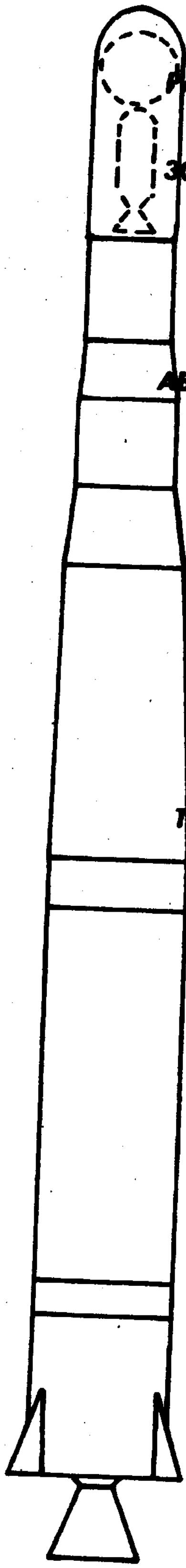
• The NASA AGENA "B" contract (-592) with Lockheed Missiles and Space Division (LMSD) was amended to include the special support necessary for the Topside Sounder and Communications Satellite. The basic AGENA "B" boosters were included in the original contract; however, the details of the spacecraft were not available to define the amount of effort necessary to provide the shrouds, adapters, telemetry, etc. This information is now available and design will begin immediately.

Technical Progress

• The activation of Atlantic Missile Range Pad 12 is proceeding three days behind the activation schedule which was based on a pad availability of 15 January. An initial delay was incurred because ATLAS 90D was not launched from this pad until 23 January. Pad modifications were started the following day. Problems have been encountered in the support of the heavier umbilical tower; however, Convair Astronautics and LMSD are combining their efforts to provide a solution to the problem that will not affect the schedule. The present situation indicates that the modification will be on the original schedule in a few weeks and that the first launch will not be delayed because of pad availability.

• The AGENA "B" vehicle scheduled for the first Ranger (lunar test) spacecraft launching on 25 July is undergoing subsystem checkout at the Lockheed Sunnyvale facility. It is scheduled to begin an integrated systems test on 1 March; included in the systems test will be the R-F compatibility checks with the Jet Propulsion Laboratory Ranger spacecraft.

• Guidance equations for the General Electric Mod III radio-inertial guidance system have been formulated for Ranger missions by Space Technology Laboratories (STL). Flow diagrams were sent to Burroughs Corporation on 19 January. Burroughs will determine a suitable computer program which will be returned to STL by 26 March for checkout. This portion of the program is on schedule.



VELA HOTEL

Program Objectives

• The objective of the VELA HOTEL Project is to conduct a research and development program including experiments and prototype testing to gain information which will lead to the definition of an operational space-based system for high altitude nuclear detonation detection.

Program History

• The Panofsky Panel on High Altitude Detection, reporting to the President's Scientific Advisory Committee, made several recommendations with respect to research and development work which should be accomplished in order to increase basic understanding of the physical mechanisms involved. The Department of Defense agreed to assume over-all responsibility with Atomic Energy Commission support in the high-altitude detection area. Further, it was agreed that the AEC would undertake laboratory development of the nuclear detection instrumentation and that the portion of the effort concerning measurements of natural radiations in space should be implemented jointly by the DOD and the NASA.

• Within the Department of Defense, the Advanced Research Projects Agency was assigned the management responsibility for Project VELA on 22 September 1959. On 18 September 1959, ARPA issued Order Number 102-60 to ARDC for a study and evaluation of the technical and operational factors associated with the detection of high-altitude nuclear detonations. The initial results were used in October 1959 to provide the State Department with supporting technical data for the United States delegation at the Geneva conference. Amendment No. 1 to the original ARPA Order directed ARDC to extend and refine the original study. It was subsequently requested that a joint working group including ARDC, AEC and NASA representatives, chaired by ARDC, be established. The mission of the Technical Working Group was to recommend a research and development program which would investigate the concept of nuclear detonation detection from satellites. To facilitate conducting the work involved, the Joint Working Group formed subcommittees for payload, space boosters, and communications and control.

Program Concept

• The program recommended by the Joint Working Group included the placing in orbit three full-scale experimental satellites from nine ATLAS/AGENA launches. These launches would start two years after program initiation. The satellites were to be placed in orbits outside the natural radiation belts of the earth and were to contain X-ray, gamma ray and neutron detectors. Because of the high cost, the research program was not approved; instead a "limited scope" program was authorized by ARPA.

• With its funds, AEC is initiating a piggyback flight program aboard Rangers (Lunar probes), NASA Scouts and Mariners (Venus probes). Some low-altitude experimentation and a few long-life satellites will be required in addition to these AEC flights. Therefore, additional ARDC/AEC programs will be implemented as follows:

1. Several DISCOVERER piggyback low-altitude polar orbit flights which obtain background radiation data below the Van Allen belts.

2. A limited number of small long-life satellites in highly elliptic orbits with apogees of about 50,000 nautical miles.

• The DISCOVERER piggyback flights as proposed will carry Lawrence Radiation Laboratory experiments consisting of X-ray detectors, gamma ray-neutron detectors, PENG (charged-uncharged discriminator) detectors and solid state spectrometers.

• The small satellites as now invisioned could be launched into various orbits ranging from 200 nautical miles perigee and 50,000 nautical miles apogee to 35,000 nautical miles circular depending on the weight of the final stage vehicle and the desired results. The instrumentation planned for these small satellites is of a prototype design and will consist of X-ray and gamma detectors. Both a THOR boosted vehicle and a BLUE SCOUT vehicle are under consideration for orbiting these satellites.

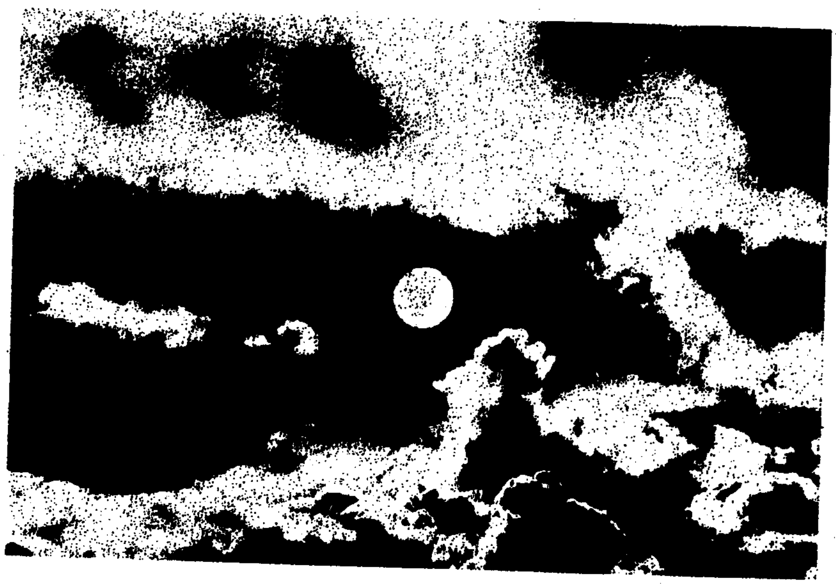
Monthly Progress — VELA HOTEL

Program Administration

• Aerojet-General, Aerospace Corporation, and AFBMD met on 20 January to discuss vehicle configurations for the VELA HOTEL high-altitude program.

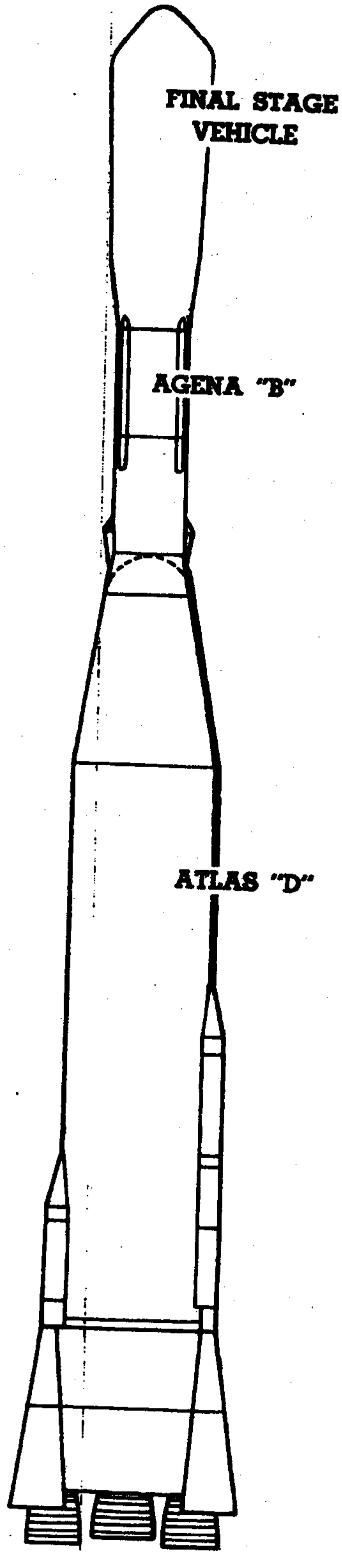
• On 23 January AFBMD forwarded a letter to ARPA giving costs, a management schedule, and contractor support for the low-altitude VELA HOTEL DISCOVERER piggyback program. Program go-ahead has been given Aerospace Corporation, Lockheed Missiles and Space Division, and Lawrence Radiation Laboratory.

SPACE
defense programs



SAINT
ORBITAL INTERCEPTOR

SAINT



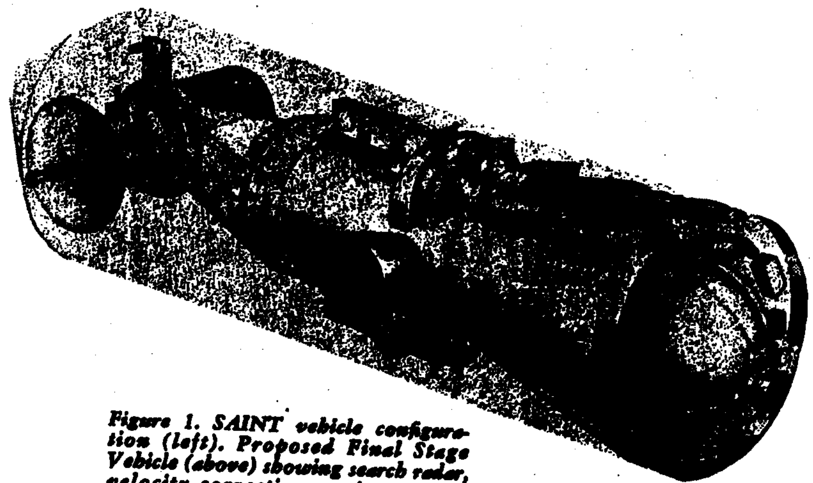


Figure 1. SAINT vehicle configuration (left). Proposed Final Stage Vehicle (above) showing search radar, velocity correction engine nozzle, control-gas storage spheres, and attitude control jets.

The SAINT (Satellite Inspector System for Space Defense) Program has been established to develop and demonstrate feasibility of a co-orbital satellite inspector system capable of rendezvousing with and inspecting suspected hostile satellites and assessing their mission.

Program Objectives

1. Design, fabricate, and demonstrate feasibility of a prototype vehicle capable of co-orbital rendezvous with another satellite at 400 nautical miles with a capability of inspecting and identifying the unknown satellite.

2. Study and define a SAINT vehicle which could be used as an ultimate defense vehicle having a capability of rendezvous up to 1,000 nautical miles with necessary orbit changes.

3. Develop and fabricate those long lead type items required for the ultimate defense system including a capability of negating hostile systems.

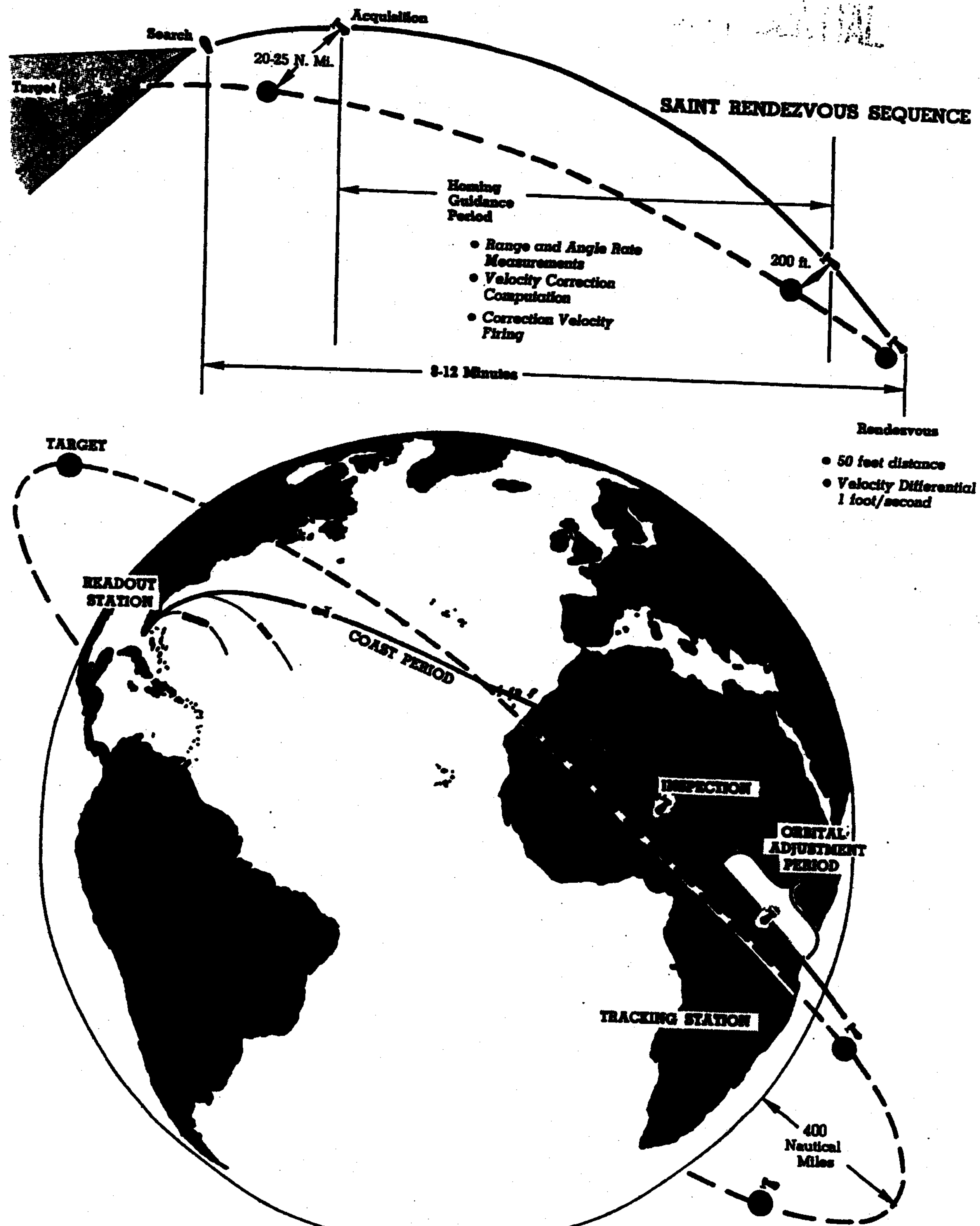


Figure 2. SAINT Program feasibility demonstration flight and rendezvous sequence.

Program History

Initial satellite interceptor system studies were conducted by industry in 1958 under SR187. Studies were continued in 1959 by the Radio Corporation of America under ARPA contract and Space Technology Laboratories under AFBMD management. The STL study was completed 21 December 1959 and the RCA study 31 January 1960, both indicating SAINT would be a feasible system of practical value to the Department of Defense. Subsequently, the following actions have been taken:

1. AF System Development Requirement No. 18 published ....21 April 1960
2. AFBMC approval of SAINT Development Plan ....15 July 1960
3. Department of Defense approval of Development Plan ....25 August 1960
4. Air Force Development Directive No. 412 ....17 October 1960
5. Assigned Systems No. 621A. .31 October 1960
6. RCA chosen as Final Stage Vehicle and payload contractor ...25 November 1960

Concept

Philosophy — The philosophy for development of the prototype vehicle calls for a step-by-step development program with a conservative choice of subsystems and emphasis upon reliability. Ground tests will provide assurance of component capability and reliability before flight.

Over-all System — Unidentified orbiting objects will be acquired, catalogued, and the ephemeris accurately determined through the facilities of the National Space Surveillance Control Center (NSSCC) utilizing available acquisition and tracking equipments. (It is anticipated that, for the ultimate operational system, the capabilities of NSSCC will be expanded to provide additional information such as target size, configuration and stability in orbit, possibly within 12 hours after detection.) This information will be relayed to a Defense Command Control Center which will determine if inspection is necessary. Should inspection be deemed necessary, the ephemeris information will be used to compute data which will be inserted into the guidance system of a SAINT vehicle. The vehicle will be launched into an appropriate position at a time which enables the final stage vehicle to go into orbit with the unknown satellite and inspect it at close range. This inspection data will be stored in the payload for transmission upon command to ground stations. After reception by the ground stations the data will be processed, displayed and evaluated, to determine the mission and intent of the unknown satellite.

Vehicle — The SAINT system as presently envisioned, consists of three stages including an active "Final Stage" or rendezvous vehicle. Early configurations of the SAINT vehicle will consist of a Series "D" ATLAS booster, AGENA "B" second stage, and a SAINT final stage vehicle. This configuration is shown in Figure 1. Later final stage vehicles having increased maneuvering capability and additional sensors would be boosted with the ATLAS/CENTAUR. The final stage vehicle (Figure 1) will include a radar seeker, launch and homing guidance system, attitude control, maneuvering propulsion and a payload. The payload will include a camera and various other sensors to determine the nature of the target satellite and its functional purpose. In addition the payload will have a storage and communications capability.

Feasibility Demonstration — Four flights launched from the Atlantic Missile Range, are planned for the feasibility demonstration. The first flight is scheduled in December of 1962 with the subsequent flights scheduled at three month intervals. The feasibility demonstration configuration of the SAINT vehicle will consist of a Series "D" ATLAS booster, AGENA "B" second stage and a SAINT final stage vehicle. The demonstration final stage vehicle weighs approximately 2,400 pounds. In this demonstration (Figure 2), the final stage vehicle will be programmed to rendezvous with an existing satellite if one is available in a three hundred to five hundred mile easterly orbit. If such a satellite is not available, a target satellite will be placed in a 400 nautical mile, 28.8 degree inclination circular orbit by a 609A system booster. Rendezvous will be accomplished while under surveillance of a Southeast Africa station and a TV image of the target, in addition to the telemetered data of final stage vehicle performance, will be transmitted to the ground station. The image and data will also be stored and read out on command as the vehicle passes over the Air Force Missile Test Center. For the purpose of the feasibility demonstration rendezvous is defined as a closing of the final stage vehicle with the target satellite to within 50 feet and a relative velocity of less than one-foot per second. Station keeping will be maintained for one orbital period.

Future Development — Continued study toward definition of an ultimate operational system is being pursued simultaneously with the other phases of the program. This effort will distinguish certain long lead type items on which development action must be initiated and provide further refinements to the system. Included are extension of the maneuvering capability of the vehicle into 1,000 nautical mile orbits with the necessary station keeping and inspections of multiple targets as well as more exotic sensor capability. For example, a sensor capable of detecting a nuclear warhead is most desirable. Effort is currently underway to proceed with the development of such a sensor.

Program Management

AFBMD management of this program is based upon the associate contractor structure composed of a First Stage contractor, Second Stage contractor, Final Stage Vehicle and Payload contractor, and Systems Engineering and Technical Supervision contractor (Aerospace Corporation). Military support is provided by the National Space Surveillance Control Center through the Air Force Command and Control Development Division, and by the 6594th and 6555th Missile Test Wings.

Facilities

The demonstration program will utilize existing launch, tracking and data reduction facilities insofar as possible. However, some additional ground support equipment will be required at the Air Force Missile Test Center and at the Southeast Africa tracking site.

Monthly Progress — SAINT Program
Program Administration

- Early in January, AFBMD conducted a two-day meeting with representative from Radio Corporation of America, Convair Astronautics, Lockheed, and Aerospace Corporation. The purpose of this meeting was to exchange information pertaining to the first, second, and final stage vehicles; identify interface problems and define an approach for their solution.
- Contract negotiations for the Final Stage Vehicle were completed on 27 January. Radio Corporation of America, the Final Stage Vehicle contractor, will start work on 1 February.
- Representative of AFBMD met with NASA personnel at the Marshall Test Center to coordinate the USAF SAINT Program and the NASA Orbital Rendezvous and Refueling Program. This meeting, held at the request of Headquarters ARDC, is in keeping with the Command policy of a free exchange of information by ARDC and NASA on space problems.

ORBITAL INTERCEPTOR

The Orbital Interceptor Program has been established to develop an operational, space based, anti-intercontinental ballistic missile defense system.

Program Objective

- The primary objective of the Orbital Interceptor Program is to develop a space based defense system which will detect, intercept, and destroy hostile intercontinental ballistic missiles during the powered phase of their trajectory. A second and equally important system objective is to develop the capability of detecting, intercepting, and destroying space vehicles launched from a hostile nation.

Program History

- In mid 1959, both the Air Force and ARPA, by independent studies, became aware of the potential of a space based system for ballistic missile defense. Convair, under an ARPA sponsored study, had developed a concept for a Space Patrol Active Defense (SPAD) system which showed considerable promise. An AFBMD study, directed by Headquarters ARDC, concluded that a space based system which intercepted ballistic missiles during the boost phase was extremely attractive. In January 1960, by agreement between the Office of the Secretary of the Air Force and the Director of Defense Research and Engineering, the Air Force and ARPA entered into a joint program whereby ARPA would retain responsibility for system study, and ARDC would supplement this work with applied research. AFBMD was designated as the agency to integrate both efforts and serve as executive project agent for both organizations. In February 1960, the Ramo-Wooldridge Corporation was placed on contract for a study of their Random Barrage System (RBS) which was another design approach to a boost phase AICBM system. At the conclusion of the SPAD and RBS studies in May 1960, both the Air Force and ARPA carried on an extensive evaluation of the results. At the direction of ARPA, an ARDC Technical Evaluation Board was convened at AFBMD to evaluate the technical validity, operational capability, and program feasibility of the system concept and to recommend a follow-on program. Other evaluations were carried on by ARPA, the Air Force Scientific Advisory Board, AFMDC, and The RAND Corporation. All agreed essentially that the concept was valid, that no acceptable system design was yet in evidence, that more detailed design studies were required, and that an extensive applied research effort must be undertaken to collect the data required for design implementation.

Program Concept

- The Orbital Interceptor system will consist of a large number of space based interceptors deployed at random along inclined orbits which are distributed so that defense coverage of hostile nation areas of interest is provided. The altitude of the orbital interceptors will be approximately 200 nautical miles. Each of the satellite/interceptors will be independent, automatic, and self contained. They will not have communication with each other but will have contact with the ground based defense network when they pass over a secure communications "fence" in mid-United States. Under normal circumstances, each satellite will have a pre-set program which will cause it to search for targets only over hostile territory. By employing an infrared search set, the satellite will detect an ICBM as it emerges from the atmosphere. Upon determination that this target is within its area of kill, an interceptor containing an infrared seeker will be launched to home in on the target. Upon approaching the ICBM, the interceptor will deploy a large number of light weight pellets designed to strike the missile booster while it is still burning. The combination of orbital velocity and interceptor incremental velocity provide the pellets with extremely high energy. This energy is sufficient to cause major damage to the booster motor, thereby destroying the ICBM or causing the warhead to fall as much as 1,000 miles short of its target.

- The size of the orbital interceptors is such that a fairly large number can be deployed into orbit simultaneously from one booster. A booster such as the ATLAS/CENTAUR could be used as an interim booster for research and development test and initial operational deployment of the system. Economic feasibility of the system, however, is dependent upon the development of a large low cost booster, such as the PHOENIX, since 50 to 70 percent of the system cost is that of deploying payload in orbit.

- As in any defense system, the Orbital Interceptor system can be saturated. A hostile nation could reduce the effectiveness of the system by concentrating his launch sites in a given area and launching his missiles in a salvo of less than one minute. The possibility of a nation resorting to this strategy, is difficult to evaluate. The system does possess, however, very attractive characteristics which enable it to be extremely effective against dispersed launches and against missiles with long burning times. These characteristics enable the system to be particularly suited to defense against mobile ICBM launches, space launches, attacks from minor missile powers, accidental launches both friendly and hostile, and against sustained ICBM launches after the first onslaught of a general war. The number of orbital interceptors required for these missions is considerably less than that required for compact salvos.

Program Status

• The current Orbital Interceptor FY 61 program consists of four parts: system design studies; support system studies; Orbital Interceptor oriented applied research studies; and test vehicles (R&D test program).

• ARPA has directed AFBMD to undertake three or more competitively selected system design studies. The objectives of each of these studies are: to perform detailed design studies of the satellite, interceptor and deployment package; to analyze the design requirements for the support systems; and to analyze the technical, economic, and operational feasibility of the system design. A second part of the study is to conduct detailed analyses, simulation, and experimental testing of the critical components and techniques which are essential to establishing technical validity of the design. A Source Selection Board is currently in session to select the contractors who will participate in this program. It is expected that the contractors will initiate their studies in March 1961 and will continue for a twelve-month period.

• Approval is expected within the next month from ARPA for the initiation of studies of the Ground Launch Complex, Command and Control System, and Boosters. Approval is also expected for comprehensive operations analysis, cost/effectiveness, countermeasure, and reliability evaluation studies.

• AFBMD has been working with ARPA and the cognizant Divisions and Centers of ARDC to define a program of Orbital Interceptor oriented applied research which will provide essential data and techniques. Extensive and expanded effort is required in: infrared target radiation, background, and blackout measurement; hypervelocity kill mechanism measurements; and in guidance and control, propulsion, and infrared equipment techniques. A substantial program of kill mechanisms has been recommended to ARPA and a decision is expected in January. As other programs are defined and prepared, they will be submitted to ARPA. It is essential that these applied research programs be initiated as soon as possible so that the data collected can be integrated into the system feasibility studies.

Management

• In October 1960, a decision was reached that ARPA would retain program responsibility and fund the major part of the program in FY 61. AFBMD was retained as the executive project agency to integrate the system and applied research parts of the program.

• All the work under the present phase of the Orbital Interceptor program, whether it be on contract with industry or placed through another ARDC organization, is under the technical management and direction of AFBMD. The Aerospace Corporation is assisting AFBMD by providing system analysis, technical analysis, and evaluation services. Under present plans, this phase of the program will provide data by January 1962, from which an evaluation can be made as to the technical, economic, and operational feasibility of the Orbital Interceptor system. If feasible, it is planned to initiate development of the system and its support systems by April 1962. By this time, program responsibility will transfer from ARPA to the USAF.

Ground Facilities

• The large number of satellites required for full operational deployment of the system will demand production type launches from facilities located at both the Atlantic Missile Range and Vandenberg Air Force Base. The frequency of launch will require new facilities at each location.

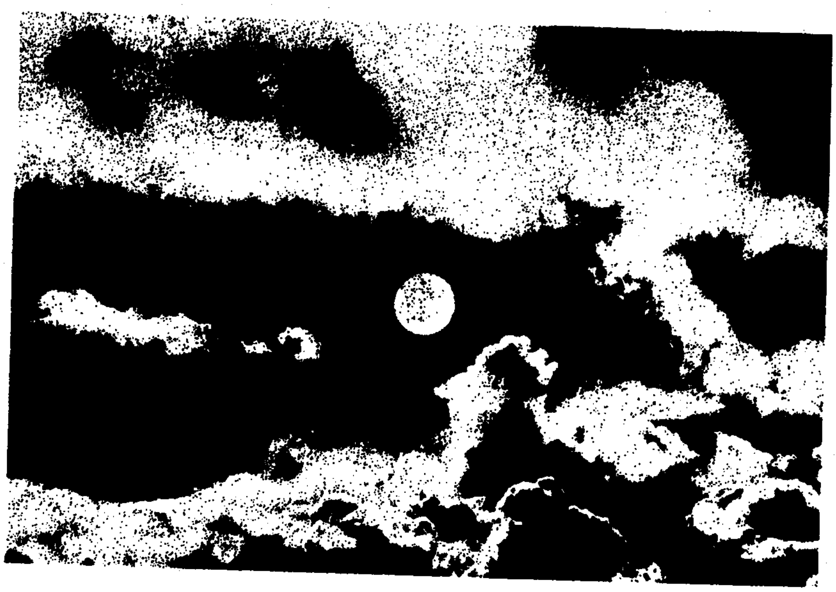
• A major element of the system is the ground based command and control complex. This complex will provide the facilities for secure communications with the satellites so as to transmit necessary programming instructions, and to receive information on operational status. This complex will also provide ground links with the Air Defense Commander and the National Space Surveillance Control Center. Wherever possible, existing facilities will be utilized. However, there will be command and control requirements peculiar to the Orbital Interceptor System which must be designed and procured as a separate support system.

Monthly Progress — ORBITAL INTERCEPTOR

Program Administration

- In response to a Headquarters USAF request, budget plans and supporting background documentation were transmitted to Headquarters ARDC in support of the FY 1962 Space Center Weapon System (ORBITAL INTERCEPTOR/BAMBI) Program. Information on budget levels of 24, 31, 61 and 79 million dollars was presented.
- As a result of Headquarters ARDC assigning a KC-135 to the Air Force Missile Test Center in support of the joint ORBITAL INTERCEPTOR/MIDAS Project (RAMP), representatives of AFMTC, the 6555th Test Wing, and Aerojet Corporation met at AFBMD to finalize the details for operational support of this project. The KC-135 will be used to fly infrared equipment during Atlantic Missile Range ballistic missile launches so that infrared radiation measurements can be obtained. Aerojet is under contract to provide for the operation of the infrared measuring equipment and the collection of the data.

BIOASTRONAUTICS



BIOASTRONAUTICS

BIOASTRONAUTICS

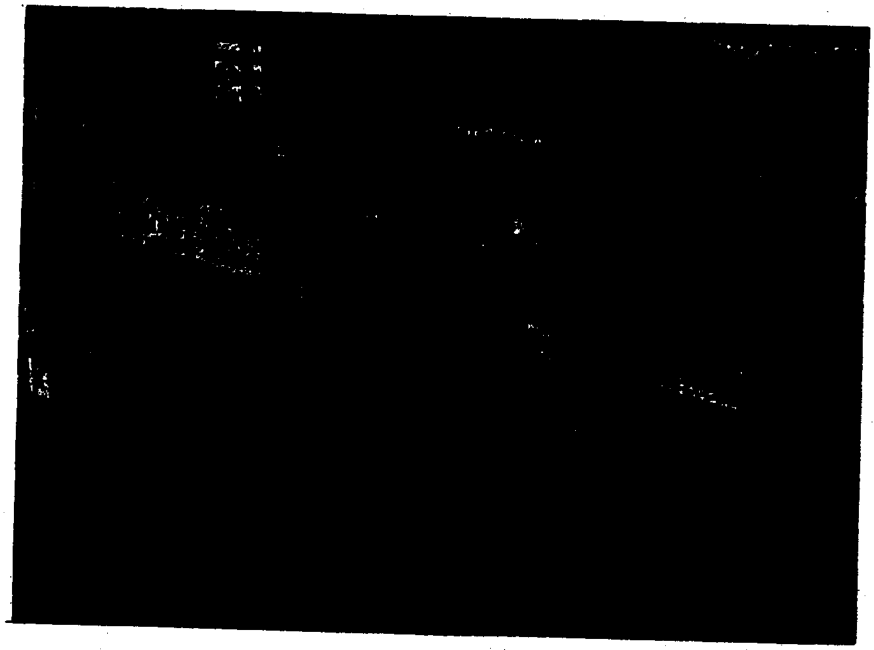
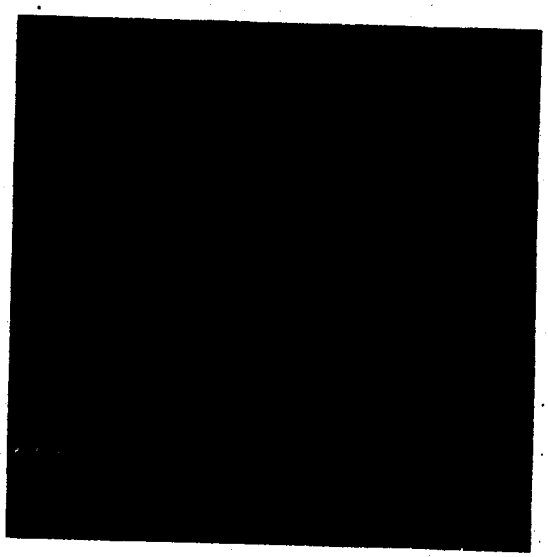


Figure 1. Van type Biomedical facilities at Vandenberg Air Force Base. This laboratory is used for final check and preparation of animals prior to launch. Interior view of Biomedical van (below) showing some of the instrumentation racks used in monitoring the test animal.



Program Objectives

The complete exploration of space requires that the biological effects of the space environment be defined. AFBMD is continuing its aggressive research and development programs in this technical area to insure that necessary bioastronautics knowledge will be available during the 1963-1965 time period so that the limits of manned operational space systems can be established. This is completely dependent upon preliminary biological space exploration, including development of systems that will support both animals and man, and extensive investigations of the space environment. Problems which must be solved before these goals can be reached are: capsule development, life support design, and biological instrumentation. Space flight stresses (long term weightlessness, operational experience in the radiation belts and isolation) must also be determined.

Program Summary

Successful initial manned space flights necessary in reaching our national military objectives are depending on knowledge obtained from space tests with lower life forms, including primates. The BIOASTRONAUTICS Program is furnishing such data during actual ballistic and orbital flights in the space environment. Experiments include those made on a space available basis aboard scheduled ICBM shots and certain tests with more advanced biological capsules utilizing the DISCOVERER Program. Data obtained from these tests will be correlated with data obtained from laboratory experiments. The results will be of great significance to the Air Force DYNA-SOAR Program, the NASA MERCURY Project, and are necessary to the success of future military missions. The BIOASTRONAUTICS Program is supported by selected studies exploiting techniques and developments in Bio-instrumentation, capsule design, weightlessness effects, and environmental control.

Bioastronautics Capsules

This technical effort includes the research, design, development pre-flight test, and flight test of a Biomedical recoverable capsule (Sub-system L) in the DISCOVERER Program. Thus far, two packages have been launched on DISCOVERER flights. Currently in pre-flight test is the Mark II biomedical recoverable capsule designed to support a six-pound primate for 27 hours on orbit.

A BIOMEDICAL Program Space System Development Plan has been prepared. This plan proposes addi-

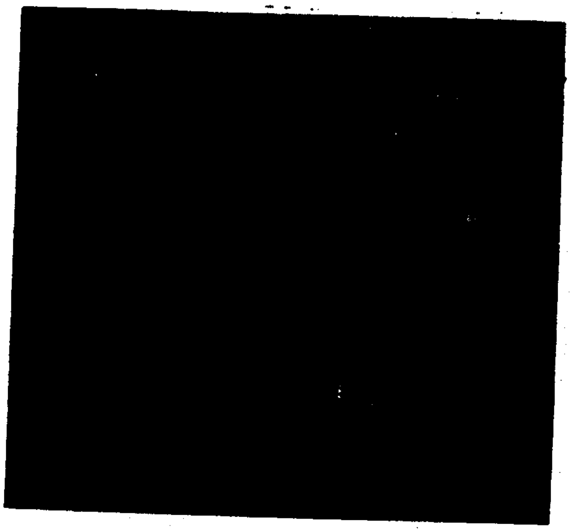
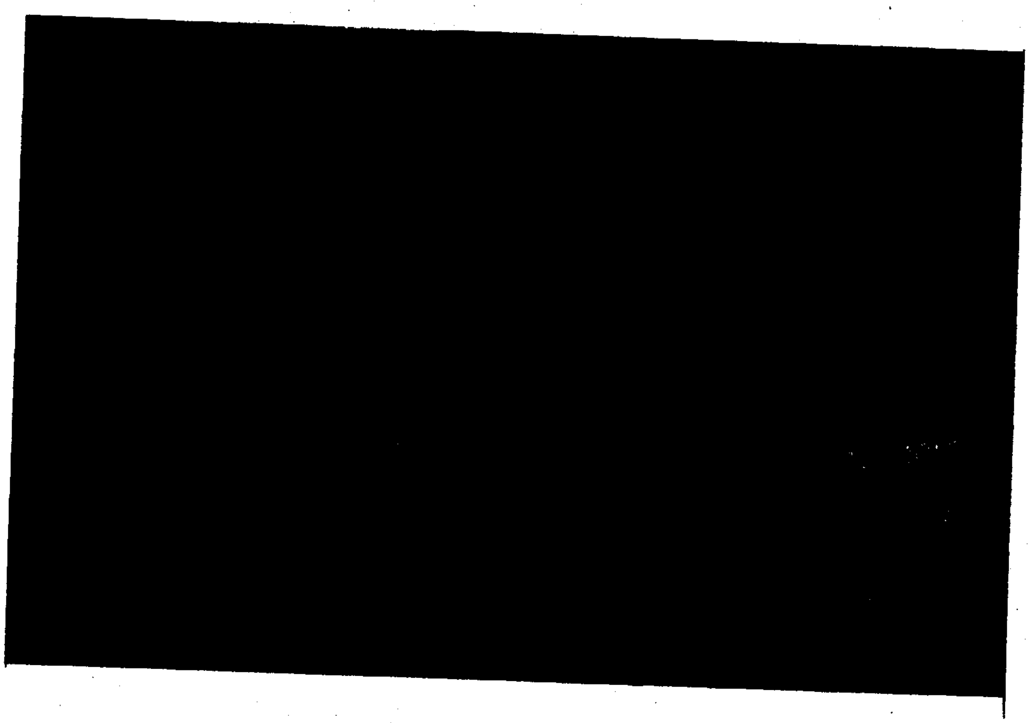


Figure 2. The Advanced Biomedical Capsule mockup (below) with a model of the 50-pound chimpanzee and the support couch partially installed. Mockup shows restraint harness and tasks performance panel in place. Specimen-recording and telemetry equipment are mounted on the top of the capsule. Opposite end of the mockup (left) showing oxygen spheres, blowers, and collant equipment. This mockup was constructed as part of the Advanced Biomedical Capsule Study.



tional biomedical (Mark II) recoverable capsules on DISCOVERER flights in CY 1961. These additional flights will provide much needed data to support the logical follow-on Advanced Capsule Program.

Another program area is the development of advanced biomedical capsules and life support systems that can be used for a Bioastronautics Operational Space System (BOSS). A study contract with Lockheed Missile and Space Division has culminated in a mockup of a capsule for support of a fifty-pound primate for long periods of time in the space environment. Sophisticated inquiries concerning the response of the animal to that environment will be made during such flights.

Subsequent work will lead to a completely functional nonflyable prototype which will be put through performance static test in thermal, altitude, acoustic, and gaseous environment management. A Development Plan to program such a capsule into a Bioastronautics Operational Space System for space exploration is being prepared. This plan will be ready for review in January 1961.

Biopacks

Bioastronautics information is being collected from packages on DISCOVERER, ATLAS-E Pod and RVX-2A flights. By coordinating efforts between the School of Aviation Medicine, Air Force Special Weapons Center and the Geophysics Research Directorate, a series of experiments were scheduled to investigate biological aspects of ambient space radiation. These experiments have been made on a man-contract-basis using Government Furnished Equipment and in-house research funds.

Monthly Progress — BIOASTRONAUTICS Program

Space Radiation Measured

• On 9 November, an Air Force Special Weapons Center tissue equivalent ion chamber was successfully carried in an ATLAS RVX-2A re-entry vehicle through a ballistic trajectory. This ion chamber had 1/4-inch lucite walls, so that its output represented the energy deposition rate at 1/4-inch depth in tissue from ionizing radiations encountered by the vehicle. The chamber was mounted in approximately the center of the nose cone and was therefore surrounded by a considerable amount of structure. Preliminary estimates indicate that this material was, effectively, a shielding of 10 grams per square centimeter or more. With this much shielding, the principal radiation detected by the chamber is believed to have been high energy proton radiation trapped at the lower edge of the inner Van Allen belt. The chamber first encountered detectable radiation at around 1100 kilometers (18 degrees North). The level increased as the vehicle traveled southward, reaching a peak dose rate of approximately 500 mrad/hour between 1100 and 1000 kilometers (10 to 6 degrees North). Prior to launch, calculations were made to determine the expected dose rate from trapped protons using data presented by Freden and White from an emulsion experiment. The agreement between the observed maximum dose rate and the calculated value was very good. This was taken as a justification for the belief that the observed dose rate was due to trapped proton radiation. There were several nuclear emulsion experiments successfully recovered on this flight, so verification of this assumption should be forthcoming. A complete analysis of the ion chamber experiment will be available in the next few months.

Project GIPSE

• Development of a Gravity Independent Photosynthetic Gas Exchanger (GIPSE) for flight on an ATLAS E Pod this May is 95 percent complete. This device has been developed to investigate the feasibility of gravity independent operation of such a system in the weightless space environment. The system utilizes a thermophyllic strain of algae (chlorella pyrhenoidosa) which converts carbon dioxide by the photosynthetic process to produce oxygen for potential life support. This conversion takes place in a continuously circulating liquid exposed to the proper light intensity, controlled temperature and plant nutrients in the solution. The oxygen produced in solution diffuses through a semi-permeable silicone rubber membrane and the gas is then conducted to its ultimate use. This particular system produces about one and one-half liters of oxygen in 24 hours.

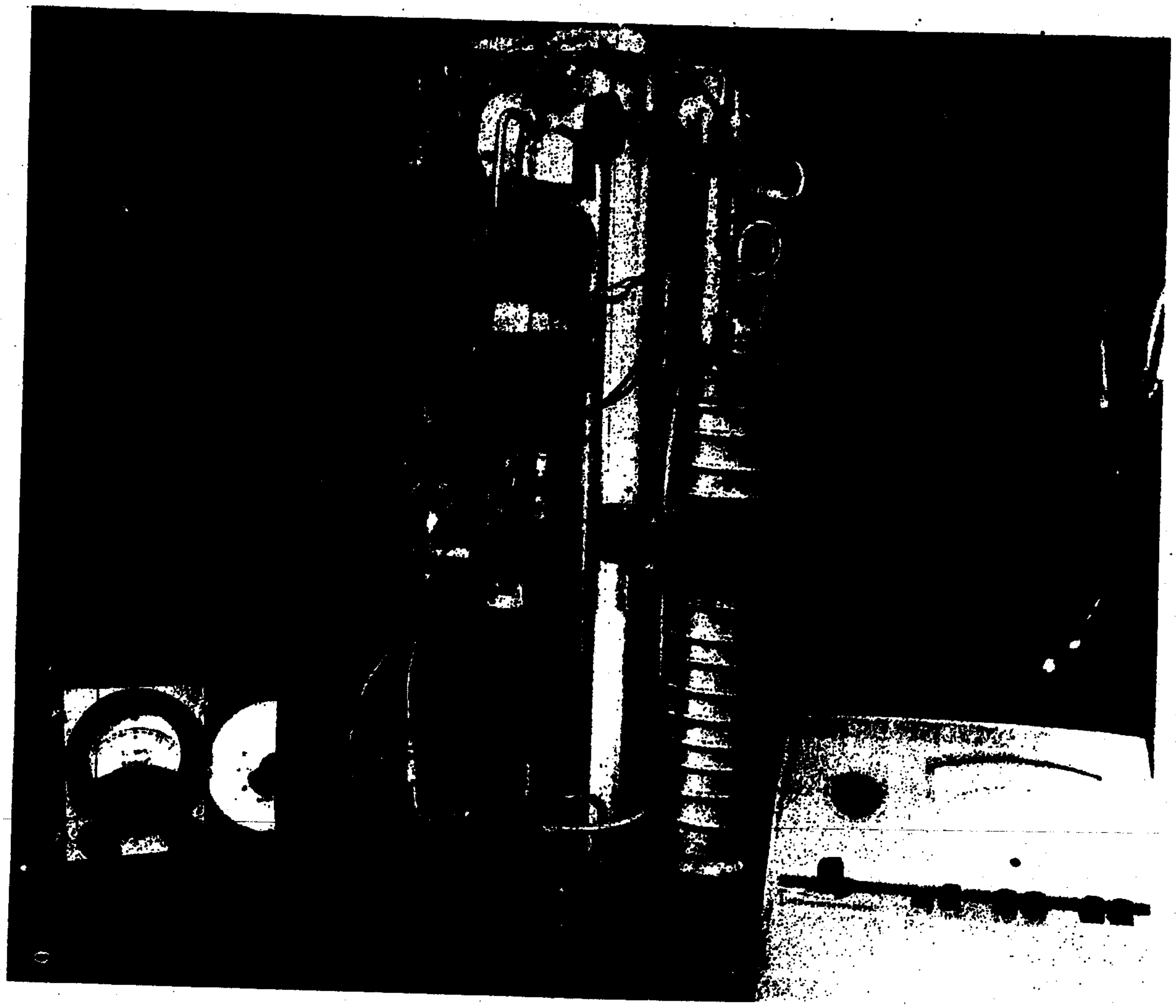


Figure 3. The Gravity Independent Photosynthetic Gas Exchanger (GIPSE) shown during environmental testing. The main cylinder (behind the valves and transducers) contains the oxygen producing solution. The cylinder with the tubing coiled around it is the heat exchanger.

Biomedical Test Program

- Results of analysis of the biopack specimens carried in the recovered DISCOVERER XVIII capsule during its three days in orbit (7-10 December) have been released. This biopack was exposed to a normal space environment. It did not encounter the severe radiation from solar flare activity as DISCOVERER XVII did in November.

- The purpose of the Biopack was to determine the effect of cosmic radiation on biological samples and to correlate biological effects with types and intensities of the measured radiation. The material contained in the Biopack is identified in Figure 4.

- The total three-day radiation dose was well below 100 millirads of X-ray equivalent dosage. This dose is typical of what is expected in a normal DISCOVERER flight environment, as compared with the 30 to 35 radiation exposure sustained by DISCOVERER XVII which was on orbit during a high intensity solar flare.

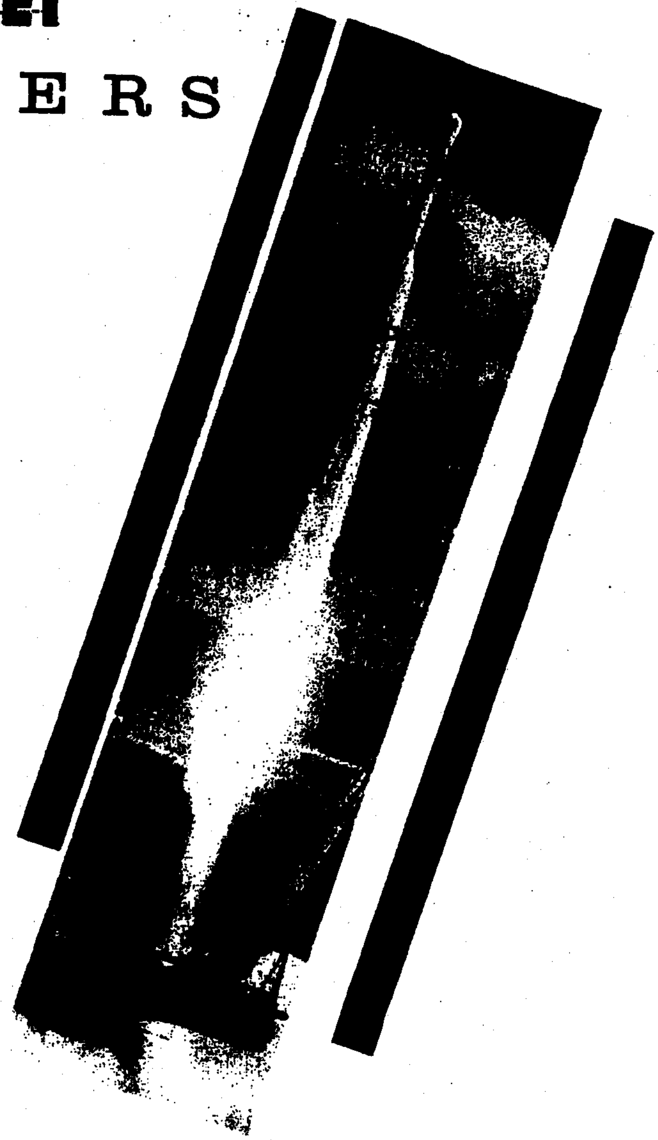
- Substantial amounts of alpha and heavier particles were detected. The only dosimeter response was from the photographic type. Primary electrons were not detected. The effect of the orbital environment on the algae, spores and tissue appears negligible. Their condition, when compared with control specimens retained on the ground, was so little changed that it was extremely difficult to detect any difference.

Figure 4. The experiments contained in the DISCOVERER XVIII Biopack.

SPACE
program boosters

Space Program

BOOSTERS



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

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

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

THOR

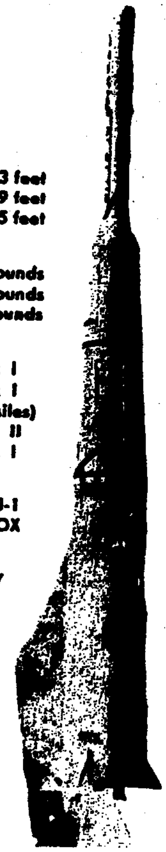
Prime contractor:
Douglas Aircraft Co.

Engine manufacturer:
Rocketdyne Div., North American Aviation

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

Guidance — Bell Telephone Laboratories or autopilot only

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



SECRET

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 sixteen 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

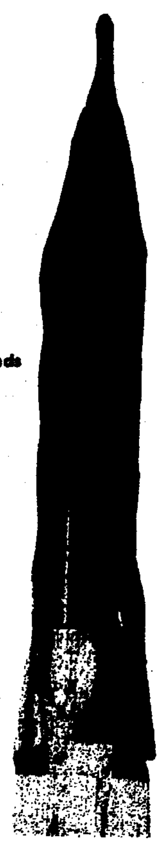
Prime contractor:
Convair

Engine manufacturer:
Rocketdyne Div., North American Aviation

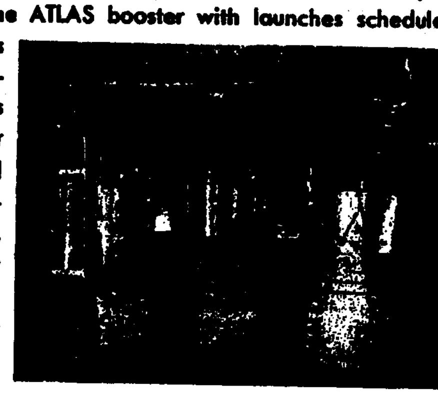
Height	69 feet
Diameter	10 feet
Weight	261,206 pounds
Engine	
Series D ATLAS	MA-2
Fuel	JP-4
Oxidizer	LOX

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

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



The first ATLAS boosted space flight was launched from the Atlantic Missile Range on 18 December 1958. As of 1 December 1960, the ATLAS booster has performed successfully in six out of a total of eight launches. The ATLAS Series "D" radio-guided ICBM, strengthened and modified for space purposes, is used for the SAMOS and MIDAS military space programs. Additionally, the same booster will be used for the NASA/AGENA "B," SAINT, and the VELA HOTEL programs. The Communication Satellite (ADVENT) Program will use the ATLAS booster in two configurations. The first will be a "D" Series ATLAS modified to accommodate the AGENA stage. Later on the program will use the ATLAS "D" modified for a CENTAUR upper stage. All ATLAS boosters, except the CENTAUR upper stage version, appear similar to the ATLAS "D" Series ICBM. The CENTAUR stage version has a strengthened, constant diameter tank section and the radio guidance system is eliminated because it is commanded by the guidance system in the second stage. 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. There are 75 firm programmed space launches employing the ATLAS booster with launches scheduled through 1963. Several other programs and extensions of existing programs indicate that perhaps 200 ATLAS boosters will be required during the next four years. Since ATLAS "D" boosters and ATLAS ICBMs are presently being produced on the same production line, deliveries must be worked out jointly to supply both space requirements and ballistic missile needs to the extent possible within the production capability.



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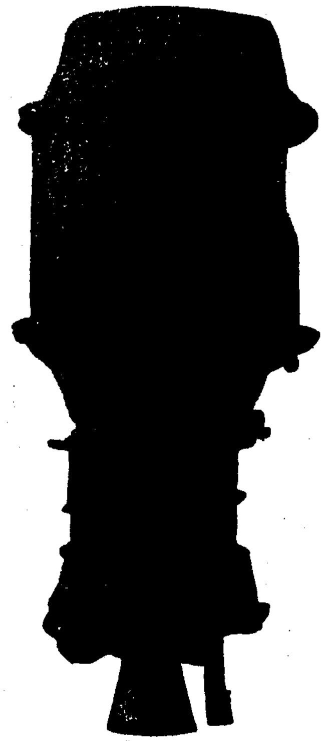
AGENA

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



Prime contractor:
Lockheed Missile and Space Division

Engine manufacturer:
Bell Aircraft Corp.

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

Fuel
Unsymmetrical Dimethyl Hydrazine

Oxidizer
Inhibited Red Fuming Nitric Acid

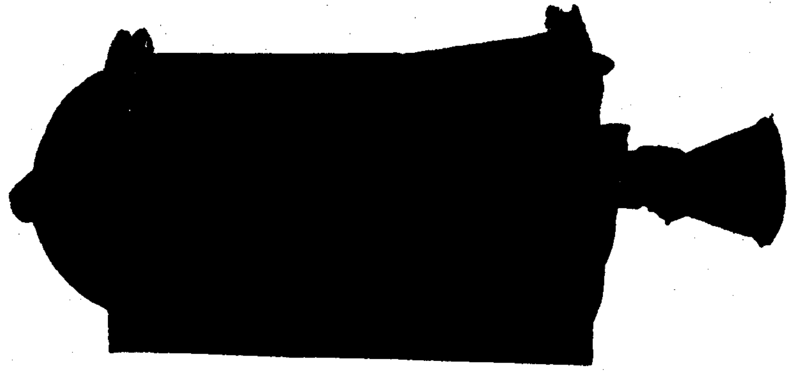
Guidance optical-inertial

Used as second stage for:
DISCOVERER
SAMOS
MIDAS

NASA/AGENA "B"

ABLE-STAR Vehicle

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



Contractor:
Aerojet-General

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

with Restart Capability
Nozzle Expansion Ratio—40.1

Fuel
Unsymmetrical Dimethyl Hydrazine

Oxidizer
Inhibited Red Fuming Nitric Acid

Guidance
STL ABLE Guidance System
Burroughs J-1 Computer

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

ABLE Vehicle

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

Contractor:
Aerojet-General Corp.

Height	18 feet 7 inches
Diameter	4 feet 8 inches

Weight

AJ10-42	4622 pounds
AJ10-101	4178 pounds

Fuel
Unsymmetrical Dimethyl Hydrazine

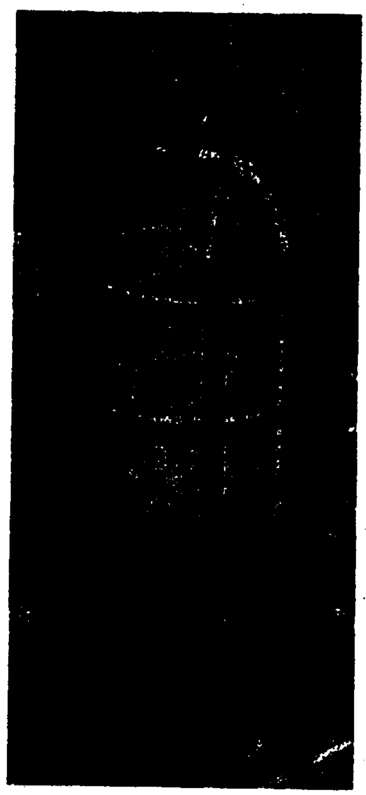
Oxidizer
Inhibited White Fuming Nitric Acid

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

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

ABL 248 Vehicle

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



Contractor:
Allegany Ballistic Laboratory

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

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

Specifications....

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

FIRST STAGE

NOTES

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

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

(3) *Single restart capability.*

(4) *Dual burn operation.*

(5) *Allegany Ballistic Laboratory.*

AGENA	E "A"	F "B"	G
Engine Model	YLR81-Ba-5	XLR81-Ba7 (4)	XLR81-Ba-9 (3)
(1)Weight—inert	1,262	1,328	1,346
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
(2)TOTAL WEIGHT	8,165	14,789	14,807
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn Time—sec.	120	240(4)	240(4)

SECOND STAGE

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

SECOND ↔ STAGE

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

THIRD STAGE

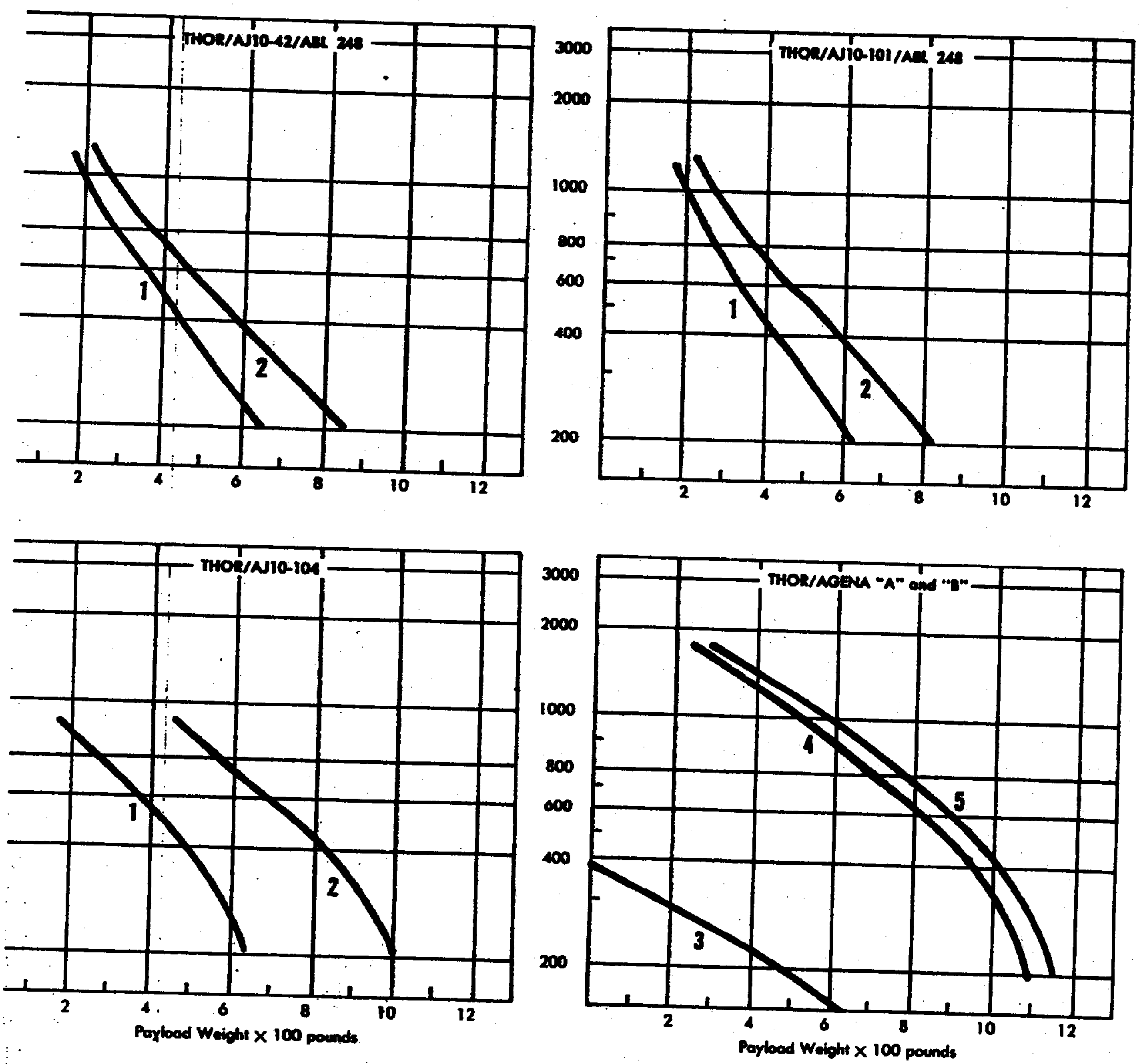
Program Vehicle Combinations

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

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

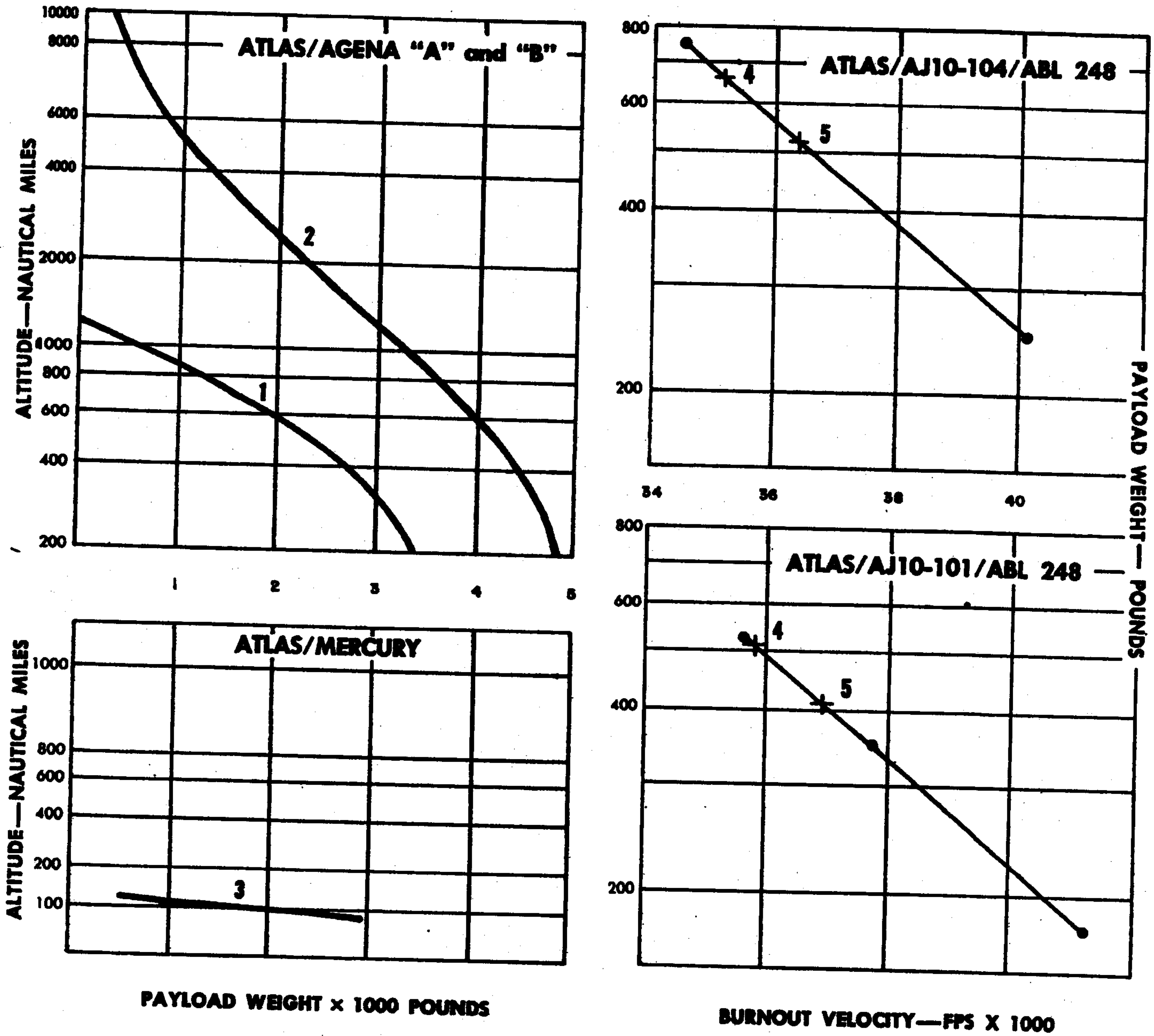
ABLE-4 and -5 . . . . D-J-L
TRANSIT 1A . . . . A-H-L
TRANSIT 1B, 2A, 3A, 3B, 4A . . . C-K
COURIER . . . . C-K
TIROS . . . . A-H-L

Performance Graphs — THOR BOOSTED



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

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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