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a foreword to...

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12 January 1961

Summary of AIR FORCE BALLISTIC MISSILE DIVISION Activities in Space

DECEMBER 1960

FOREWORD

With the completion of the most significant year of progress in Space research and exploration, the highlights of AFBMD accomplishments in Space during 1960 are summarized in the foreword section of this month's report. Included with this review are major milestones that are scheduled or forecast for attainment during 1961. Noteworthy December events reported in the monthly progress sections include the successful aerial recovery of the DISCOVERER XVIII capsule, following three full days of orbiting the earth; the valuable telemetry data obtained from the MIDAS RM-1 (radiometric measurement) payload, placed in a successful orbit by the DISCOVERER XIX vehicle; and BIOASTRONAUTICS information concerning the single-channel, surgically implanted transmitter and the DISCOVERER Biopack equipment.

This issue completes the first full year of publication of the monthly Air Force Ballistic Missile Division Activities in Space report. The questionnaire attached to the front cover has been prepared to obtain information on which future revisions to and distribution of the report will be based. Your cooperation in answering the questions and returning the form to WDLPR-4, AFBMD, is requested.

for Henry B. Kreitman Jr. Col USAF

O. J. RITLAND
Major General, USAF
Commander

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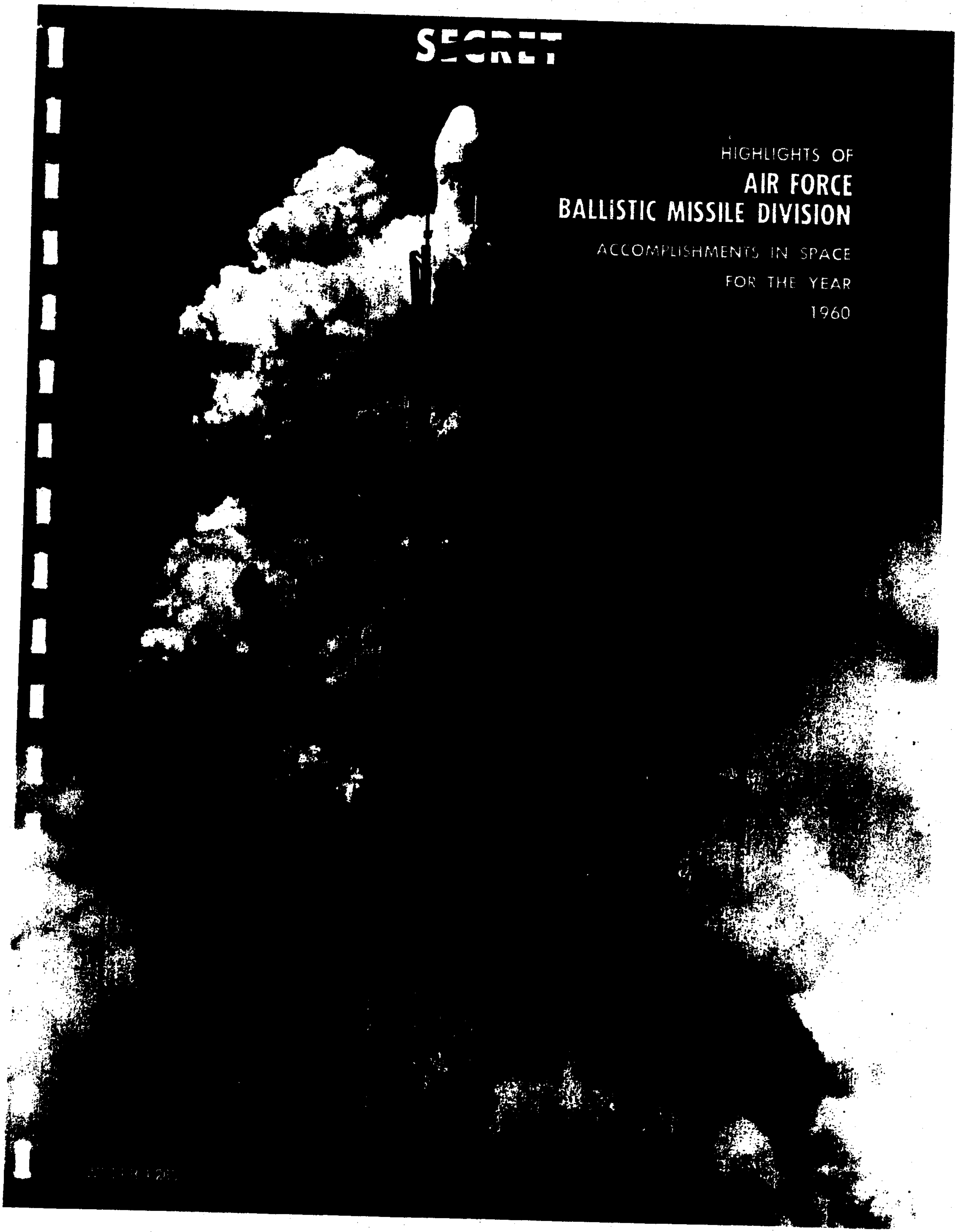
HIGHLIGHTS OF

AIR FORCE BALLISTIC MISSILE DIVISION

ACCOMPLISHMENTS IN SPACE

FOR THE YEAR

1960



During 1960, space research and exploration progressed at an accelerated pace. Highly significant "firsts" were achieved in Space programs for which AFBMD was totally or partially responsible. Among the most outstanding of these were the PIONEER V solar satellite, the aerial recovery of DISCOVERER capsules from earth orbits, the successful weather satellite (TIROS) and navigational satellite (TRANSIT), and the progress realized in the hyper-environmental test system (Project 609A) Blue Scout vehicles. In the following paragraphs, the major 1960 accomplishments of each program are summarized. Each summary is then followed by the major milestones which are scheduled or forecast for attainment during 1961.

DISCOVERER

• The purpose of the DISCOVERER Program is the design, development, and flight test of 41 two-stage satellite vehicles. In the early phase of the program the flight configuration employed consisted of the THOR IRBM with slight modifications and the AGENA "A" second stage. The present and future flight configuration will employ the DM-21 booster, an improved THOR with reduced weight and increased thrust, and the AGENA "B" orbital stage. The AGENA "B" satellite vehicle represents a number of improvements over the earlier AGENA. Among the improvements are: double propellant capacity, improved engine specific impulse (45:1 expansion ratio), and an engine restart capability. The first flight utilizing both the final DM-21 configuration and the final AGENA "B" configuration occurred on 7 December 1960 with the launch of DISCOVERER XVIII.

• The DISCOVERER Program is not designed to be developed into a military weapons system; however, it is designed to develop and flight test many of the components common to future satellite systems. Specific program objectives include:

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

2. Attaining satellite stabilization in orbit.

3. Obtaining satellite internal thermal environment data.

4. Testing of techniques for recovery of a capsule ejected from the orbiting satellite.

5. Testing of ground support equipment and development of personnel proficiency.

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

• This program has provided much valuable data concerning the program objectives. Of the eleven DISCOVERERS launched during 1960 seven attained orbit; six of these had recovery as an objective; five of the recoverable capsules were properly ejected from orbit; four of the capsules were recovered after extended exposure to the space environment, three of these were air-recovered, and one sea-recovered. One other was located in the sea but lost due to severe weather conditions. The DISCOVERER Program has provided three very significant firsts in the conquest of space; the first recovery of a capsule after extended exposure to the space environment, the first air recovery of a capsule from outer space, and the first return and recovery of living tissue exposed to solar flares.

• The data acquired from past flights would classify this among the most successful space programs, and future flights will be equipped with new developments providing greater altitude/payload capability, and more precise orbital parameters, provided by the Bell Aircraft XLR-81Ba-9 engine for the AGENA vehicle, coupled with the improved performance of the DM-21. In the near future the boosters will be equipped with the Bell Telephone Laboratories Series 400 guidance system, which will increase the accuracy of the orbital altitude and period.

• Significant contributions toward military space systems during the year included the development of the following capabilities:

1. Reorientation and stabilization of satellites on orbit.

2. The flight test and refinement of the AGENA satellite vehicle and subsystems.

3. Development of a capability for recovery in undamaged condition of a capsule ejected from a satellite on orbit.

4. Delivery of an improved and more capable AGENA vehicle.

5. Exercise of the communications, control, tracking, and data acquisition network.

6. Training and exercise of the Air and Sea Recovery Forces.

7. Establishment of a sound base of experienced personnel and manufacturing facilities directly applicable to future satellite programs.

• The most significant problem area encountered during the past year was that of securing the proper ejection of the recovery capsule from the orbiting satellite vehicle. This problem was solved by accomplishing several design changes including lengthening the distance between the main satellite vehicle and the recovery body during separation before initiating the firing of the spin rockets. Also the solid propellant spin rocket system on the recovery body was replaced by a more reliable stored gas spin system. These changes, coupled with intensive testing of recovery system components, have made possible the successful recoveries to date.

• This program will provide further advances in the Air Force progress into the aerospace environment during the next year. The more powerful and precisely guided DISCOVERER vehicles will fly equipment designed to collect background infrared information for MIDAS, continue testing of AGENA components for other satellite programs, collect selected geophysical and biomedical data and will further perfect the technique of reliable recovery of capsules from space vehicles.

MIDAS

• A MIDAS R&D Development Plan dated 15 January 1960 was prepared by AFBMD and presented to the Air Force as a "Minimum Essential Development Plan," which AFBMD stated was of extremely "high risk." Analysis of the ballistic missile test program, and DISCOVERER Program experience to that date indicated that the scope of the proposed ground and flight testing program was the bare minimum required to accomplish the development objectives. It consisted of a 10-flight program through CY 1962 and was satellite vehicle oriented. A 15 January Dev/Ops Development Plan submitted concurrently with the R&D Plan contained the necessary ground elements of the system leading toward an operational capability in early 1963. The R&D plan was approved and funded. The Development/Operational Plan was not approved.

• MIDAS flight test No. 1 was launched from the Atlantic Missile Range on 26 February 1960. The flight vehicle consisted of modified ATLAS 29D, an AGENA "A" vehicle, and an experimental Aerojet-General infrared scanner. Many communications and geophysical environmental experiments were included. The launch and booster performance were as planned. On separation of the satellite stage from the ATLAS, both the satellite stage and the booster were destroyed. Post-launch analysis indicated that this probably was the result of a failure or malfunction of the premature separation destruct system. All test objectives through the ATLAS boost phase were accomplished.

• MIDAS flight test No. 2 was launched on 24 May 1960 from AMR. The flight vehicle was composed of modified ATLAS 45D, an AGENA "A" vehicle and carried a second model of the Aerojet General infrared scanner. The satellite had an empty weight on orbit of 4,879 pounds. The primary flight objectives were to place a MIDAS satellite, carrying an infrared detection payload, into a circular orbit at an altitude of 262 nautical miles, to achieve and maintain a stable nose-down attitude, and to secure infrared information from the payload. These objectives were achieved with the exception of maintaining the stable attitude in orbit and, due to the failure of the data link telemetry transmitter after the fourth orbit, infrared data in the "filter-in" (2.7 micron) narrow bandwidth configuration was not obtained. However, during the active period of the data telemetry, data were obtained on background radiation in the 1.8 to 2.7 micron (filter out) region and operability of the detection system was checked by observation of celestial infrared sources. Due to the instability of the vehicle, the detectors were exposed to direct illumination by the sun with no apparent deleterious effect to their sensitivity. Immediately after exposure, the ensuing signals were normal.

• MIDAS II is, at this writing, still in orbit. It was tracked by Honolulu on 30 November on pass 2903. Maximum signal strength of the SAPUT beacon was 3.0 microvolts on the TLM-18 antenna.

• One of the highlights of the year 1960 was a review of the program technical status and concepts accomplished by the President's Science Advisory Committee during 6-9 September. The group consisted of twelve most eminent scientists, under the chairmanship of Dr. W. K. H. Panofsky, Stanford University. The committee concluded that despite problems, there was no doubt that the MIDAS concept is sound and that all engineering problems can be overcome. The committee also concluded that every attempt should be made to achieve the proposed operational schedule.

• MIDAS Series I tests, flights 1 and 2, resulted in the following program progress milestones for 1960:

Design Verification

1. Basic ATLAS-AGENA compatibility and integrity.

2. Ground support equipment and facilities.

3. Achievement of circular orbit. (260 nautical miles.)

4. Demonstration of PAM/FM data link.

5. Demonstration of ground control and acquisition of payload and telemetry data.

6. Demonstration of solar auxiliary power unit telemetry.

7. Structural integrity of large precision optics subjected to launch environment.

8. Survivability and recoverability of infrared detectors exposed to direct solar radiation for short periods.

9. Operability of infrared-electrical equipment in zero gravity field.

Problems Disclosed

1. Determined inadequacy of attitude control design.

2. Deficiency of moving belt reticles.

3. Need for comprehensive preplanned computer program for data analysis.

• To obtain data for design of the payload and data processing system, utilization is being made of the results from a comprehensive infrared measurement program. The program scope includes: ground based, airborne, satellite, and missile measurements. RM-1, a DISCOVERER vehicle, launched 20 December 1960 specifically for MIDAS infrared background measurements, was a direct effort in this program. The vehicle orbited but due to loss of stabilization gas, the AGENA did not assume the stabilized orientation desired. A rotational movement occurred throughout the flight causing a rapid sweeping of the field of view. This caused a degradation in the definition of the infrared background data and imposed a problem on the data reduction process. The data are currently being processed and evaluated.

General Program objectives for 1961, MIDAS Series II, are:

1. Verification of ATLAS/AGENA "B" and components.

2. "Dual-Burn" or restart capability to establish a 2000 nautical mile orbit.

3. New guidance and control necessary to the new orbit.

4. Verification of solar power package in the 2000 nautical mile orbit environment.

5. Test of the second evolution payload package design.

6. Continued verification of ground elements and telemetry links.

7. Preparation for Series III tests and initial complete "system" testing.

8. A continuation of the infrared background measurement program with the launch of RM-2 in the latter days of January 1961. The objectives and payload remain the same as the RM-1 with the additional objective of a possible short restart test of the dual burn engine.

ADVENT

• In April 1960, ARPA reoriented the former STEER, TACKLE and DECREE programs into a single R&D program under the code name ADVENT. The objective of ADVENT is to demonstrate the technical feasibility of global communications (surface-to-surface) at microwave frequencies employing active real-time repeater satellites in synchronous equatorial orbit.

• AFBMD, previously given responsibility for overall program supervision, prepared a development plan for ADVENT, which was submitted to ARPA on 5 May 1960. In August, ARPA approved the development plan with modifications. Following ARPA approval, AFBMD initiated contractual action for the development of all subsystems. The General Electric Missile and Space Vehicle Department contract for development of a Final Stage Vehicle (satellite) for the STEER program had been reoriented to the ADVENT objective in April.

• On 15 September 1960, the Secretary of Defense transferred responsibility for management of the ADVENT program from ARPA to the Department of the Army. The Department of the Army organized the U. S. Army ADVENT Management Agency, Ft. Monmouth, N. J. and vested responsibility for ADVENT management in that agency. Under the terms of the Secretary of Defense memorandum transferring management responsibility, AFBMD was given responsibility for development and launch of the vehicle systems, including injection into orbit and control on orbit of the Final Stage Vehicle.

• As of 31 December 1960, all work statements covering the AFBMD portion of ADVENT have been finalized, and letter contracts have been issued covering all initial efforts for long lead-time developments required to meet the March 1962 initial launch date. Contracts in being and proposed are as follows:

Contractor	Work
In Being	
Aerospace Corporation	Vehicle Systems Engineering
General Electric	Final Stage Vehicle
Convair	Atlas
Convair	Centaur
Lockheed	Agena
Philco	Tracking, Telemetry & Command Ground Equipment
Proposed	
Pratt & Whitney	Centaur Engines
Convair	Assembly and Test Operations

• General Electric, which has been under contract for more than a year, has completed conceptual design of the Final Stage Vehicle. Subsystems have been defined and preliminary engineering is in progress, with a Preliminary Engineering Inspection scheduled in April 1961.

• The most urgent current problem which must be solved early in 1961 is lack of funding. Insufficient funds for FY 61 were transferred with the program by ARPA to the Army. The U. S. Army ADVENT Management Agency has been unable to secure additional funding and has been reluctant to release available FY 61 funds. Funding of the ADVENT program throughout calendar year 1960 has been on a month-to-month basis. This has frequently endangered program schedules and continuity of development effort.

• During the coming year, design and fabrication of all major subsystems will be completed as the program moves downstream toward the March 1962 initial launch date. This is conditioned upon timely receipt of adequate funding.

ABLE Projects

ABLE-4 THOR

• A NASA supported program, the ABLE-4 THOR test vehicle, was launched from the Atlantic Missile Range on 11 March 1960, at 0800:06 EST. All stages of the vehicle operated satisfactorily and the payload, PIONEER V, was injected into an elliptical solar orbit. The trajectory was designed to enable the payload to pass as close to the sun as vehicle performance permitted.

• The vehicle consisted of a THOR first stage, ABLE second stage with AJ10-101 liquid fuel propulsion system, an STL guidance system, and an ABL 248A-3 solid fuel third stage.

• The PIONEER V, a 95-pound instrumented payload, was designed for conducting scientific experiments related to magnetic field and radiation phenomena in deep outer space. Two-way communication with the space vehicle was accomplished over far greater ranges than ever achieved previously and on 26 June, after three and one-half months, the last transmission from the vehicle was received. At that time, the PIONEER V was twenty-two and one-half million miles from earth.

• Among the significant accomplishments of this flight were: the mapping of the interplanetary magnetic field, the quantitative measurement of the interaction of the solar wind and the geomagnetic field, the discovery of a third major dynamic element of charged particles surrounding the earth, the acquisition of additional data on the inner and outer Van Allen radiation belts, and the first interplanetary probe to carry its own self-sustaining auxiliary power supply.

ABLE-5

• NASA Order S-2365G established a requirement for AFBMD to provide and launch two ATLAS/ABLE-5 vehicles for the purpose of providing scientific information about cislunar conditions by placing into a lunar orbit a spacecraft designed and built by Space Technology Laboratories.

• The vehicles consisted of a modified ATLAS booster, an Aerojet ABLE second stage, an ABL X248 third stage, and a spacecraft. The intent of the ABLE-5 program was to place a scientific observatory into relatively close lunar orbit with the nominal perilune 1400 miles and the apolune 2500 miles above the surface of the moon. The instruments which the spacecraft carried consisted of flux gate and search coil magnetometers; a set of radiation sensors — a plasma probe, a scintillation counter, a scintillation spectrometer, an ionization chamber, a Geiger counter, a cosmic ray telescope, and a micrometerorite counter. The general objective of these sensors was to acquire detailed information about distribution of magnetic fields, charged particle spectral density, and meteoric statistics. The first of the two vehicles (ATLAS/ABLE-5A) was launched from the Atlantic Missile Range on 25 September, and due to a failure of the second stage, failed to meet program objectives.

• The second vehicle (ATLAS/ABLE-5B) was launched on 15 December, but did not achieve a successful orbit. The vehicle failed after about 67 seconds of flight.

• One of the major 1960 booster problems was the inability of the ABLE-5 program to achieve a successful launch using the ATLAS/ABLE booster configuration. A failure review group was formed following the ABLE-5B mission and has been making a thorough investigation using all data and hardware available, but a determination of the cause of failure has not as yet been made.

• For the coming year, the Space Probes Division has been informed that there is a requirement to boost one ANNA payload into an earth orbit in late 1961 with a possibility of a second ANNA payload into an earth orbit in late 1961 with a second ANNA mission. These are the only known future booster system requirements, but it is expected that the various government agencies and/or private concerns will have a need for future booster system support.

TRANSIT/COURIER

During 1960, there were five booster vehicles launched in the TRANSIT/COURIER Program. A schedule of these launches showing payload, date, results and remarks appears above, right.

PAYLOAD	DATE	RESULTS	REMARKS
TRANSIT 1B	13 Apr 60	Achieved orbit Perigee 175.4 Apogee 408.6	First restart of a rocket booster in space
TRANSIT 2A	22 Jun 60	Achieved orbit Perigee 341.4 Apogee 570.3	Slosh problem detected in Ablestar stage
COURIER 1A	18 Aug 60	Failed to orbit	Thor Booster failed due to malfunction in hydraulic system
COURIER 1B	4 Oct 60	Achieved orbit Perigee 501 Apogee 658	Temporary fix of Ablestar slosh problem. Thor hydraulic problem fixed
TRANSIT 3A	30 Nov 60	Failed to orbit	Thor shutdown prematurely

All five of the above launches used the newly designed Thor Ablestar booster vehicle. This vehicle used the first liquid rocket engine to be restarted in space. The first such restart took place on 13 April 1960, when the TRANSIT 1B was injected into orbit over Southern Europe by the second burning of the second stage Ablestar vehicle. This vehicle was developed under ARPA Order 17-59, which initiated the TRANSIT/COURIER Program.

Three major problem areas arose during the flights of the Thor-Ablestar vehicle. During the launch of TRANSIT 2A, a propellant sloshing problem was discovered in the Ablestar second stage. This problem was solved by giving the Ablestar stage 50% more control and stabilization gas supply and by putting anti-slosh baffles in both propellant tanks. On the launch of COURIER 1B, the Thor first stage booster suffered a hydraulic failure in its engine control system. This caused the engine to go hard over and the Thor looped and exploded. Post flight analysis and laboratory tests indicated that the low pressure relief valve had failed. Inspection, manufacturing and checkout procedures were reviewed and improved to prevent a damaged valve from being placed in the missile. Ground and flight instrumentation were added to verify the condition of the system during countdown and flight. A malfunction in the main engine cutoff (MECO) circuit of the Thor booster for TRANSIT 3A caused MECO to occur at MECO enable. As a result, the velocity was about 2500 feet per second low. The Ablestar second stage separated and operated normally until cutoff and was destroyed by Range Safety. Range Safety action was taken since it was virtually impossible for any orbit to have been obtained.

The exact determination of the cause of the failure could not be made, but it appears that one of the MECO switches may have been installed incorrectly, causing it to malfunction or that a sense line to one of the fuel injector pressure switches could have been plugged or leaking. Recommendations for future Transit boosters include a new MECO circuit using new switches, careful screening of all switching events that occur during instantaneous impact point dwell times over land masses and review of vehicle checkout and quality control procedures. The schedule for TRANSIT launches in 1961 follows below:

FLIGHT	DATE	INCLINATION
TRANSIT 3B	21 February 1961	28.5°
TRANSIT 4A	May 1961	67.5°
TRANSIT 4B	July 1961	67.5°

Beginning with TRANSIT 4B in July 1961, Thor Ablestar boosters will be used with a BTL guidance system.

MERCURY

• During calendar year 1960, NASA requested six additional modifed ATLAS "D" series boosters. This increased the number of boosters required in support of MERCURY to fifteen. Effort was continued on, or initiated for, special studies and tasks as requested by NASA. For instance three major tasks requested by NASA are:

1. Modification of the Burroughs Guidance Computer to present real time data at the time of orbital insertion. This task and the accompanying interconnects to transmit the data to NASA computation facilities was completed during July.

2. The Abort Sense and Implementation System (ASIS) designed to detect dangerous variations within the ATLAS booster and transmit the signal to the NASA Capsule Escape System was open loop tested on five R&D missiles and one MERCURY flight. An ASIS Reliability Program was initiated to insure maximum overall reliability consistent with the Pilot Safety Program.

3. On 6 June 1960 the Commander, AFBMD, signed the formal documentation which initiated the AFBMD Pilot Safety Program of the ATLAS booster for NASA Project MERCURY. The purpose of this program is basically to assure that the inherent reliability of the ATLAS weapon system is realized for Project MERCURY manned launches. The safety program will be developed as the program progresses with maximum effectiveness to be realized on that launch just prior to the first manned launch. The effort consists of three sub-areas:

1. Quality Assurance
2. Factory Roll-out Inspection
3. Flight Safety Review at AMR

• Severe setbacks have been realized during 1960 in the launch schedule area. The AFBMD Space Systems Development Plan for the support of MERCURY published in March 1960 was written to support four scheduled launches in calendar year 1960. The first launch accomplished was MA-1 which experienced a catastrophic failure at approximately 57 seconds after lift off. The specific cause of this failure has not yet been established. Due to the failure analysis activities and intensified test programs aimed at determining the cause and any necessary modifications to MERCURY vehicles for follow-on launches, no other launches were accomplished in 1960. The overall situation was aggravated due to the failures of MA-1 and Able-5B, which also uses the ATLAS booster. Next launch for MERCURY (MA-2) which will incorporate the modifications deemed necessary from MA-1 and Able malfunction analysis, is scheduled for the first quarter 1961. The follow-on schedule will be adjusted accordingly and launches will be scheduled at approximately six week intervals. The first manned launch is scheduled for MA-7 in late 1961.

• The latest 1960 funding estimate furnished NASA headquarters for AFBMD support through calendar year 1962 is $61.350 million. As discussed earlier, this includes booster hardware, launch effort, and that effort peculiar to Mercury and requested by NASA.

• In late August the AFBMD technical support contractor effort for MERCURY was transferred from Space Technology Laboratories, Inc. to The Aerospace Corporation. This effort includes the Technical Direction and Systems Engineering responsibility for the MERCURY/ATLAS Space boosters.

• Throughout the year contacts were made with other space programs for the purpose of transfer of common information. These contacts included DISCOVERER and DYNA SOAR in areas such as retro rockets, attitude stabilization and aeromedical information.

• Although the program has not progressed as planned in calendar year 1960 from the launch rate aspect, it must be realized that the delays resulted from operational difficulties not only in the MERCURY Program but also in programs closely associated with MERCURY.

• Delays such as these are to be expected in a research and development program operating on the edge of the state-of-the-art. It is fortunate in a sense that these problems have become apparent early in the program and not at a point further downstream where the impact of such events may have been considerably more serious.

PROJECT 609A

Development Program

• Specifications for all 609A vehicle configurations were completed during the year. Experiments were selected and integrated into the payload carriers of the development flights. Modifications to launch pads and erection equipment was virtually complete. Design of additional buildings at the Atlantic Missile Range for storing and preparing 609A vehicles for launch was initiated.

• Because of a lack of funds, work on the design of operational facilities was stopped in November. The development flight test program was extended to make a more equitable workload for the 6555th Test Wing, and reduce the time gap for the development and operational launch programs.

• The first 609A vehicle "Blue Scout Jr." was launched from the Atlantic Missile Range on 21 September. Although the payload objectives were not attained, the vehicle development objectives were met. Non-availability of the AFSWC payload delayed the launch of the second XRM-91 vehicle until 8 November. The second stage of this vehicle exploded at T plus 62 seconds.

• The Bureau of Naval Weapons was provided with configuration and performance data so that they may proceed with payload development. Extensive efforts were made to determine the 609A support required by the Vela Hotel project.

Operational Program

• In response to the 25 November Hq ARDC letter assigning AFBMD the function of validating and integrating experiments for the 609A operational phase, a Payload Review Committee was formed at AFBMD. Sufficient requirements from approved and funded programs were received to establish a need for approximately 50 vehicles. To allow a launch rate of approximately 38 vehicles per year during the operational phase, it was determined that rocket motor storage buildings, two new missile assembly buildings and a combined systems checkout building would be required. Half of an existing hangar would also be required for technical support.

Forecast

• During 1961 the remaining nine-vehicle development flights will be completed. The planning for the operational phase will be completed and the release of funds is anticipated. Funding to restart the design effort of operational facility buildings and to construct the first of three sets of these buildings at the Atlantic Missile Range is anticipated.

DYNA SOAR

Step I (Sub-orbital) From program approval on 9 May to year-end, primary emphasis was accorded to completion of trade-off studies, prosecution of developmental activities leading to a configuration design freeze milestone in February 1961, and determinations of ground support equipment and facilities data in detail. Selected items of significance are summarized as follows:

1. A trade study on increasing second stage propellant tank capacity and pressurization led to a final determination both configurations would exceed the required second stage mean burn-out velocity, and an attendant unwarranted reduction in reliability.

2. The DYNA SOAR escape system was changed to a complete glider abort from a flyable capsule. This glider abort consists of separation of the glider from the booster train by means of a 40K acceleration rocket. In the event the rocket is not used for abort, it will provide a means of attaining desired corridor injection velocity for a normal mission profile. The adoption of a total glider escape concept imposes additional weight penalties on the booster which has been found to require major structural changes to the present Lot J TITAN configuration.

3. The DYNA SOAR air vehicle is aerodynamically stabilized by fins at the base of the first stage. To avoid introducing intermediate guidance complications during staging, the booster will use a "fire-in-the-hole" technique which calls for the second stage engine to be ignited prior to separation of the first and second stage. Design and fabrication requirements problems such as provision for escape of the rocket exhaust and prevention of damage from heat and blast are being successfully solved.

4. Initial specifications for ground support equipment design and qualification listing have been developed and ground support equipment requirements accurately identified.

5. Increased length of the DYNA SOAR vehicle has dictated use of a gantry system in place of the erector system presently in place at the Cape Canaveral Missile Test Center (TITAN Program).

Step II (Orbital) Studies on potential Step II boosters have been initiated with final selection consistent with a tentatively scheduled hardware go-ahead in July 1962. The basic booster requirements are 15-20 thousand pounds in a low altitude orbit.

• A NASA study covers an application of the Saturn C-1 (two basic modifications). Martin and Convair studies involve ICBM derivatives with high energy upper stages. Four configurations each of the TITAN and ATLAS are being considered.

• Redirection of Booster Development Effort. In November 1960 new design control weights were evolved by the System Program Office: Glider 9700 lbs, transition minus rocket fuel 1244 lbs, rocket fuel 3100 lbs. In consideration of the increased weight and a requirement for boost burnout velocity preferable in the 19,000 — 22,000 fps range, it is safe to assume a more powerful booster than TITAN I, Lot J will be required.

• Completion of Malfunction and Detection System. Further consideration must be given to determining the impact of accepting TITAN booster reliability existing when the Lot J becomes operational. The requirement for manned flight and inclusion of a total glider escape rocket concept will have a profound impact on the final Malfunction and Detection System design.

• Resolving Technical Aspects of Radio Guidance Backup. A trade study will be prepared to cover such radio guidance subsystem matters as:

1. Reacquisition: Investigation to determine problems of reacquisition of the missile in the event of loss of track.

2. Accuracy: A final determination of accuracy which i- compatible with that of the primary inertial guidance system.

3. Data Link: Provision for altitude and horizontal velocity to be sent up to the glider.

NASA AGENA "B"

• The NASA AGENA "B" Program was initiated early in 1960 by Letter Contract AF (647)-592 with Lockheed Missiles and Space Division dated 14 April 1960. This letter contract included sixteen AGENA "B" second-stage vehicles to be launched during the next four years. Early in August this number was reduced to nine AGENA "B" stages through 1962 to facilitate planning and cost negotiations. It is anticipated that the remaining seven AGENA "B" boosters will be added to the contract in 1961 and 1962.

• Technical progress during 1960 included the engineering modification necessary to adapt the existing AGENA "B" booster to meet the requirements of the Ranger portion of the NASA AGENA "B" program. This engineering was completed and released to manufacturing on 22 December and will be used to manufacture five second-stage vehicles to be launched within the next two years. The first of these vehicles completed final assembly 27 December and is presently proceeding through testing and will be launched in July 1961. Design studies have been made in support of the Nimbus Topside Sounder satellites and the engineering will be accomplished during 1961.

• The present launch schedule calls for launches in July and October of 1961 of the Ranger configuration AGENA "B" booster from the Atlantic Missile Range. They will be lunar test vehicles in support of the lunar impact missions in 1962. This requires the modification of Stand 12 at AMR which is presently underway. Present indications are that these objectives for 1961 can be fulfilled.

SAINT

• The feasibility studies of the SAINT program were completed in January 1960. The conclusions of the Space Technology Laboratories study of January 1960 were in agreement with the initial satellite inspector system studies conducted by industry in 1958 under System Requirement (SR) 187 and with the Radio Corporation of America (RCA) feasibility study completed in December 1959. The essence of the studies performed was that the SAINT would be a feasible system of practical value to the Department of Defense.

• A System Development Requirement was published by USAF on 21 April 1960. The SAINT Development Plan was approved by the Air Force Ballistic Missile Committee on 15 July and by the Department of Defense on 25 August. System Number 621A was assigned to the SAINT. Work statements were prepared for the SAINT Final Stage Vehicle and Payload and forwarded to selected industrial companies by Request for Proposals in August.

• Evaluation of the proposals received was conducted during October and November and resulted in the selection of RCA as the contractor to accomplish the work necessary on both the Final Stage Vehicle and the Payload. Detailed work specifications for a definitized contract were initiated in December by the AFBMD SAINT Program Office, aided by the Systems Engineering Contractor (Aerospace Corporation) and RCA.

• The 1961 effort will be primarily devoted to the management of tasks necessary to design and fabricate the SAINT feasibility demonstration vehicle. A definitized contract with RCA is anticipated in January 1961 and definitized contracts with Convair for ATLAS "D" boosters and Lockheed for AGENA "B" second stage vehicles following shortly thereafter. Continued study toward definition of an ultimate operational system will be 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 1000 nautical mile orbits with the necessary station keeping and inspections of multiple targets as well as more exotic sensor capability.

• The first scheduled launch of a SAINT vehicle is programmed for December 1962 following the launch of a target in November 1962.

ORBITAL INTERCEPTOR

• By mid-1960, conceptual studies performed by Convair, Ramo-Wooldridge and Lockheed, had been completed. Following completion of the conceptual studies, 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. As a result of conclusions and recommendations based on these evaluations, a Phase II program, System Design Feasibility, has been implemented.

• The 1961 effort will be devoted to re-evaluation of the basic concept established during 1960 in Phase I. This re-evaluation will be in terms of the deficiencies that have become apparent. Detailed consideration will be given to integrating technology and design into a specific system configuration which can be evaluated in terms of economic and operational practicality, as well as technical feasibility. The objective of the Phase II 1961 effort is to determine the economic, operational, and technical feasibility of a preliminary system design. In conjunction with applied research programs presently in being, System Design Feasibility Studies, Support System Studies, a Test and Validation Program, and an expanded Technology program will be conducted during 1961, with the above objectives in mind. The decision as to the feasibility of the Orbital Interceptor Space Counter Weapon System (SCWS) depends on the outcome of these concurrently conducted system design, support system design, test and validation, and technology programs. A decision that the Orbital Interceptor SCWS is feasible and that the USAF should proceed with Phase III (the initial development effort toward an operational capability) most probably can be made after January 1962.

BIOASTRONAUTICS

• Four major program areas have been pursued during this year. The first was the technical management of the current bioastronautic payload. The prime project in this area was the research, development, design, and preflight test of a biomedical recoverable space capsule in the DISCOVERER series. The first capsule was completed and passed a rigorous battery of operational assurance tests. It is now certified as flight qualified for launch on a DISCOVERER vehicle, launch is scheduled for early 1961.

• The second program area was the development of an advanced biomedical recoverable space capsule. A study was completed which resulted in a mockup of the capsule. Subsequent work has been initiated to build a full scale model of the advanced capsule which will be subjected to complete operational assurance testing. In building this capsule present state of life support system technology will be exploited to its practical limit. The advanced capsule is scheduled for completion in 1961.

• The third program area in bioastronautics was concerned with the research and development of life support system components. The effort was concentrated on the development of miniaturized internally implanted biosensors and associated multichannel radio transmitter. An initial single-channel internally implanted biosensor transmitter was successfully demonstrated during laboratory simulated space environmental conditions. Work is in progress on the multichannel system which is scheduled for test during the early part of 1961. The latter system will be implanted in a Rhesus monkey and flown in one of the ATLAS E pod shots. Biological parameters to be measured and recorded through telemeter link during flight include heart rate, heart sounds, and respiration.

• Effort in the fourth area has been concentrated on biopacks for flight into the space environment. These flights were made aboard DISCOVERER and

RVX2A vehicles on a space available basis. Biopacks flown aboard DISCOVERER XVII and DISCOVERER XVIII were designed to measure radiation levels and effects of the weightlessness condition so that environment effects on biological systems could be determined. Experimental packages included living cells (human synovial and conjunctival cells, embryonic membrane, cancer tissue, bone marrow, monocytic cells, and nerve tissue from chicken embryo), ampules of algae, bread mold, bacterial spores, essential life substances (powdered alanine, gamma globulin, and albumin) as well as a variety of radiation dosimeters (glass rods, chemical dosimeters, track plates, and emulsion packs). Results of these experiments are considered significant. Similar experimental packages are programmed for flights in 1961. A small capsule containing mice was flown on one of the RVX2A shots and recovered after impact. The animals survived and are under study for possible genetic effects due to radiation. A zero gravity liquid gas interface experiment was designed, test equipment fabricated, and flown on another of the RVX2A shots. The vehicle was not recovered so results were not conclusive. Another experiment of this type is scheduled for early 1961.

• Labororatory work was essentially completed for the design and fabrication of two other biopack experiments. One of these was a gravity independent photosynthetic gas exchanger. The other was for a gravity independent monophasic cryogenic gas storage system to investigate the principle for possible utilization in oxygen systems aboard space capsules. These experiments are scheduled for launch aboard an ATLAS E Pod shot early in 1961. Laboratory and shop work progressed on the bioacoustic energy measurements in the SAMOS vehicle. Launch is scheduled for mid-1961 so that bioacoustic energy can be measured during launch and orbit.

• In addition to the above, definite plans were made and work initiated for a biopack radiation shielding experiment to determine requirements and optimum protection of living systems. The development of an implanted arterial blood pressure transducer suitable for use with primates was also initiated.

TIROS

• On 1 April 1960, at 0640:09 EST a three-stage THOR boosted flight vehicle placed the TIROS I payload into the most perfect circular orbit achieved by this nation up to that time. With this successful launch and orbit of the TIROS I payload, AFBMD's responsibility in the program ended. The payload design, fabrication and testing were accomplished by the Radio Corporation of America for NASA, who was the primary program agency.

• The vehicle consisted of a modified THOR first stage, with the inertial guidance system removed, an Aerojet-General AJ10-42 second stage which utilized a Bell Telephone Laboratories guidance system, and an Allegany Ballistics Laboratory X-248 solid propellant third stage. The 270-pound cylindrical payload contained two television cameras designed to observe, record and transmit weather data. The achieved orbit had an apogee of 409 nautical miles and a perigee of 378 nautical miles. The satellite operated very satisfactorily while in orbit, transmitting a large number of pictures of cloud formations in the earth's atmosphere. Signals from the vehicle ceased on 1 July 60. This flight proved the feasibility of using an earth satellite to provide information for more accurate long-range weather forecasting.

SATELLITE

systems

DISCOVERER
MIDAS
ADVENT

SATELLITE SYSTEMS

Discoverer

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.

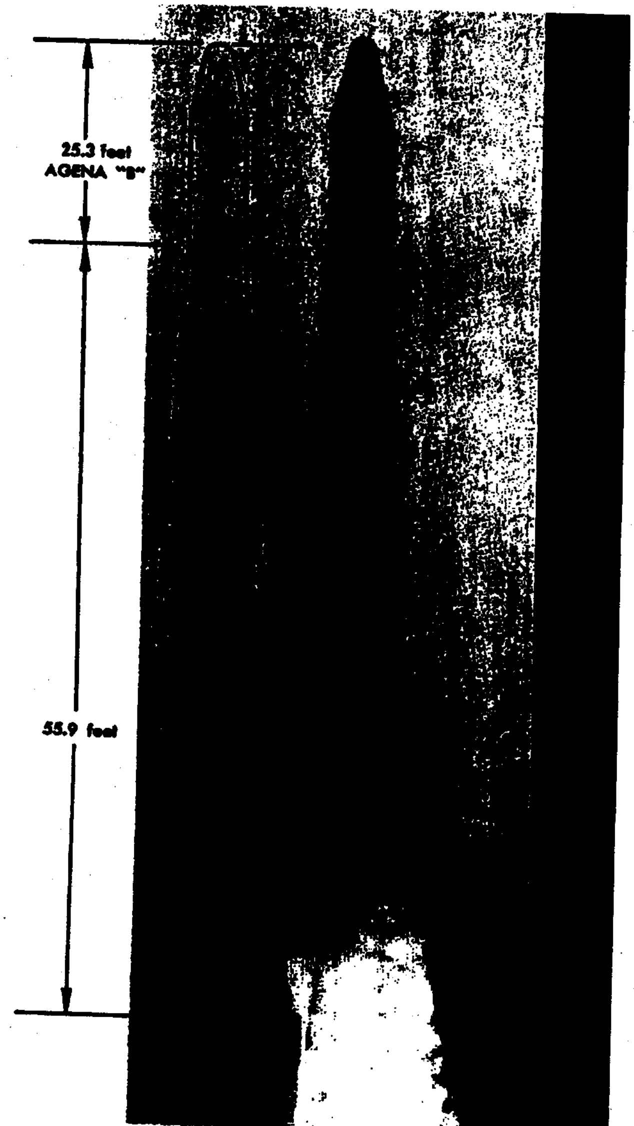
(e) Testing of ground support equipment and development of personnel proficiency.

(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 4. A history of DISCOVERER flights to date is given on page 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
THOR 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.

FLIGHT VEHICLE

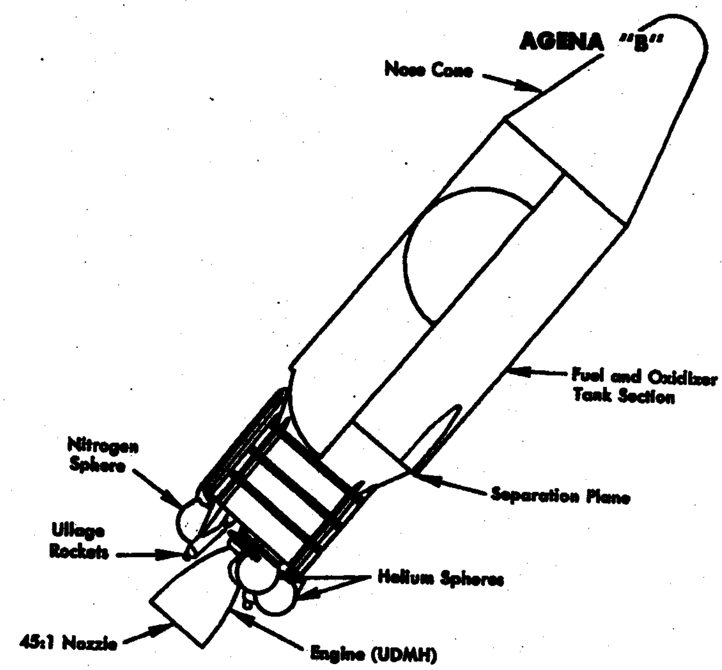
The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page 5. Specifications for the two THOR configurations and three AGENA configurations used are given on page 1.

AGENA VEHICLE DEVELOPMENT

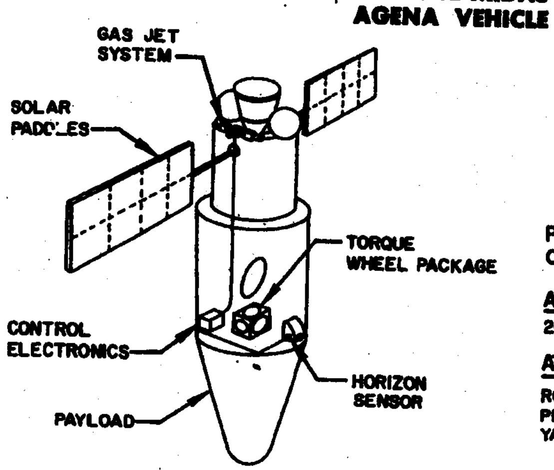
The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. Basic design was based on use of the ATLAS ICBM as the first stage. ATLAS trajectory characteristics and the stringent eccentricity requirements of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

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

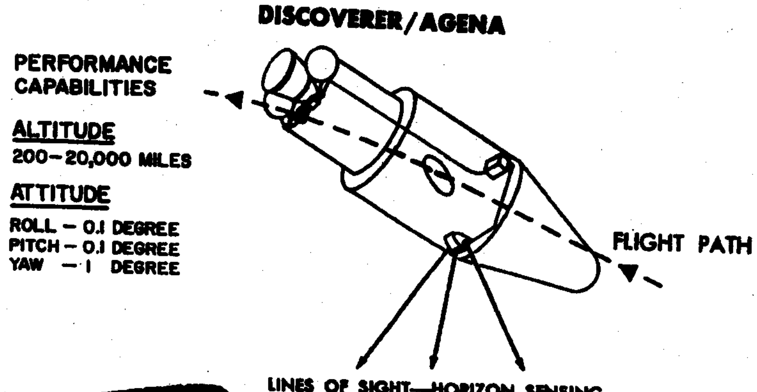
AGENA "B"



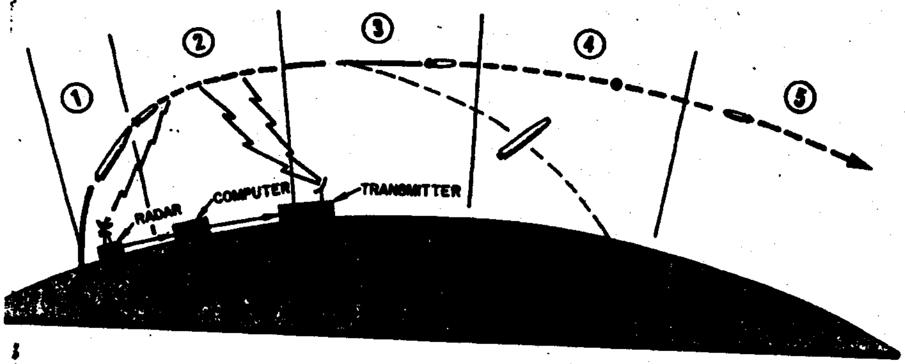
SAMOS and MIDAS AGENA VEHICLE



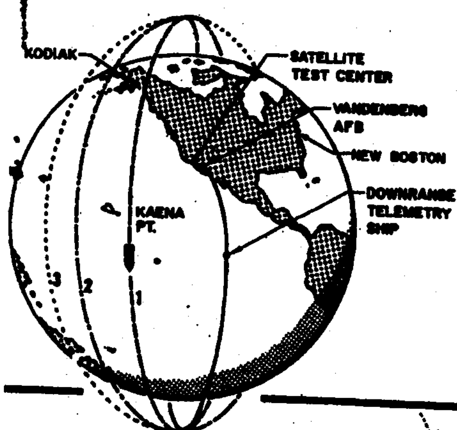
DISCOVERER/AGENA



Powered Flight Trajectory

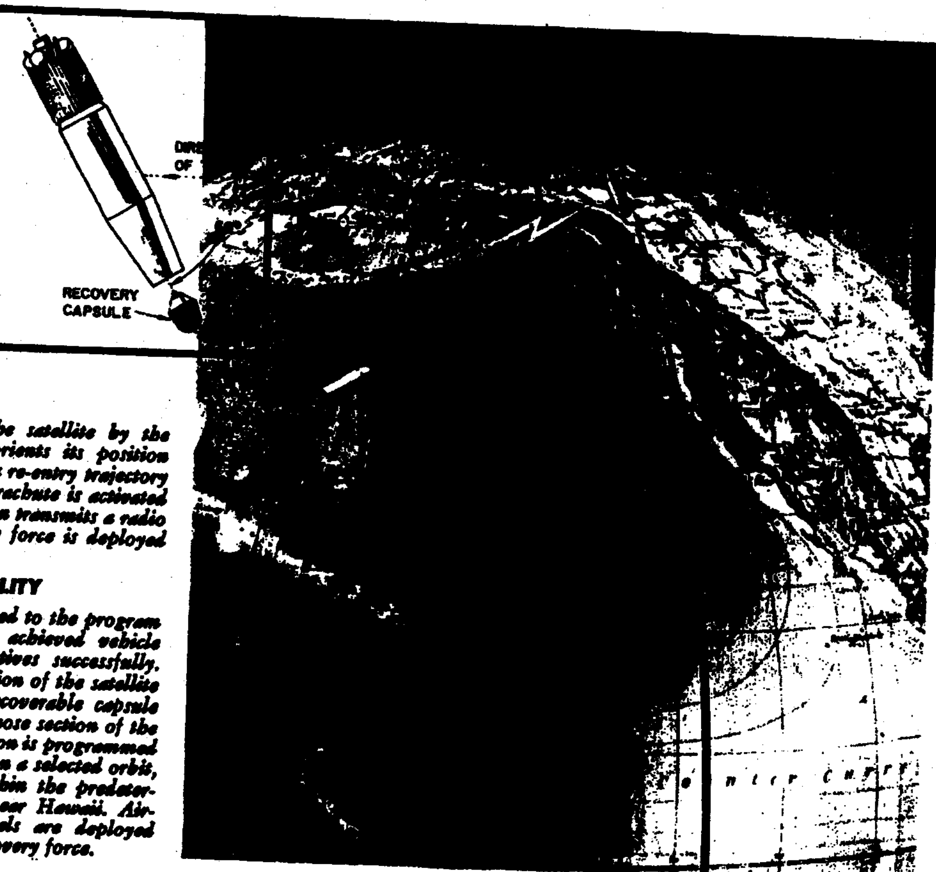


1. **First Stage Powered Flight** — 2.5 minutes duration, 78 n.m. downrange, guided by programmed autopilot and BTL guidance.
2. **Coast Period** — 2.4 minutes duration, to 380 n.m. downrange, attitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to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



Orbital Trajectory

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



CAPSULE RECOVERY SEQUENCE

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

RECOVERY CAPABILITY

This objective was added to the program after the first launch achieved vehicle flight and orbit objectives successfully. It includes the orientation of the satellite vehicle to permit a recoverable capsule to be ejected from the nose section of the AGENA vehicle. Ejection is programmed to occur on command on 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.

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	BDEFGHI	Ascent tracking, telemetry reception, computation and transmission of ignition and shutdown corrections.
Downrange Telemetry Ship	BGIJK	Telemetry reception and tracking during ascent and early part of first orbit.
New Hampshire Tracking Station	BDFGHIJ	Orbit tracking, telemetry reception, commands to satellite.
Kodiak Tracking Station	BDFGHIJ	Orbit tracking, telemetry reception, initial acquisition on pass 1, monitor events in recovery sequence.
Hawaiian Tracking Station	BDFGHIJ	Orbit tracking, telemetry reception and transmission of commands to satellite.
Hickam AFB Oahu, Hawaii	D	Over-all direction of capsule recovery operations.

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

***Equipment**

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

13
9 on orbit
4 Recovered
7 failed
8 orbit

LAUNCH SCHEDULE

Config.	Month	Year	Launches
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	2
C	F	1961	1
C	M	1961	1
C	A	1961	2
C	M	1961	2
C	J	1961	2
C	J	1961	2
C	A	1961	2
C	S	1961	2
C	O	1961	2
C	N	1961	2
C	D	1961	1

★ 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 XVIII Flight

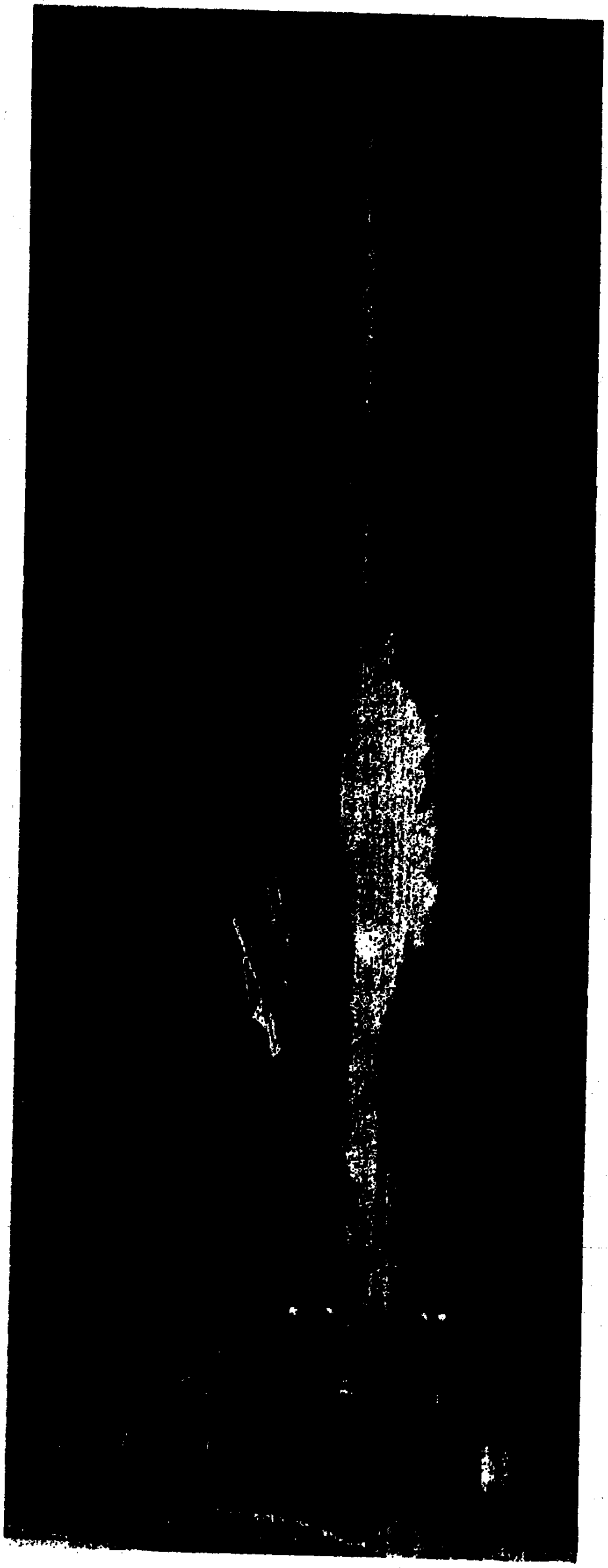
• DISCOVERER XVIII was launched from Vandenberg Air Force Base at 1221 PST on 7 December. This vehicle was the first combination of the improved DISCOVERER configuration. The booster was the DM-21 with the MB-3, Block 2 engine and the second stage was an AGENA "B" with the Bell XRL-81Ba-9 engine which includes a 45:1 area ratio nozzle.

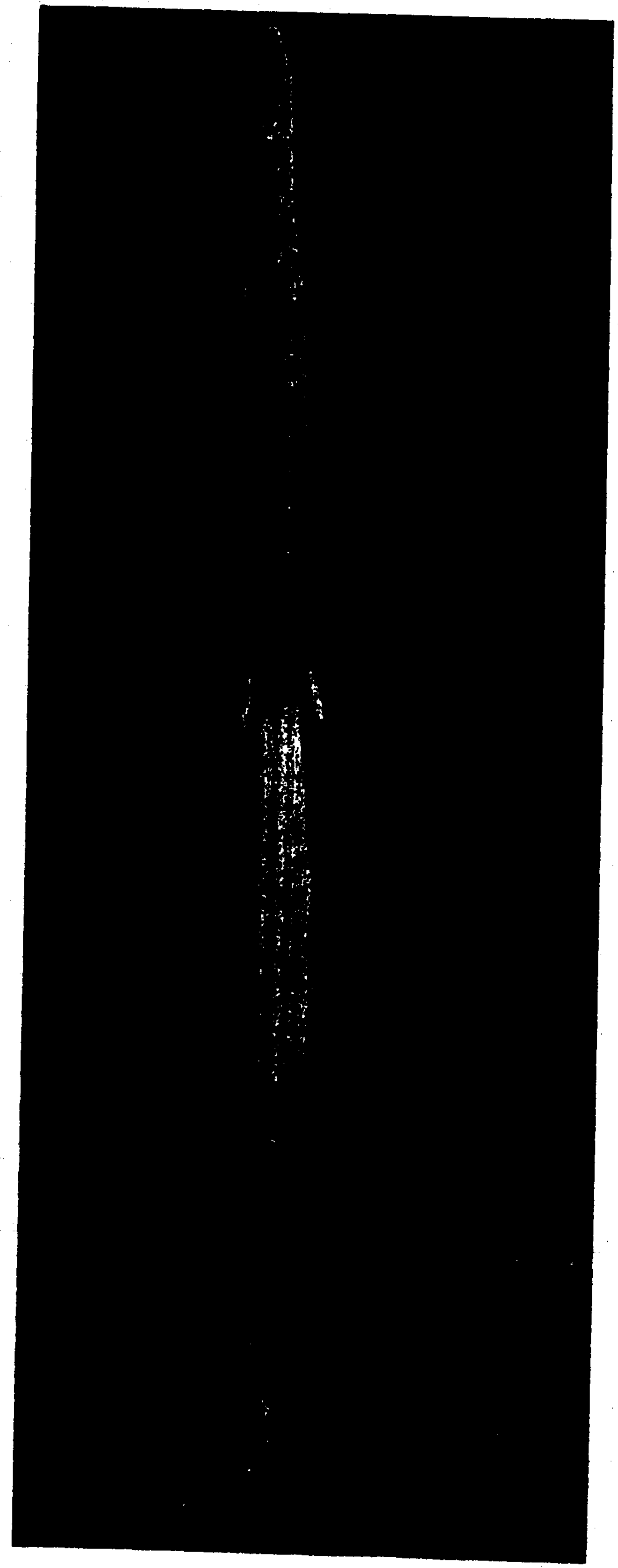
• Liftoff and booster operation were normal. THOR main engine cutoff occurred as planned at an altitude of approximately 46.4 nautical miles and a velocity of 11,080 feet per second. The AGENA "B" engine ignited as programmed and operated for 234.7 seconds, providing an injection velocity of 25,900 feet per second. The resulting orbit has a 380 nautical mile apogee, a 133 nautical mile perigee and a period of 93.67 minutes.

• All systems operated satisfactorily, remaining within prescribed limits. Attitude stability was maintained and ground-to-space communications were normal. On the 48th orbit, after three days exposure to the space environment, a successful capsule ejection was accomplished.

• All elements of the recovery force were on station at the time of parachute deployment. C-119J number 3 obtained a bearing on the descending capsule with its FLR-2 direction finder equipment. The descending capsule and parachute were sighted at 1531 PST at a distance of five nautical miles and an altitude of approximately 40,000 feet. Three other C-119J aircraft reached the area in time to observe the descending capsule. At 1542 PST aircraft number 3, flying at 10,200 feet altitude at an IAS of 122 knots, snagged the parachute on its first attempt. The capsule, in good condition, was reeled aboard the aircraft at 1558 PST. The DISCOVERER XVIII capsule was the fourth to be recovered from orbit and the first to be recovered after more than three days in orbit. Subsequent to capsule ejection the AGENA vehicle was reoriented to a normal ejection attitude. A stable attitude on orbit was recorded through the 89th orbit. After this orbit sufficient electrical energy was not available to maintain a prescribed attitude.

Figure 1. Interior view of Vandenberg Air Force Base blockhouse during launch of DISCOVERER XIX. The three consoles to the right monitor and control all checkout, loading and launch operations for DM-21 booster. The remainder of the racks to the left are DISCOVERER vehicle launch control equipment. The TV screens permit closed circuit monitoring of various pre-launch and launch operations. Photographs on opposite page show DISCOVERER XVIII (left) and DISCOVERER XIX (right) during liftoff from Vandenburg Air Force Base.





• Biomedical experiments similar to those carried in DISCOVERER XVII were carried as part of a continuing effort to gain more knowledge about the space environment. Only preliminary results are available, but indications are that all experiments were successful.

DISCOVERER XIX Flight

• DISCOVERER XIX was launched from Vandenberg Air Force Base at 1237 on 20 December carrying a non-recoverable radiometric payload furnished by the MIDAS Program. Booster and second stage performance were near nominal. A comparison of programmed and actual orbital parameters is shown in the following table:

PARAMETER	PROGRAMMED	ACTUAL
Apogee, nautical miles	343	348
Perigee, nautical miles	113	104
Inclination Angle, degrees	81.82	83.48
Eccentricity	0.0313	0.0326
Period, minutes	92.97	92.86

DISCOVERER XIX Programmed and Actual Orbital Parameters

• Telemetry data obtained during the period of reorientation to a nose-aft horizontal attitude indicated a very rapid loss of control gas pressure. This nitrogen-freon mixture is exhausted through reaction jets in response to guidance system signals and provides the motive force to maintain satellite stability on orbit. When the satellite was acquired by Kodiak on its first pass, the gas supply was completely exhausted and the satellite was unstable. The reasons for the control gas loss have not yet been determined. The most probable cause from analysis to date indicates an electronic equipment malfunction occurred.

• The oscillations of the satellite throughout its active lifetime resulted in communications difficulties caused by mis-orientation of vehicle antennas. This affected radar tracking, command reception by the satellite and ground data reception. The communications operations were accomplished, however, and substantial amounts of usable data were obtained about satellite and payload operation. The payload gathered background infrared radiation data for use in the MIDAS Program.

• In addition to the normal DISCOVERER tracking stations, Atlantic Missile Range stations 1 and 12, Thule, Greenland and Woomera, Australia were utilized for payload telemetery readout.

Future Flights

• The launch of DISCOVERER XX is planned during January and DISCOVERER XXI will be launched shortly thereafter.

Technical Progress

Boosters

• By incorporation of an improved diffuser plate in the liquid oxygen tank of the DM-21 booster, rapid liquid oxygen load can be initiated immediately and higher flow rates utilized. This modification has resulted in reduction in the terminal count on the DISCOVERER system to a total of nine and one-third minutes from the former time of fifteen minutes.

Second Stage Vehicles

• The sixteenth full-duration firing in the current test program was successfully completed in mid-December. The addition of an acoustic damper, a plate welded inside the gas generator, has resulted in a power level setting of from 2 to 3 percent higher than predicted. It is currently used only on test engines.

• The first 30-second firing of an engine conditioned to minus ten degrees Fahrenheit was successfully completed in mid-December. Another successful firing was conducted with the engine conditioned to plus-160 degrees. These firings were in support of the thirty-day restart program which will provide the capability of restarting the satellite engine after extended periods on orbit. Also included in the program is the evaluation of two systems under consideration as possible solutions to the turbine pump lubrication problem. One is a 120 cc oil accumulator and a conax explosive valve placed in series with the turbine gear case. The other approach is to apply molybdenum disulphide to the gears and bearings. Both solutions will be evaluated in continued tests.

• The thrust chamber of one XRL-81Ba-9 engine was replaced after 2600 seconds operation in the reliability program. This is almost double the specification requirement. The replacement will permit

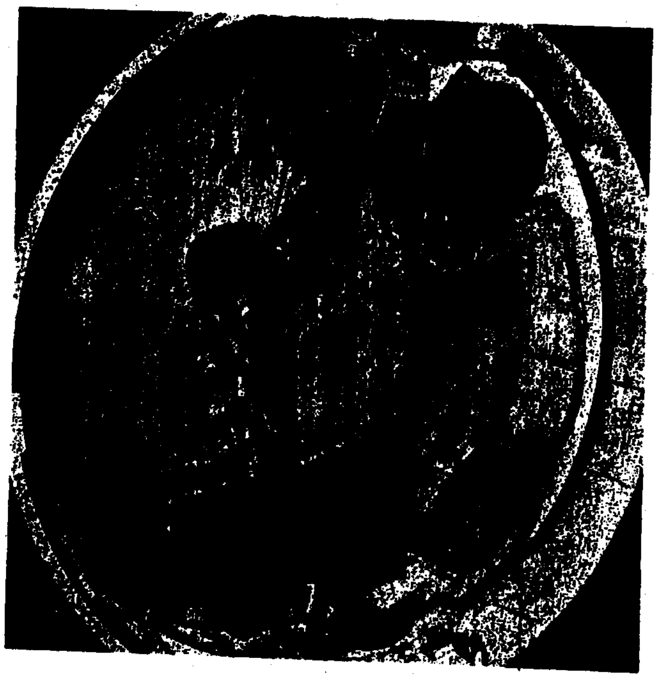
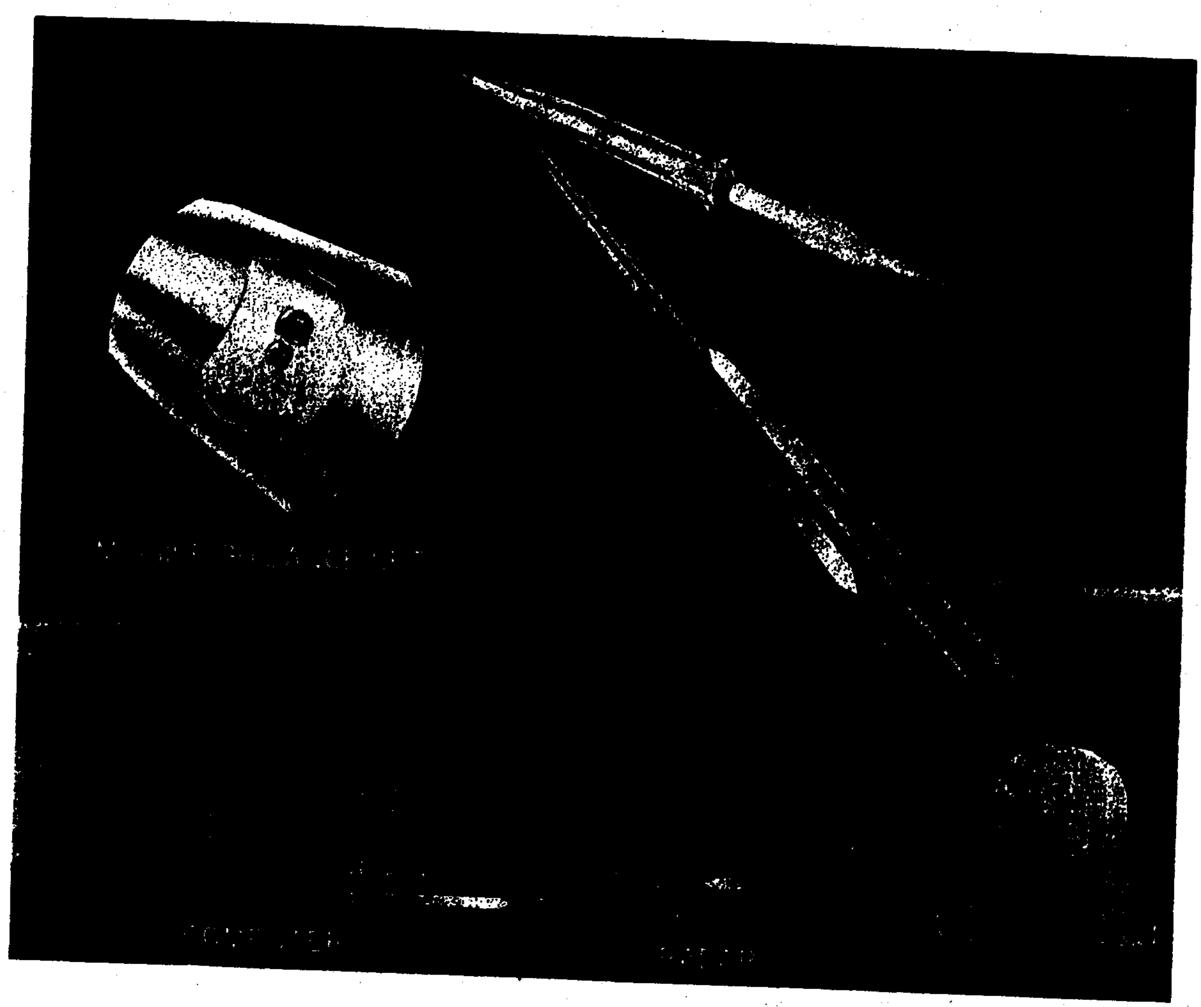


Figure 2. Technician checking out missile-borne guidance equipment installed in DM-21 booster vehicle. Black wave guide shown following contour of vehicle on right of photograph provides link between missile-borne and ground guidance units. Drawing below shows the radio data link of guidance system units during powered flight of a typical DISCOVERER vehicle. Ground equipment shown (right to left) includes: hardbase radar antenna, Bell Telephone Laboratories Radar set and Remington-Rand Univac Computer. Inset shows positioning of missile-borne Series 400 guidance equipment.



gathering statistical data on more than one thrust chamber. One turbine pump assembly was replaced after developing a weld crack following 4,200 seconds operation. The turbine pump assembly specification requires only 2,880 seconds of reliable operation.

Balloon Drop Tests

- During the week of 12 December, two high altitude balloon drops were conducted on the backup, two-stage DISCOVERER Mark 4/5 vehicle recovery parachute. On the first test all systems performed within specifications. During the second test the balloon ruptured prior to reaching the drop altitude. This test has been rescheduled for 4 January.

- Four drop tests were conducted at Vandenberg Air Force Base on 19 December to determine the radar reflectivity of the Mark 4/5 vehicle parachute. These tests established the compatibility of the proposed parachute metalized configuration with the APS-95 radar now installed in the RC-121 aircraft.

Biomedical Test Program

- The capsules recovered from DISCOVERER XVII in November and DISCOVERER XVIII in December each contained a special BIOASTRONAUTICS research project. Results of the DISCOVERER XVII experiments are nearly complete and are included in the BIOASTRONAUTICS Section of this report. Preliminary results of the DISCOVERER XVIII experiments will be available in January.

Facilities

- Construction has started on modifications to Complex 75-1, Pad 1, at Vandenberg Air Force Base. The pad is being activated to support the DISCOVERER Program. The first DISCOVERER flight from this pad is scheduled for May.

- The scheduled conversion of Complex 75-3, Pads 4 and 5 (the only two currently active DISCOVERER pads) to new propellant loading and pressurization equipment and launch monitor and control equipment will start early in 1961.

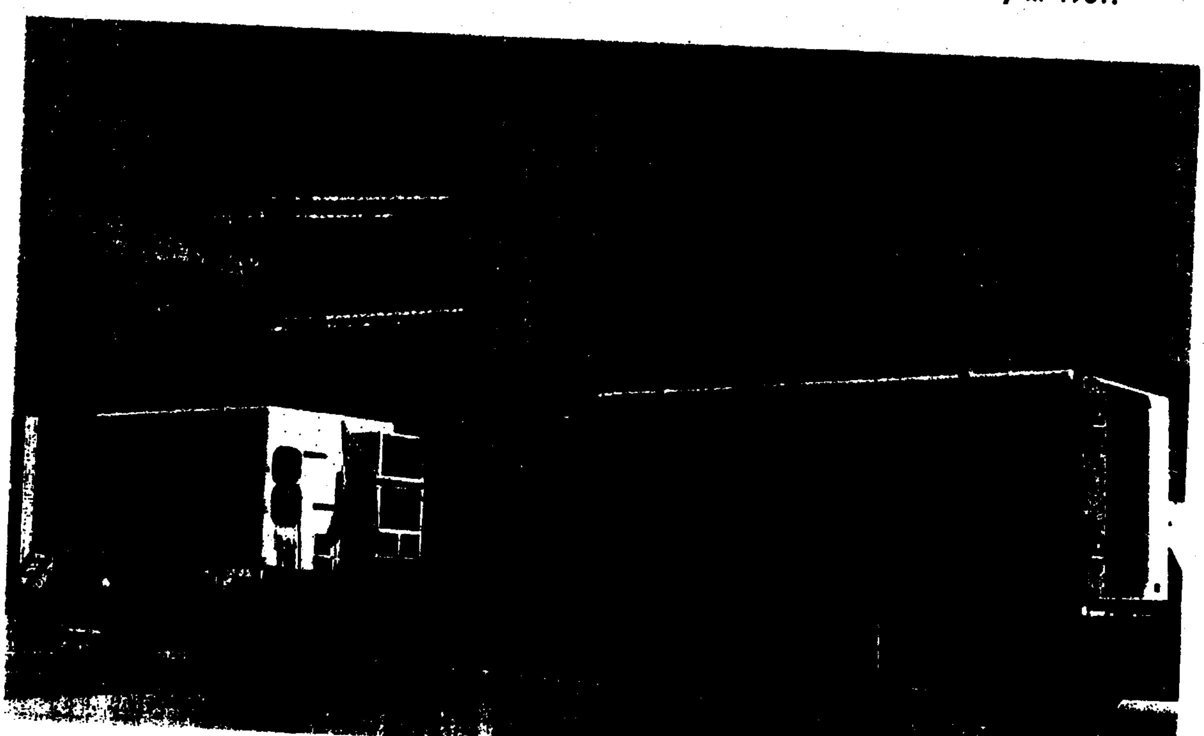


Figure 3. Initial equipment for new Tern Island tracking and data acquisition station shown prior to shipment. This station became operational in mid-December and will provide automatic tracking and acquisition of data from DISCOVERER satellites during re-entry and recovery operations. The tracking and data acquisition van (left) includes the automatic-tracking quad helix antenna. The communications and control van (right) includes ground timing and data conversion systems, telemetry receivers, tape recorders and other communications equipment. Installation of a VERLORT radar is planned for this station at a later date.

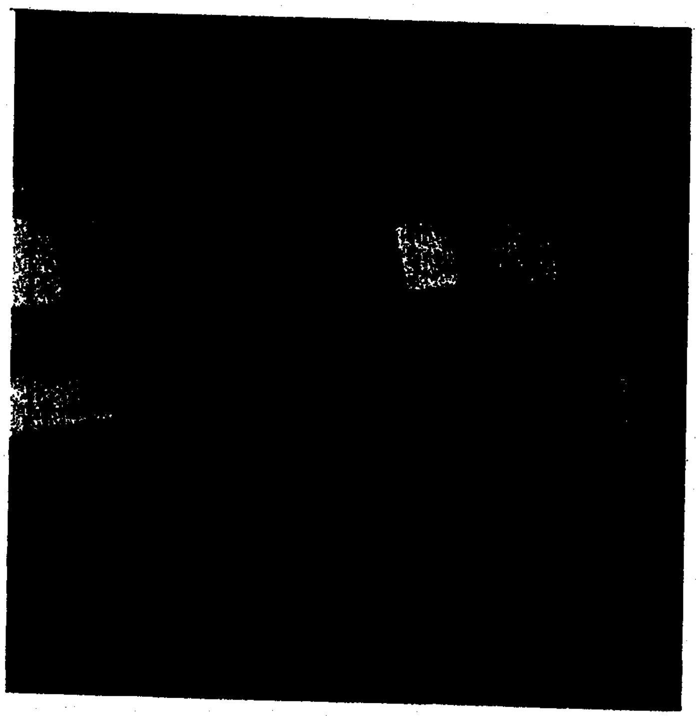


Figure 4. A view (below) of the recently completed master control room at the Air Force Satellite Test Center. From this room, Air Force officers and civilian scientists can supervise the launch, tracking and control of several satellites simultaneously. In addition to current data displayed on the closed-circuit TV at each console, information is displayed on the large movie screens in the control room from the projection booth in the rear. Air Force officers (left) are at the assistant test controller and assistant test director consoles. The movie screens are visible in the background.

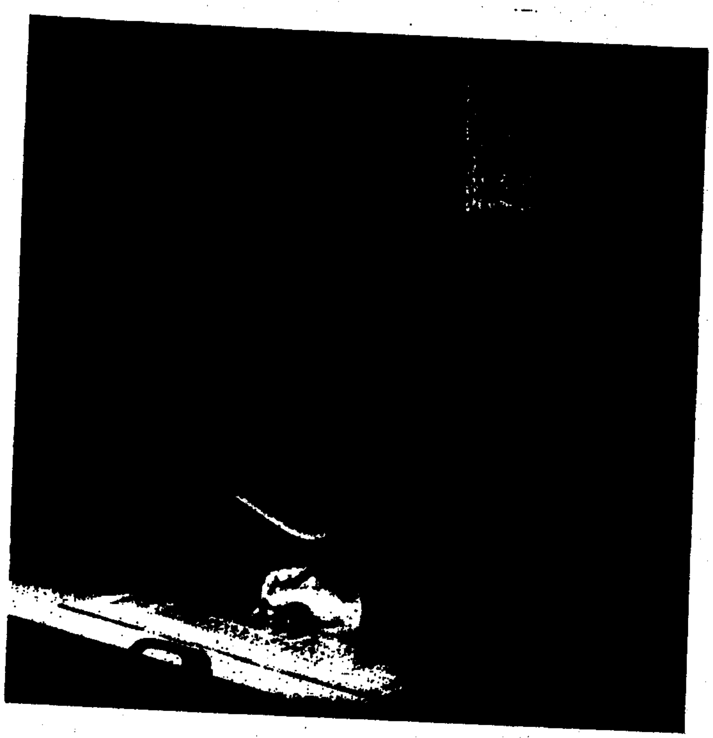
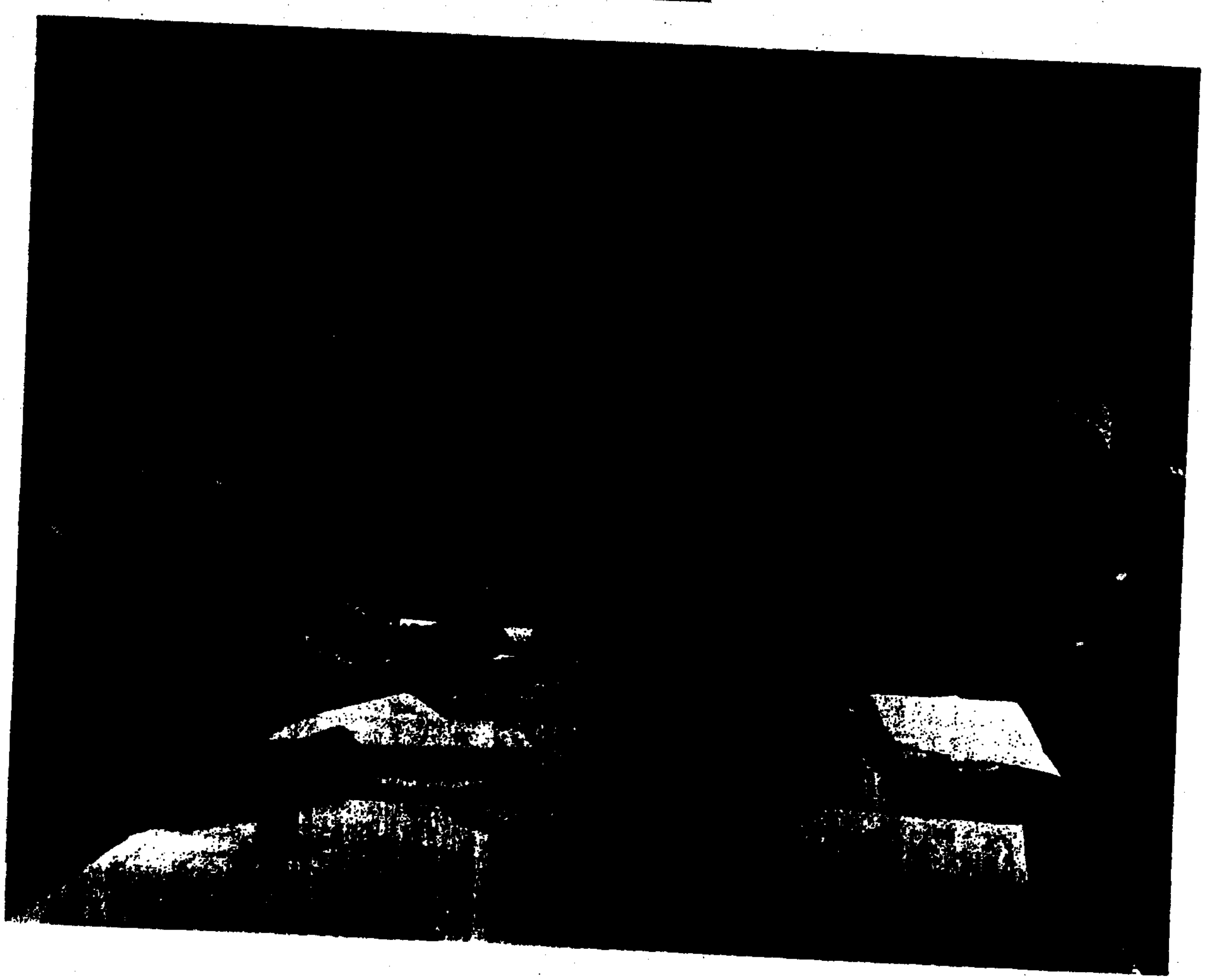


Figure 5. A group of Air Force officers (below) in the Satellite Test Center status room. This group independently monitors the satellite flight tests conducted by the center. At the meeting shown the initial evaluation of test data for DISCOVERER XX is being completed before the data is fed into the computer. The operations planning officer (left) listing DISCOVERER information on a plotting board which is then instantaneously transmitted by closed-circuit TV to other operating groups within the center. A TV monitor is visible in the right of the picture.



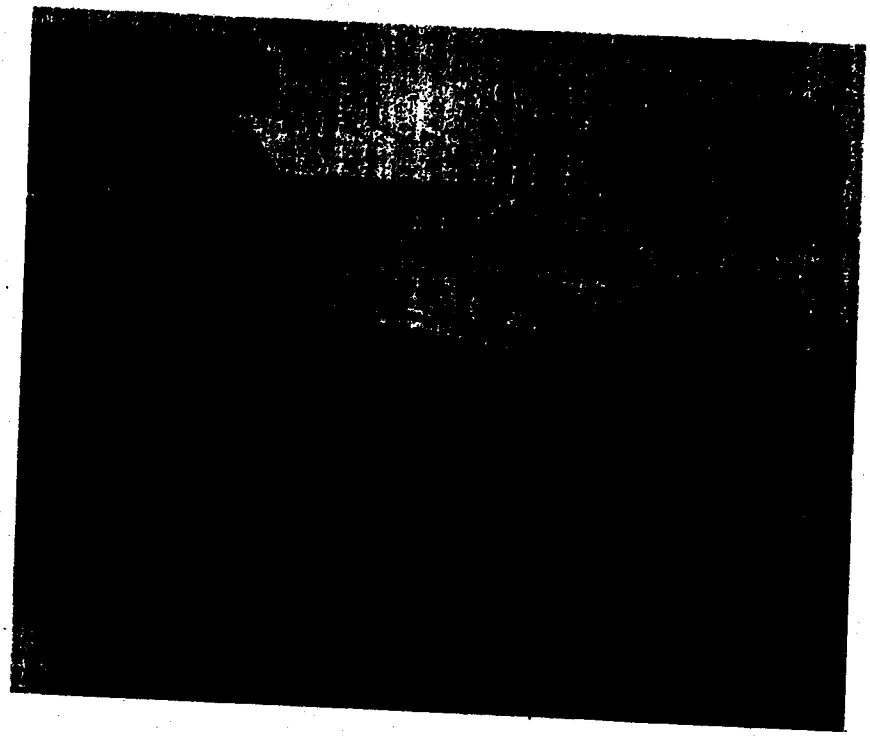
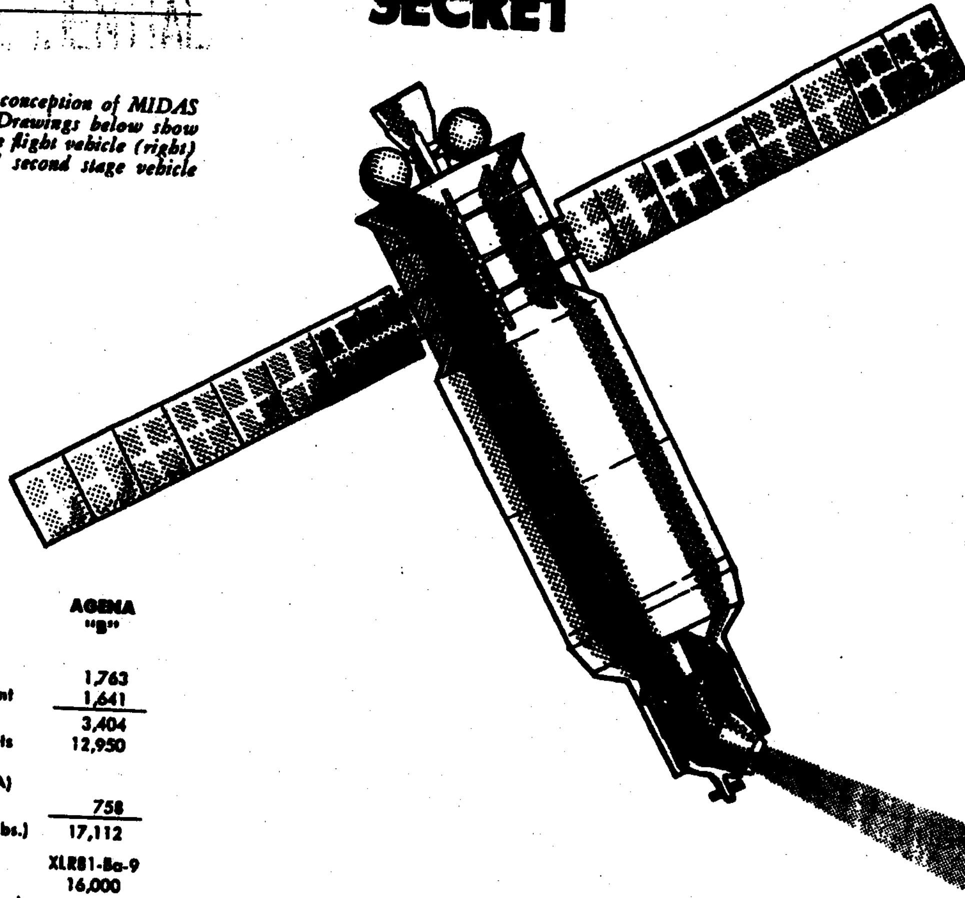


Figure 6. Military and civilian computer programmers (below) at the console of the Control Data Corporation 1604 Computer during a DISCOVERER flight test. Air Force programmers (left) operating the CDC 1604 high speed printer.

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).



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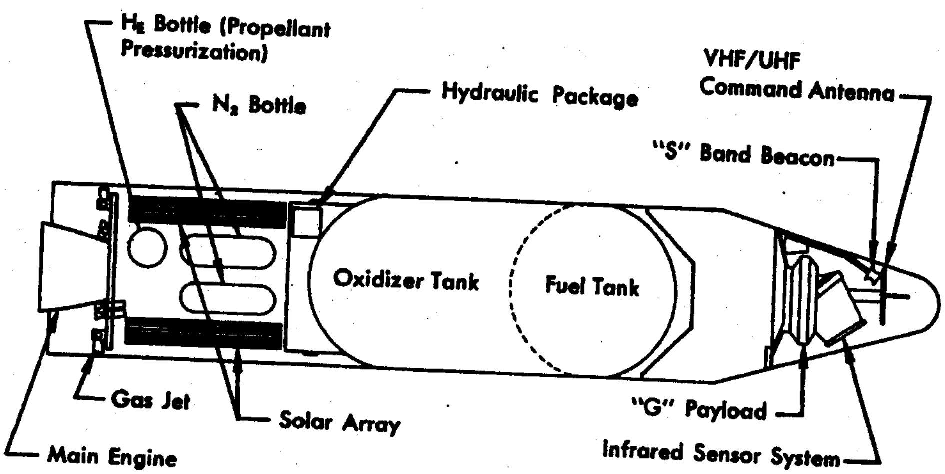
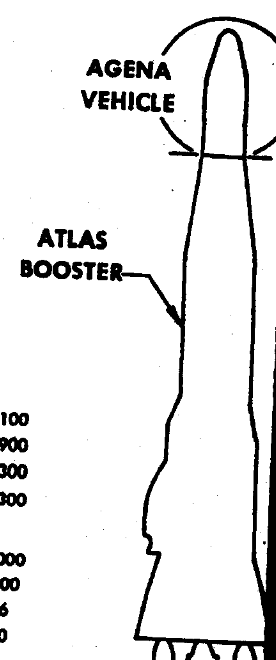
SECOND STAGE	AGENA "B"
Weight—	
Inert	1,763
Payload equipment	1,641
Orbital	3,404
Impulse Propellants	12,950
Fuel (UDMH)	
Oxidizer (IRFNA)	
Other	758
GROSS WEIGHT (lbs.)	17,112
Engine	XLR81-Ba-9
Thrust, lbs. (vac.)	16,000
Spec. Imp., sec. (vac.)	290
Burn Time, sec.	240
Restart Provisions	Yes



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

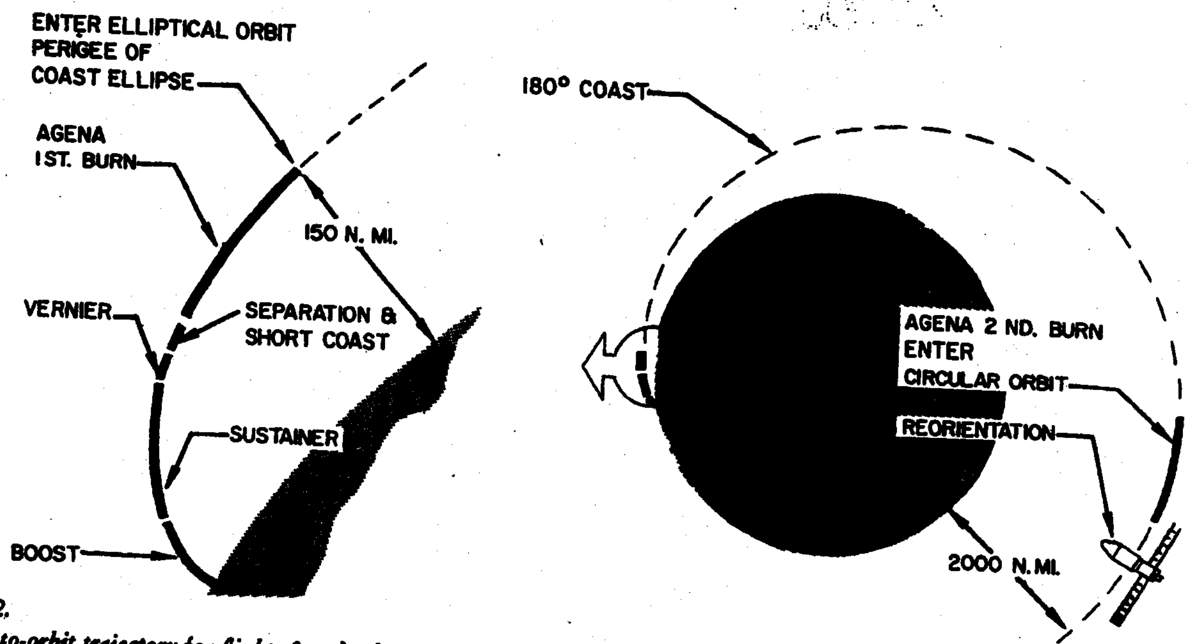


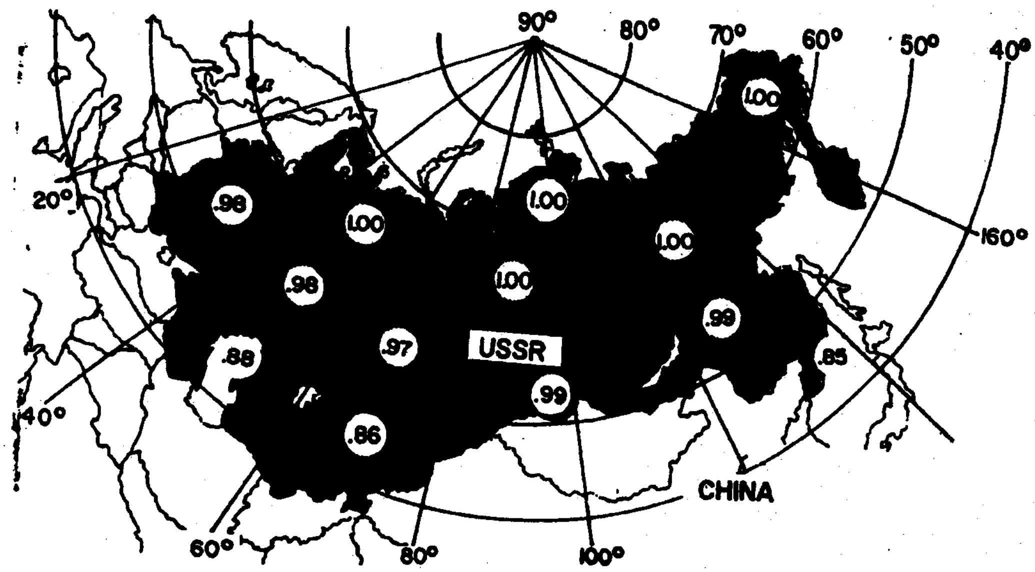
Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. From boost through separation, guidance and control is provided by the ATLAS radio inertial system. The AGENA inertial guidance system, with horizon scanner, provides attitude, velocity and directional control to establish the orbit and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

[redacted]

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

PROGRAM HISTORY

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



[redacted]

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

[redacted]

TECHNICAL HISTORY

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

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

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

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

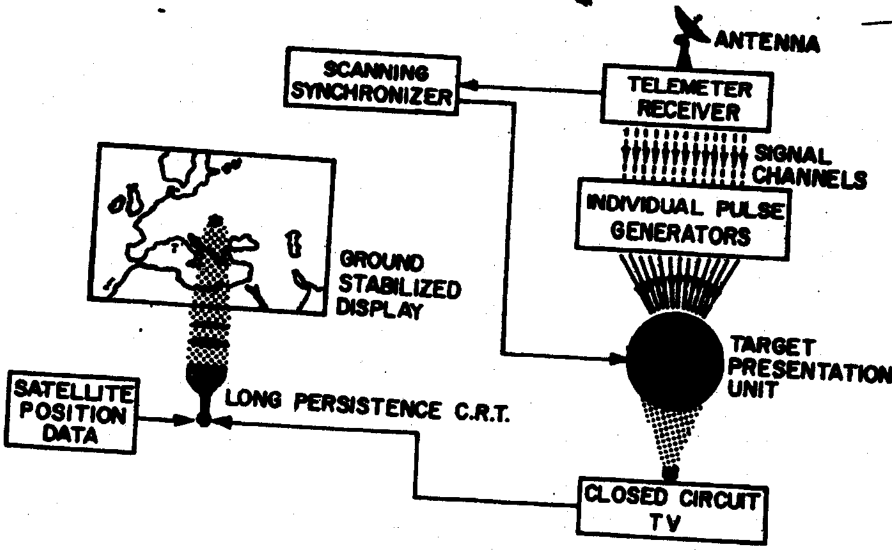
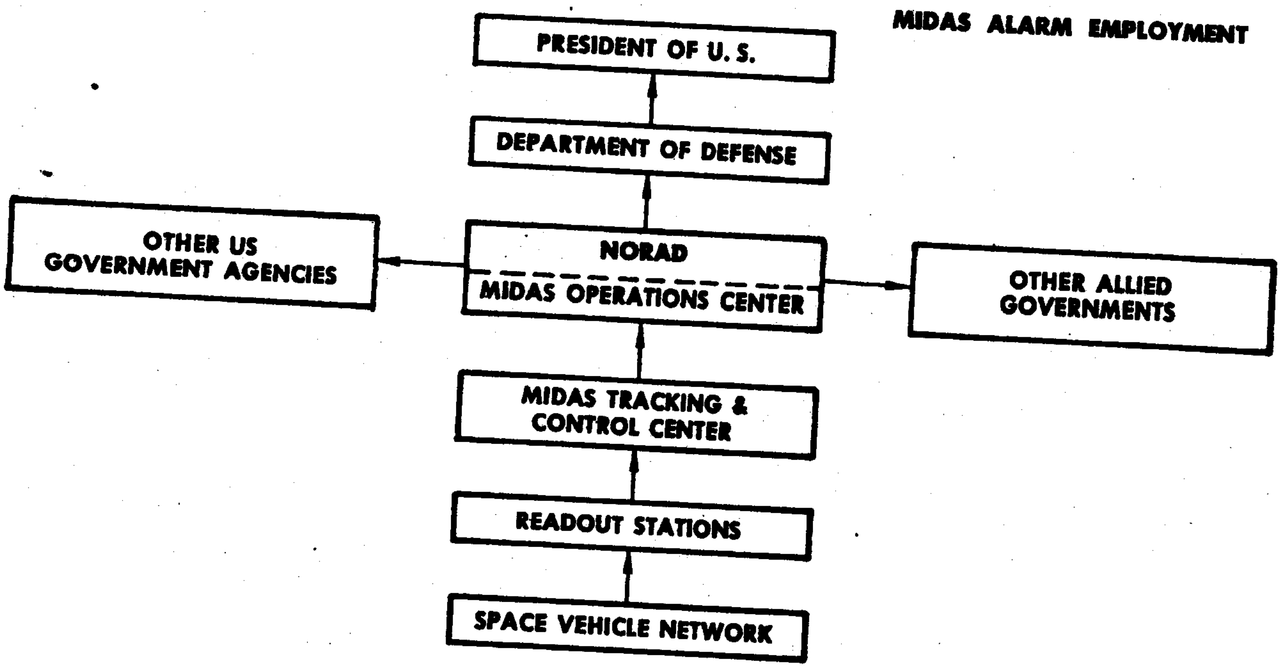


Figure 5.
Simplified version of ground presentation system (left) for display of infrared warning data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having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

	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
VEHICLE CONFIGURATIONS	ATLAS "D"/AGENA "A"	ATLAS "D"/AGENA "B"	

MIDAS Launch Schedule

MIDAS GROUND SUPPORT FACILITIES

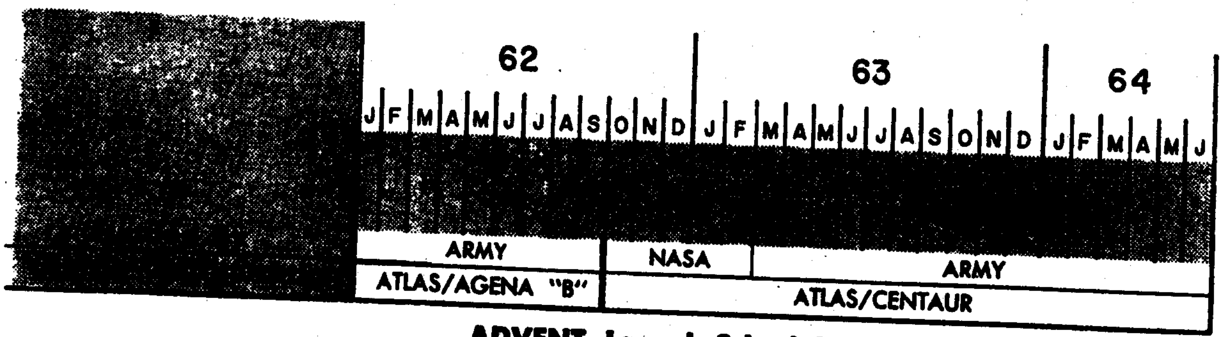
Facility	*Equipment**	*Flight Function*
Satellite Test Center	ABCDEP	Operations control, orbit computations and predictions, initiation of commands to satellite (via tracking stations), process payload data.
Vandenberg AFB Tracking Station	ABCEFGHIJKLMP	Ascent and orbital tracking; telemetry reception; 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



ADVENT Launch Schedule

Monthly Progress — ADVENT Program

Program Administration

• Additional funding of $1.5 millions was released to AFBMD by the U. S. Army ADVENT Management Agency (USAAMA) on 2 December. These funds will cover the General Electric contract for the Final Stage Vehicle until approximately 10 January.

• Brigadier General Powell and representatives of AFBMD/BMC attended a meeting at USAAMA on 2 December to discuss preliminary action on ADVENT Program management agreements. Although several issues remain to be completely resolved, significant progress was made toward agreement on major items. The degree of detailed control which USAAMA will exercise and definition of terms such as "supervise" and "guide" remain unresolved.

Technical Progress

Launch Vehicles

• The work statements for the ATLAS booster and for the Assembly and Test Operator Contractor for the PHASE III launches have been forwarded to BMC for transmittal to Convair with requests for detailed technical and cost proposals. These work statements are the last applicable to the fabrication and launching of the booster vehicles.

• A revised proposal for the PHASE I AGENA vehicles will be submitted in early January. Although this action will delay negotiation of the final contract, the initial work is covered by a letter contract with Lockheed Missiles and Space Division (LMSD) and preliminary design and studies have started.

• Convair is currently preparing the detailed technical and cost proposal for the CENTAUR vehicles required for the PHASE III (Army funded) launches. This proposal is scheduled for submission to AFBMD on 15 February. The continued reductions in predicted payload capability of the NASA developed CENTAUR vehicle indicates that extensive modifications will be required to provide a vehicle capable of meeting the ADVENT Program performance requirements. Preliminary discussions indicate that the Convair proposal will require a vehicle approximately five feet longer and 8,000 pounds heavier than the initial NASA production configuration. Analytical studies and preliminary design are underway to accurately determine the required modifications. If sufficient information is available, the general approach for establishment of the ADVENT-CENTAUR configuration will be presented to the CENTAUR Management Coordinating Committee at the 11 January meeting. AFBMD will recommend that the ADVENT-CENTAUR configuration be developed for the NASA funded ADVENT-CENTAUR launches.

• A technical review of the Pratt and Whitney proposal for CENTAUR vehicle LR119 engines is being accomplished by AFBMD and the Aerospace Corporation.

Final Stage Vehicle

• The vehicle systems contractors (Convair, Lockheed and General Electric) and the communications contractor (Bendix) attended interface specification meetings on 6-8 December. Bendix requested that General Electric provide approximately 42 watts more power than previously estimated. This power increase is required to supply redundant power amplifiers which would be provided to increase the reliability of the communications payload. On 22 December, the U. S. Army Signal Research and De-

Monthly Progress — MIDAS Program

Program Administration

• Revisions to the 24 October proposed MIDAS Development Plan have been completed. The document to be printed in early January reflects the guidance received during the 4 November briefing to the Air Force Ballistic Missile Committee.

Flight Test Progress

Radiometric Measurement Flight (RM-1)

• The RM-1 flight, DISCOVERER XIX, was launched from Vandenberg Air Force Base at 1237 on 20 December. This non-recoverable vehicle carried a MIDAS radiometer designed to gather and telemeter to ground stations background infrared radiation information. The satellite provided data for approximately four and one-half days, as planned. The radiometer functioned well and valuable data has been acquired; however, because of a tumbling satellite, data analysis has been made more difficult. Reduction and analysis of this data is now in progress.

• The radiometer telemetry consisted of four temperature channels, taking readings from various points on the radiometer; three data channels in the 2.7-micron region and three in the 4.3-micron region; and two reference channels, one for each of the two radiation regions being measured. These reference channels provided a means of calibrating out any variations in the sensitivity of the radiometer detectors which might have resulted from such factors as temperature variation. All channels, with the possible exception of the 4.3-micron reference channel, functioned properly; some early data on that channel appear to be erratic.

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• The nitrogen-gas cooling system for the 4.3-micron channel functioned perfectly during the flight. Termination of transmission resulted from battery degeneration; no component problems were encountered.

[redacted]

Future Flights

• A second flight, designated RM-2, is scheduled for 24 January. An identical radiometer will be carried.

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Technical Progress

Second Stage Vehicles

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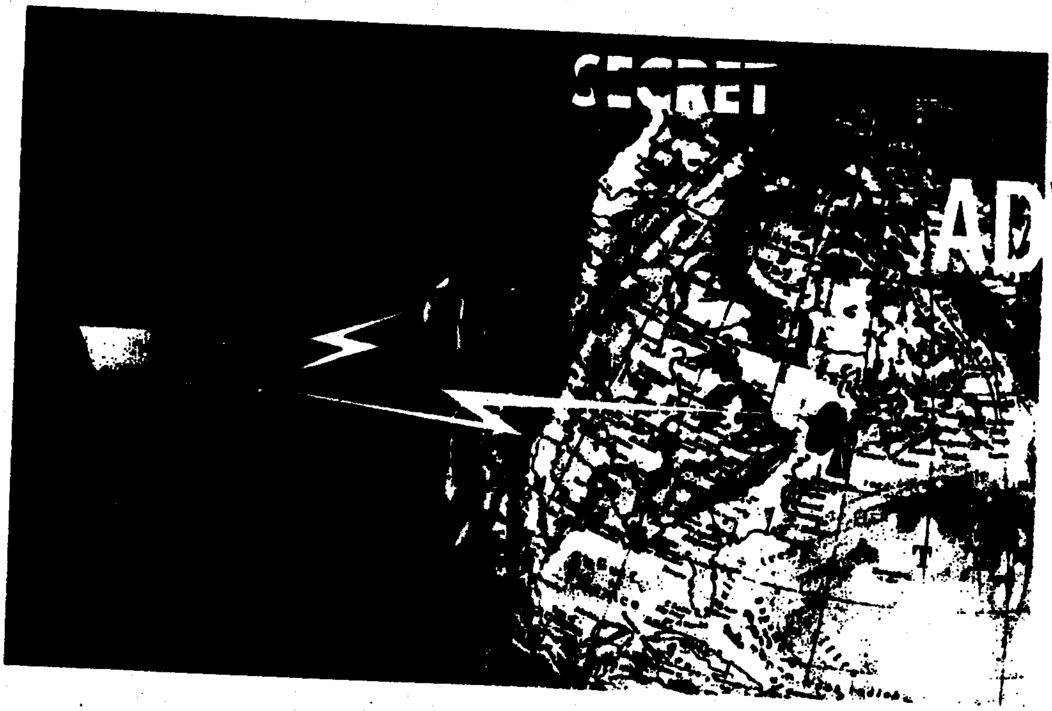
Infrared Scanners

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

SECRET

ADVENT



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

PROGRAM HISTORY

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

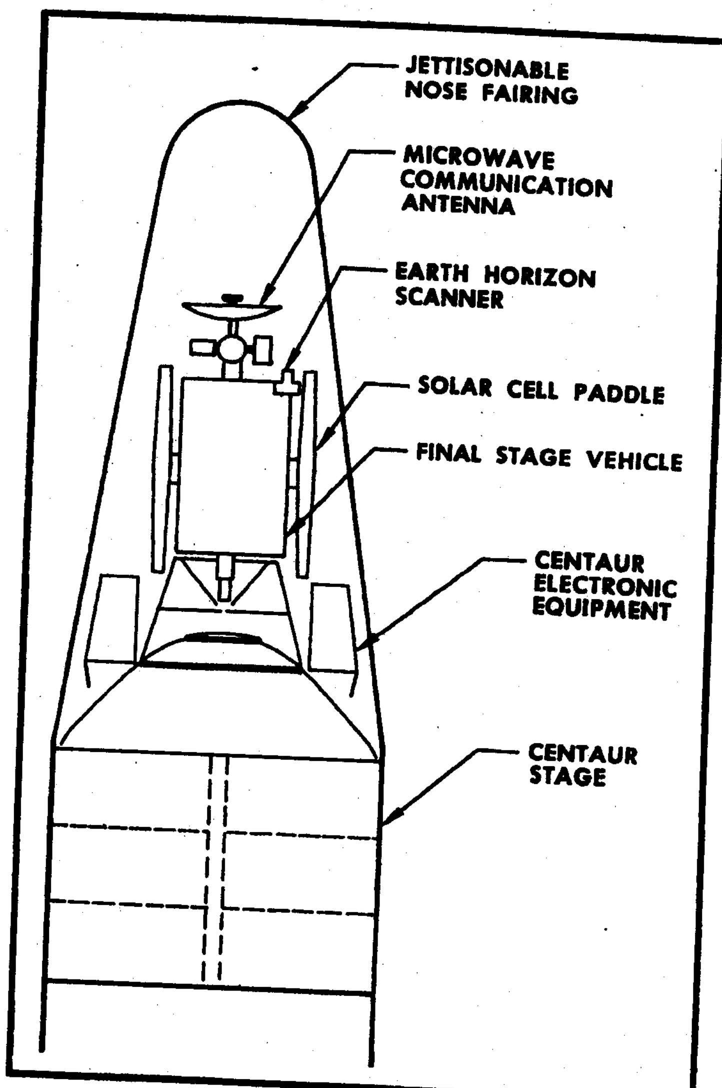


Figure 1. Proposed satellite with jettisonable fairing mounted on CENTAUR second stage.

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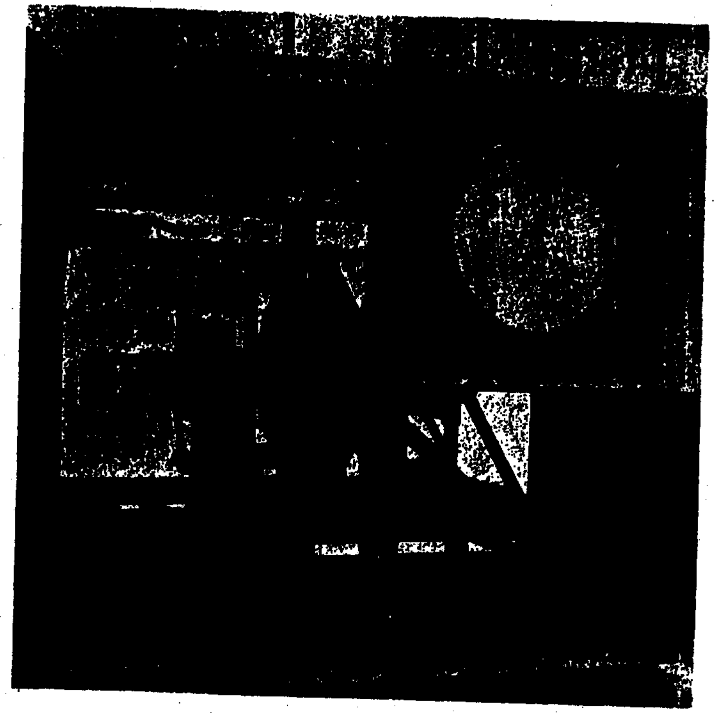


Figure 7. Initial Baird-Atomic, Inc., ground presentation equipment (below) shown installed in the Satellite Test Center, Sunnyvale, California. The two units shown are the command and monitor console (right) and ground stabilization unit (left). A close-up of the ground stabilization unit with the cabinet doors open is shown in the top photograph. The screen of this unit presents visual readout of satellite scanner information prior to ground stabilization. The stabilizing television camera and associated equipment are installed in the left side of the ground stabilization unit cabinet. The screen in the center of the command and monitor console (bottom right) presents ground stabilized readout of satellite scanner information.

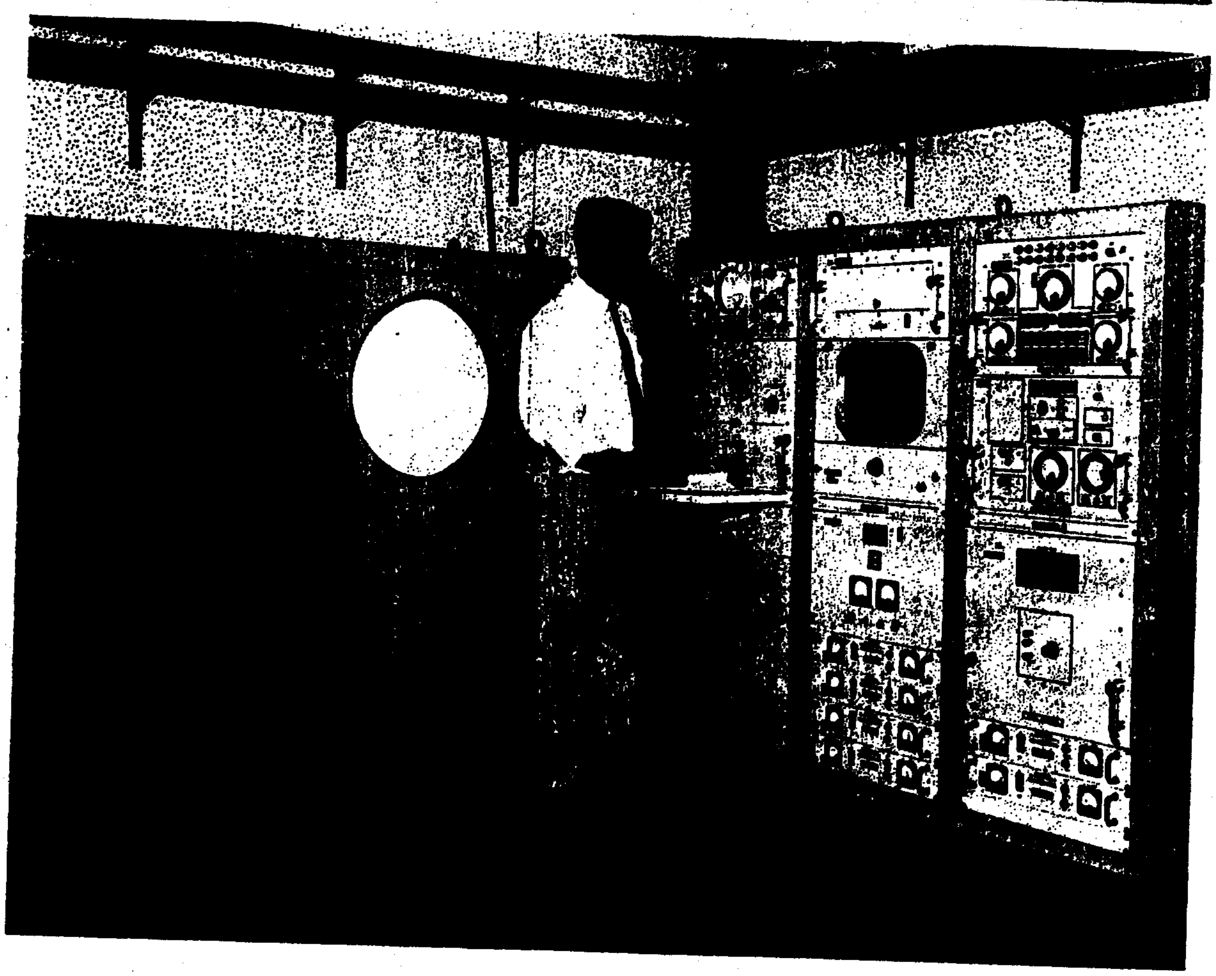
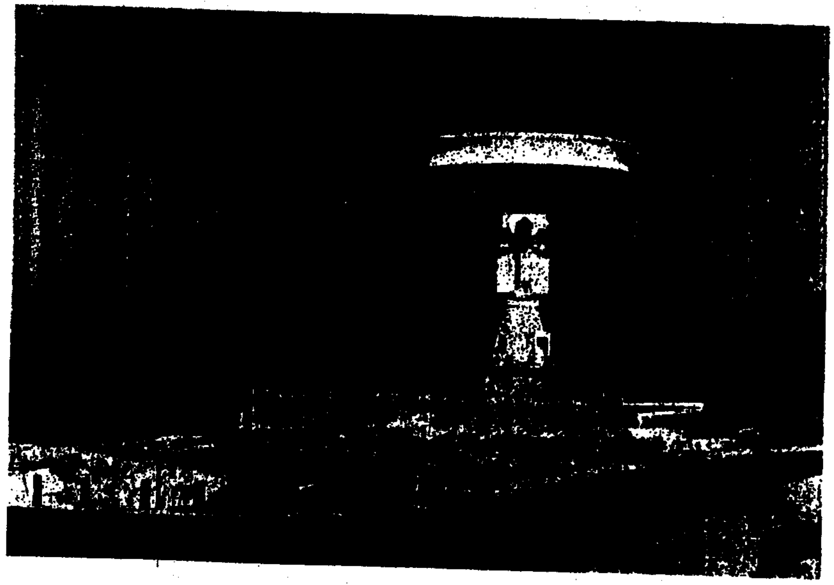
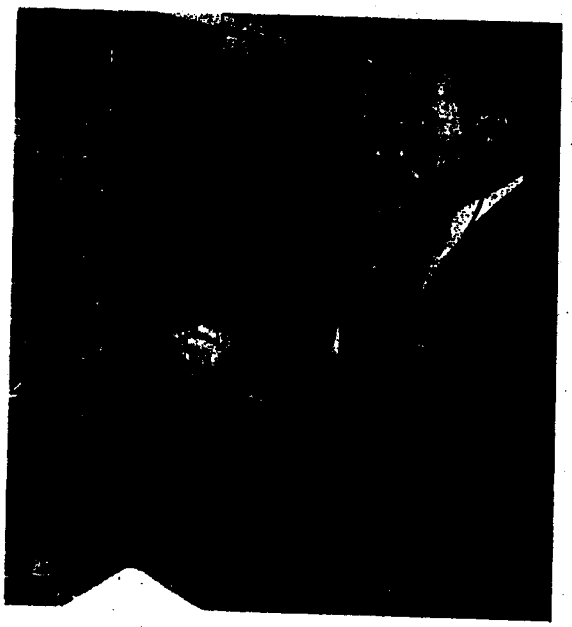


Figure 8. View of 60-foot antenna at tracking and data acquisition station at New Boston, New Hampshire . . .





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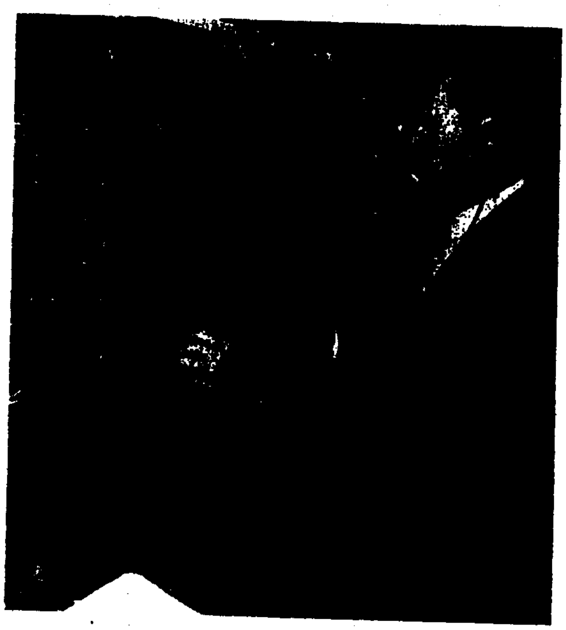

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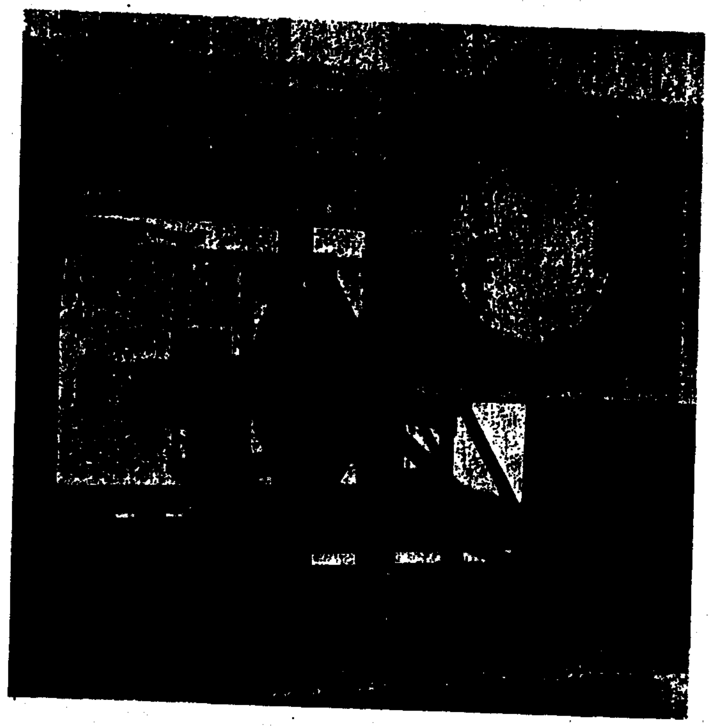

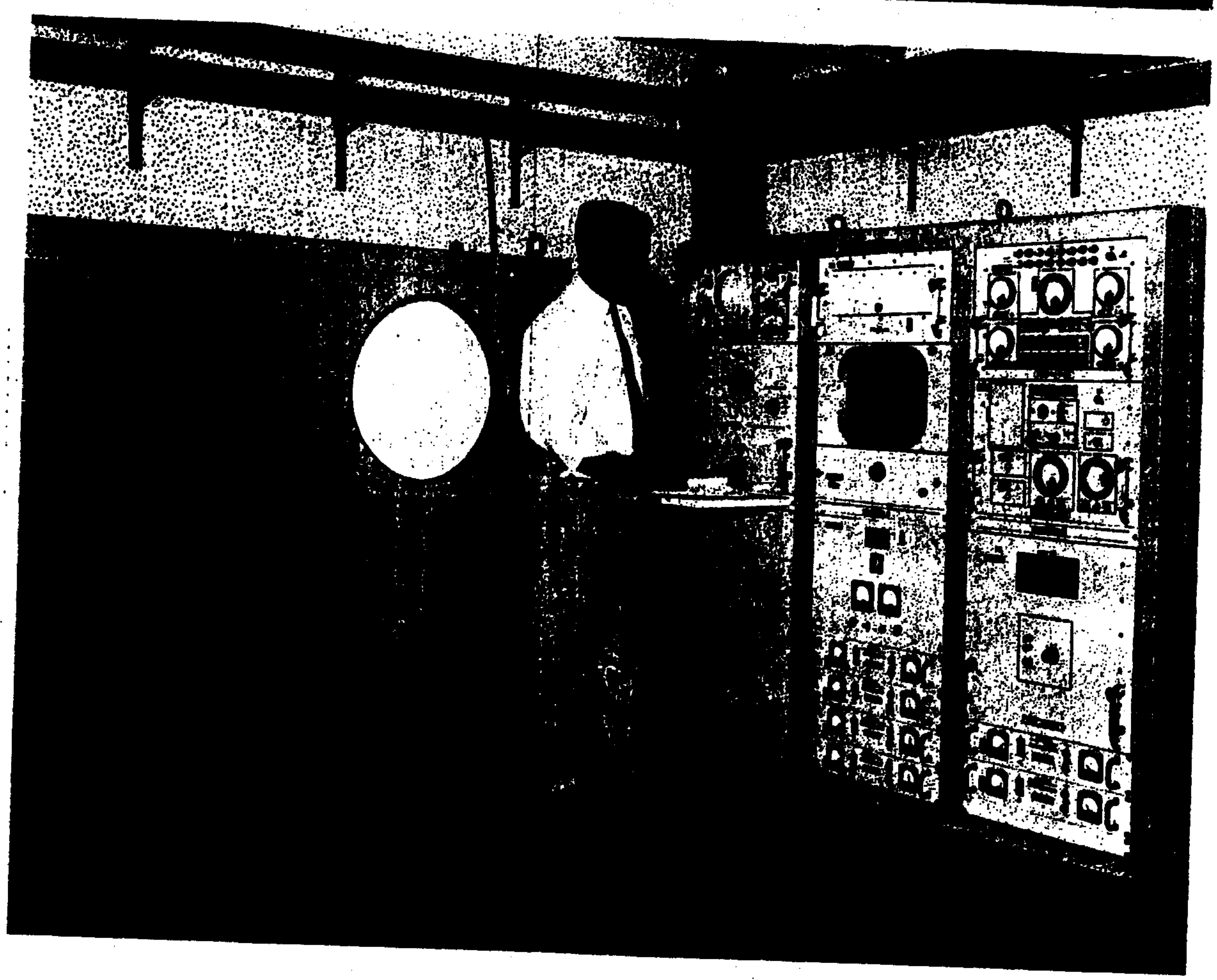

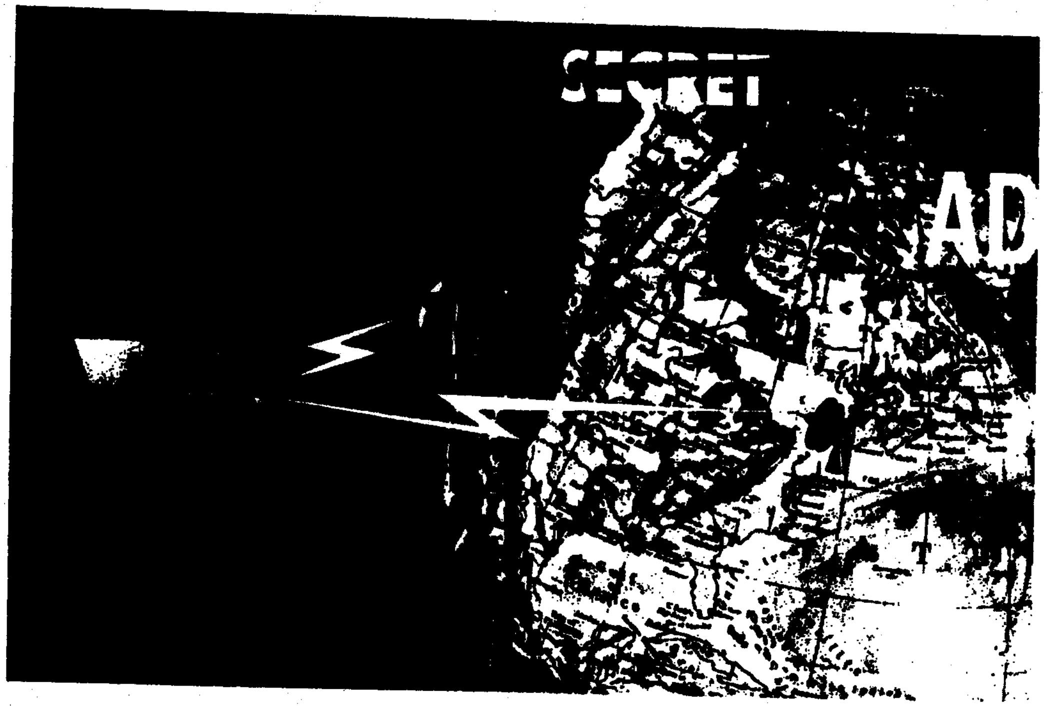

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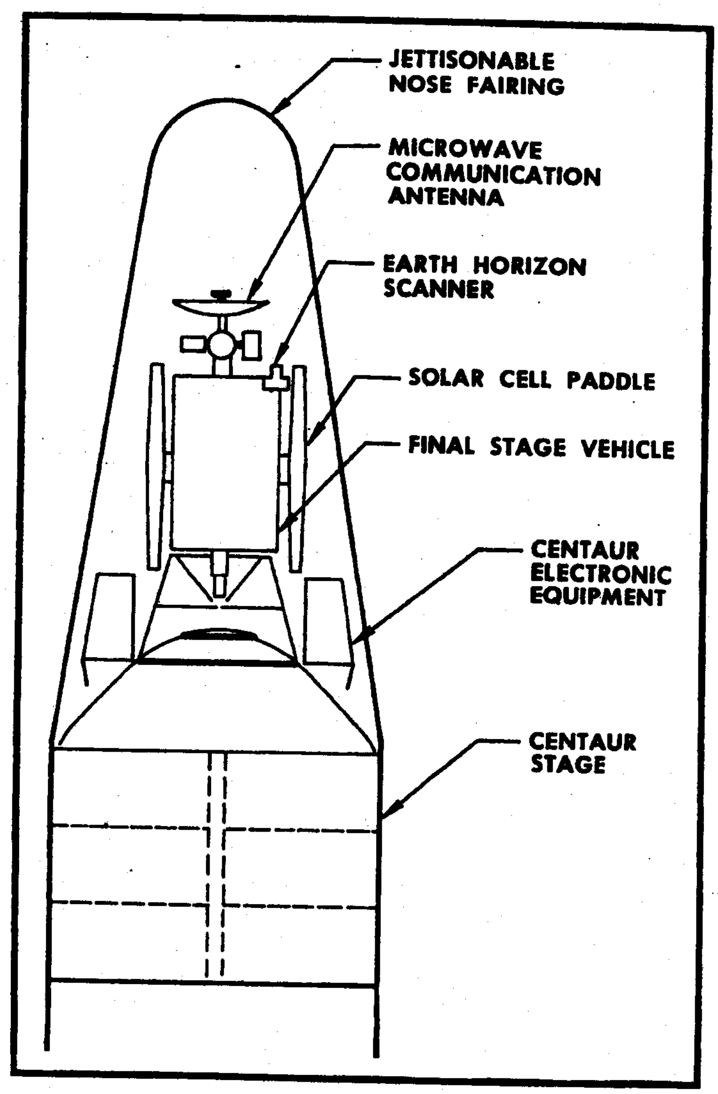

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• In addition to the normal tracking stations, Thule, Greenland, Woomera, Australia and Atlantic Missile Range stations 1 and 12 were utilized for payload telemetry readout.

Future Flights

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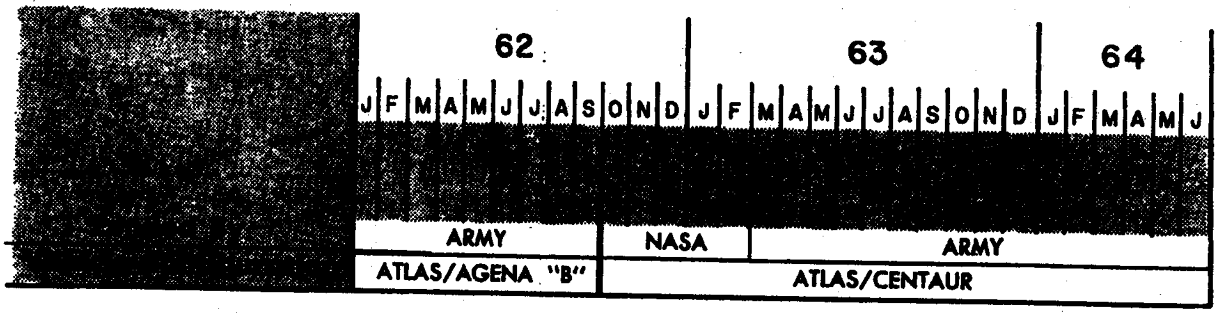

ADVENT Launch Schedule

Monthly Progress — ADVENT Program

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Technical Progress

Launch Vehicles

- The work statements for the ATLAS booster and for the Assembly and Test Operator Contractor for the PHASE III launches have been forwarded to BMC for transmittal to Convair with requests for detailed technical and cost proposals. These work statements are the last applicable to the fabrication and launching of the booster vehicles.

- A revised proposal for the PHASE I AGENA vehicles will be submitted in early January. Although this action will delay negotiation of the final contract, the initial work is covered by a letter contract with Lockheed Missiles and Space Division (LMSD) and preliminary design and studies have started.

- Convair is currently preparing the detailed technical and cost proposal for the CENTAUR vehicles required for the PHASE III (Army funded) launches. This proposal is scheduled for submission to AFBMD on 15 February. The continued reductions in predicted payload capability of the NASA developed CENTAUR vehicle indicates that extensive modifications will be required to provide a vehicle capable of meeting the ADVENT Program performance requirements. Preliminary discussions indicate that the Convair proposal will require a vehicle approximately five feet longer and 8,000 pounds heavier than the initial NASA production configuration. Analytical studies and preliminary design are underway to accurately determine the required modifications. If sufficient information is available, the general approach for establishment of the ADVENT-CENTAUR configuration will be presented to the CENTAUR Management Coordinating Committee at the 11 January meeting. AFBMD will recommend that the ADVENT-CENTAUR configuration be developed for the NASA funded ADVENT-CENTAUR launches.

- A technical review of the Pratt and Whitney proposal for CENTAUR vehicle LR119 engines is being accomplished by AFBMD and the Aerospace Corporation.

Final Stage Vehicle

- The vehicle systems contractors (Convair, Lockheed and General Electric) and the communications contractor (Bendix) attended interface specification meetings on 6-8 December. Bendix requested that General Electric provide approximately 42 watts more power than previously estimated. This power increase is required to supply redundant power amplifiers which would be provided to increase the reliability of the communications payload. On 22 December, the U. S. Army Signal Research and De-

[redacted]	60	61	62
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VEHICLE CONFIGURATIONS	ATLAS "D"/AGENA "A"	ATLAS "D"/AGENA "B"	

MIDAS Launch Schedule

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.

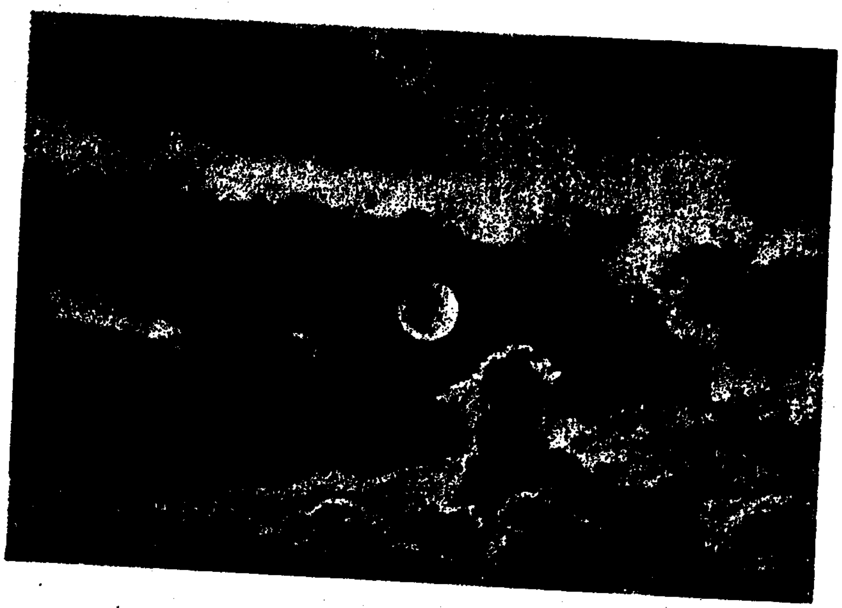
(2) Equipment listed is either presently available or planned and approved for procurement.

**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

BOOSTER

support programs



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

BOOSTER SUPPORT PROGRAMS

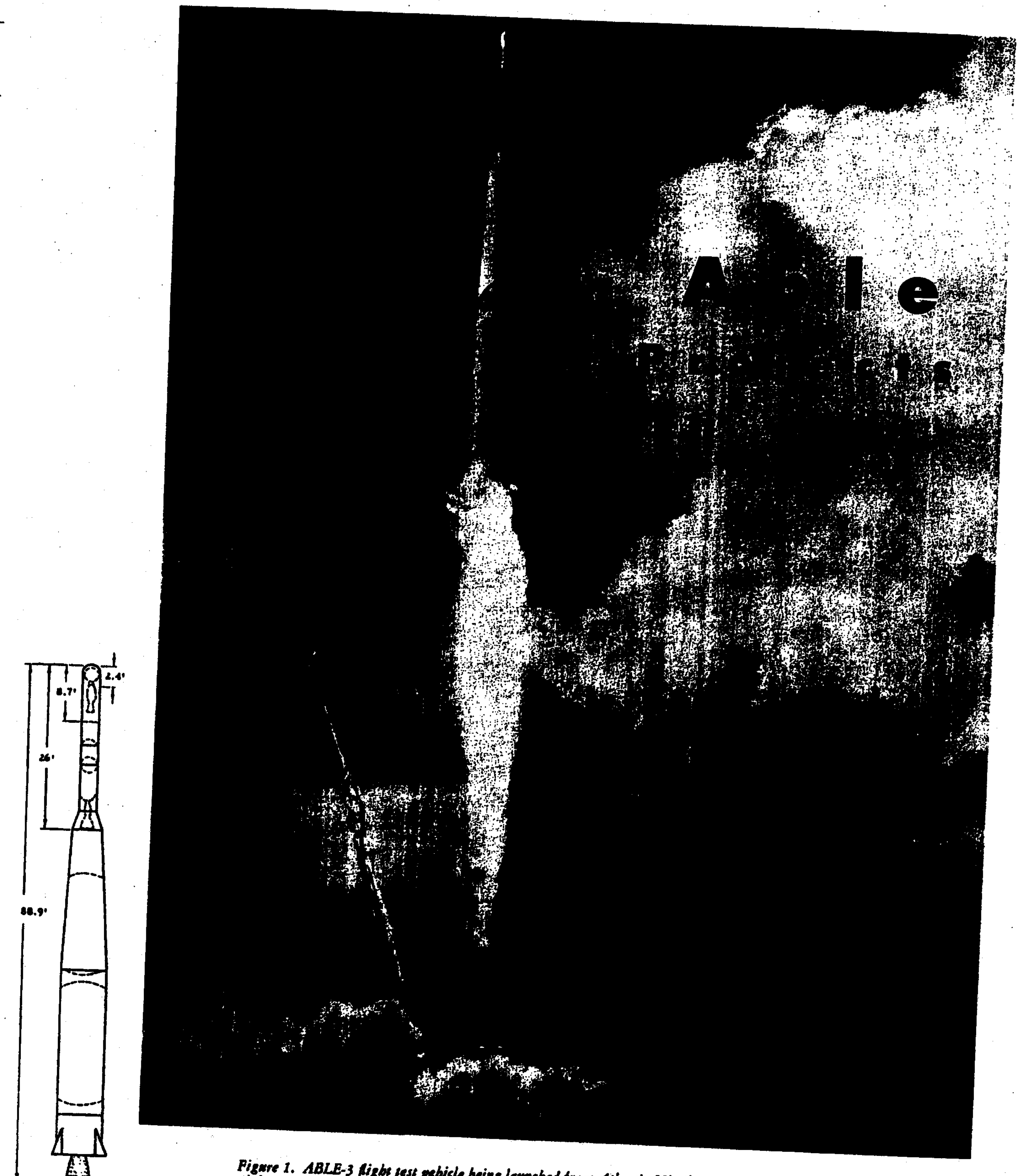
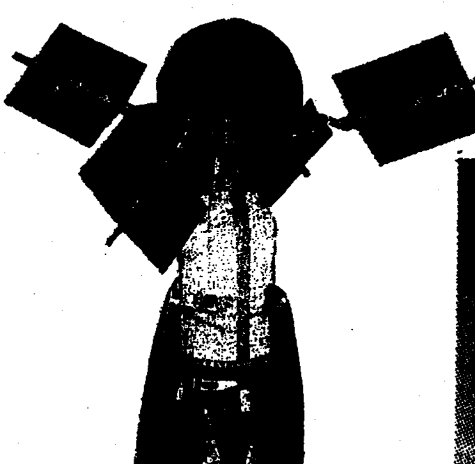


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.

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.



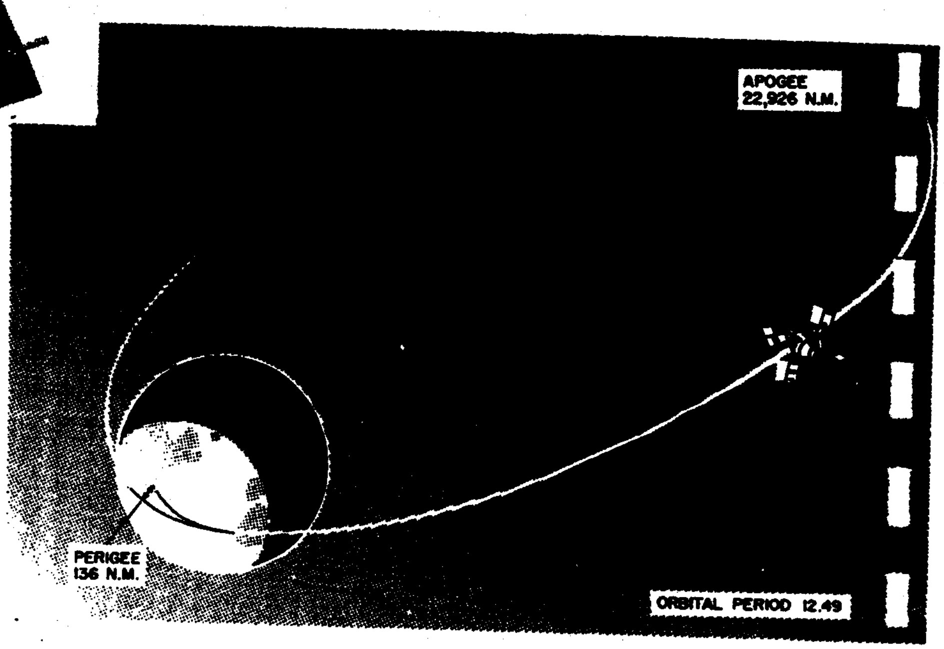


Figure 2. ABLE-3 third stage and payload (above) with solar paddles fully extended. Drawing of extremely elliptical orbit achieved by ABLE-3 (EXPLORER VI).

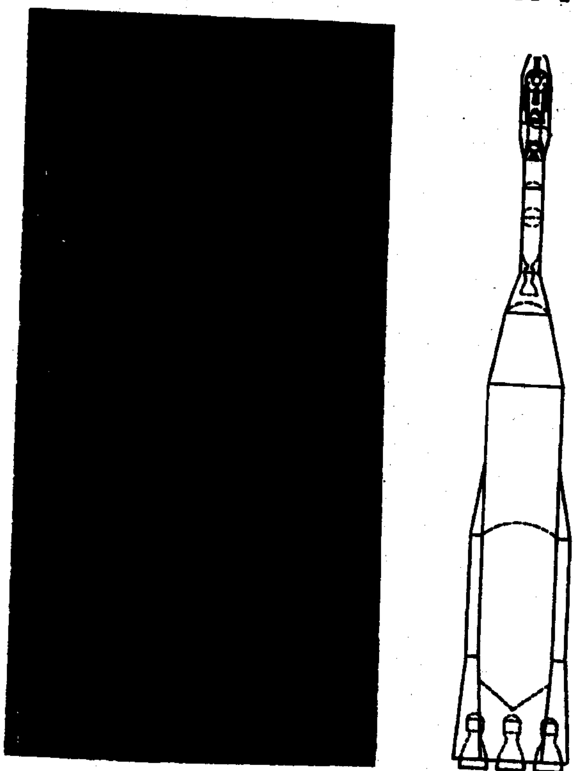


Figure 3. ABLE-4 ATLAS vehicle configuration drawing and photo of vehicle installed on Atlantic Missile Range launch stand 12.

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

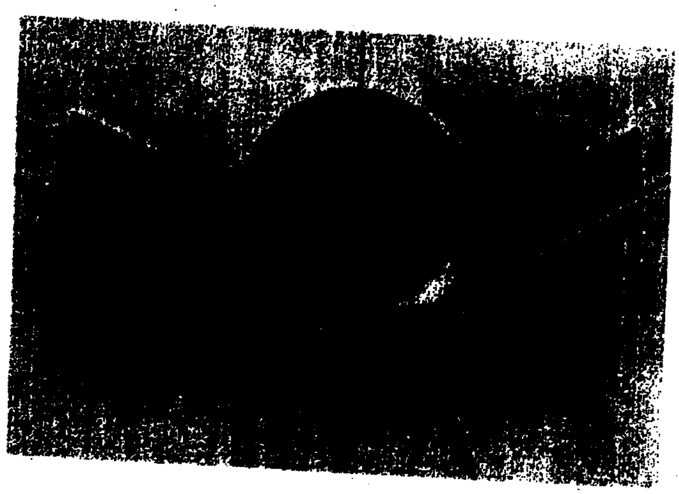
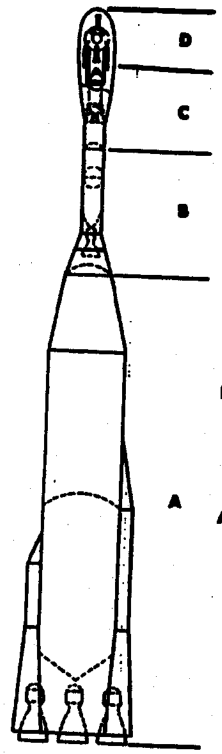


Figure 4. PIONEER V satellite vehicle shown in orbital flight position. This solar satellite was launched from the Atlantic Missile Range on 11 March 1960.



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	367,789 lb

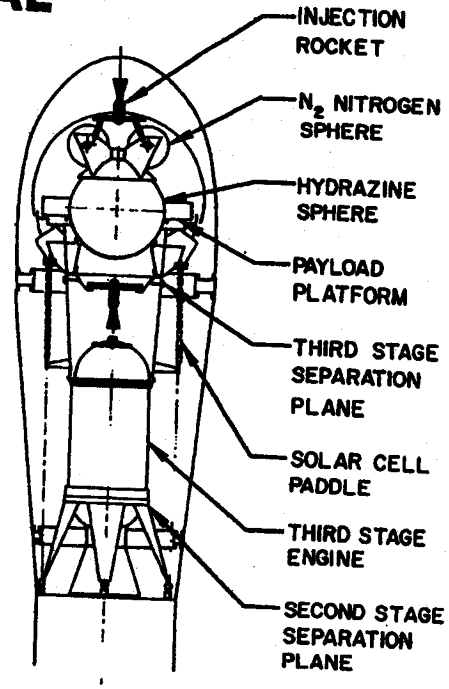
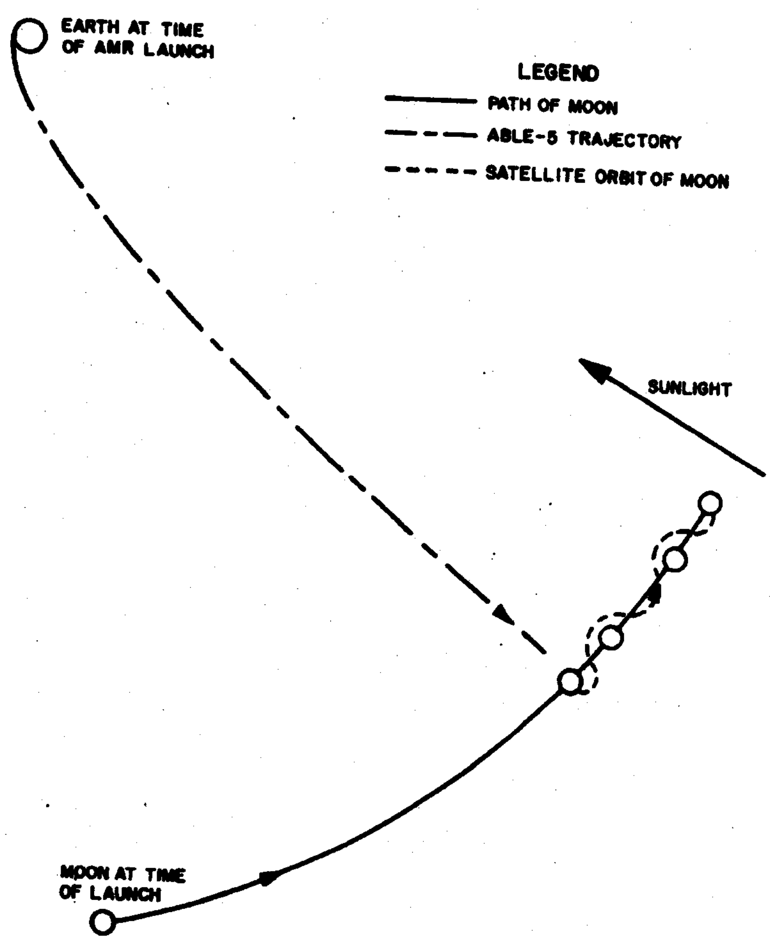


Figure 5. ABLE-5 vehicle configuration drawing and specification list. Third stage and payload configuration (right). Trajectory of ABLE-5 into lunar orbit is shown in drawing (below).

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 x 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 x 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

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.

Monthly Progress — ABLE Program

ABLE-5B Program Objectives

• The objectives of the ABLE-5B Program were:

1. To obtain scientific data on the environment encountered by an instrumented probe in interplanetary space beyond the immediate gravitational field of the earth.

2. Guide an instrumented probe along a trajectory which will reach and enable a close orbit about the moon.

3. Obtain scientific data on the environment encountered by an instrumented probe orbiting the moon.

4. Demonstrate the capability of the ground stations to track a space probe into a lunar orbit and receive telemetered information.

5. Demonstrate the performance and operation of the monopropellant hydrazine payload propulsion system for vernier midcourse velocity corrections and orbit injection.

6. Demonstrate the capability of the second stage guidance equipment to steer the test vehicle and terminate second stage propulsion within the proposed accuracy limits.

ABLE-5B Prelaunch Progress

First Stage

• A combined fuel and liquid oxygen loading test was satisfactorily completed on 1 December and a joint ATLAS-ABLE Flight Acceptance Composite Test was conducted on 5 December, with satisfactory results. The power changeover switch on the booster was found to be defective and was replaced. A successful Flight Readiness Demonstration was performed on 7 December.

Second Stage

• The second stage was mated with ATLAS 91D on 2 December following a successful leak test. As a result of second stage testing, the coherent guidance transponder modulator and power amplifier were removed and replacement units were installed.

Third Stage

• Following completion of alignment and balance checks, the third stage was attached to the second stage, on stand, on 9 December.

Satellite Vehicle

• During December, environmental testing of some payload components was completed. Malfunctions which occurred in two of the experiments, in the digital telemetry unit and the coherent r-f system were remedied and the units were reinstalled after requalification.

• The receiving inspection revealed a leak in the No. 2 injection tank and the No. 3 vernier tank. Both tanks were replaced with spare units, reinspected, and found acceptable.

• The satellite vehicle was erected on stand on 10 December in preparation for the 15 December launch.

Ground Support Equipment

• The electrical launch facility equipment for Complex 12 was re-installed, including the 100-ampere transistorized 28 volt power supply, and successfully validated. Interruptions in 28 volt power of several seconds duration were experienced during second stage tests. The stand-by power supply was installed and no further problems were encountered.

Ground Guidance System

• All constants were specified for both the Ground Guidance System and the Mod I computer equations. The equations and constants were checked by three nominal runs for each of the possible launch days. Extensive noise runs and close-loop interpretive simulations were also made.

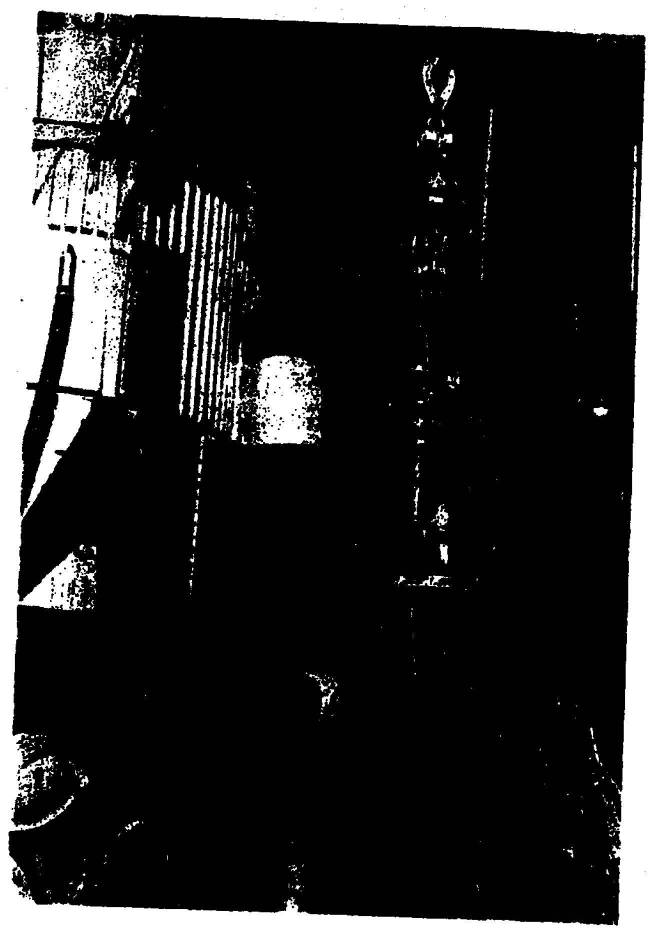
Ground Stations

• The Manchester station was in complete readiness to support the launch.

• The Hawaii station was in peak operating condition for the launch, following replacement of the HP560A Doppler printer. Performance testing and certification of the TLM-18 antenna modifications was successfully completed.

• Singapore personnel fabricated some Doppler data extraction equipment from available components. The equipment was capable of yielding usable data, although not as accurate as the Doppler Data extraction unit at AMR. Minor equipment problems were resolved and the station was in operating condition for the launch.

Figure 6. ABLE-5 second stage during hangar checkout at the AMR (above). Bottom views show second stage (left) and third stage (right) being hoisted alongside gantry for mating on ATLAS 91D booster.



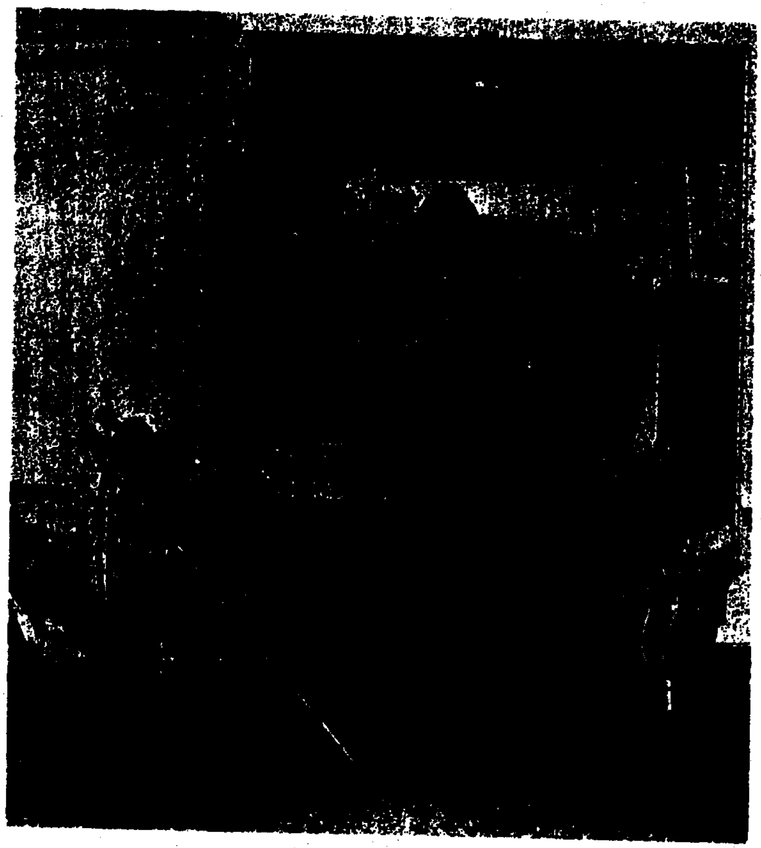


Figure 7. Servicing hydrazine engine of ABLE-5 payload (left). Bottom views show sealed payload just before being hoisted onto gantry (left) and mated onto ABLE-5 vehicle with solar cell paddles being installed and adjusted (right).

Reliability Studies

- Calculations made of the anticipated booster/second stage clearance during the staging sequence indicated that there would be no chance of collision. The bending stability and rigid-body picture for ATLAS 91D was re-examined to insure the autopilot change made to suppress the frequency instability noted on ABLE-5A would not degrade stability margins.

- A study was also made of flight loads in relation to angle of attack, for both ABLE-5A and ABLE-5B. It was determined that flight loads were below design loads, and that the measured engine angles of the ABLE-5A launch compared favorably with those obtained by flight simulations. It was recommended that new angle-of-attack limitations (7 degrees at maximum q and 4.5 degrees in the transonic regime) be adopted instead of the NASA limitations used for ABLE-5A (5.5 degrees and 3.8 degrees, respectively). Final limitations used were the lower values. Initial review of the ABLE-5B flight data indicates that the angle-of-attack limitations were not exceeded at any time during the flight.

ABLE-5B Flight

- Technical difficulties with the ground support equipment caused a one-day postponement of the scheduled 14 December flight. On 15 December at 0110 PST ABLE-5B was launched from the Atlantic Missile Range, Complex 12. Powered flight appeared normal until approximately 67 seconds after liftoff. At this time, approximately 41,000 feet altitude, the vehicle broke up and impacted 8 to 12 miles from shore. Initial examination of the flight test data indicates that all measured parameters were normal until T plus 67.3 seconds, when a transient was noted in the first and second stage axial accelerometers, followed immediately by a decrease in booster liquid oxygen pressure. Film data shows a change in flame pattern at this time, followed by structural failure of the combined vehicle. First stage telemetry was lost approximately six seconds after the initial abnormal indication, and from the second stage considerably later. Salvage operations are continuing in an attempt to reconstruct the vehicle. Examination of the second stage structure recovered showed no evidence of propellant leakage or of combustion in that stage. The cause of the malfunction is not known at this time.

- An ABLE-5B Review Group consisting of participating contractors and chaired by AFBMD has been formed to investigate the cause of the malfunction. The final report of the Review Group is scheduled for completion in late January.

Figure 8. ABLE-5 vehicle shown during pre-dawn preparations for 15 December launch from Atlantic Missile Range Complex 12.

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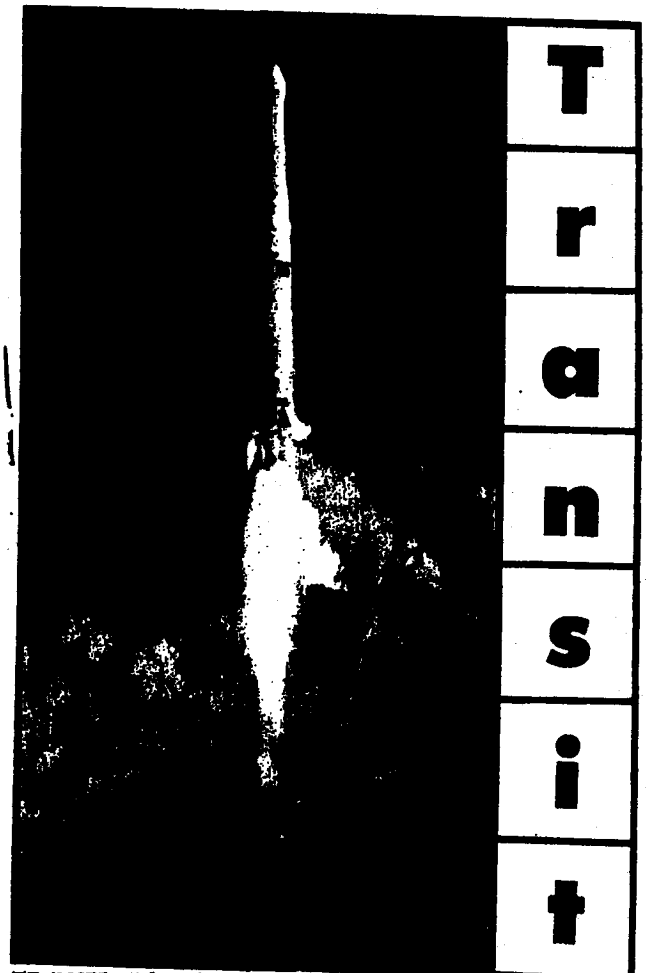


TRANSIT 3A launched from Atlantic Missile Range

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

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

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

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

C. FIRST STAGE—THOR IRBM

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

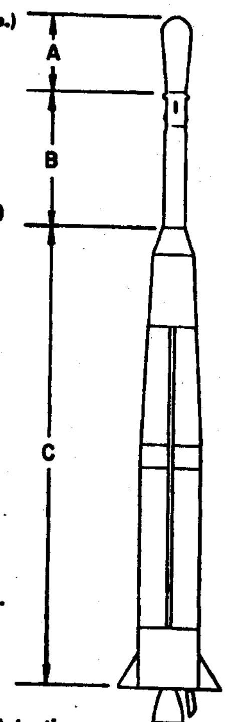


Figure 1. TRANSIT 1A three stage flight vehicle.

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.

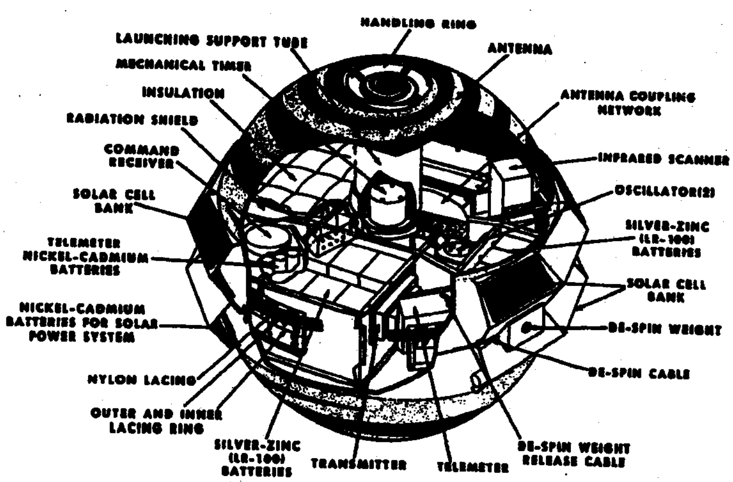
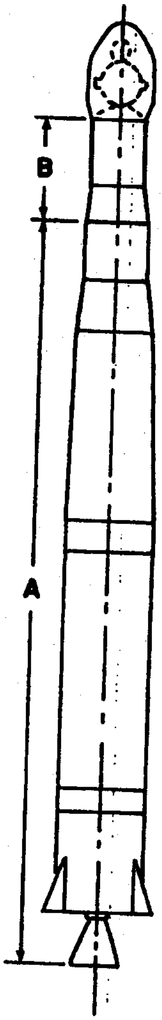


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV 1).

The program was originally authorized by ARPA Order No. 97-60, which assigned AFBMD responsibility for providing the booster vehicles, integrating payloads to the vehicles, and flight operations from launch through attainment of orbit. The TRANSIT project was transferred to the Navy on 9 May 1960. The Navy has now assumed both the administrative and technical responsibility for the TRANSIT program. Payload and tracking responsibility has been assigned to the USN Bureau of Weapons. Applied Physics Laboratory is the payload contractor.



B. SECOND STAGE—ABLESTAR (AJ10-104)

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

A. FIRST STAGE—THOR IRBM

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

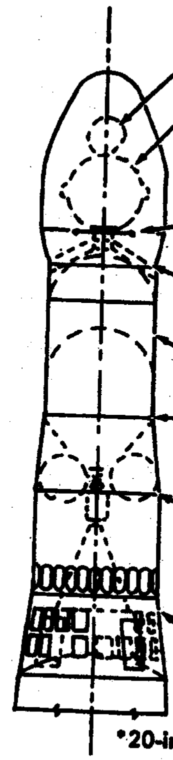


Figure 3. Two stage vehicle used for TRANSIT 1B and subsequent flights.

Program Objectives

1. Provide accurate navigational reference information for POLARIS launches.

2. Precise determination of satellite position by measuring the doppler shift of satellite transmitted radio signals.

3. Investigate the refractive effect of the ionosphere on radio transmissions.

4. Acquire additional geodetic and geographical data by precision tracking of the orbiting satellite.

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

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

Payload Description The 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.

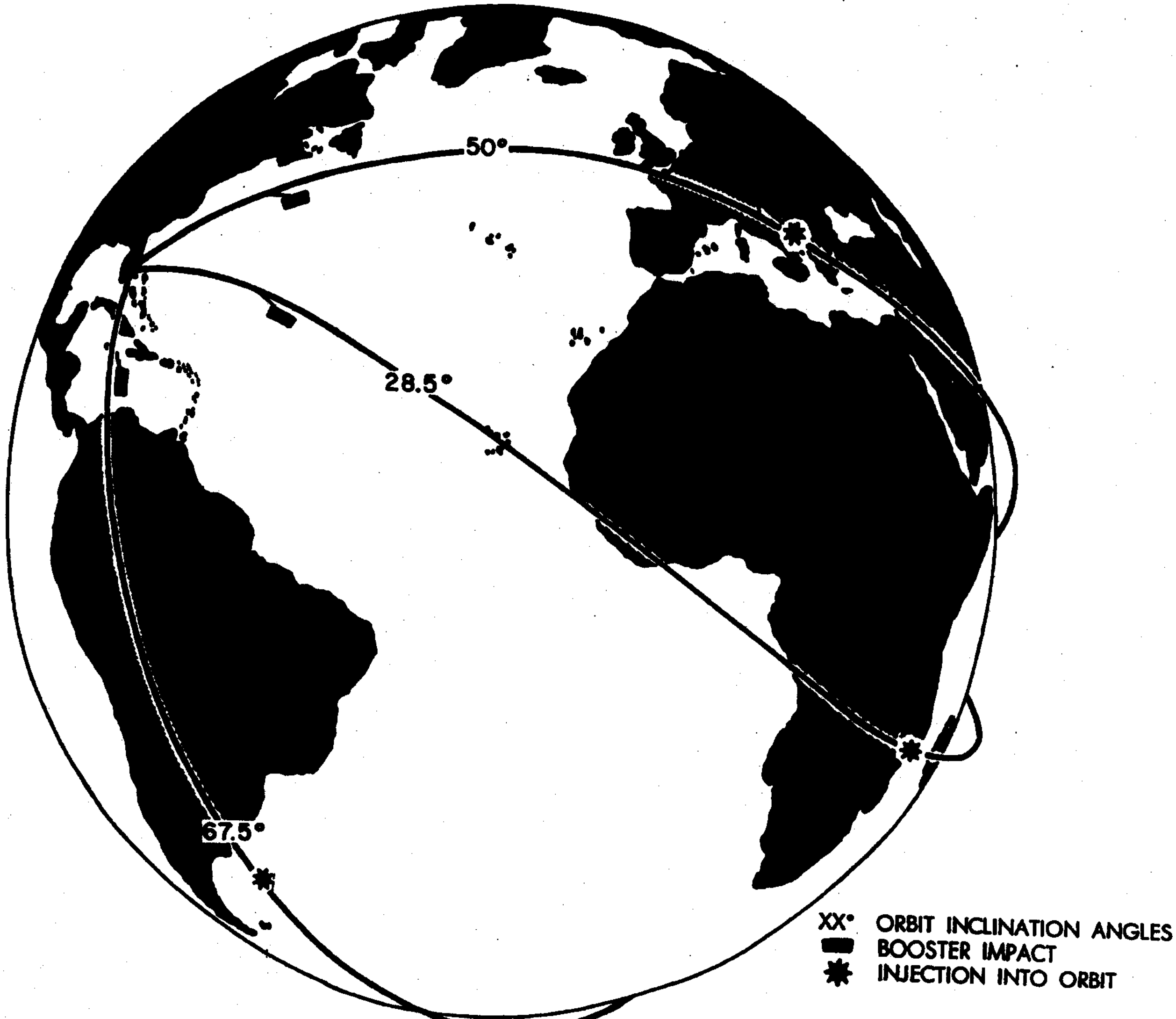
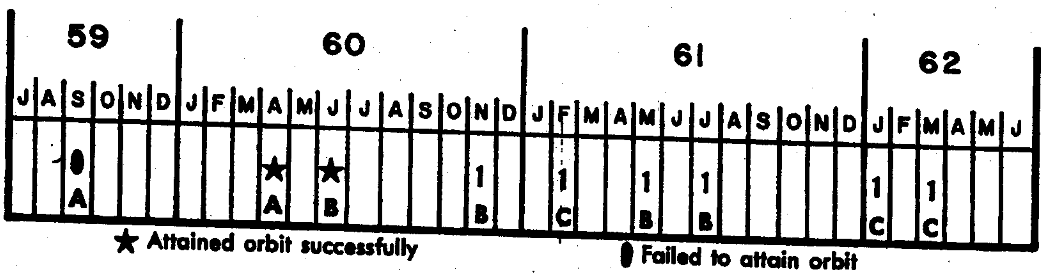


Figure 4. Typical TRANSIT launch trajectories showing flight path, booster impact areas, and orbital injection points.

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 Punta Arenas, Chile, for the TRANSIT 2A and 3A launches. It was located in Erding, Germany, for the TRANSIT 1B flight.



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. It was subsequently destroyed by Range Safety.*

Monthly Progress – TRANSIT Program

Program Administration

- The U. S. Navy (Bu Weps) has given program approval for TRANSIT 3B, 4A, 4B, 5A, and 5B. The Navy has requested that the previously programmed orbit inclination of 22.5 degrees for TRANSIT 5A and 5B be changed to 28.5 degrees.

- With the launch of TRANSIT 3A, Space Technology Laboratories' role as the Systems Engineering Contractor came to an end. The Aerospace Corporation will assume the task of providing Systems Engineering and Technical Support for TRANSIT 3B and subsequent flights. The Space Technology Laboratories' second stage guidance system will be used on the TRANSIT 3B and 4A flights. A Source Selection Board reviewed bids for developing the guidance system for TRANSIT 4B and subsequent vehicles during December. The contractor will be Bell Telephone Laboratories.

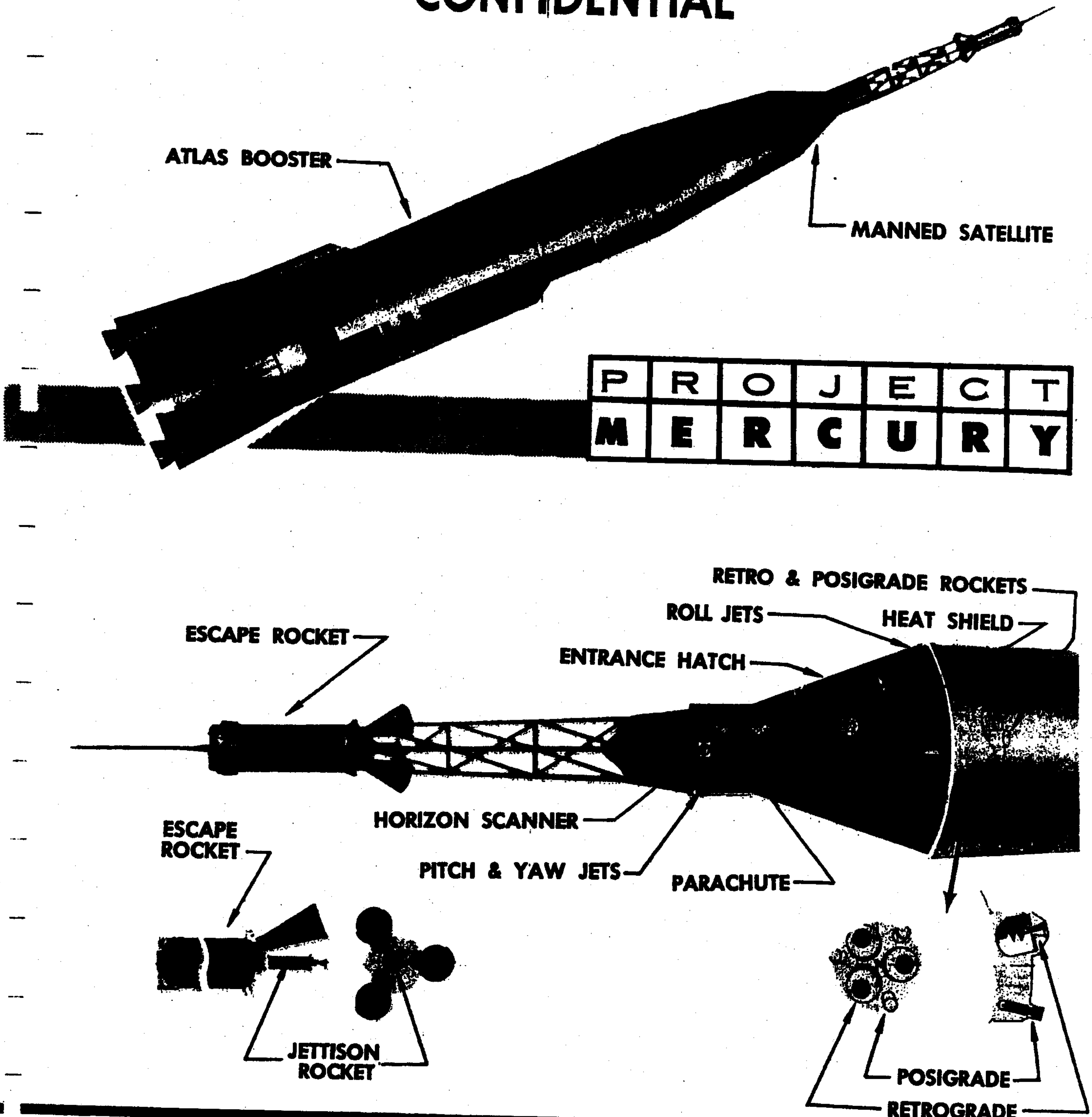
Flight Test Progress

- TRANSIT 3A was scheduled for launch on 29 November with an orbit inclination of 28.5 degrees. On 11 October, the U. S. Navy (Bu Weps) requested that the orbit inclination angle be changed to 67.5 degrees. AFBMD accomplished the tasks required to comply with the request, and on 30 November TRANSIT 3A was launched. Approximately ten seconds before the scheduled THOR shutdown, the main engine cutoff circuit was armed. Simultaneously with the arming of the circuit, the THOR shut down. With this early shutdown, it was impossible for the second stage to make up the velocity deficiency and accomplish the mission. The vehicle was destroyed by the Range Safety Officer. An investigation has been initiated to determine the cause of the malfunction.

Technical Progress

- The mobile downrange tracking station was shipped from Punta Arenas, Chile, to Space Technology Laboratories at Los Angeles for electromechanical overhaul. Atlantic Missile Range personnel are presently undergoing training in the operation and maintenance of the equipment. Transfer of the station to the Atlantic Missile Range will be accomplished in early January.

- The THOR booster and the Ablestar second stage are on schedule for the February TRANSIT 3B launch.



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

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

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

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

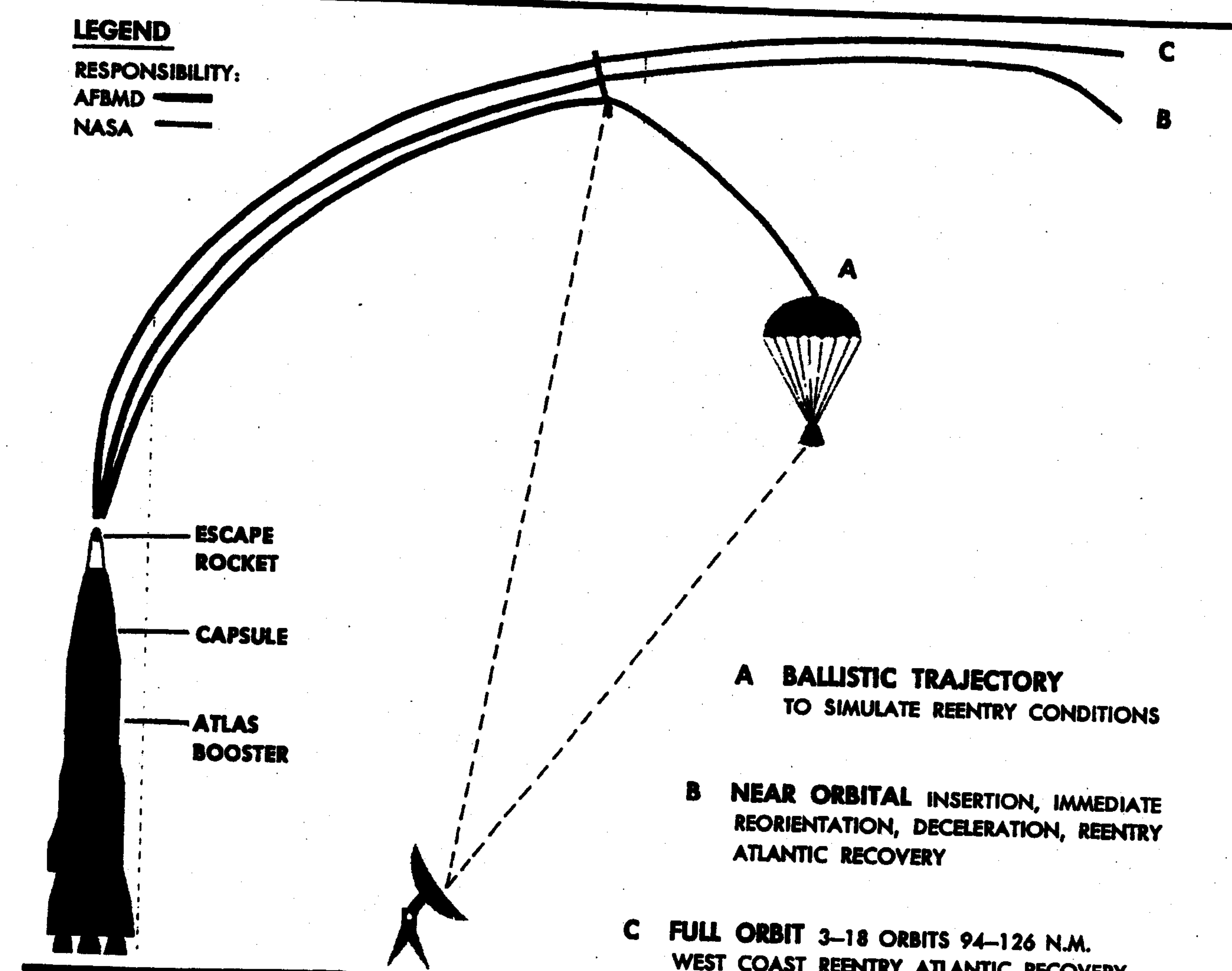


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.

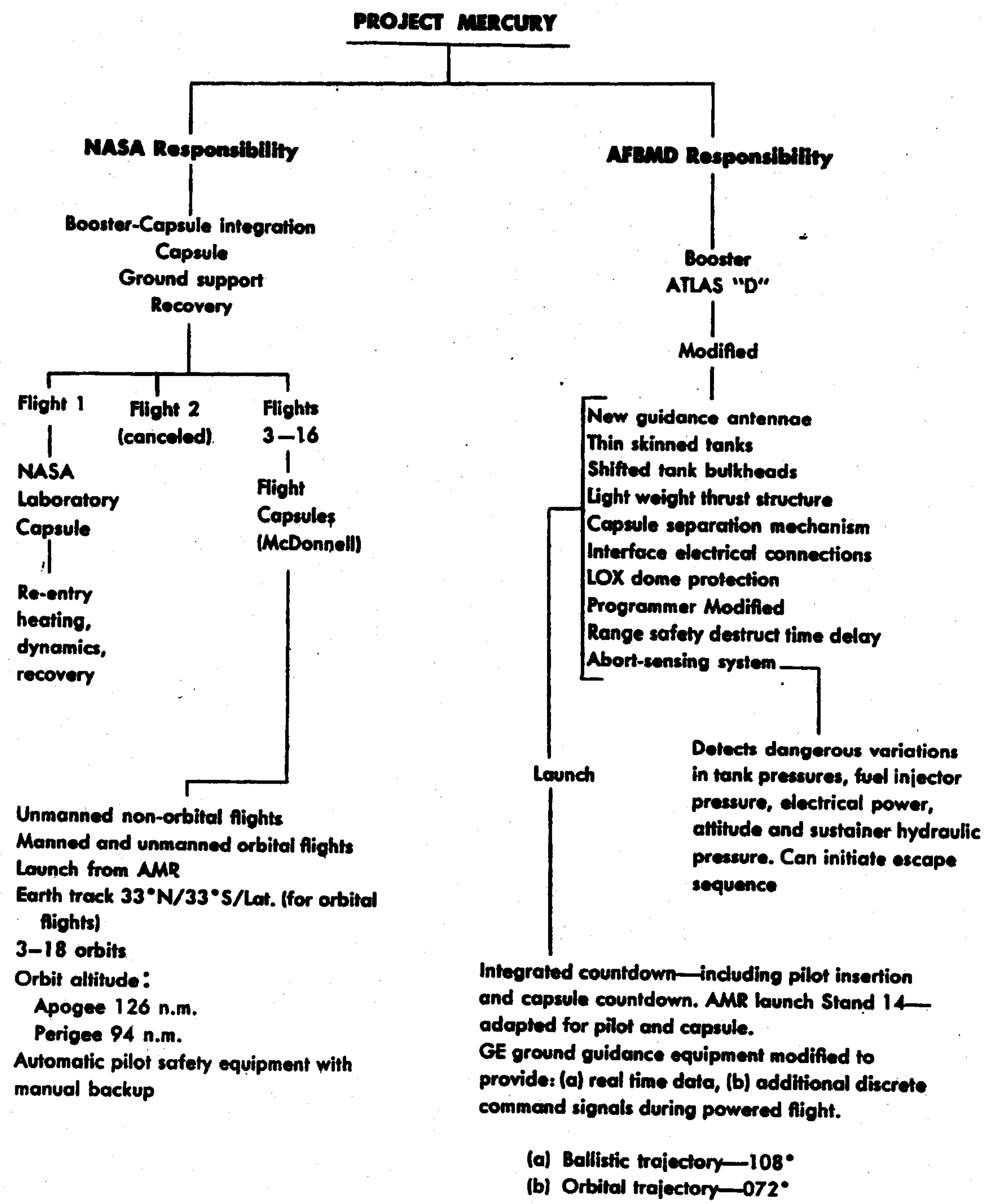


Table 1. Outline of NASA and AFBMD responsibilities in PROJECT MERCURY.

PROJECT MERCURY

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

Design, engineering studies
Equipment modification
Hardware fabrication

Launch support
Trajectory data
Missile allocation

Flight scheduling

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

Table 2. AFBMD responsibilities in support of PROJECT MERCURY.

Launch Schedule

59	J	A	S	O	N	D
			★			

60	J	F	M	A	M	J	J	A	S	O	N	D
							⬮					

61	J	F	M	A	M	J	J	A	S	O	N	D
	1	1	1	1		1	1		1	1		1

62	J	F	M	A	M	J	J	A	S	O	N	D
		1		1				1				1

★ Successful flight ⬮ Unsuccessful flight

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

• The results of the 21 November MERCURY/REDSTONE (MR-1) malfunction investigation were presented at a NASA conducted meeting on 1 and 2 December. Because of the MR-1 failure, initiated by improper electrical connector disengagement sequence resulting in booster shutdown, NASA was anxious to review the MERCURY/ATLAS electrical system compatibility. No problem areas were revealed in the MERCURY/ATLAS system compatibility review. However, in reviewing the capsule systems, NASA and McDonnell Aircraft personnel found that certain capsule circuits did not possess the redundancy required for optimum reliability. Incorporation of the circuit design changes desired by NASA meant that the scheduled 9 December launch data could not be met. This delay, coupled with the NASA ABLE-5B launch scheduled for the week of 12 December, the NASA MR-2 launch rescheduled for 19-21 December, plus minimum range activity throughout the holiday period, resulted in the rescheduling of MA-2 for 9 January. Because of a malfunction which occurred on the 15 December ABLE-5B flight, NASA has requested an indefinite hold in the launch date for MA-2.

• During the period of this indefinite hold, a special committee was established by AFBMD and NASA, to investigate previous ATLAS space booster failures and to recommend a course of action for future space launches utilizing ATLAS boosters. The committee is co-chaired by NASA and the Air Force (AFBMD). Although all programs utilizing ATLAS boosters were considered, special attention was given to the MERCURY (MA-1) and ABLE-5B malfunctions. Final determinations will be available in mid-January.

• The NASA Space Task Group has requested information about the ATLAS engine rough combustion investigation. On 13 December, the ATLAS Program Office of Space Technology Laboratories presented a briefing on the status of this study. Although the basic causes for combustion instability have not been determined, a very promising development in the form of a combustion baffle-injector in the combustion chamber has been investigated. A reduction in holddown time was also forecast. A request has been sent to the Rocketdyne Division of North American Aviation for a cost proposal and development schedules for this baffle-injector.

Flight Test Progress

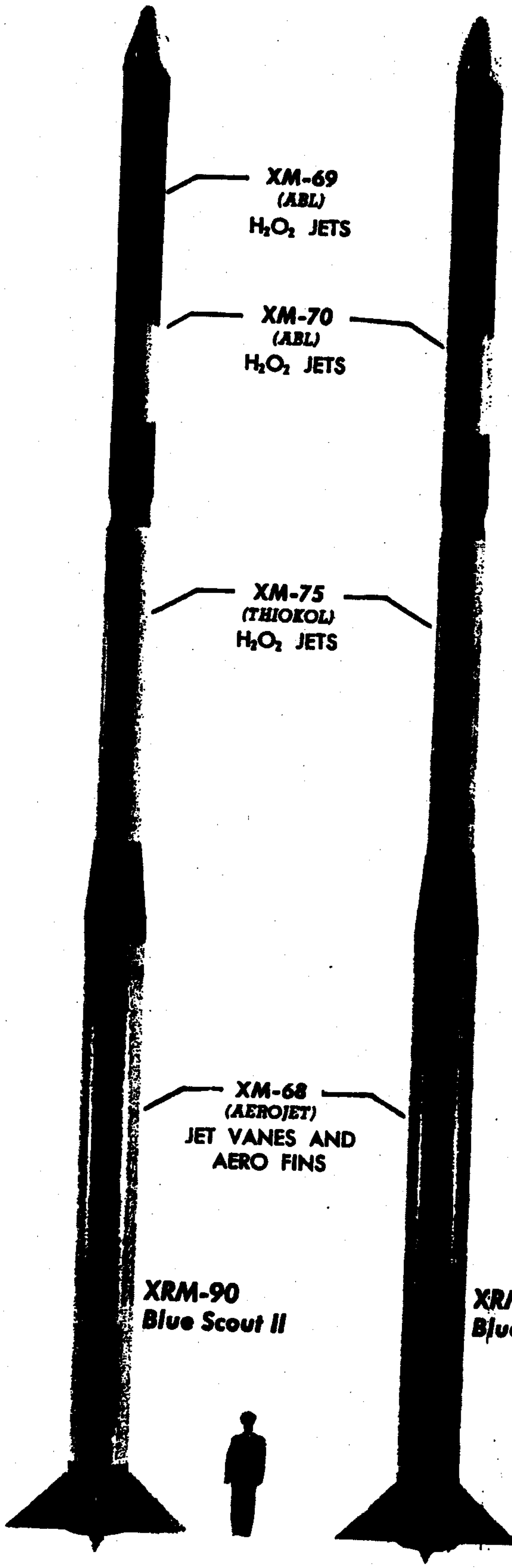
• ATLAS 67D (MA-2), which completed the Flight Readiness Firing on 19 November, remains erected on Atlantic Missile Range Stand 14. A continuous inspection program has been inaugurated during this stand-by period. Critical components and electrical connectors, which are prone to corrosion, will be subjected to intensive, detailed inspections throughout this period. Also, during the week preceding the new launch date, a complete Flight Acceptance Composite Test will be conducted on this booster.

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



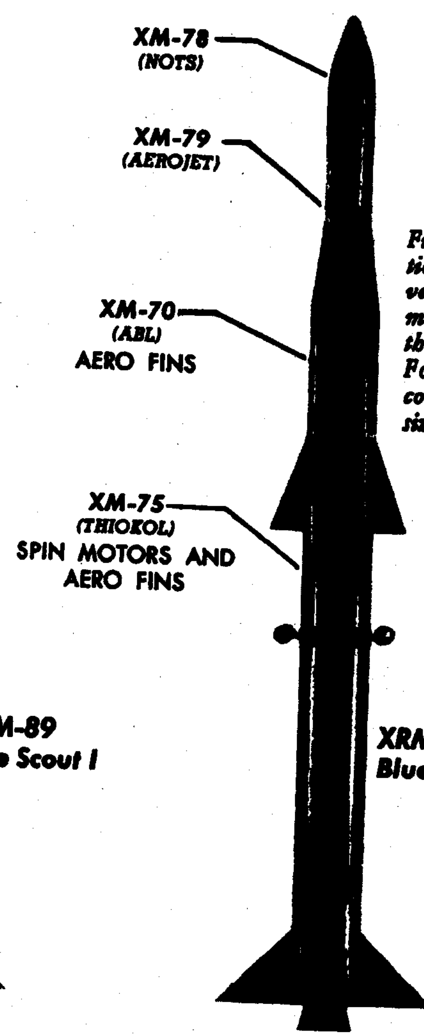


Figure 1. Three variations of Project 609A vehicles demonstrate the mission versatility of the program. The Air Force officer permits comparison of vehicle sizes.

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/altitude combinations; (b) boost-glide trajectories; (c) ballistic missile trajectories; (d) downward boosted, high-speed re-entry profiles, and (e) full orbit to approximate maximum of 400 miles with 150 pound payloads.

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

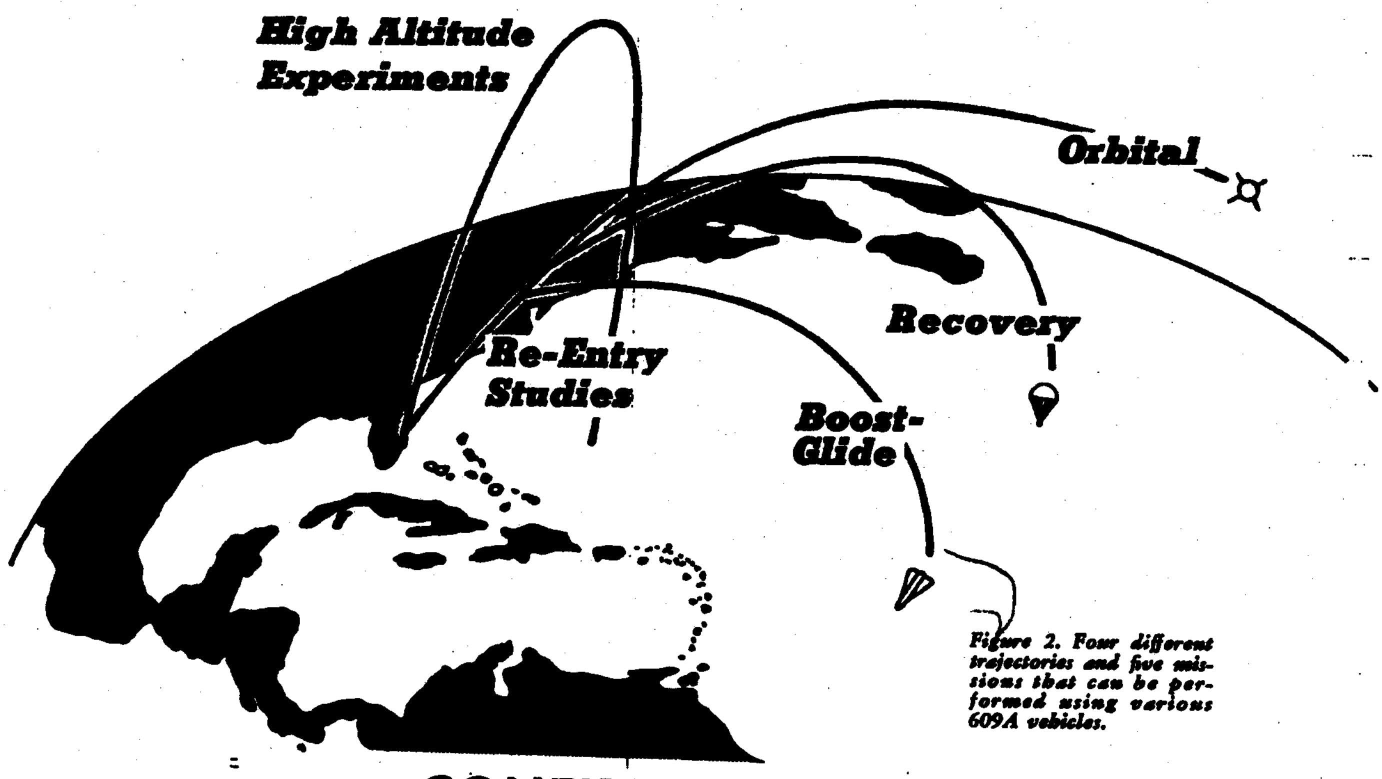
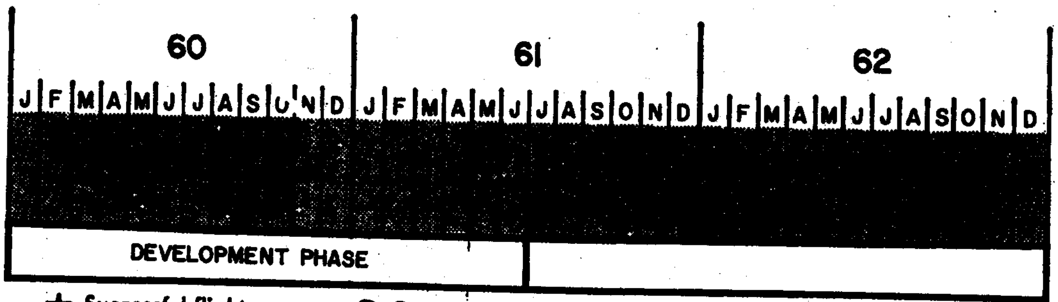


Figure 2. Four different trajectories and five missions that can be performed using various 609A vehicles.

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.*

*Type of Flight

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

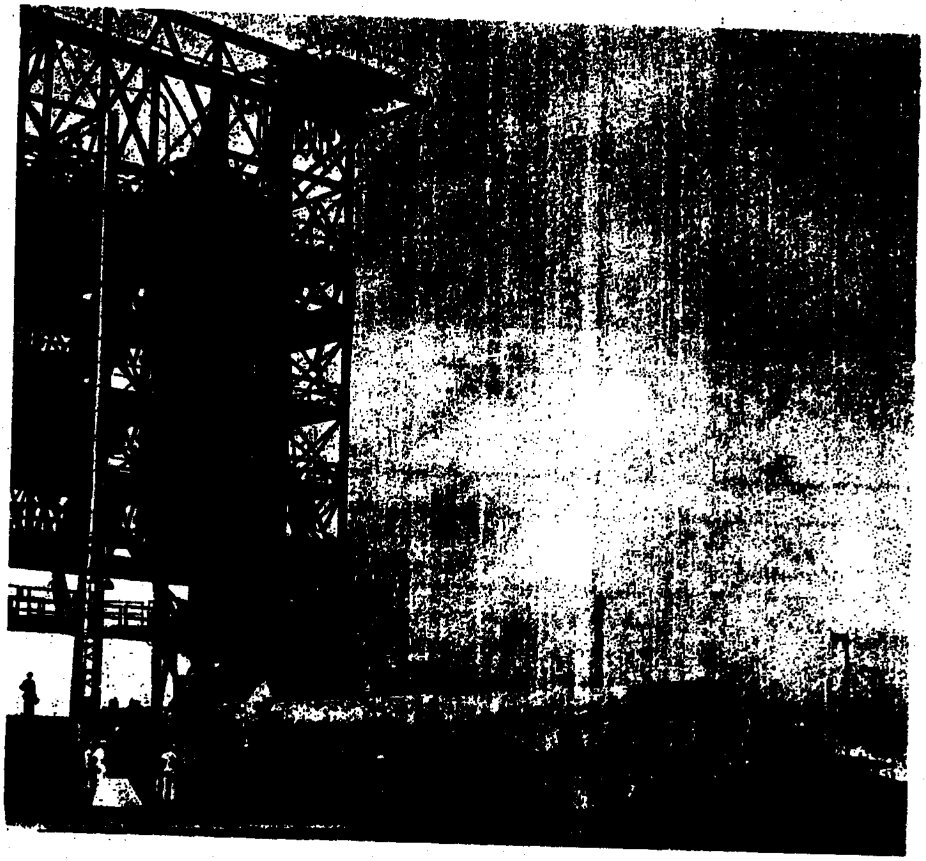
Monthly Progress — Project 609A

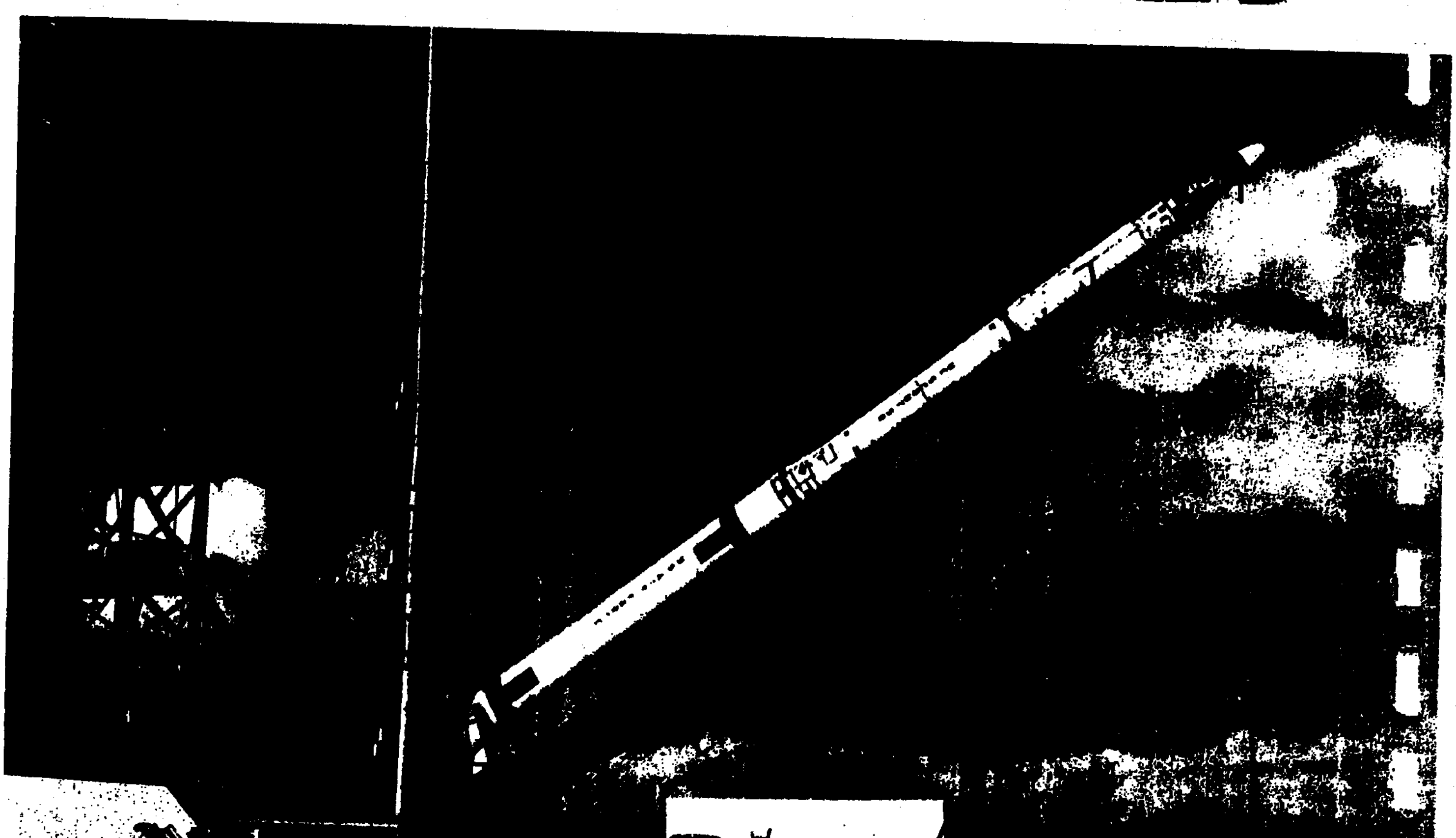
Program Administration

- As requested by Headquarters USAF, a complete review of the 609A Program was presented to Headquarters ARDC, Headquarters USAF and the Department of Defense. The briefing presented vehicle configurations, program status, space booster cost comparisons, and concluded with the recommendations that the reprogramming of funds currently withheld by Headquarters USAF be approved to complete the development program and that the follow-on "Application Program" be approved and funded. Dr. Rubel, Office of Assistant Secretary of the Air Force for Research and Engineering, approved the former and desires to study the latter. He stated that a decision would be made in the very near future.

- Information has been furnished the Bureau of Naval Weapons in response to a request for "Blue Scout" performance and configuration data. The Navy requested this data in order that they may proceed with the development of various payloads requiring boosters of the general performance of the SCOUT/609A orbiting and probe-type vehicles.

- The preliminary review on possible applications for 609A vehicles to support weapon system and space system development programs has been completed. These results, combined with the ARDC probes program requirements, indicate future potential applications for about 200 vehicles. A continuing effort is being made to further define the requirements for SCOUT type vehicles in this area. Among the programs included in this review were SAINT, VELA HOTEL and BAMBI.





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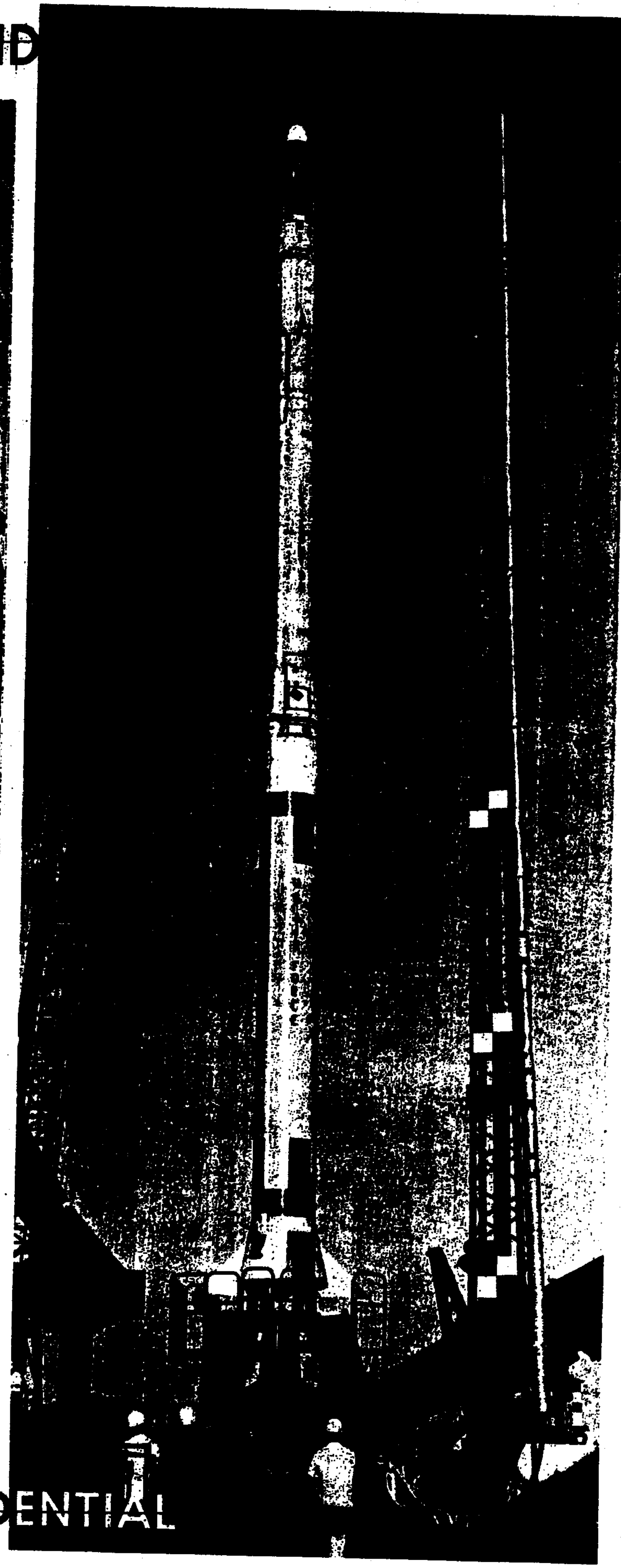


Figure 3. Blue Scout 1 (opposite page) being delivered to Atlantic Missile Range Launch Complex 18. This third 609A flight (D-3) scheduled for 6 January will contain a 90 pound data recovery capsule. Air Force technicians are checking one of the payload experiments in the right hand photo. Lower photo shows the erection of the XRM-89. The data recovery capsule is visible on the end of the payload. The protective shrouds will be placed over the payload after the final checks have been performed. The mating of the vehicle to the launch pad is shown above. It is interesting to compare the simplicity of this pad to those used for liquid fueled boosters. This is one of the reasons for the economy realized in the 609A Program. The transporter-erector is being lowered (right) following placement of the vehicle on stand.

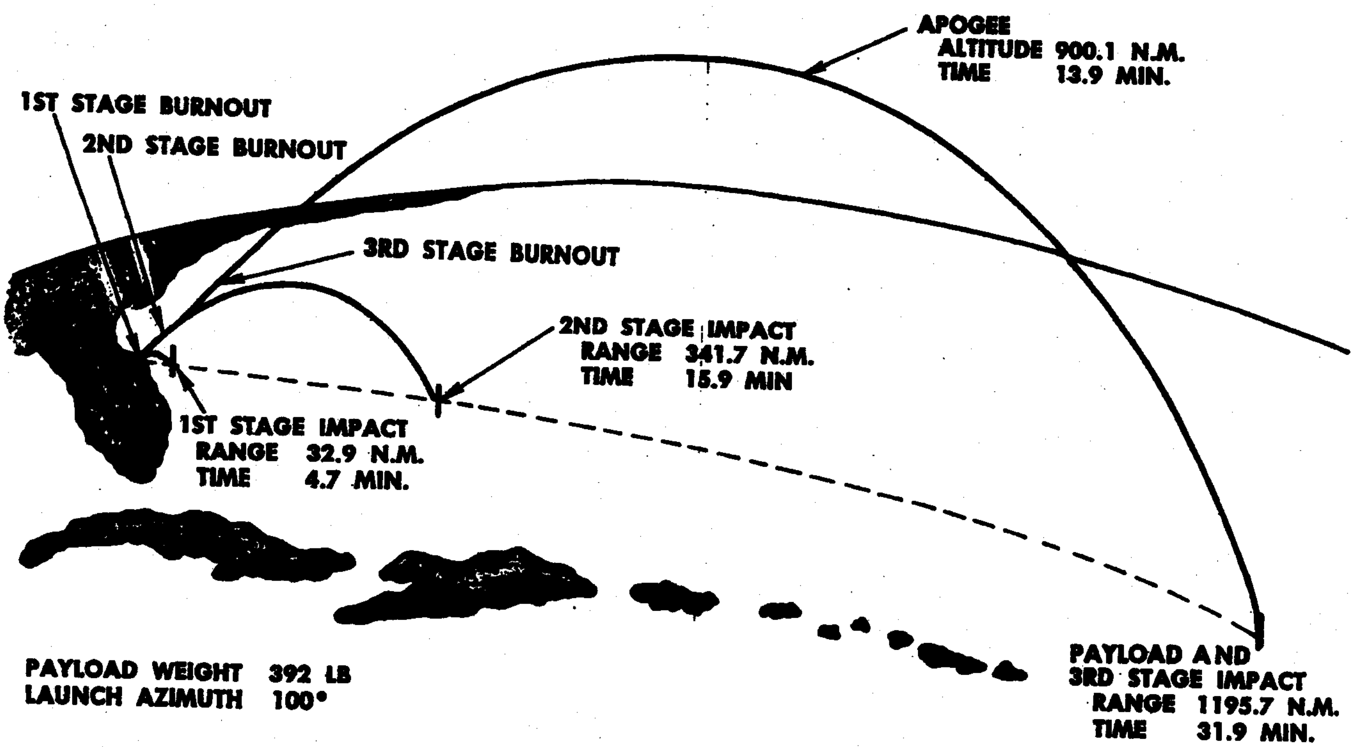


Figure 4. Trajectory for third 609A flight.

• At an Air Force/NASA coordination committee meeting on 7 December, Minneapolis-Honeywell delivery delinquencies and a NASA proposal that a systems checkout function be established at Chance-Vought for 609A vehicles were discussed. NASA agreed to impress upon Minneapolis-Honeywell the importance of meeting delivery schedules and to discard the checkout issue.

Flight Test Progress

• The third 609A flight (D-3) is scheduled for 6 January 1961 and will carry a 392 pound payload containing nine experiments prepared by various ARDC agencies. The payload's 90 pound data recovery unit will impact near Antigua. Figure 4 shows the flight trajectory. Three main problems have been encountered during launch preparation of the "Blue Scout I" vehicle for this flight. First, the XM-70 motor was found to be leaking desensitized nitroglycerin and had to be treated with a sealant. Both NASA and ABL stated that seepage is considered to be a common occurrence and expressed no concern regarding the flight worthiness of the motors. However, the leaking fluid presented a pad safety problem which prompted Range Safety at AMR to issue an order suspending assembly operations until the motor had been pumped out and resealed. Second, a safety ruling prevents utilization of launch complex 18 by the 609A Program when another vehicle is on an adjacent stand. Third, guidance system checkout difficulties necessitated the removal of the guidance system for recalibration. It has become apparent that facility improvement is required; that additional test equipment is needed; that coordination, procedures, drawings, and quality control must be improved; and that the number of contractor personnel must be increased. Concurrent action is being taken by Aeronutronic, the 6555th Test Wing and the project office to accomplish improvement in all these areas.

Technical Progress

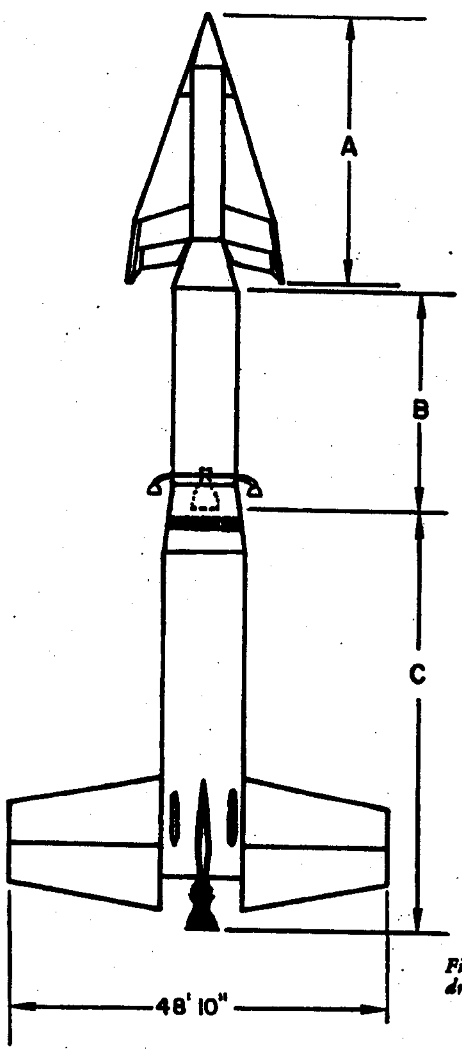
• A rocket motor propellant classification test was conducted on 3 December at Edwards Air Force Base using a rejected XM-68 motor. One-hundred pounds of explosives were detonated inside the motor. The motor did not have a high order detonation. Preliminary information indicates that the test provided an explosion equivalent to approximately 1,000 pounds of TNT and the propellant classification should be Class II. The Class II category means that the motor may be handled as if it presented a fire hazard only, rather than a full scale explosion hazard. This will have a favorable effect on the launch complex safety requirements.

• The Navy is continuing the program to improve the performance of the ABL X254 and X248 motors. This program is funded jointly by the Navy and NASA. These motors will produce a decided improvement in the "Blue Scout" and NASA Scout vehicle performance and should be available for use in approximately one year.

DYNA SOAR

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

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



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

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

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

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

SECOND STAGE MODIFICATIONS

Ignition prior to Separation

Intertank Section Strengthened

FIRST STAGE MODIFICATIONS

Stabilizing Fins Added

Skirt Section and Intertank Section Modified and Strengthened

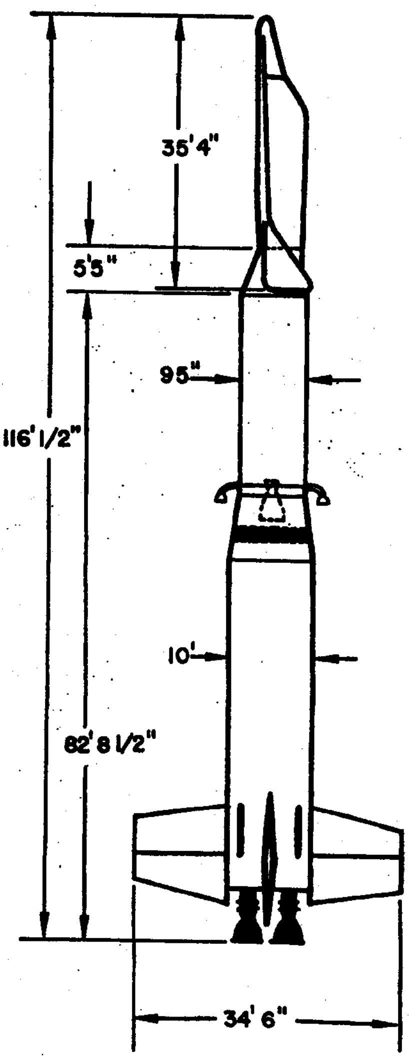
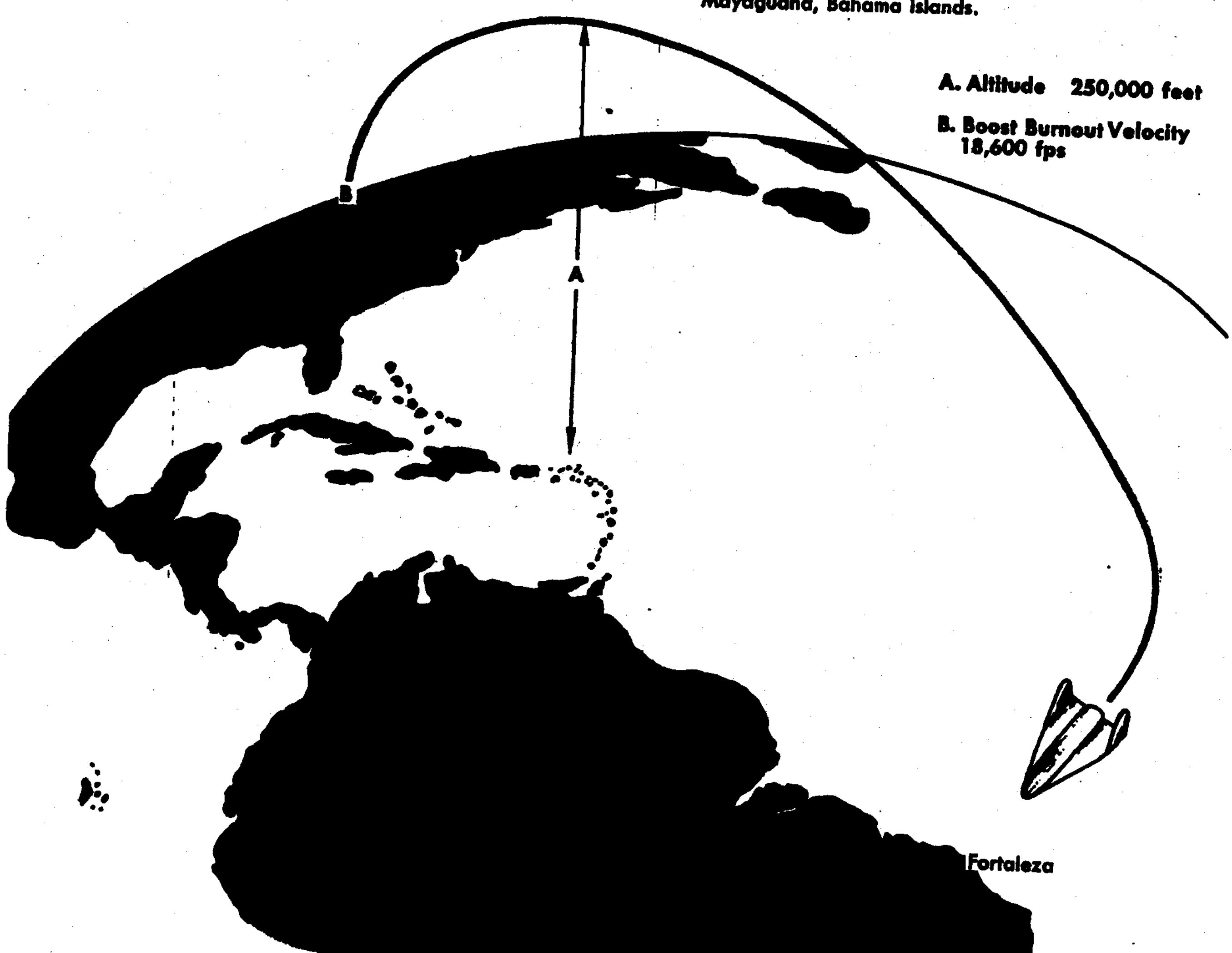


Figure 1. DYNA SOAR vehicle configuration drawing and specification list.

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

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



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

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

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

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

2. Modifying the LR 87-AJ-3 or LR 91-AJ-3 rocket engines to obtain structural compatibility with the modified booster; include malfunction shutdown and fail safe systems; and adding a cartridge start system.
3. Lighten and simplify the second stage engine.
4. Modification of an AMR launch pad.
5. Provide an integrated launch countdown.

Monthly Progress – DYNA SOAR Program

- On 30 November 1960 the Air Force took possession from the Navy of the vertical test fixture located at the Martin Company, Baltimore, Maryland. Modification for production acceptance testing of the booster is scheduled. However, the position on the entire developmental vertical test program for DYNA SOAR cannot be anticipated until completion of final review by the System Program Office.
- Early in December the System Contractor (Boeing) presented refined DYNA SOAR glider requirements for Step II. The data will be subject to System Program Office review and will ultimately become the basis for promulgation by AFBMD of DYNA SOAR Step II booster requirements.
- AFBMD is undertaking studies of the possibility of using TITAN II for DYNA SOAR Step I in place of TITAN I. The studies will consider the present status of Step II requirements together with requirements for improved booster performance in Step I.
- The first DYNA SOAR Executive Council Meeting was held at the Boeing Company, Seattle, Washington on 14 December. Council members present included Air Force Commanders of agencies actively participating in the DYNA SOAR Program and top executives of participating industrial contractors.
- AFBMD/Aerospace personnel participated in a test plan work session at Edwards AFB on 5 through 16 December 1960. This effort will enable ultimate publication of a final DYNA SOAR System Development Test Plan in accordance with AFR 375 requirements for a System Package Plan.

NASA AGENA "B" PROGRAM

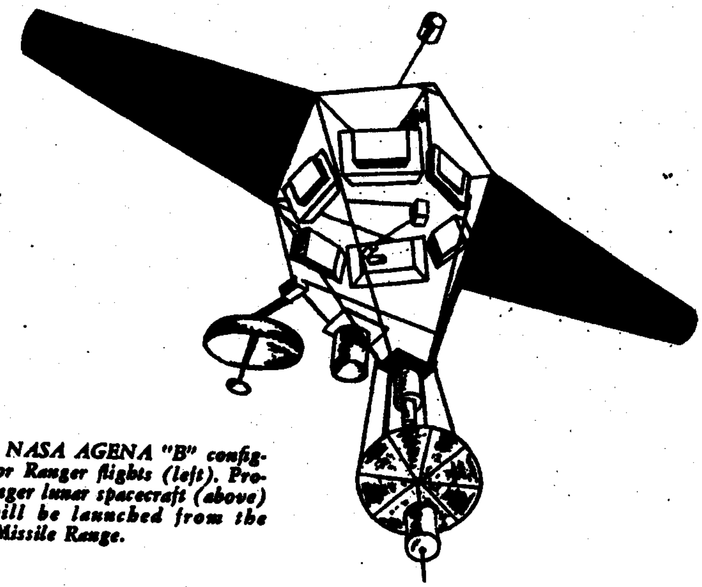
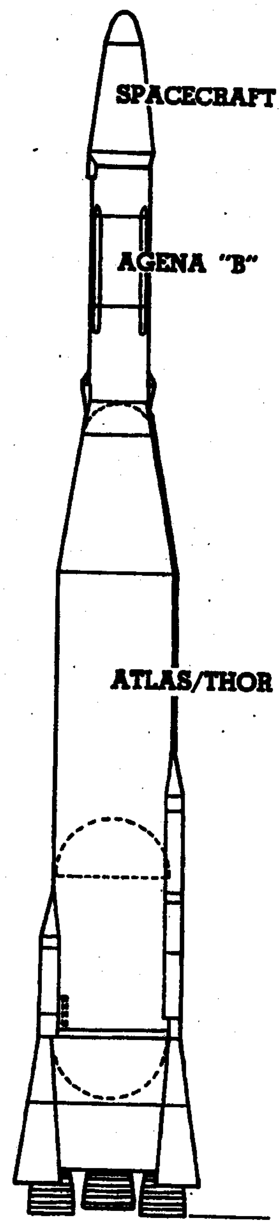


Figure 1. NASA AGENA "B" configuration for Ranger flights (left). Proposed Ranger lunar spacecraft (above) which will be launched from the Atlantic Missile Range.

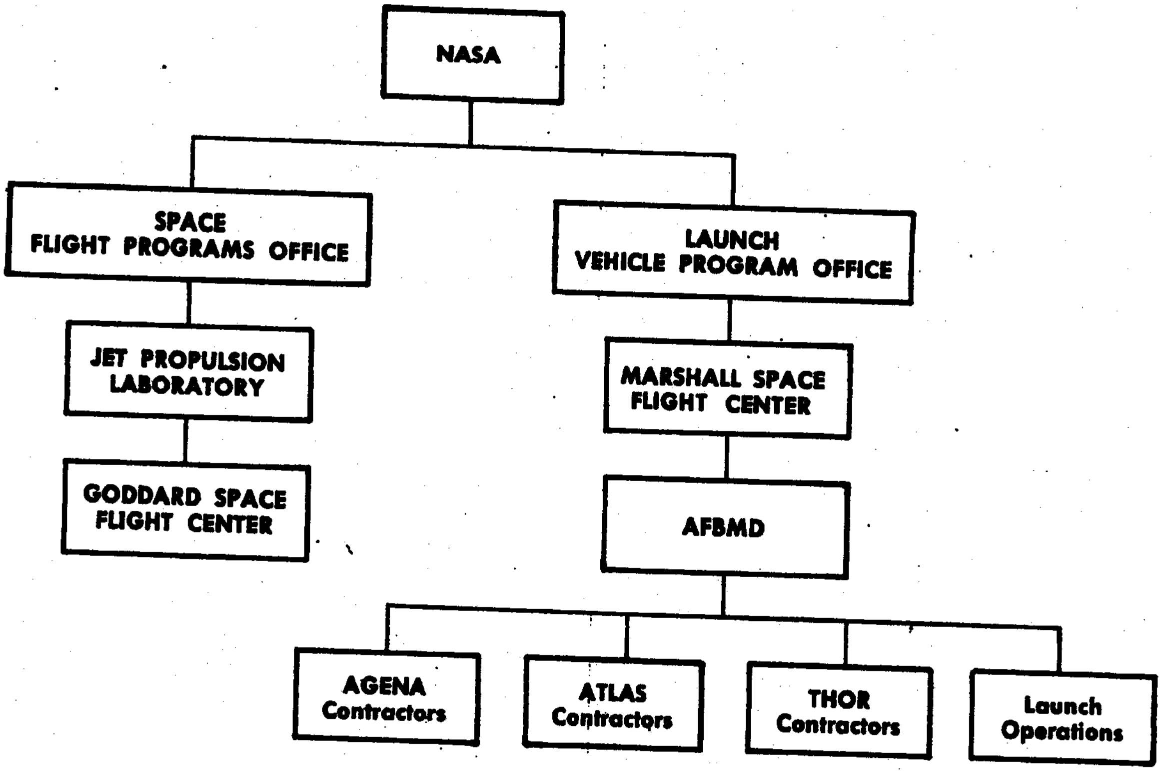


Program Objectives—The basic objective of the NASA AGENA "B" Program is to place a separable spacecraft on a prescribed ballistic trajectory or into lunar orbit to gather scientific information and data. The program will first demonstrate the capability of jettisoning the spacecraft shroud and separating 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
July	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.

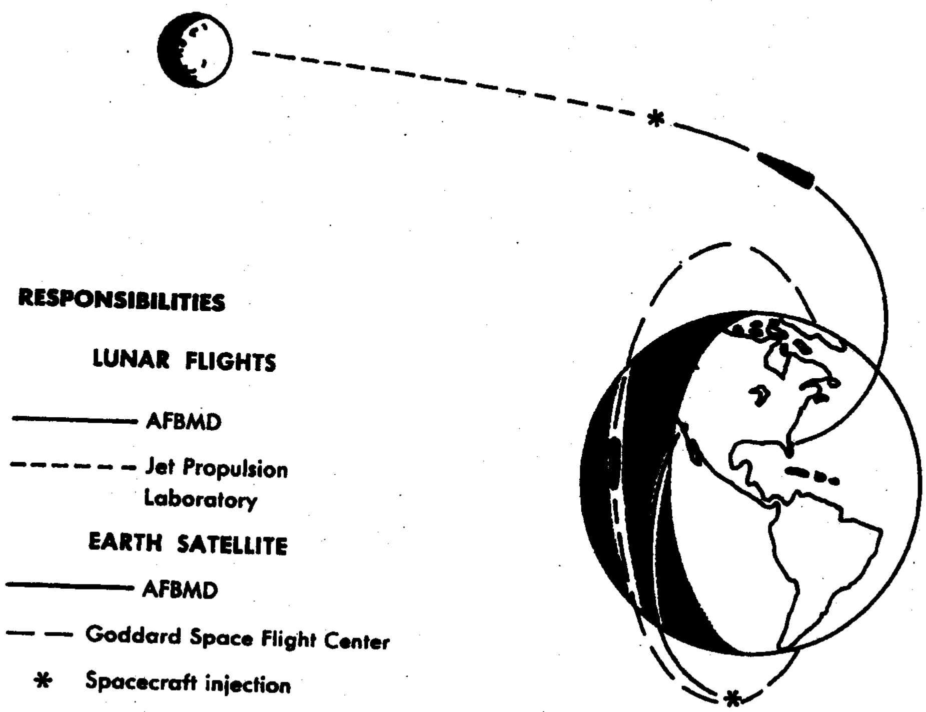
Program Status — AFBMD has taken the following action to support the NASA AGENA "B" Program:

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

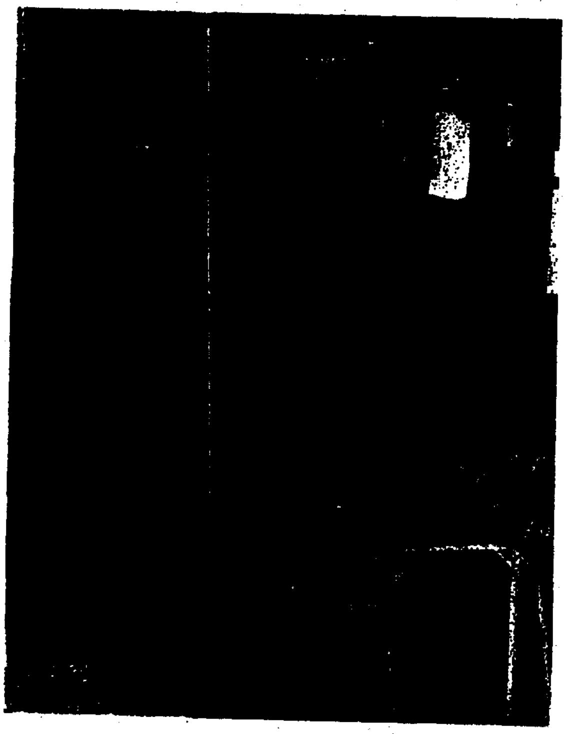
- A Communications Satellite has been added to the program. It will be a passive, semi-rigid sphere, similar to the Echo I satellite now in orbit. Final technical information will be furnished Lockheed Missiles and Space Division in January 1961. This launch is scheduled for April 1962.

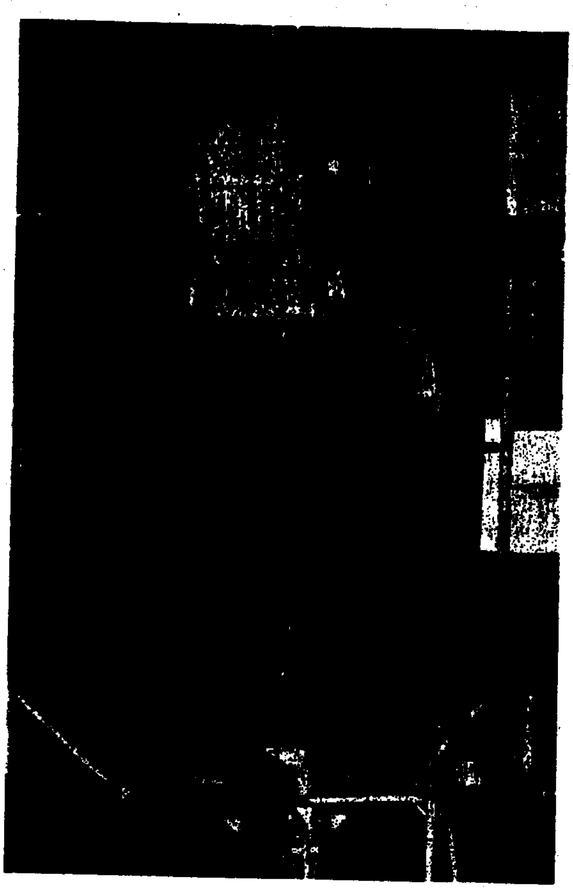
- The Program Requirements Document for the NASA AGENA "B" Program has been distributed by the Atlantic Missile Range.

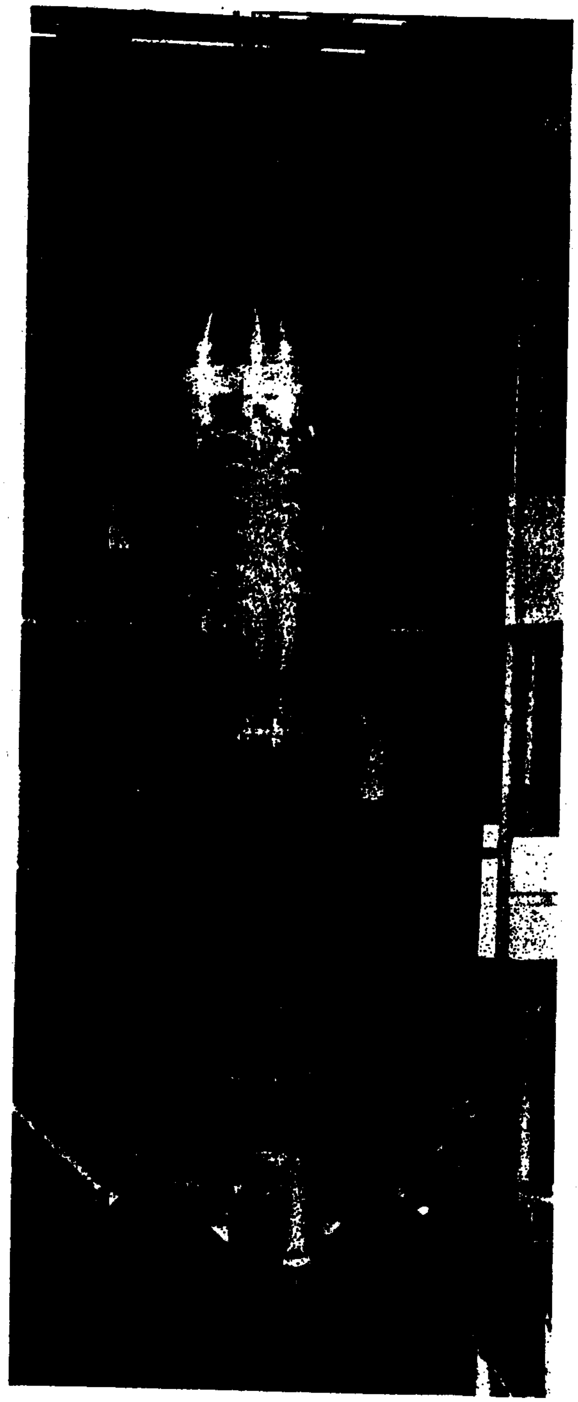
- Discussions were held with Douglas Aircraft and Convair-Astronautics in mid-December concerning a re-examination of available data to improve statistical descriptions of DM-21 and ATLAS performance parameters. NASA has requested refined information on error sources and tolerances for use in evaluating over-all probability of mission success versus payload weights.

Technical Progress

- The first NASA AGENA "B" booster, scheduled for launch in July 1961 carrying the first Ranger spacecraft, completed final assembly on 22 December and was transferred to Systems Test Area on 27 December. This vehicle is progressing satisfactorily and it is expected that the launch will be accomplished on schedule.







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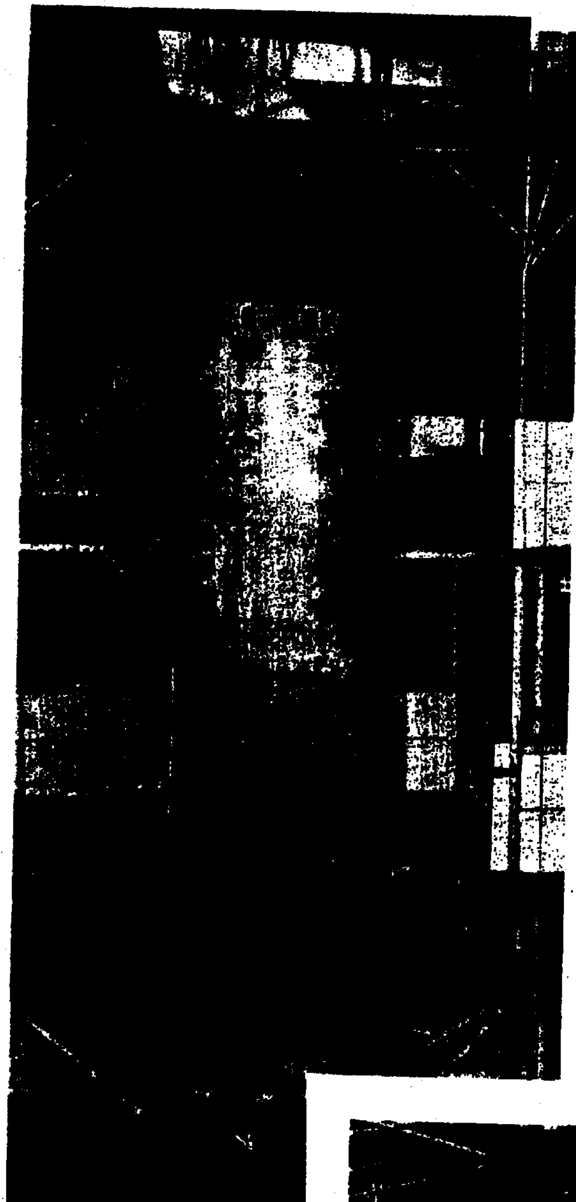
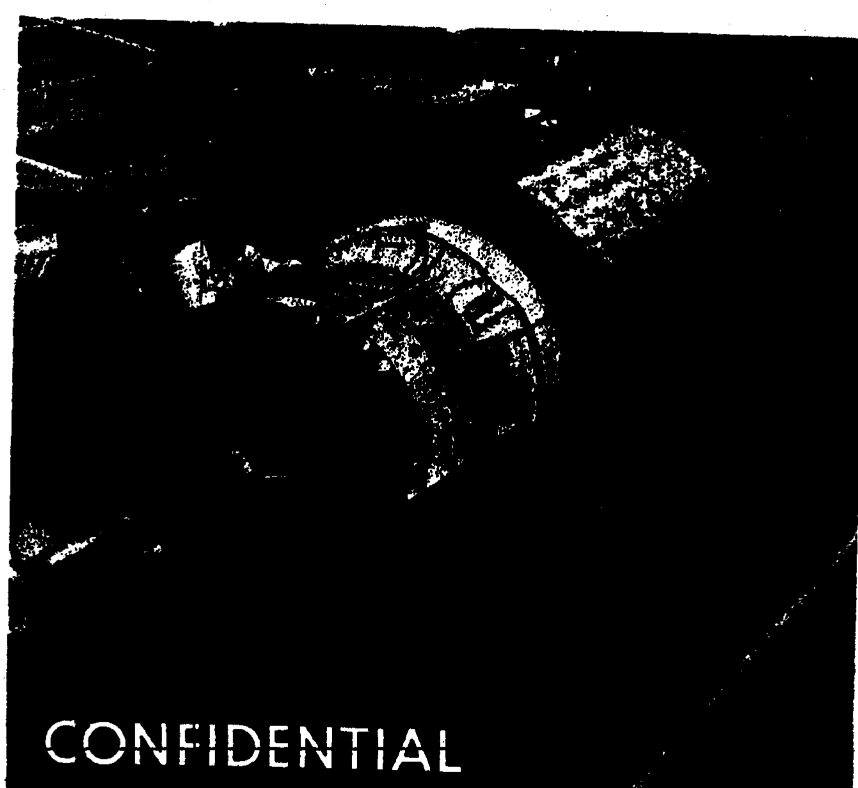


Figure 2. Premating of AGENA "B" vehicle for the first NASA AGENA "B" flight. This ATLAS boosted flight will carry a Ranger lunar spacecraft. The upper photo (opposite page) shows the booster adapter, which adapts the AGENA to the ATLAS, being readied for the "stacking" operation. The lower left photo shows the installation of the aft main body. This section houses the nitrogen bottles, the engine, and the attitude control system. In the other photo the stainless steel fuel and oxidizer tank is being lowered into the booster adapter. On the left (this page) the forward main body has been attached to the propellant tank. This section houses some of the electronic equipment. Following this operation, the AGENA is "de-stacked" and the structural assemblies are mounted horizontally in a stand for installation of the engine and other flight equipment. The photo below shows the vehicle in the systems test area with the engine installed. The AGENA entered systems test on 27 December and is on schedule.



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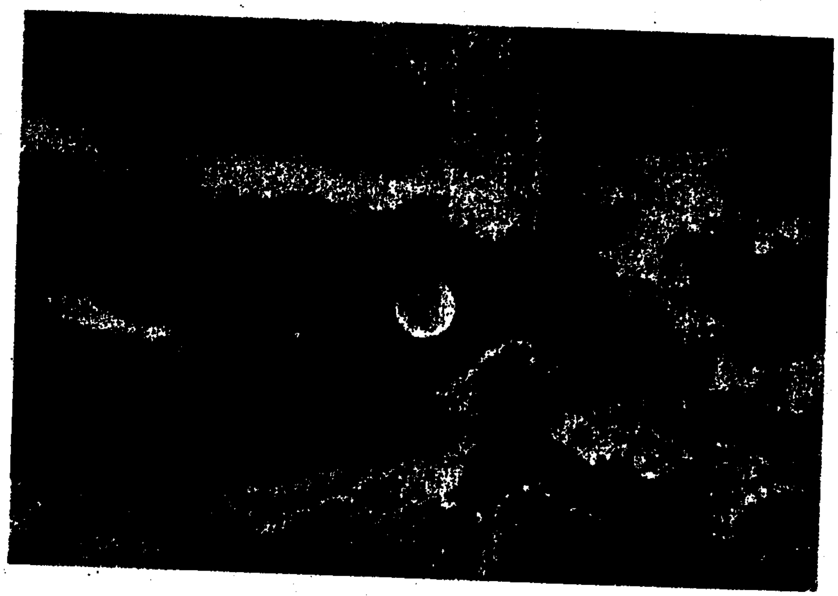
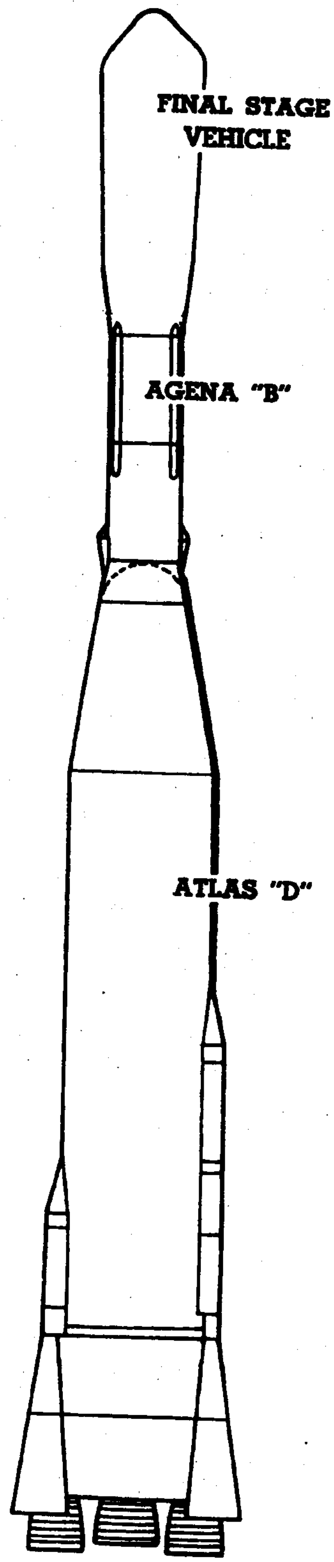


SAINT
ORBITAL INTERCEPTOR

SAINT



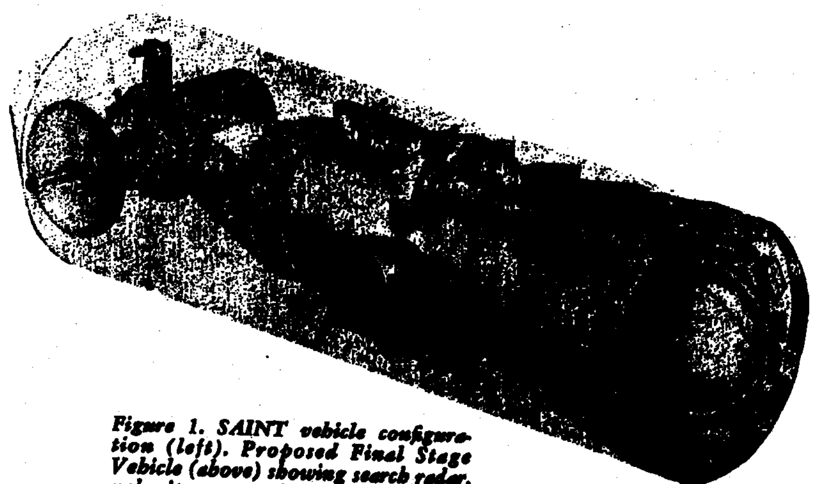


Figure 1. SAINT vehicle configuration (left). Proposed Final Stage Vehicle (above) showing search radar, velocity correction engine nozzle, control-gas storage spheres, and attitude control jets.

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.

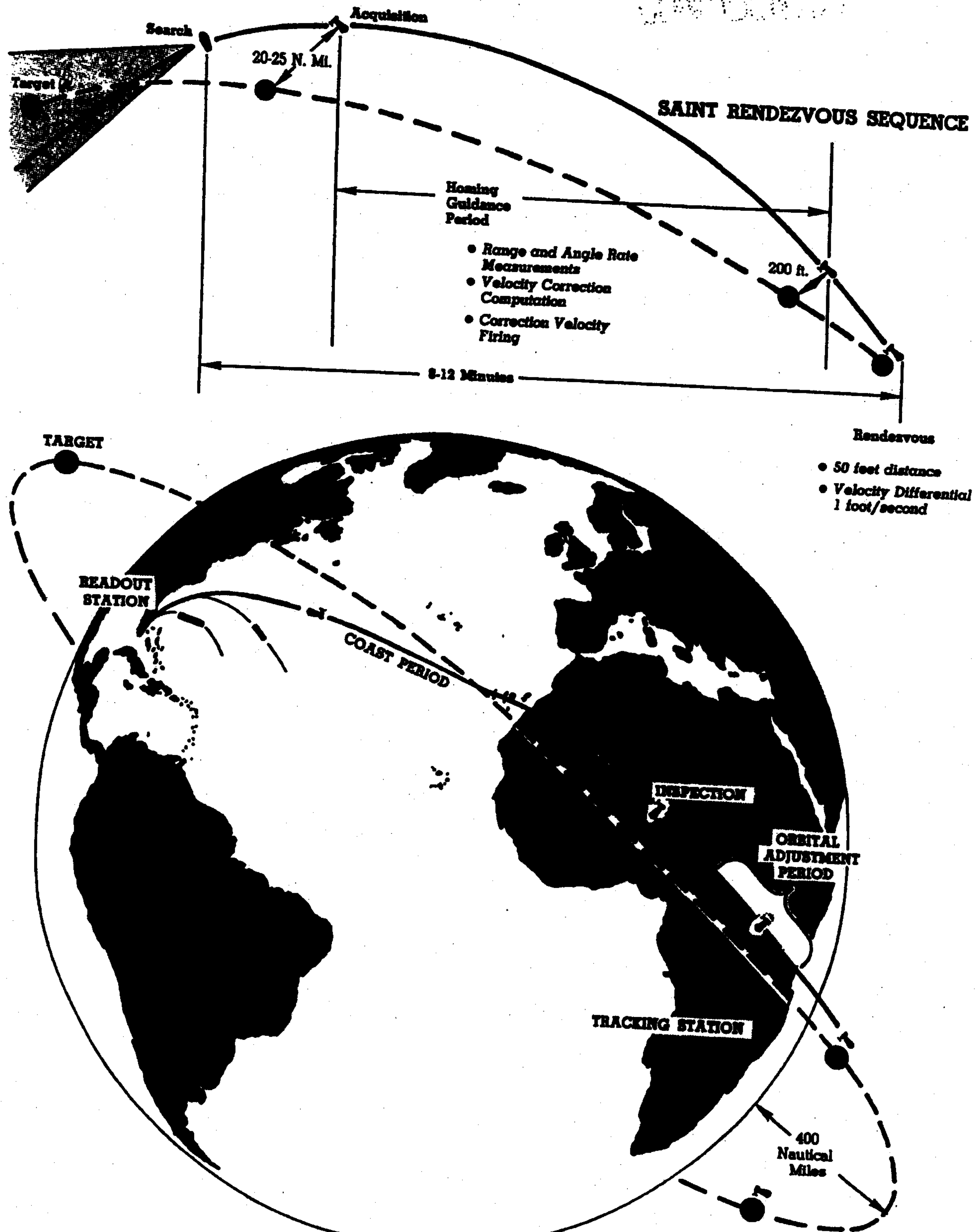


Figure 2. SAINT Program feasibility demonstration flight and rendezvous sequence.

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 HAWK EYE 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 2,000 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

- Pre-contract discussions are being held between the AFBMD SAINT office, Aerospace Corporation, Radio Corporation of America, Convair Astronautics and Lockheed. Contracts will be formalized in the near future.

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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

• A guidance and control research project in support of the ORBITAL INTERCEPTOR Program was discussed at Headquarters ARDC on 6 December. AFBMD was requested to aid Wright Air Development Division in the re-orientation of anticipated applied research projects.

• On 20 December, representatives of AFBMD, BMC, and Aerospace briefed 24 weapon system contractors on the ORBITAL INTERCEPTOR Request for Proposal. The proposals are for a twelve-month system design feasibility study. The bids are due to be returned on 13 February.

• The Development and Funding Plan for ARPA Order 162-61 (Project Lofter) has been approved by ARPA. A total of $3.9 million, the amount requested for the assigned tasks, was approved for Fiscal Year 1961. This order provides for a four-year program consisting of a series of infrared, ultraviolet and optical equipment for search track and discrimination of ballistic and satellite targets and a space flight test platform in which to test the equipment developed.

BIOASTRONAUTICS

BIOASTRONAUTICS

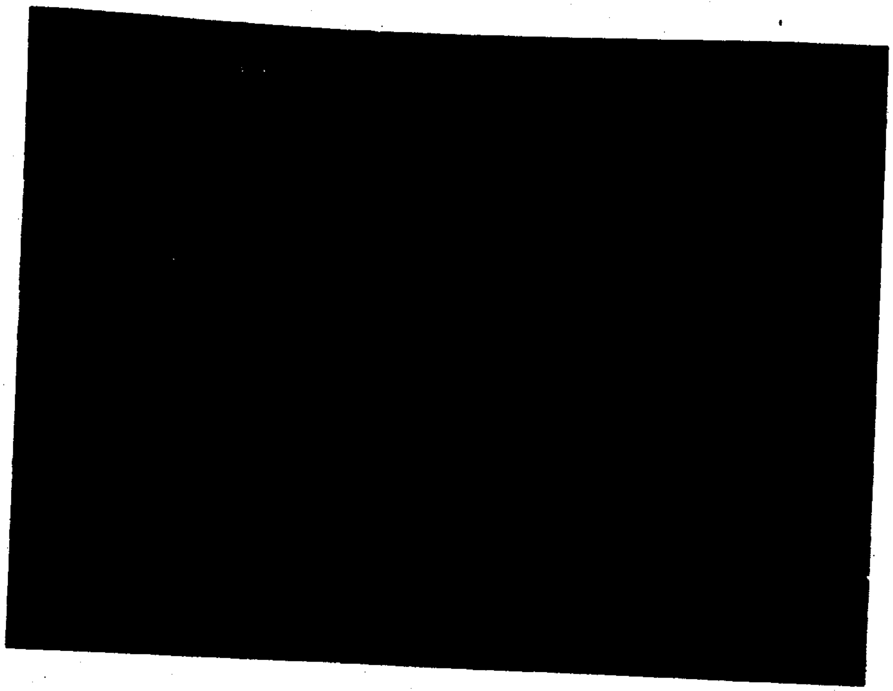
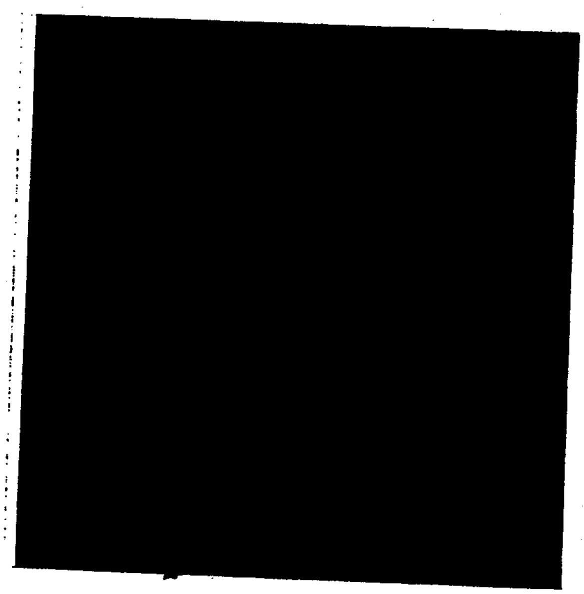


Figure 1. Van type Biomedical facilities at Vandenberg Air Force Base. This laboratory is used for final check and preparation of animals prior to launch. Interior view of Biomedical van (below) showing some of the instrumentation racks used in monitoring the test animal.



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

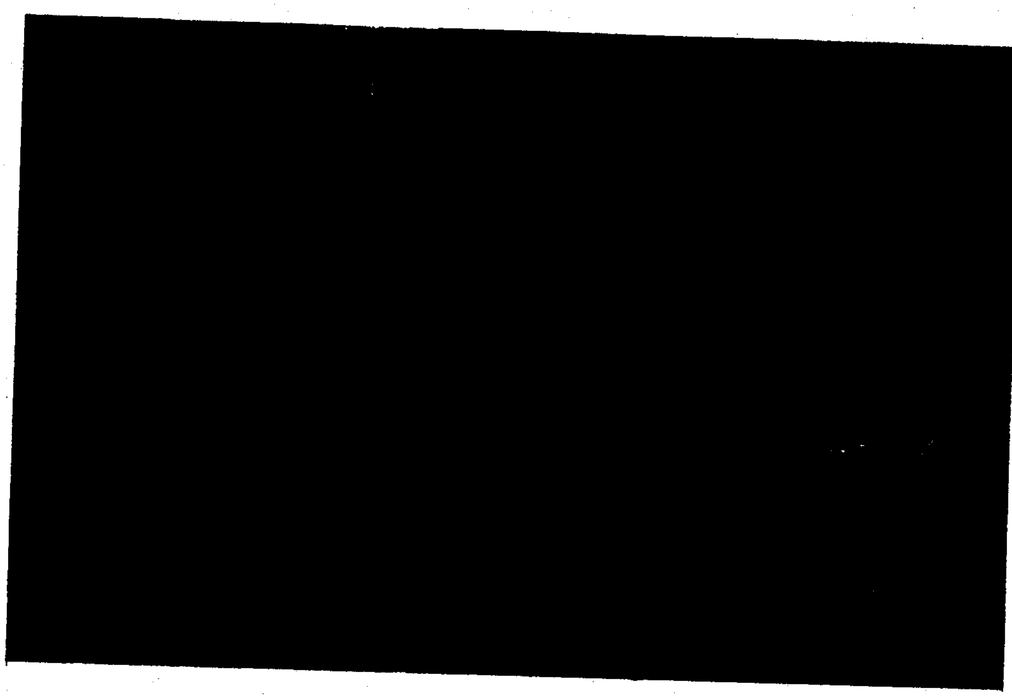
Successful initial manned space flights necessary in reaching our national military objectives are depending on knowledge obtained from space tests with lower life forms, including primates. The BIOASTRONAUTICS Program is furnishing such data during actual ballistic and orbital flights in the space environment. 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.

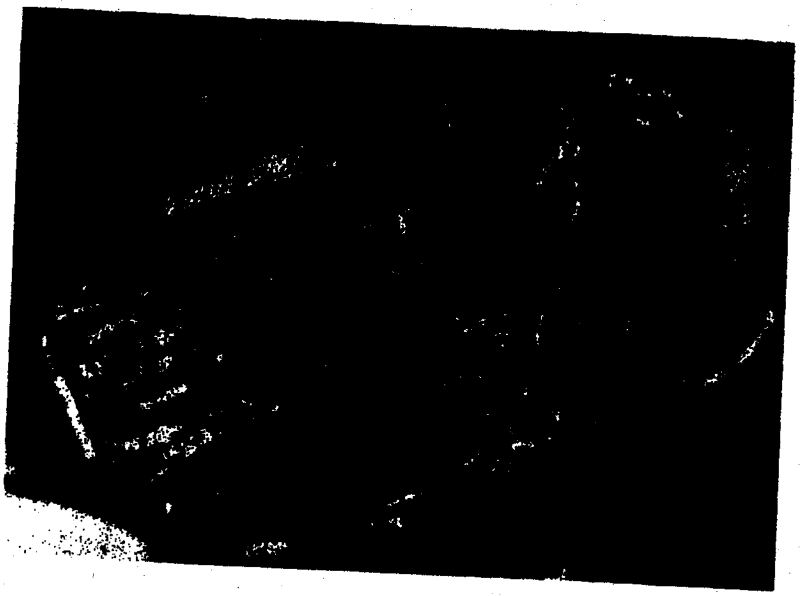
Monthly Progress — BIOASTRONAUTICS Program

Surgically Implanted Transmitter

- The first phase of a successful internal animal telemetry feasibility test program, using live Rhesus monkeys to demonstrate the feasibility of wireless transmission of biological data through the intact skin of an animal in the missile environment, was recently completed.
- A requirement has long existed to develop a technical capability in wireless biological telemetry. Such a capability will permit easier, more reliable, more accurate data collection from unencumbered and unrestrained animals and men in the space environment. Accordingly, an effort was initiated to develop a single-channel, miniaturized, surgically implanted radio transmitter. This device collected biological data inside a Rhesus monkey, coded the data, transmitted through the skin of the animal (without wires) to a nearby receiver, where it was decoded and conditioned for transmission by standard telemetry techniques.
- The development of such a system included design development and bench test of the electronic components, development of surgical techniques, components-animal interface static tests and finally full-scale omnienvironmental tests. These tests established feasibility of the concept by exposing the animal with its implanted transmitter to the simulated combined stresses of launch, orbit and recovery. Acoustic noise, random and programmed vibration (both high and low frequency) sustained acceleration and RF interference were simultaneously simulated.
- The system worked extremely well, transmitting an excellent quality electrocardiogram signal under combined environmental stress, while the conventional instrumentation failed to produce useful data. The life support system performed very well, protecting the animals from injury due to the combined stresses. The surgical technique developed proved satisfactory, since the transmitter retained its position and no ill effects have been seen.
- The program continues, with development of a multichannel device for surgical implantation into a Rhesus monkey and a flight on a ballistic missile scheduled for the first quarter of 1961.

DISCOVERER Biopack Experiments

- The capsules recovered from DISCOVERER XVII in November and DISCOVERER XVIII in December each contained a Biopack and an Emulsion Block as part of a special BIOASTRONAUTICS research project. Results of the DISCOVERER XVII experiments are nearly complete and are included. Preliminary results of the DISCOVERER XVIII experiments will be available in January. The results of these experiments cannot be considered conclusive, however, until further experimentation is conducted in these areas to provide confirming evidence.
- The purpose of the Emulsion Block was to detect and measure cosmic radiation in the space environment. The Block was overexposed because an



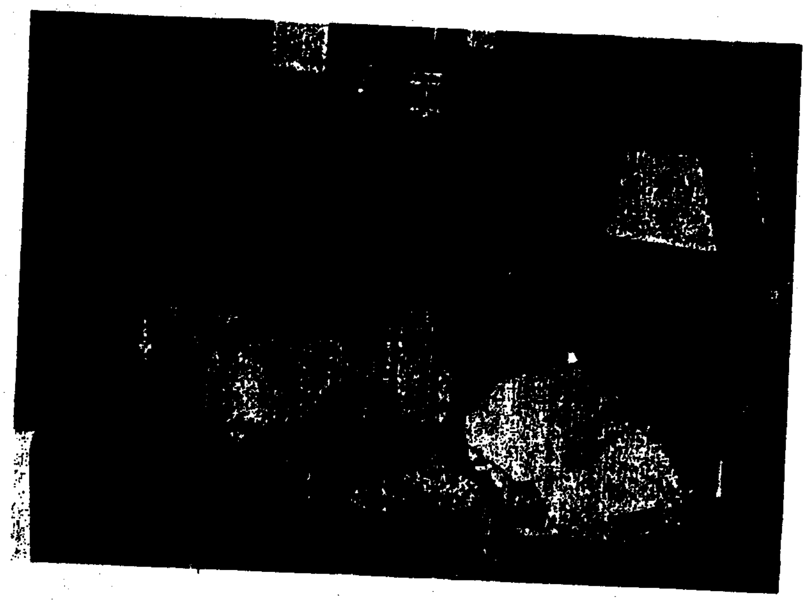
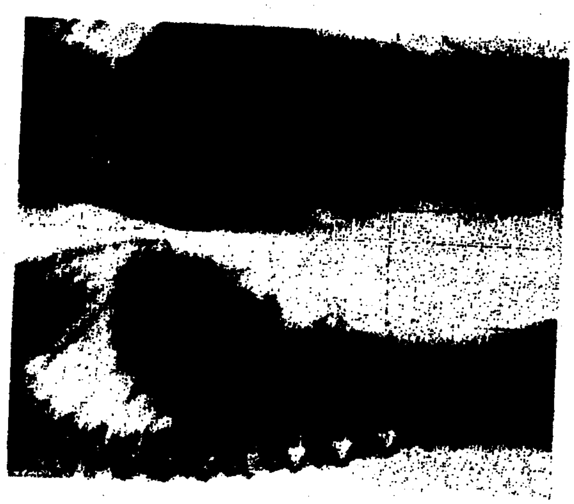


Figure 3. Close-up (above) of the pulse rate modulated transmitter prior to dipping into a protective potting compound. Single channel data transmission from a transmitter implanted in a Rhesus monkey has been successfully demonstrated. A Rhesus monkey (right) which has a transmitter placed beneath her skin is having a physical examination prior to starting the high-frequency vibration test. Below are two X-ray pictures showing the miniature transmitter implanted in a monkey. The electrical leads which pick up certain physiological phenomena are visible on the left of the transmitter.



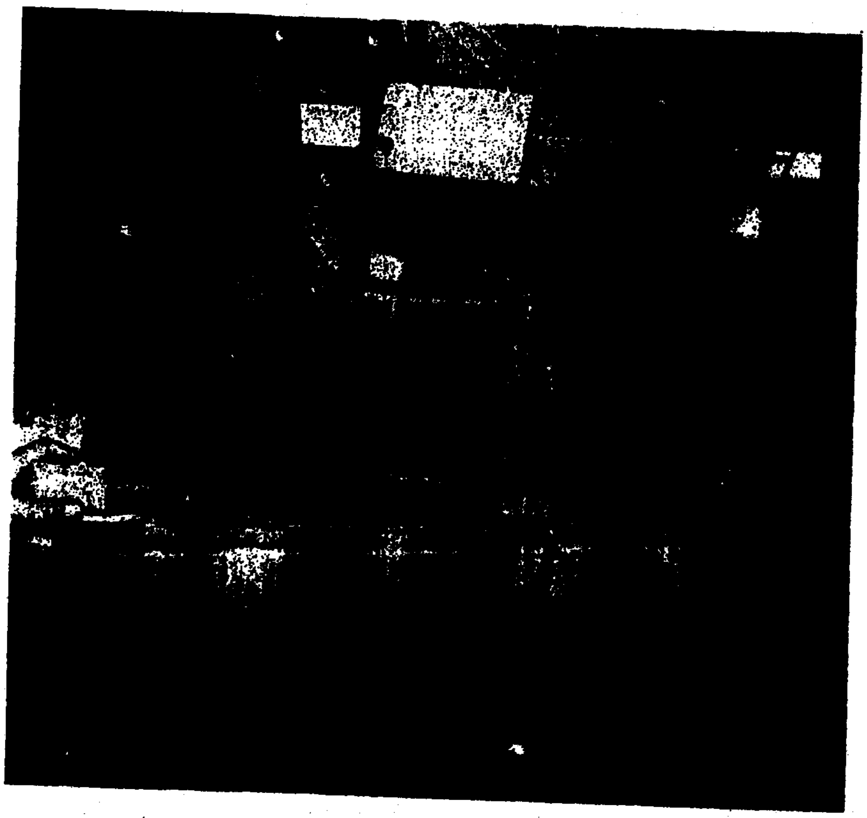


Figure 4. Lower photo shows the monkey undergoing final battery charge prior to installation in the omnienvironmental centrifuge capsule. The primate, on her pallet, has been installed in the omnienvironmental capsule (left). The three speakers are used to simulate the noise levels reached during powered flight.

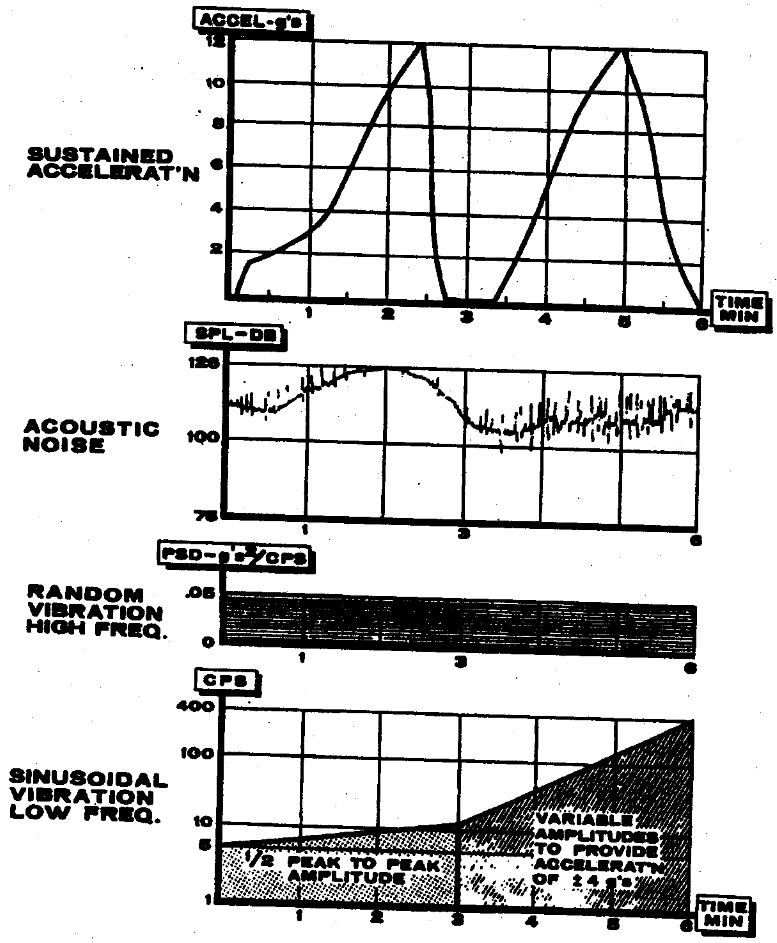


Figure 5. The chart on the right shows the combined environmental test conditions to which the monkey was exposed. The chart below presents typical electrocardiogram test results demonstrating the feasibility of the technical approach and the excellence of the data received from the internal transmitter as compared to that received using external leads.

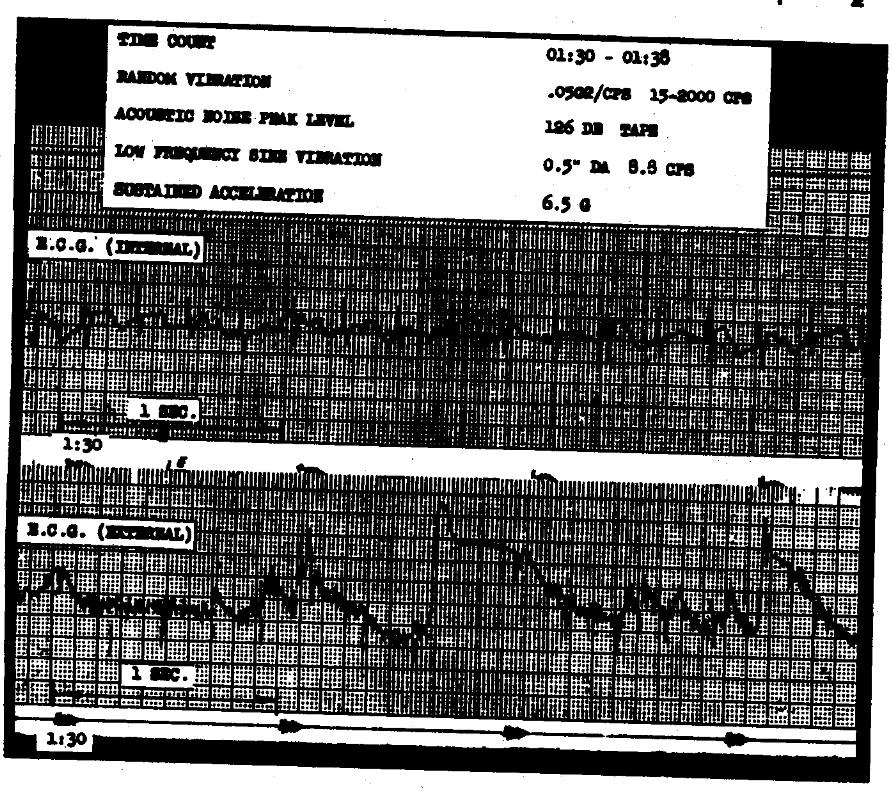


Figure 6. The experiments contained in the DISCOVERER XVII Biopack.

intense solar flare occurred during the fifty-hour flight. As yet, no significant information is available.

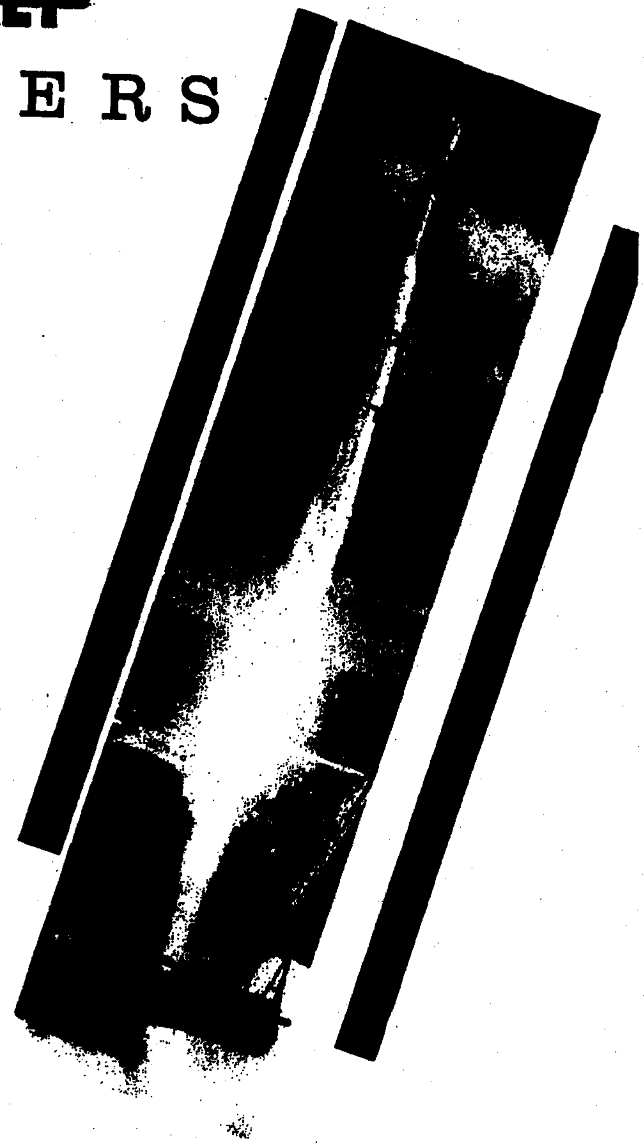
- **The purpose of the Biopack was to determine the effect of cosmic radiation on biological samples and to correlate biological effects with types and intensities of the measured radiation. The material contained in the Biopack is identified and the aluminum can which housed the experiments is shown in Figure 6.**
- **Despite the exposure to the intense solar flare, the radiation dose received inside the Biopack was found to be about 30 rad. This is considered to be a tolerable level for human exposure. Preliminary analysis of the DISCOVERER XVIII Biopack, which was not exposed to a solar flare, shows a dosage of 100 millirad. This radiation level is lower than the limits prescribed for people working in Atomic Energy Commission facilities.**
- **Although the satellite passes through the outer Van Allen radiation belt four times on each orbit, no electrons entered the can. This effect requires further study. Dosimeters wrapped in lead showed a higher exposure to dangerous radiation that those protected by aluminum. The experiment suggests that heavy shielding may be dangerous during solar flares.**
- **Exhaustion of the nutrient media caused early degeneration of the human cells. Although some cells revived in new media, there is no evidence that the cells were affected by radiation. The cells are being kept alive to determine if any mutations occur in succeeding generations. Algae cells are under consideration as a means of providing oxygen, protein, fat, and removal of wastes during human space travel. The algae were virtually unaffected during the flight and did not undergo mutation. Bacterial spores were not harmed by space radiation but were capable of surviving a post flight treatment which killed unexposed spores. This effect is being investigated as a possible basis for a spore system of radiation measurement.**

Future BIOASTRONAUTIC Space Probe Experiments

- **The integration of experiments prepared by the Air Force Special Weapons Center on radiation detection and the Aerospace Medical Laboratory, WADD, on a chemical oxygenation mechanism for the first ATLAS "E" pod space probe has begun. A total for four such bioastronautic space probe experiments are tentatively scheduled for this March flight.**

SPACE
program boosters

Space Program BOOSTERS



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

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

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

THOR

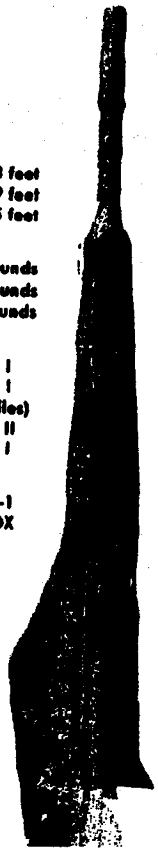
Prime contractor:
Douglas Aircraft Co.

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



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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

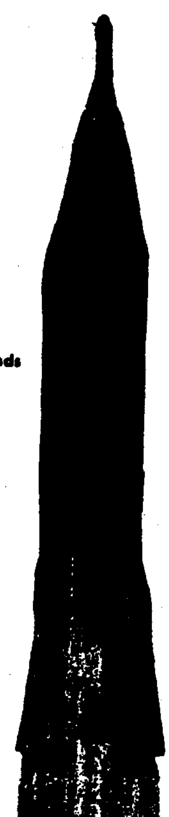
Prime contractor:
Convair

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)

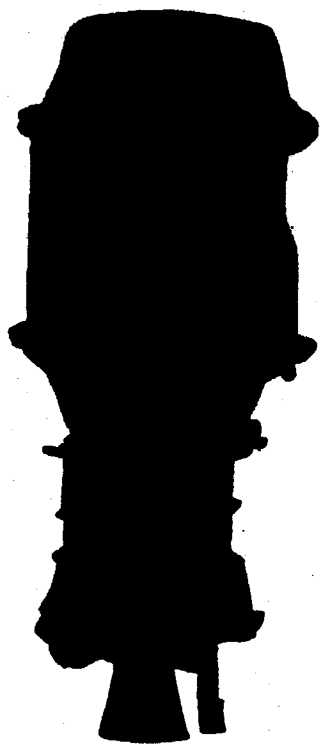
Used as first stage for:
SAMOS
MIDAS
ADVENT
ABLE-4 and -5
PROJECT MERCURY



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.

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

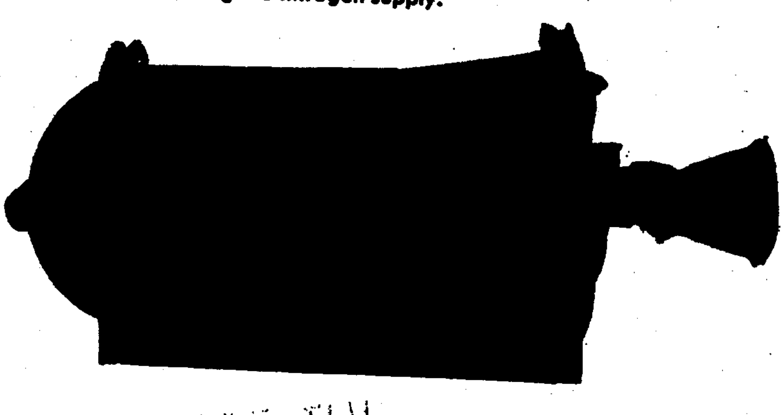
Guidance optical-inertial

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

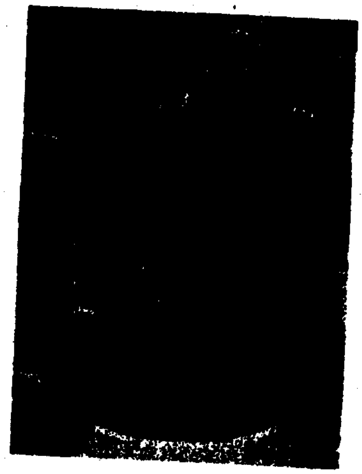
ABLE Vehicle

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



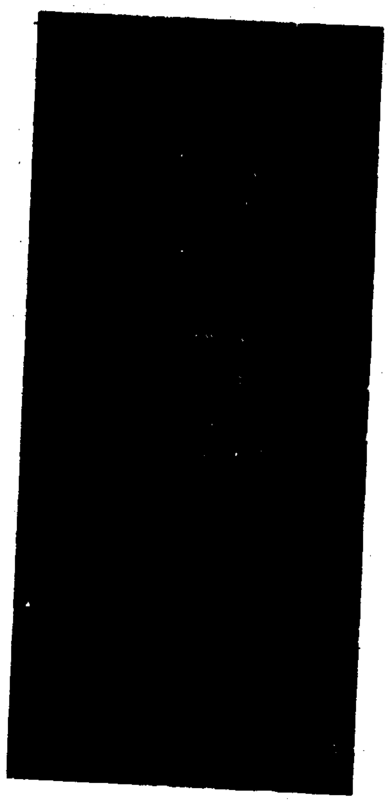
Oxidizer
Inhibited White Fuming Nitric Acid

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....

FIRST STAGE

THOR	A DM-18	B DM-21	C DM-21A
Weight—dry	6,727	6,590	6,950
Fuel	33,500	33,500	33,500
Oxidizer	68,000	68,000	68,000
TOTAL WEIGHT	108,227	108,090	108,450
Thrust-lbs., S.L.	152,000	167,000	152,000
Spec. Imp.-sec., S.L.	247.0	247.8	247.0
Burn Time—sec.	163.0	152.0	163.0

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

NOTES

1. *Payload weight not included. Does include controls, guidance, APU and residual propellants.*
2. *Does not include THOR adapter (225 lbs.) or ATLAS adapter (315 lbs.).*
3. *Single restart capability.*
4. *Dual burn operation.*
5. *Allegany Ballistic Laboratory.*

SECOND STAGE

AGENA	E "A"	F "B"	G "B"
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

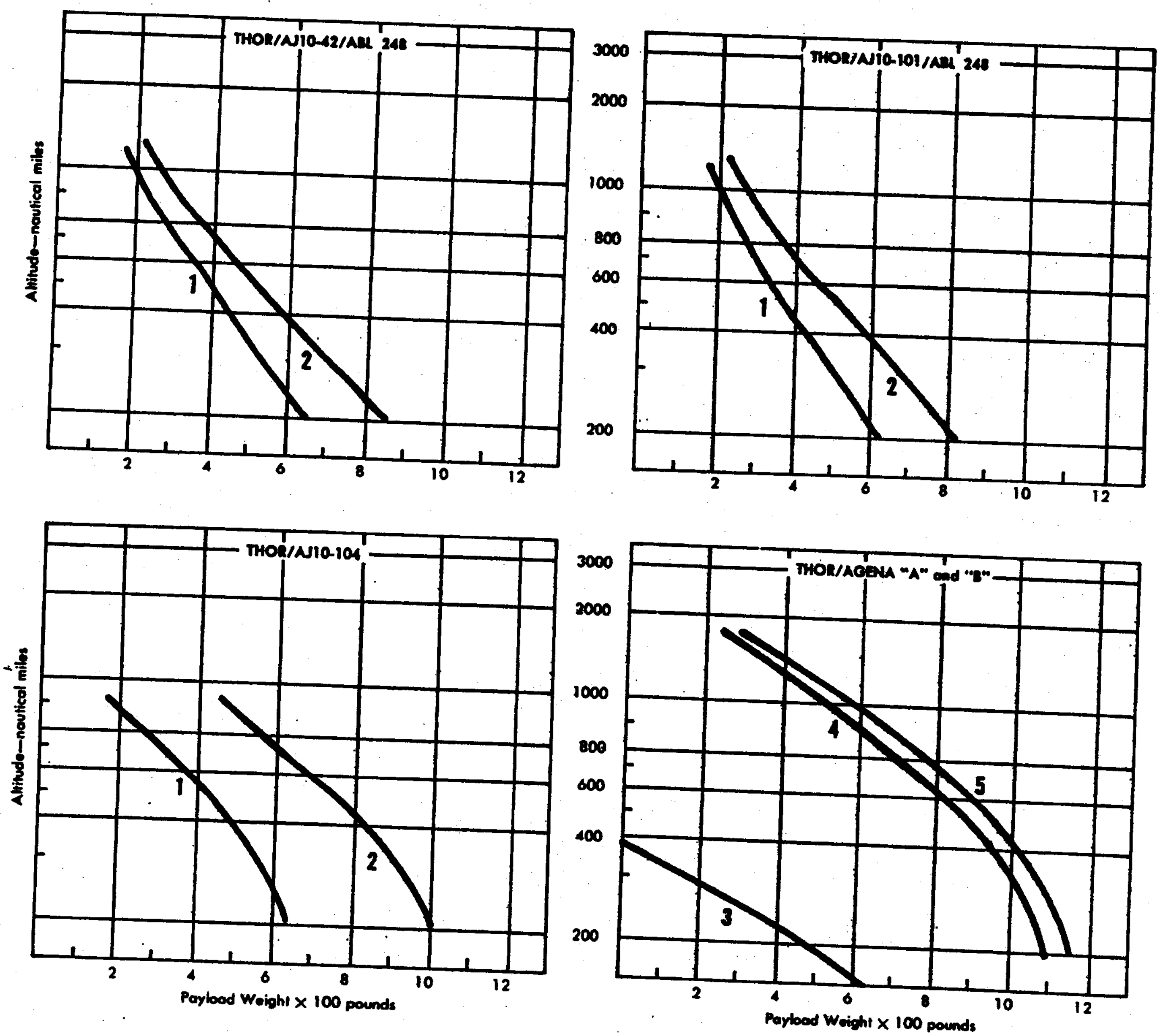
THIRD STAGE

	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

Program Vehicle Combinations

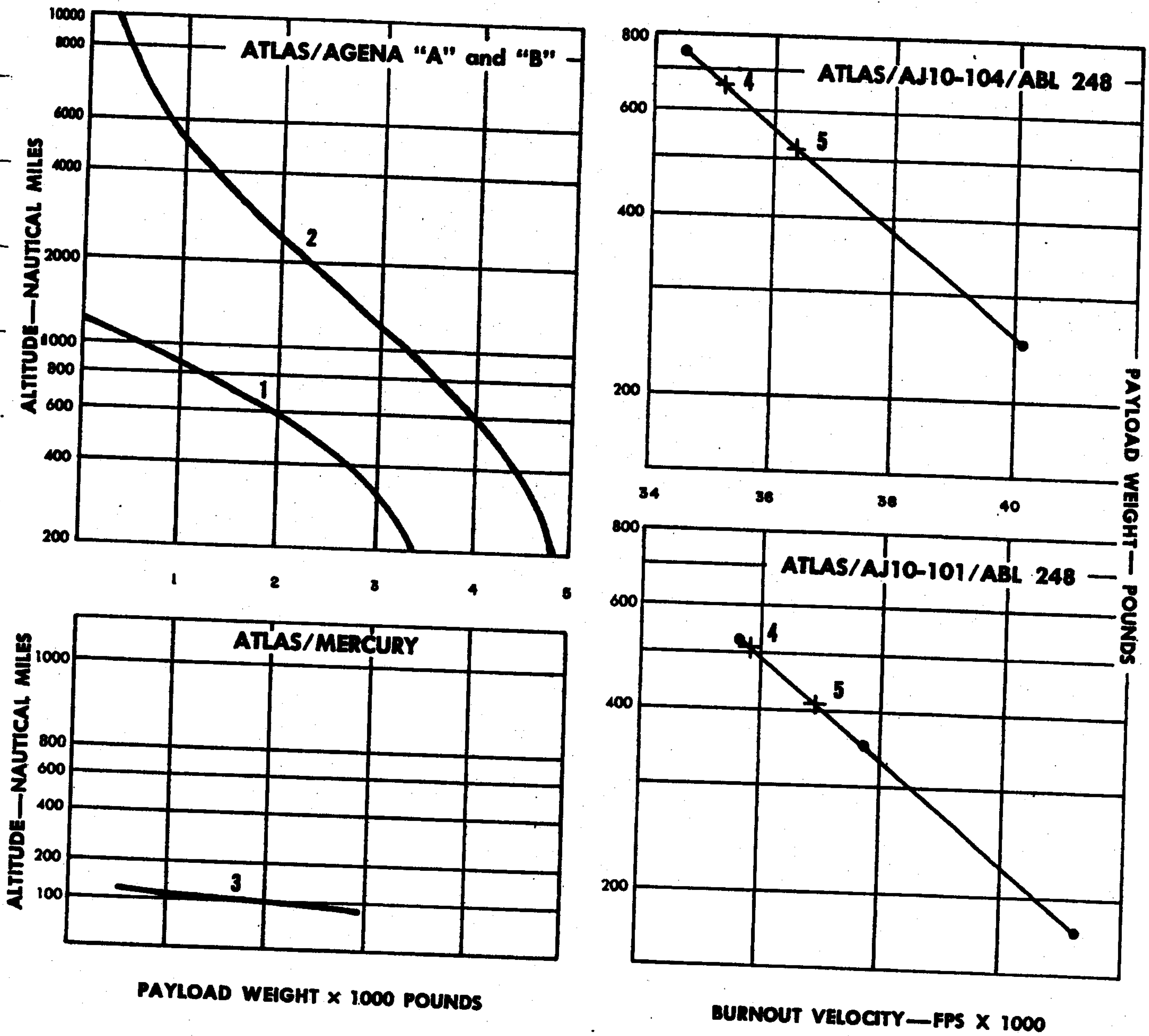
DISCOVERER (1 thru 15) ...... A-E
DISCOVERER (16 thru 19) ..... A-F
DISCOVERER (20 and subs) .... B-G
ADVENT .... D-F
ADVENT .... D-G
MIDAS (1 and 2) .... D-E
MIDAS (3 and subs) .... D-G
SAMOS (1 thru 3) .... D-E
SAMOS (4 and subs) .... D-G
ABLE-1, -3 and -4 .... A-J-L
ABLE-4 and -5 .... D-J-L
TRANSIT 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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