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Summary of

AIR FORCE BALLISTIC MISSILE DIVISION

SPACE

DOWNGRADED AT 12 YEAR INTERVALS; NOT AUTOMATICALLY DECLASSIFIED. DOD DIR 5200.10

NOVEMBER 1960

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WDLPR-4-255

[redacted] ~~CONFIDENTIAL~~

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

Summary of
AIR FORCE BALLISTIC MISSILE DIVISION
Activities in Space

NOVEMBER 1960 [Special Issue — data not included in regular November issue is underscored below.]

5 December 1960

This report includes information on the recovery of the DISCOVERER XVII capsule following a two-day exposure to the space environment. This was the second flight test of an AGENA "B" vehicle. The MIDAS section includes photographs and progress reports on the construction of the Donnelly Flats tracking station in Alaska. The ADVENT Section includes a Program History starting on 29 August 1958 and reporting significant facts up to the present. A preliminary report of the TRANSIT 3A flight is included. With the successful flight and orbital performance of COURIER 1B on 4 October, all objectives of this program were fulfilled. Coverage of this program is being terminated with the Program Summary given in this issue. This month the SAINT section has been revised to include a proposed payload and the flight trajectory in graphic form. Information about the ORBITAL INTERCEPTOR Program is included for the first time. Also included this month is a BIOASTRONAUTICS section which includes a review of the successes accomplished with the Mark II biomedical capsules.

~~O. J. RITLAND~~
Major General, USAF
Commander

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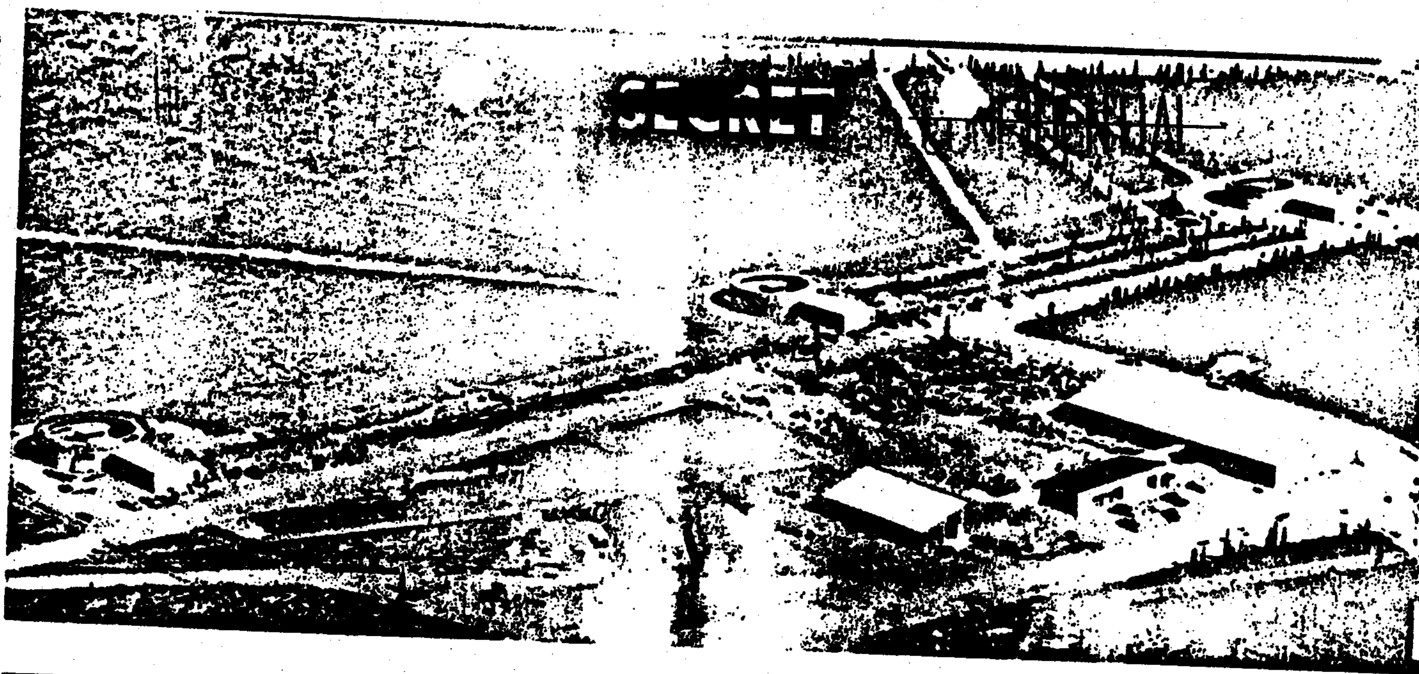

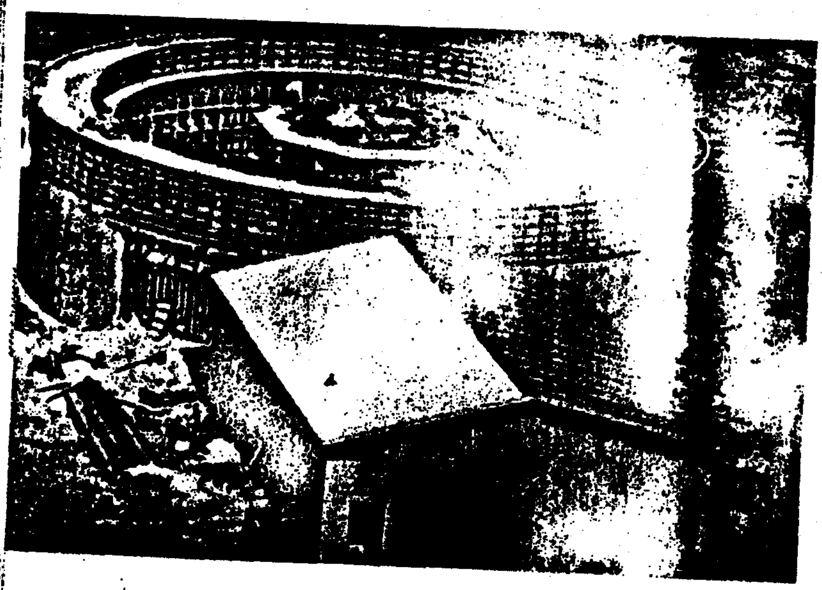

Figure 8. Aerial view (above) of the Donnelly Flats, Alaska technical facilities. The three radome structures can be seen in the background. The corrugated steel storage buildings are in the left foreground, the next building houses the diesel powered generators, next is the heated vehicle storage building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

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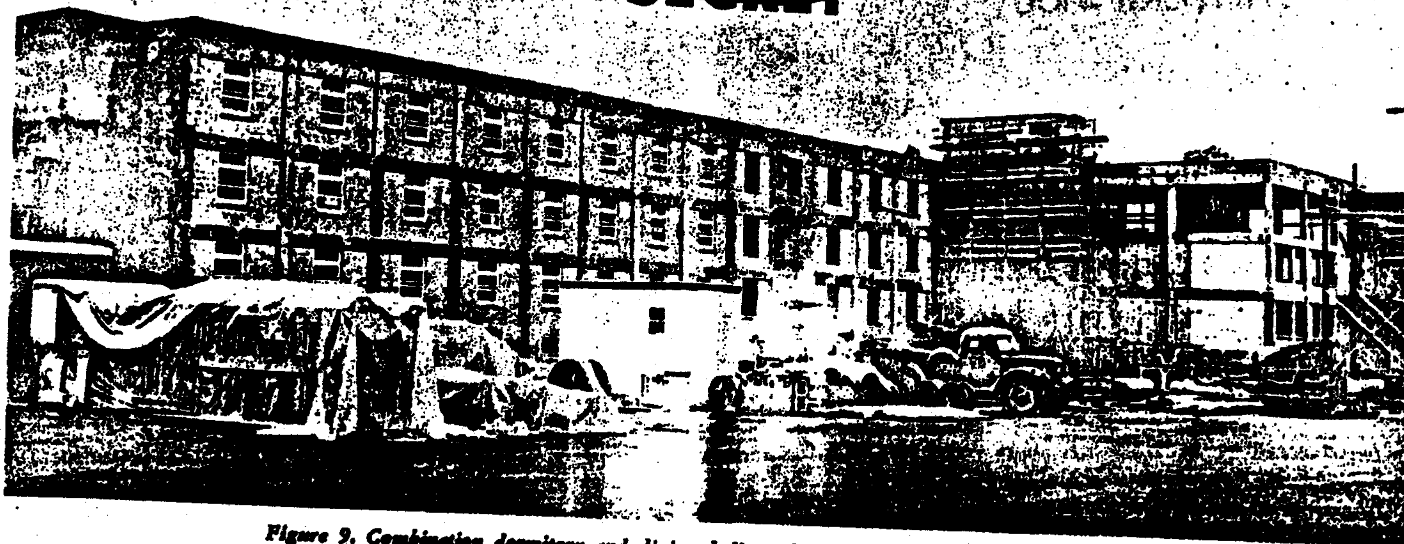
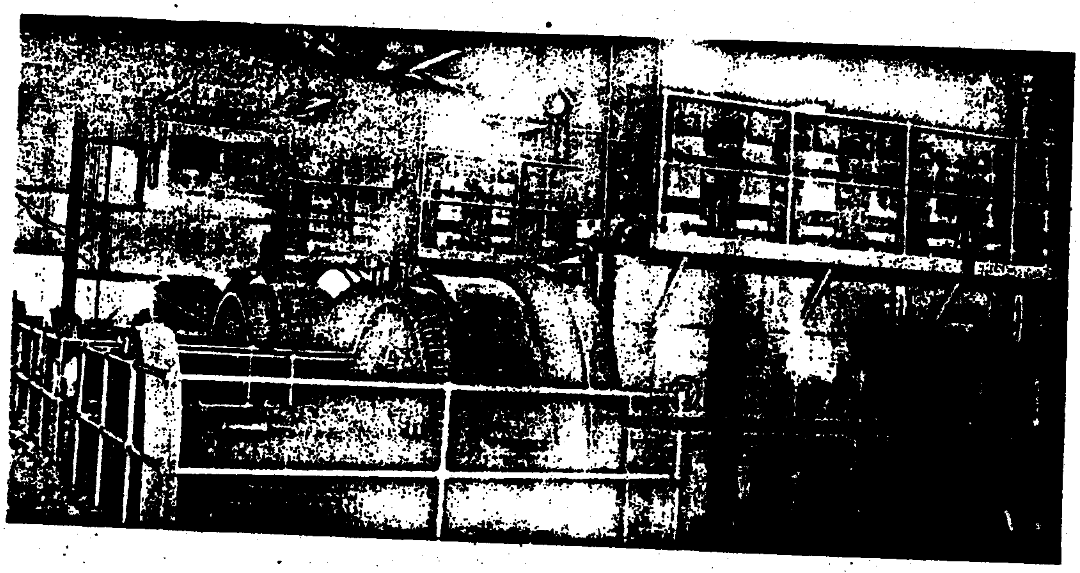


Figure 9. Combination dormitory and dining hall at the Ft. Greely, Alaska support facilities. Construction of both technical and support facilities is progressing rapidly despite the severe weather.



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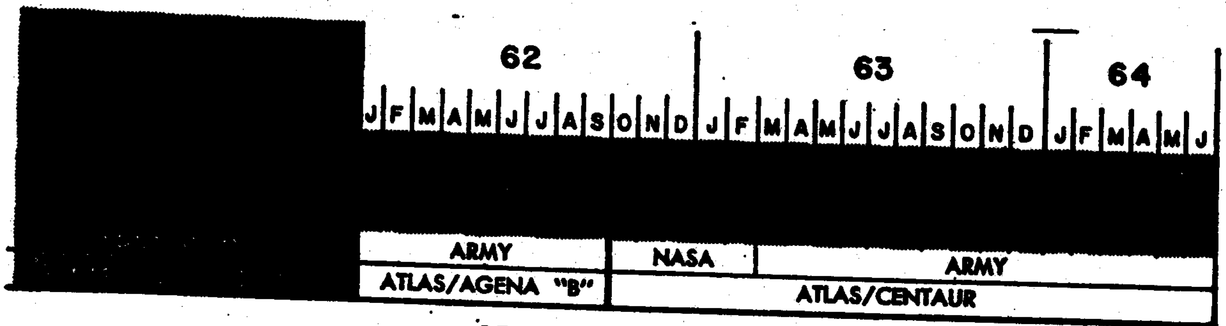

ADVENT Launch Schedule

Monthly Progress—ADVENT Program

Program Administration

• Brigadier General Thames, Commanding General, US Army ADVENT Management Agency (USAAMA) and members of his staff visited AFBMD on 15 November. A general orientation on the various AFBMD space and ballistic missile programs was presented and the conventional AFBMD/BMC management methods were discussed. General Thames desired that detailed negotiation of a management agreement not be held until 2 December. He will also discuss details with all participating agencies at that time. General Powell and members of AFBMD/BMC will attend the 2 December meeting at USAAMA.

• The contract with Space Technology Laboratories, Inc. (STL) for over-all systems engineering and technical direction was terminated on 11 November. Aerospace Corporation was directed to proceed with vehicle systems engineering and technical direction effective 12 November.

• A teletype message was sent to USAAMA on 18 November requesting $1.5 millions additional funding be made available to AFBMD to cover the final stage vehicle contract through 31 December. The General Electric, Missile and Space Vehicle Department (GE-MSVD) contract will exhaust the funds now available early in December. There has been no indication by USAAMA when FY 61 funds will be released.

• The restriction on the extension of the Philco contract beyond the design study phase has been removed and purchase request action initiated for Philco to continue on additional tasks of the ADVENT tracking, telemetry and command system.

• A review of the AMR/PMR ADVENT Support Plan No. 1600 was accomplished by AFBMD, AMR and 6555th Test Wing personnel on 16-17 November. The plan was approved and interested agencies notified. Presentation of the plan was made to Lt. General Yates, Deputy Director of Defense Research and Engineering (DDRE) on 22 November. USAAMA, on 30 November, recommended to DDRE that the plan be implemented and funded in FY 61.

Technical Progress

Launch Vehicles

• Work statements for AGENA and CENTAUR launch vehicles and for LR-119 (CENTAUR) Rocket Engines, have been completed and forwarded to appropriate contractors with a Request for Proposals. The Proposal for the AGENA has been received and is currently being reviewed. Proposals for the CENTAUR and for the LR-119 Rocket Engine are expected on or before 15 December. ATLAS boosters for the ATLAS/AGENA boosted phase of the program have been ordered under existing AFBMD contracts. Work Statement for the Assembly and Test Operation Contractor for the ATLAS/CENTAUR boosted launches was forwarded to the Atlantic Missile Range (6555th Test Wing) on 8 November. Upon receipt of Atlantic Missile Range coordination, this Work Statement will be forwarded to Convair with a Request for Proposal.

• To preclude the possibility of program slippage caused by prolonged negotiations of definitized contracts, letter contracts have been written with Lockheed and with Convair covering the initial efforts (long lead time requirements) associated with second stage procurement. If necessary, similar arrangements will be made with Pratt & Whitney for the LR-119 rocket engine contract.

Final Stage Vehicle

• Formal contract negotiations with General Electric, Missile and Space Vehicle Department (GE-MSVD) are continuing.

• General Electric has prepared the Program Plan document. They are continuing the design effort of all major final stage vehicle subsystems. During the report period, Aerospace and AFBMD repre-

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sentatives attended a General Electric preliminary design review. A draft of the Final Stage Vehicle Design Criteria has been furnished General Electric. This draft was prepared by STL prior to contract termination.

Tracking, Telemetry and Command

- Philco completed the design study phase (Task 2) of the contract for the ADVENT tracking, telemetry and command ground stations at Vandenberg Air Force Base and Kaena Point, Hawaii. Representatives of Philco, STL and AFBMD presented a review of the Philco preliminary design and analysis to USAAMA on 9 November. On 14 November, USAAMA dispatched a teletype message to AFBMD directing that work on the Philco contract proceed on the condition that tracking, telemetry and command equipment be provided at Fort Dix and Camp Roberts. The message also stated that USAAMA will decide in the near future on whether to continue plans for an ADVENT tracking, telemetry and command installation at Vandenberg.
- A meeting of Philco, Bendix, AFBMD, USAAMA and USASRDL personnel was held at USAAMA on 29 November to review requirements and interface areas concerning the equipments that Philco will supply as GFE for the ground communication stations at Camp Roberts and Fort Dix to provide these stations with a tracking, telemetry and command capability.

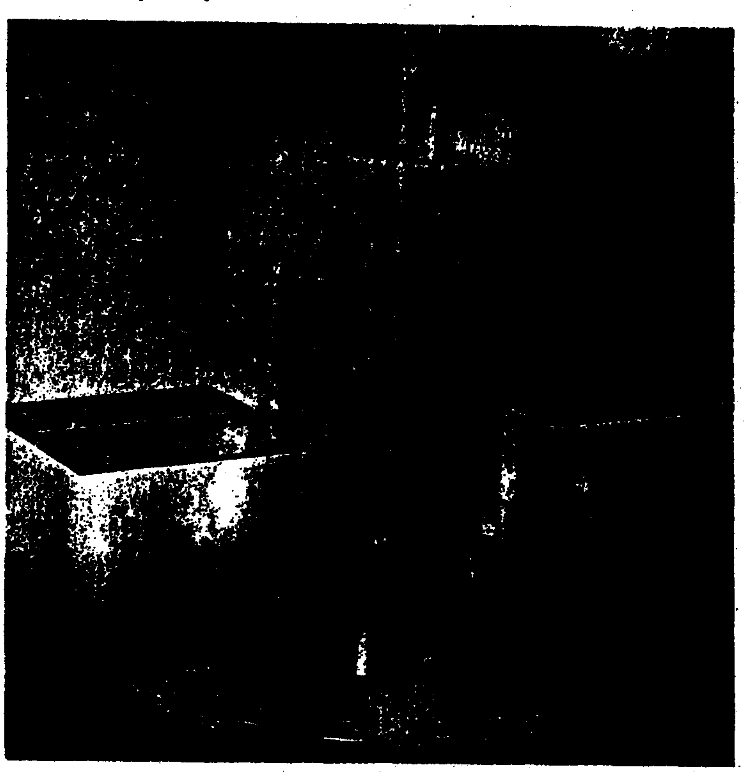

Figure 3. A model of the General Electric ADVENT final stage vehicle to be flown in a six-hour inclined orbit. These photographs show the payload with the solar paddles extended and antenna retracted (lower) and the solar paddles unfolded and the antenna extended (right). The temperature control vanes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

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ADVENT PROGRAM HISTORY

Hq USAF was briefed on System 470L Communications Satellite Development plan on 29 August 1958; ARPA briefed on 5 September. On 30 September, the Secretary of Air Force outlined in a memo to ARPA the urgent requirements for a communications satellite, with the major requirement being long range ground-air communications. In October an *ad hoc* committee was established to formulate a unified communication satellite development program.

ARPA memo to ARDC and the Signal Corps dated 5 November outlined a basic program for a 24-hour communication satellite. Joint preparation of a development plan by AFBMD and USASRDL was requested. AFBMD was assigned vehicle responsibility; USASRDL had communications. No agency assigned over-all program coordination. General Cook Army Signal Corps (ASC) to coordinate the development plan on *pro tem* basis. On 21 November, ARPA was requested to recognize the instantaneous long range ground-air system as top priority. It was urged that a six-hour polar orbit satellite be given top priority. SAC's strike forces operating in the polar region long range communications were a necessity.

On 10 December, General Schriever stated his position on the necessity for making AFBMD project manager. ARPA was not receptive and indicated their intention of exercising project supervision at the ARPA level, using ARDC and ASC as support agencies. It was obvious that AFBMD and ASC were expected to develop the details of the working relationship. Later in the month ARPA requested three versions of modified schedules and funding for the December development plan. One schedule was to stretch out the entire program to fit available ARPA funding; the other two reduced the 1960 launches from 8 to 4 under two conditions: (1) COURIER implemented, (2) COURIER not implemented (funds to be used for COMM SAT). A revised development plan was submitted on 19 January 1959.

In January 1959 ARPA Orders 54 and 55 initiated work on preliminary design and supporting R&D for vehicle development and communications equipment for the 1962 24-hour communication satellite program. ARPA had program management; ARDC was responsible for development of communications equipment.

On 2 February, USAF GOR 178 outlined the Air Force requirements for development and employment of a communication satellite system. Three requirements were specified: (1) two-way communications from Commanders in the U.S. with global airborne forces; (2) two-way communications between Commanders and activities both within and between points in the U.S. and overseas; (3) one-way broadcasts for rapid and wide dissemination of vital and highly perishable information. Initial capability should be obtained not later than 1962. On 4 March an abbreviated Development Plan for a 6-hour polar satellite was submitted as requested by ARPA.

On 22 May Amendment No. 1 to ARPA Order No. 54 initiated work on SAC polar communications satellite (STEER), advanced polar communications project (TACKLE) and the ATLAS-CENTAUR 24-hour orbit phase of the global communications satellite project (DECREE). An additional $6.6 million was provided. A first-launch date of 22 August 1960 was specified. Project supervision was assigned ARDC with five stipulations, three of which hampered AFBMD in its role of project supervisor. The first required ARDC to procure the communications payload and ground complexes for TACKLE and DECREE from the Signal Corps; preventing effective system integration and interface control. The second required ARDC to contract for systems engineering on a competitive basis with quality and availability of staff and facilities as the most salient factors to be considered; jeopardizing the AFBMD/STL team by not considering experience. The third placed the systems engineering contractor under the technical direction of ARPA in all matters relevant to establishing effective systems integration; delaying the program by requiring project engineering at the top management level.

On 9 June a meeting was held to discuss ARPA Order 54, Amendment No. 1. ARPA agreed to accept normal AF Source Selection Board procedure with ARPA review. AFBMD and USASRDL expected to evolve a working agreement and refer only matters of conflict to ARPA. On 11 August Amendment No. 2 to ARPA Order 54 confirmed the 9 June agreements and deleted the requirements for competitive bid contracting of systems engineering and final selection of contractors by ARPA.

On 28 September General Cook, Chief Signal Officer disagreed with the 27 August working agreement prepared by AFBMD. The Signal Corps objected to accepting technical direction from AFBMD. They also wanted a greater portion of the program; e.g., developing all electronics for the satellite, attitude control, orbit control and responsibility for all in-orbit tests.

An ARPA memo, dated 4 November, listed some of the design objectives to be incorporated into Project STEER. It emphasized that work to be accomplished must be done with technical feasibility as the primary objective and not aimed at an operational system. This memo was answered on 25 November with one from the DDR&E emphasizing the fact that ARPA programs make little sense unless they form the basis of an operational program. Objectives, such as tremendously enhanced reliability and the basic requirements for an operational satellite, should be consistent with a future operational communication satellite.

Requests to ARPA for release of FY 60 funds were made on:

7 Nov	TWX WDZSC 11-6-59 to ARPA
9 Nov	Monthly Progress report for October
17 Nov	Letter to ARPA thru USAF
27 Nov	TWX WDZP 11-64-E to USAF
3 Dec	TWX WDZP 11-63-E to USAF
8 Dec	Monthly Progress Report for November
8 Jan 1960	Progress Report for Quarter ending 31 Dec.
14 Jan	TWX WDZP 1-6-E to ARDC
8 Feb	Monthly Progress Report for Jan
8 Mar	Monthly Progress Report for Feb
24 Mar	TWX WDZYC 1042 to USAF

On 8 December a telephone call from Hq USAF to Hq AFBMD advised that Dr. York, DDR&E, had issued verbal instructions to cancel STEER. A memo from the AFBMD Liaison Officer to General Schriever on 18 December advised that Dr. York had suspended his verbal instructions of 8 December and directed a review to be conducted by ARPA/IDA.

Because no FY60 funds has been received, existing contractors were directed on 7 Jan 1960 to maintain only minimum sustaining effort and to refrain from any procurement or fabrication of hardware. Former launch schedules were invalidated. This action was intended to preserve the integrity of the engineering team. The Assistant Secretary of AF (R&D) memo to the DDR&E on 21 Jan urged that STEER be continued rather than cancelled and be turned over to the Air Force together with its programmed funds. It also pointed out that STEER would advance the objectives of DECREE. On 29 Jan Sec of AF memo to Sec of Defense stated that Sec. McElroy's memo of 18 Sept 1959 assigned certain responsibilities for the "interim satellite communications system" to the Army. The Army had interpreted it to mean only COURIER. It also urged DECREE be directed toward realization of operational capability in the 65-67 time period.

On 11 February Amendment No. 2 to ARPA Order 55 and No. 4 to ARPA Order 54 were signed, published, but not formally distributed. These companion amendments gave program responsibility to the Army, with the right to approve expenditures of funds. The Army was to procure boosters from the Air Force. On 29 Feb Amendment No. 4 to ARPA Order 54 was issued as an interim directive pending review by the JCS and decision by Sec of Defense. Cancelled STEER, TACKLE, and DECREE, and integrated efforts under a single R&D program for a 24-hour global system (ADVENT). Four six-hour polar launches beginning Sept 1961 were specified. Released $2.0 million to continue efforts through April 1960. A draft of the development plan called for by Amendment No. 4 was prepared on 3 March. On 21 March a TWX was received from ARPA stating that the 3 March development plan did not meet the requirements of Amendment No. 4. No specific reasons were given nor was any guidance offered for the requested revision.

Amendment No. 5 to ARPA Order 54 was published on 11 April. Phase-out of the Bendix contract for UHF communication sub-system was directed. Alternate microwave capability for ground-to-aircraft is not to be considered until after surface-to-surface demonstration (1962). A launch program was provided consisting of: four ATLAS/AGENA flights (Sept & Dec 61; Mar & June 62); seven ATLAS/CENTAUR flights (Sept & Nov 62; Jan, Mar, May, July and Sept 63); and NASA R&D ATLAS/CENTAUR flights (Feb, April, and June 62). Estimated program costs placed at $140 millions. ARPA had prior knowledge that minimum program cost was approximately $190 million. Partial funding for GE and STL through June was provided. Also provided "go-ahead" for microwave communication development. Amendment No. 6 to ARPA Order 54 was published on 26 April. It provided approximately $20 million more in FY 62 and FY 63 to cover the additional costs of the ARPA prescribed program using ATLAS/AGENA launches.

ARPA was briefed on two development plans on 4 May. One dated 25 Apr presented the ARPA Amendment No. 5 program. The other, dated 2 May, presented the AFBMD recommended program (no ATLAS/AGENA launches). It was indicated that the decision had been made to turn the program over to the Army with a target date of 30 June.

On 10 May an ARPA TWX to AFBMD requested detailed trajectory information for the ATLAS/CENTAUR combination assuming two cases: (1) no propulsion in the final stage vehicle (FSV), and (2) a propulsion means in the FSV. It now became apparent that ARPA wanted the satellite design to be propulsionless; thus, it would be a "payload" rather than a "stage" and Army could logically be given responsibility for the satellite under Secretary McElroy's memo of 18 Sept 1959. A briefing for ARPA on 13 May and an STL report indicated that a propulsionless FSV would not give a sufficient velocity margin at injection, nor would it permit the FSV to be positioned in operationally phased orbits.

On 7 June Amendment No. 7 to ARPA Order 54 was published to fund the program for another two months. $7.6 millions were provided. On 20 June, ARPA had reached a decision on the technical program but wanted to delay formal notification to AFBMD of this decision pending formal approval of the management transfer to the Army. In reply to a telephone query from ARPA, an AFBMD TWX stated that further delay in development plan approval would incur the risk of wasted effort, wasted funds and program schedule slippage. On 30 June, an ARPA TWX directed AFBMD to hold in abeyance a proposed contract with Philco WDL for the tracking, telemetry and command (TTC) subsystem development pending ARPA negotiations with AMR. After verbally explaining to ARPA the impact of this action on the program, ARPA sent another TWX on 1 July permitting AFBMD to proceed with the study phase of the contract.

Amendment No. 8 to ARPA Order No. 54 was published on 11 July. This was the first ARPA guidance received on ADVENT since the development plans were presented on 4 May. Amendment 8 approved the 25 April development plan (ARPA directed plan) with several modifications. The more important ones were: (1) a new 10-flight program was specified with initial launch in Dec 61; (2) no FSV hot gas propulsion in first equatorial flights; (3) no correction for solar and lunar perturbations; (4) conflicting statements about attempting less sophisticated experiments by increasing the reliability and anti-jam efforts; (5) no TTC hardware procurement pending ARPA negotiations with AMR. A meeting was held with ARPA, AFBMD, STL and USASRDL representatives on 28 July to discuss Amendment No. 8. Advantages of a hot gas system in the FSV were briefed by STL; chiefly, (1) greater useful payload could be put in orbit, and (2) system would give an operational "indexing" capability by means of a walk-in orbit (i.e., FSV's could thereby be placed at any position around the equator to give an operational system). It was pointed out to ARPA that Dec 61 launch could not be met due to lead-time on booster procurement and other considerations. The delay in development plan approval had made the Dec 61 launch date impractical.

Amendment No. 9 to ARPA Order 54 was published on 11 August. This amendment established March 1962 as the initial launch date and granted "approval" to the FSV Work Statement after the usual "project engineering" treatment by ARPA. Approval was conditioned on the requirements that (1) ARPA-specified test objectives be used, (2) ARPA-specified design criteria be used, and (3) no management responsibility or relationships be specified. The FSV Work Statement had been hand carried to ARPA for approval on 14 July. AFBMD, TWX, WDZC 16-8-16, concerning Amendment 9, was sent to ARDC on 17 August. This message recommended that every effort be made to obtain DOD support for implementing the present management relationship or devising an arrangement which the DOD would support. On 22 August, ARPA published Amendment No. 10 to ARPA Order 54, granting conditional approval of the ATLAS and AGENA Work Statements which had been delivered to ARPA on 4 August. Some modifications to the work statements were specified, and approval was withheld on management relationships and responsibilities.

During August, there was concerted activity by ARDC and Air Force to have the Air Force designated DOD management agency for the ADVENT Program. In compliance with General Schriever's request to General Ritland, AFBMD TWX, WDZC 19-8-17 was sent to ARDC on 18 August giving the recommended text of a memo from Secretary Charyk to Secretary Douglas. The reasons why the Air Force should be appointed management agency were given. It was pointed out that the program would continue uninterrupted to attain current schedules and objectives. The program technical team of AFBMD and USASRDL and their respective contractors would remain intact. This team had functioned effectively for nearly two years; all preliminary preparation had been accomplished, and the program was now ready to accelerate to full normal development status. Colonel Burrus (RDRB) visited AFBMD on 29 and 30 August to obtain material for General Schriever to discuss ADVENT program management with Secretary Gates. A dossier was prepared and hand carried by Colonel Burrus on 30 August. Duplicate copies of all material were given to General Ritland.

An ADVENT management meeting was held in the OSD on 31 August. It was determined that the OSD memo of 18 Sep 59 would govern and that management would be transferred from ARPA to the Department of the Army. Consequently, an Army memo of 14 Sept outlined in the new ADVENT management relationships. This memo was approved by Mr. Rubel, Acting DDR&E. An OSD memo of 15 Sept accomplished the management transfer. AFBMD was given responsibility for: (1) the development, fabrication and launching of the booster vehicle system and necessary system integration incident thereto; (2) the development and fabrication of the final stage vehicle, its integration with the booster vehicle system and its injection into and control on orbit; and (3) detailed systems engineering for these portions of the program. The Army ADVENT Management Agency was given responsibility for over-all management, funding, over-all systems engineering and integration of the vehicle subsystems, the microwave payload, and the ground communications network.

Amendment No. 11 to ARPA Order 54 was published on 22 September transferring administrative and technical responsibilities under ARPA Order 54 to the Department of the Army. On 3 October, Amendment No. 12 withdrew all FY-61 funds ($19,108,900) from AFBMD in preparation of transferring all program funds from ARPA to the Army.

USAAMA Order No. 1 dated 7 October 60 to Commander, AFBMD requested AFBMD to continue existing and initiate contractual effort on booster vehicles for ADVENT. The order made available $4.0 millions to cover initial efforts. Necessary contracts to be awarded within 90 days. Any technical and scientific reports and information to give appropriate credit to USAAMA. For other projects, utilization of equipment and materials procured in connection with ADVENT is subject to the direction of USAAMA.

On 11 Oct 60 TWX RDG 11-10-9 from General Schriever to General Ritland directed AFBMD to implement the provisions of the 15 Sep 60 OSD memo and to enlist the technical support of Aerospace Corporation to fulfill the AFBMD responsibilities.

On 12 Oct 60 USAAMA ltr to AFBMD requested that the work statement for vehicle systems engineering and technical direction be amended to delete the requirement for SE/TD to insure proper control on orbit, which responsibility had clearly been given to AFBMD by the 15 Sept 60 OSD memo. AFBMD replied by TWX on 4 Nov 60, expressed the AFBMD position that "control on orbit" is a function for which the USAF was made responsible by the 15 Sep 60 OSD memo; therefore we could not fail to provide SE/TD for it.

On 17 Oct 60 TWX, SIGFM/PAM-4-9 to AFBMD, specified no new major contracts or modifications of contracts, or change of contractors, or commitment of funds without prior approval of USAAMA. This prevented AFBMD from effectively carrying out the instructions of USAAMA Order No. 1.

On 18 Oct 60 TWX, WDZC 18-10-33 to USAAMA, requested permission to proceed with booster contracts upon which contractual action had been initiated prior to receipt of the USAAMA TWX of 17 Oct 60.

On 24 Oct 60 ltr from General Schriever to General Ritland gave guidance on AFBMD's conduct of the ADVENT Program.

On 25 Oct 60 USAAMA Management Directive No. 1 specified the management relationships for the ADVENT Program. Gave USAAMA detailed approval authority over all aspects of the program and offered strong evidence that very little responsibility and authority are to rest with AFBMD.

On 25 Oct 60 TWX, SIGFM/PAM-4-14 gave authority to expend limited funds on CENTAUR vehicles and CENTAUR engines and gave authority to use a portion of the funds received with USAAMA Order No. 1 to apply upon the existing GE, STL and Philco contracts. Directed that all bid proposals be reviewed by USAAMA.

On 1 Nov 60 TWX, SIGFM/PAM-4-21 to AFBMD, directed that all facilities recommended for ADVENT be referred to USAAMA for approval prior to contractual action.

On 9 Nov 60 TWX, SIGFM/PAM-32 to AFBMD directed that USAAMA will review and approve Aerospace Work Statement prior to finalization.

On 25 Nov 60 USAAMA Management Directive No. 3 on Program Control identified subsystems and functional categories of ADVENT. Satellite control on orbit and on-orbit testing was not mentioned. Specified immediate and continuing analysis to be conducted by USAAMA with conferences involving USAAMA, responsible development agencies (AFBMD, USASRDL, BuShips) and their relevant contractors. First conference to be early in December. Analysis to assign cost estimates to each element of the subsystems (e.g., attitude control element, electrical power element, orbit indexing element, etc.)

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Courier

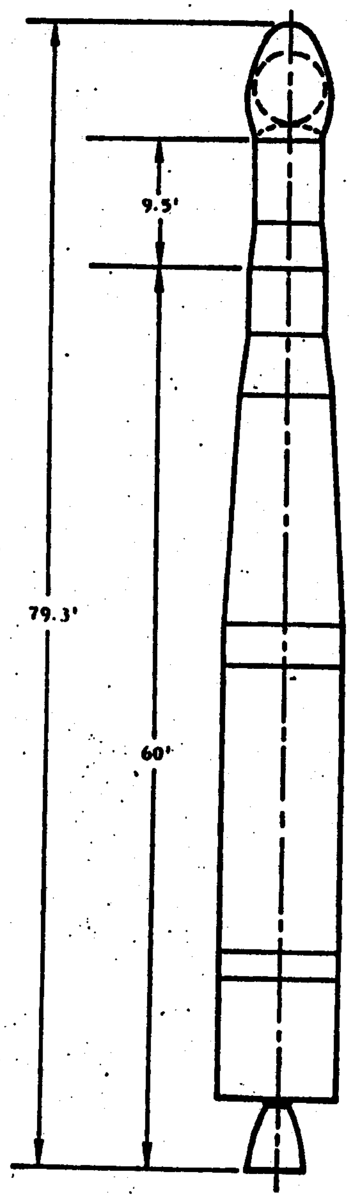
The ARPA COURIER Program consists of two flight vehicles to be launched from the Atlantic Missile Range. The program objective is to test delayed repeater communications between a satellite and ground stations. The program also will be used to determine the operating characteristics and capabilities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

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

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

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

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



SECOND STAGE—ABLESTAR (AJ10-104)

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

FIRST STAGE—THOR IRBM

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

MONTHLY PROGRESS—COURIER Program

Program Administration

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

COURIER 1A

Pre Launch

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

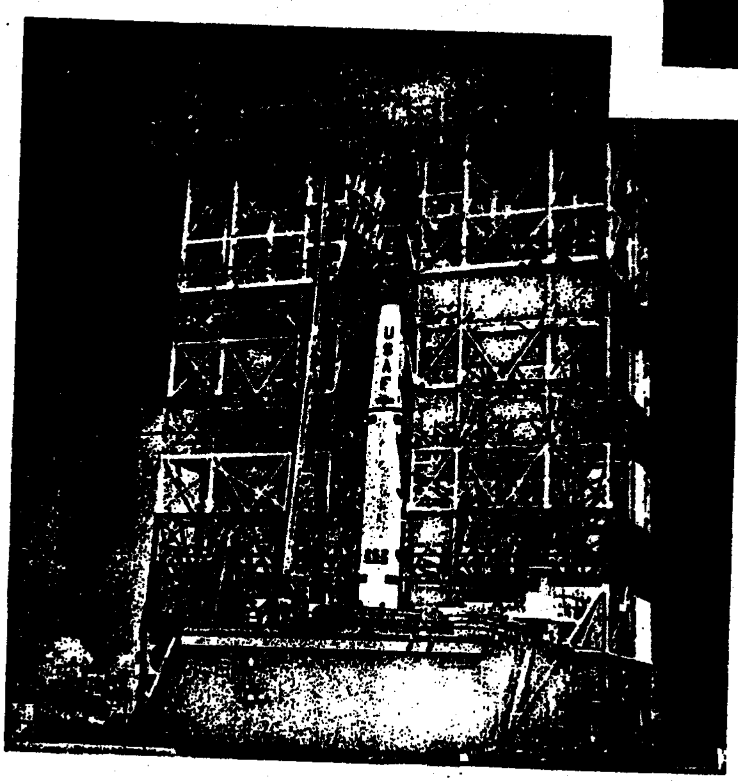


Figure 1. THOR booster 262 (left) installed on Stand 17B at the Atlantic Missile Range. COURIER 1A above prior to launch on 18 August. A loss of hydraulic pressure caused the control system to become inoperative and the missile to become unstable resulting in its destruction.

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

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

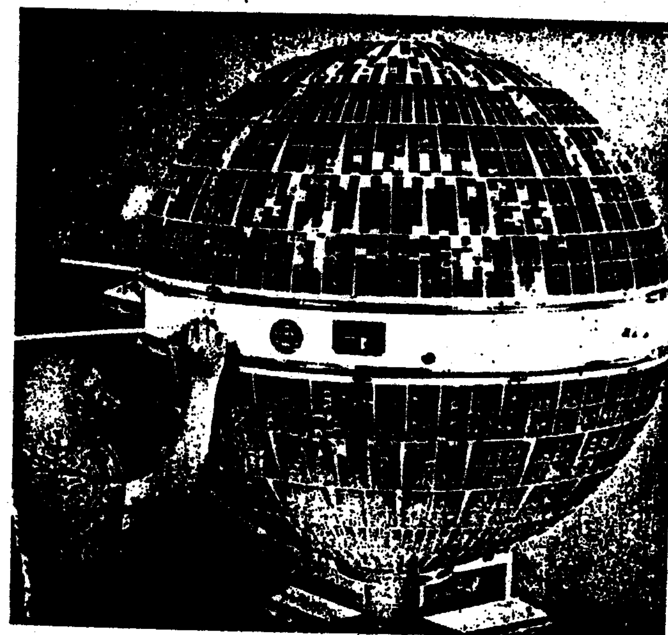


Figure 2. Installing one of the antennae on the 500-pound COURIER IB satellite vehicle. Approximately 20,000 solar cells sheath the 60-inch sphere and keep the batteries charged.

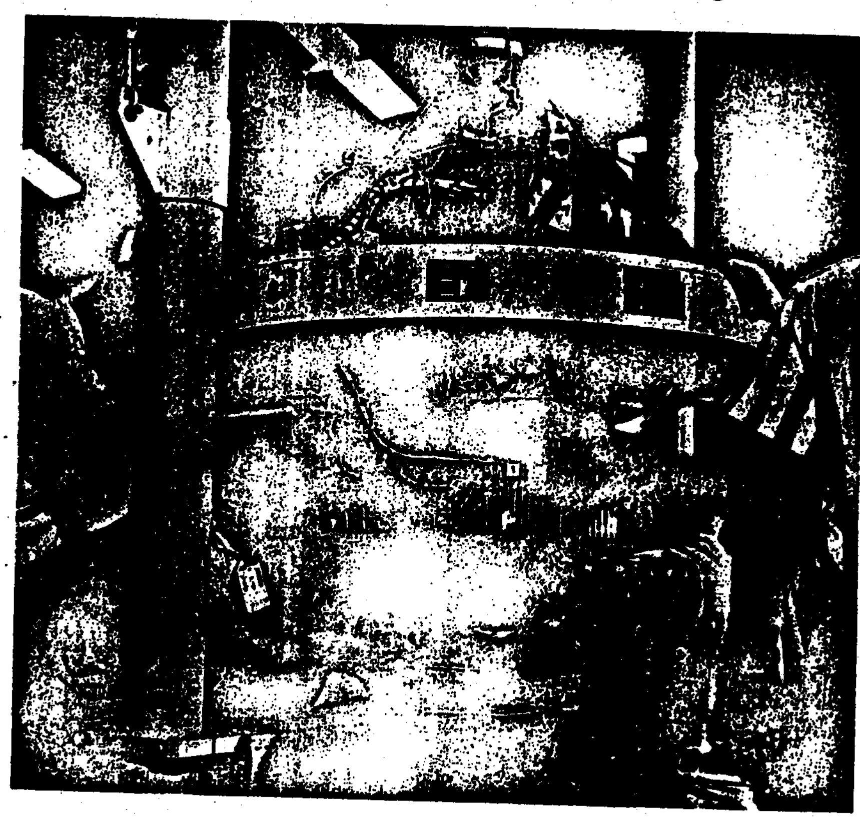


Figure 3. Preparing the payload for spin tests. The solar cell covered hemispheres have been removed revealing the UHF receivers and telemetry transmitters on the top; command decoder, microwave receivers and transmitters, and batteries on the middle shelves; and data storage units on the lower shelf.

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

Launch

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

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

COURIER 1B

Pre Launch

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

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

Launch

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

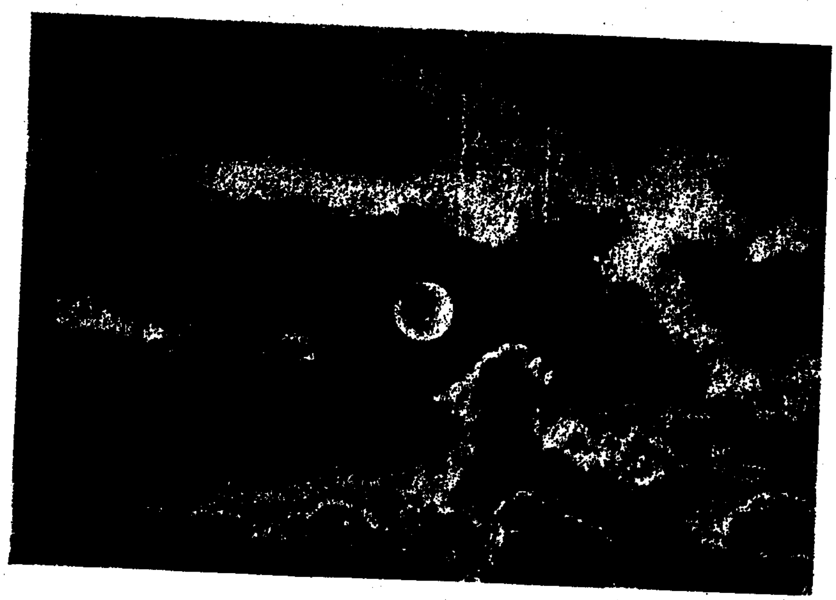
PARAMETER	NOMINAL	ACTUAL
Apogee, nautical miles	650	658.2
Perigee, nautical miles	650	501.7
Eccentricity	0	0.0195
Inclination Angle, degree	28.5	28.3
Period, minutes	109	106.7

TABLE I. COURIER 1B Orbital Parameters

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

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

a foreword to...



SPACE

TDC 60-6590

SECRET

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

WDLPR-4

5 December 1960

Summary of AIR FORCE BALLISTIC MISSILE DIVISION Activities in Space

NOVEMBER 1960

This report includes information on the recovery of the DISCOVERER XVII capsule following a two-day exposure to the space environment. This was the second flight test of an AGENA "B" vehicle. A preliminary report of the TRANSIT 3A flight is included. This month the SAINT section has been revised to include a proposed payload and the flight trajectory in graphic form. Information about the ORBITAL INTERCEPTOR Program is included for the first time. Also included this month is a BIOASTRONAUTICS section which includes a review of the successes accomplished with the Mark II biomedical capsules.

for Henry B. Kucheman Jr. Col USAF

O. J. RITLAND
Major General, USAF
Commander

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SECRET

SATELLITE
systems

DISCOVERER
MIDAS
ADVENT

SATELLITE SYSTEMS

The DISCOVERER Program consists of the design, development and flight testing of 37 two-stage vehicles, using the Douglas DM-21 Space Booster as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Project's Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

PROGRAM OBJECTIVES

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

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

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

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

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

PROGRAM SUMMARY

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

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

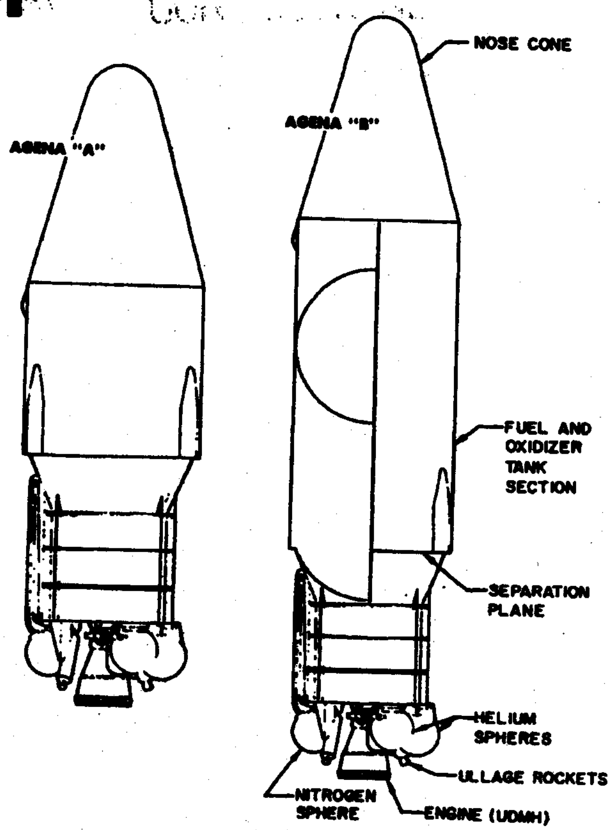
D i s c o v e r e r

[redacted]

SECOND STAGE	AGENA "A"	AGENA "B"	
Weight—			
Inert	1,262	1,328	1,346
Payload equipment	497	887	915
Orbital	1,759	2,215	2,216
Impulse propellants	6,525	12,950	12,950
Other	378	511	511
TOTAL WEIGHT	8,662	15,676	15,722
Engine Model	YLR81-Ba-5	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	15,600	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn time-sec.	120	240	240

THOR BOOSTER	DM-18	DM-21
Weight—Dry	6,950	6,500
Fuel	33,700	33,700
Oxidizer (LOX)	68,200	68,200
GROSS WEIGHT (lbs.)	108,850	108,400
Engine	MB-3 Block 1	MB-3 Block 2
Thrust, lbs. (S.L.)	152,000	169,000
Spec. Imp., sec. (S.L.)	247.8	248.3
Burn Time, sec.	163	148

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



FLIGHT VEHICLE

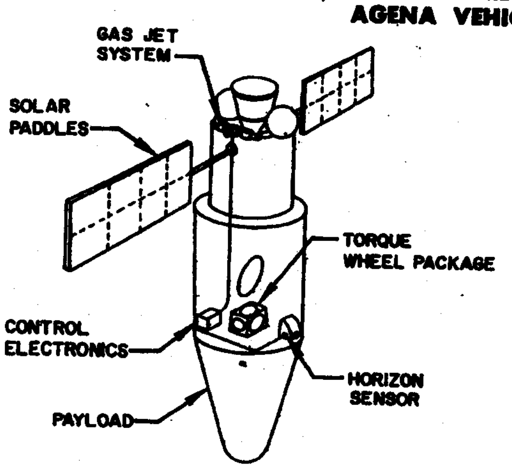
The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page A-5. Specifications for the two THOR configurations and three AGENA configurations used are given on page A-1.

AGENA VEHICLE DEVELOPMENT

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

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

SAMOS and MIDAS AGENA VEHICLE

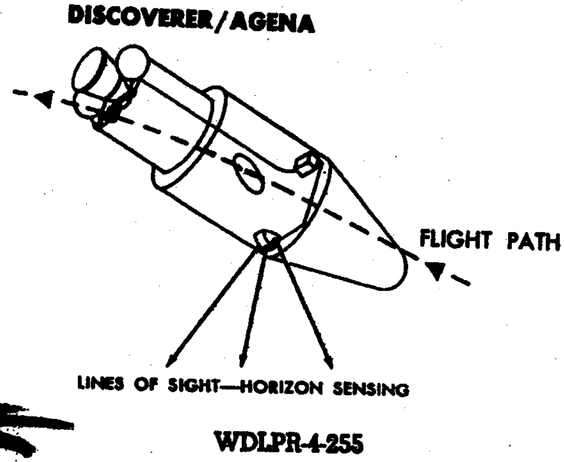


DISCOVERER/AGENA

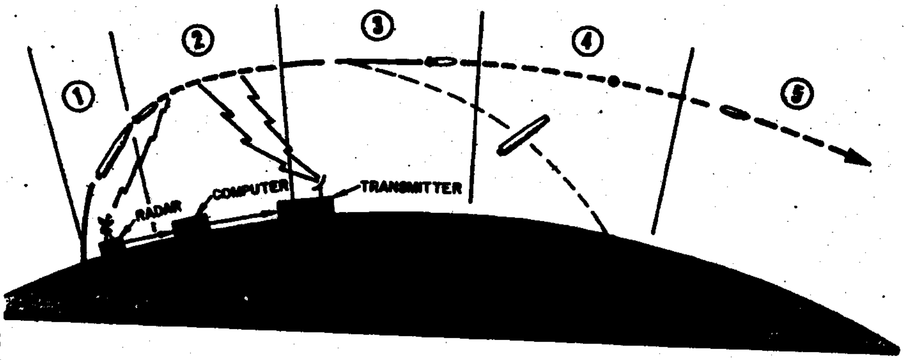
PERFORMANCE CAPABILITIES

ALTITUDE
200–20,000 MILES

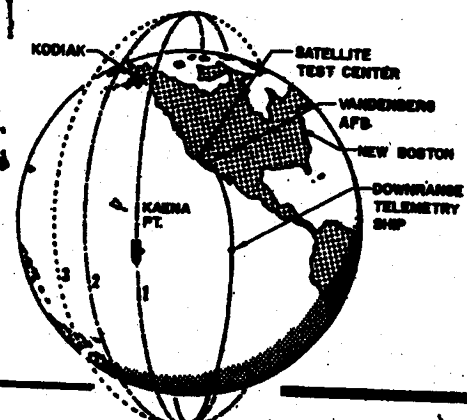
ATTITUDE
ROLL – 0.1 DEGREE
PITCH – 0.1 DEGREE
YAW – 1 DEGREE



Powered Flight Trajectory

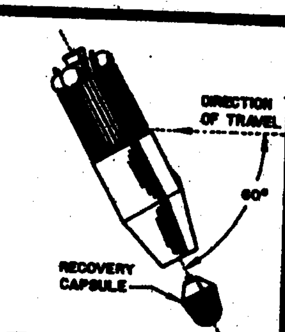


1. **First Stage Powered Flight**—2.5 minutes duration, 78 n.m. downrange, guided by programmed auto pilot.
2. **Coast Period**—2.4 minutes duration, to 380 n.m. downrange, attitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity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



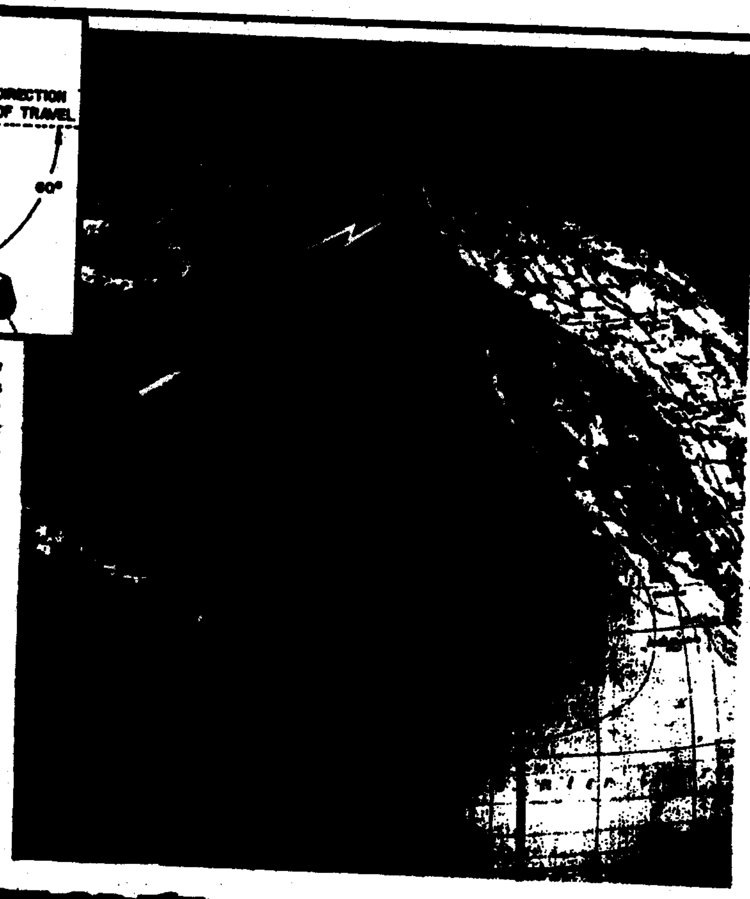
Orbital Trajectory

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 A-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 recovery 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 the recovery orbit, for capsule impact within the predetermined recovery area near Hawaii. Aircraft and surface vessels are deployed within the area as a recovery force.

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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		Over-all direction of capsule recovery operations.

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

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LAUNCH SCHEDULE

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

★ Attained orbit successfully.

® Capsule recovered.

● Failed to attain orbit.

FLIGHT HISTORY

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

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 XVII Flight

- DISCOVERER XVII was launched from Vandenberg Air Force Base at 1242 PST on 12 November. An attempt to launch on the previous day was cancelled because of propellant loading and umbilical problems. The ascent was satisfactory except that the injection altitude was slightly low and the period of the satellite orbit was approximately 2½ minutes longer than planned. The extended satellite period had little effect on satellite operation or the recovery, except to make the alternate (thirty-first) pass more desirable for recovery operations than the nominal (thirty-second) pass. With minor exceptions, the satellite operated as planned throughout the orbital period. Control gas expenditure was high during early orbits, but dropped to normal levels for most of the flight.

- This was the first AGENA "B" satellite to be orbited and the second AGENA "B" to be launched. This was also the first attempt to recover a capsule after two days in orbit, all other attempts were made after one day. The recovery was also the first "perfect" catch — the first capsule to be caught within the primary predicted recovery area. This flight also carried the first satellite mail. A letter signed by Air Force Chief of Staff, General Thomas White and addressed to Secretary of Defense Thomas Gates was in the recovery capsule. In the space letter to Secretary Gates, General White wrote "This is the first time that letters have been sent by a satellite and is in the tradition of airmen who less than 30 years ago pioneered in the first use of air mail."

- Recovery forces were deployed in the predicted impact area at 1400 PST on 14 November. At 1431, after nearly 51 hours in orbit, the capsule in DISCOVERER XVII was ejected over Alaska. Satellite attitude at ejection was two degrees left and fifty-nine degrees down, which is close to the optimum position. Capsule spin, retro-thrust, and de-spin were near nominal. Initial acquisition of the capsule beacon transmitter signal was made by one of the C119J aircraft in the recovery force at 1434 PST. Nine minutes later the descending parachute and capsule were sighted by Pelican II. During the first pass the grappling hooks struck the parachute but did not snag it. The second pass was successful. The capsule was undamaged, except for some scorching of the cover by aerodynamic heating at re-entry.

DISCOVERER XVII Experiments

- Several biomedical experiments were carried on DISCOVERER XVII and the data obtained are expected to provide important information on the space environment. Only preliminary results are available, but indications are that all experiments were successful.

- A densiometer mounted in the forward equipment compartment of the satellite revealed a greater density of gases in the compartment than was expected. Some differential gas pressure between the vacuum conditions of space and the interior of the satellite was expected. This would be caused by the out-gassing of paint, insulation and other materials together with the fact that in near-vacuum conditions gases cease to flow and are lost only by random escape of separate molecules. However, the unexpectedly high differential pressure discovered in DISCOVERER XVII could have a significant effect on the design of future space vehicles. Because of this increased density, densiometers will be carried on several future DISCOVERER flights to provide additional data and verify these initial findings.

- As part of an extensive program being carried out by the Air Force and several governmental agencies for development of superprecise tracking systems, tracking lights were carried aboard the DISCOVERER XVII satellite. The lights were photographed against a star background by optical tracking equipment in the Netherlands West Indies, Japan, India, Iran, Florida, and New Mexico. The data from this and other DISCOVERER flights employing the tracking lights will be used to develop a very precise earth-space positioning system against which other tracking devices (radar) can be calibrated.

DISCOVERER XVIII and XIX

- DISCOVERER XVIII is on the launch pad at Vandenberg Air Force Base undergoing systems checks in preparation for its launch in early December. This satellite will carry a recoverable capsule which, according to present plans, will be left in orbit three days before recovery is attempted. The first four-day capsule recovery mission for a DISCOVERER satellite is scheduled for launch in January 1961.

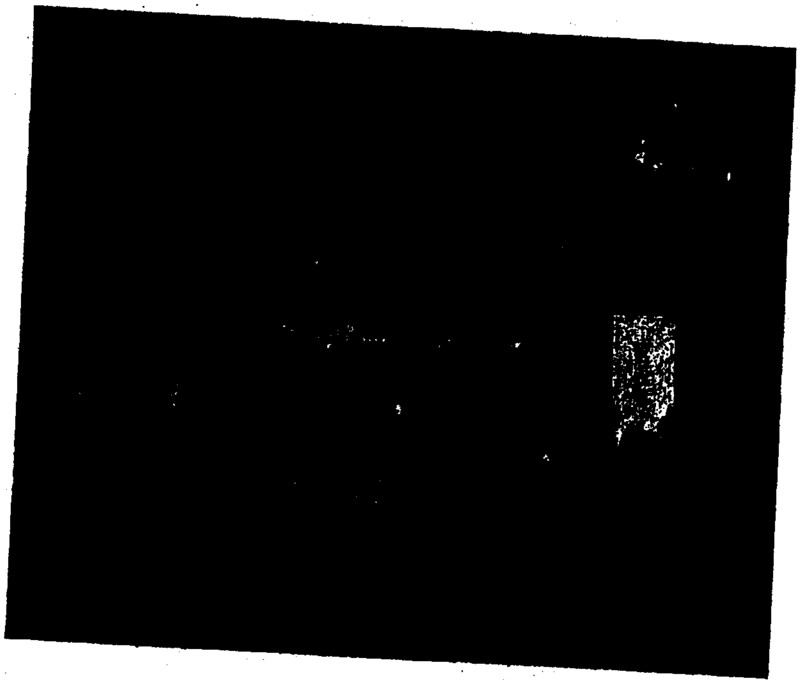
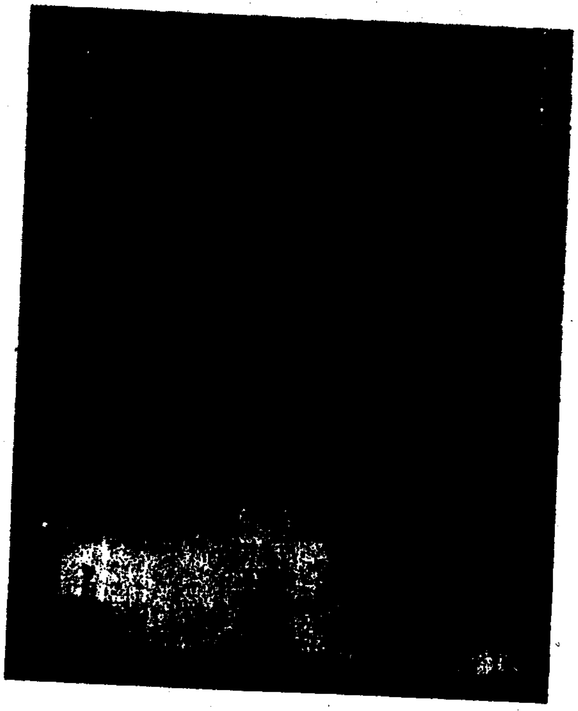


Figure 1. THOR booster 297 and AGENA vehicle 1062 following mating at Vandenberg Air Force Base. This overall view of the launch stand shows a small portion of the ground support equipment required to support these space flights. On the left is the freon trailer which provides gas for the capsule "cold gas" spin/de-spin system, the helium trailers which provide gas to pressurize the AGENA propellant tank, and the air conditioning trailer which supplies air to cool the precision electronic equipment during ground operation.

Figure 2. Checkout of the AGENA "B" vehicle prior to the DISCOVERER XVII launch. The wall on the left of the vehicle is the front of the missile shelter. The shelter can be moved forward to protect the vehicle and work area during inclement weather. Two of the launch support trailers are in the background.



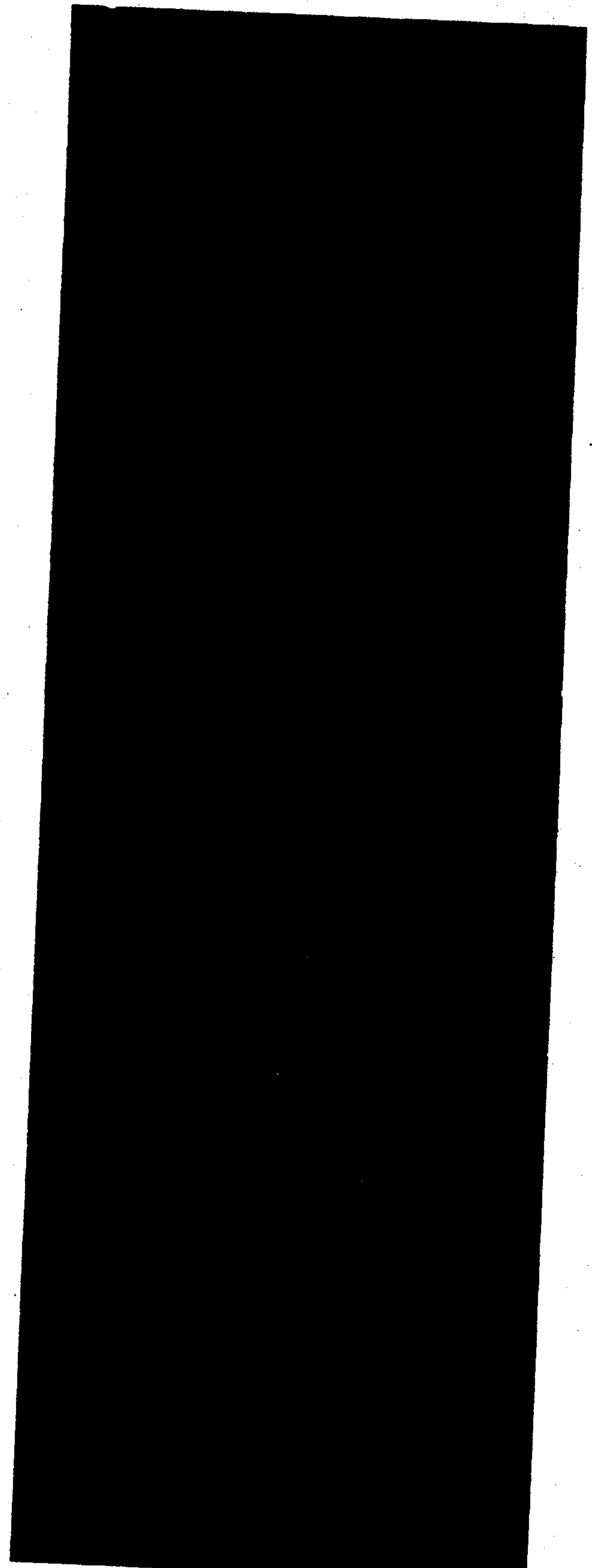
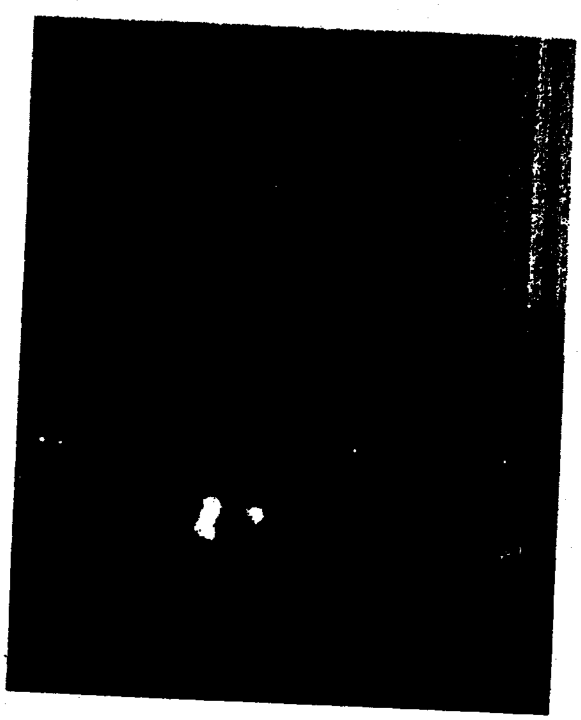


Figure 3. DISCOVERER XVII following ignition (below), during thrust buildup (above) and on its way for a trip that will carry the capsule in space for two days and travel a distance of a million miles before it is safely returned to earth. The launch took place from Complex 75-3 at Vandenberg Air Force Base on 12 November. This was the second launch of an AGENA "B" vehicle.



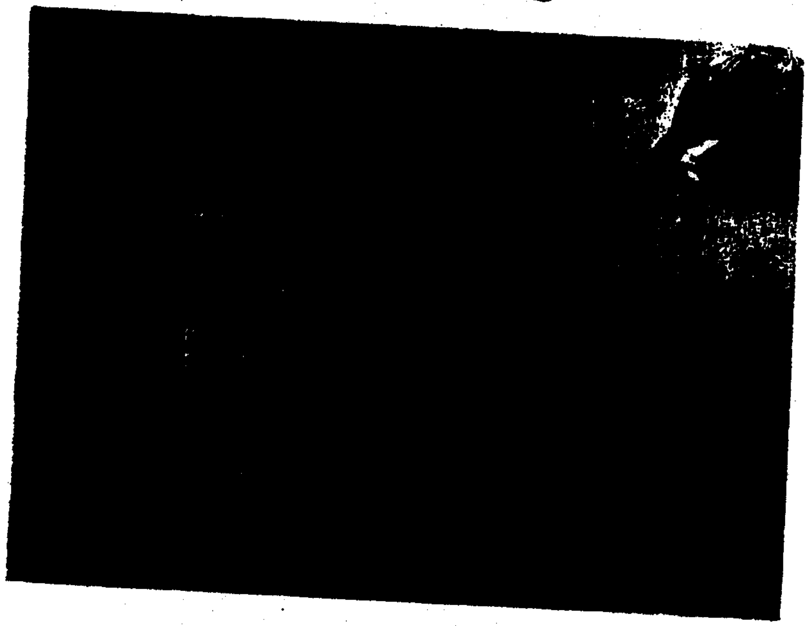


Figure 4. Photograph taken from the rear of Pelican II during recovery operations. The pickup gear trailing from the aircraft struck the parachute (note tear in canopy) but did not snag it.

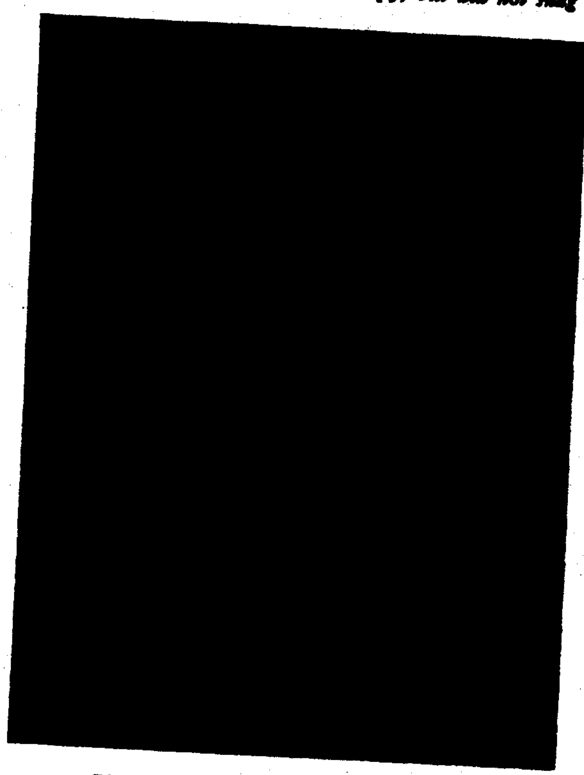


Figure 5. The nylon tow line has been played-out to reduce the shock of recovery. Now the reeling-in operation begins. The C-119J aircraft on the left was standing by to attempt recovery if the Pelican II crew had not succeeded on their second attempt.

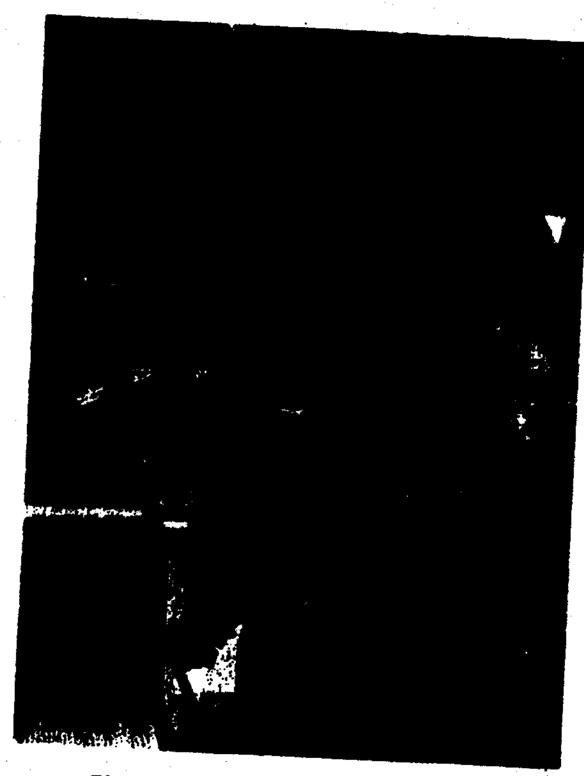


Figure 6. The tense period during which the winch operator reels in the capsule. From the time the grappling hooks snare the parachute until the capsule is safely aboard requires approximately one-half hour.

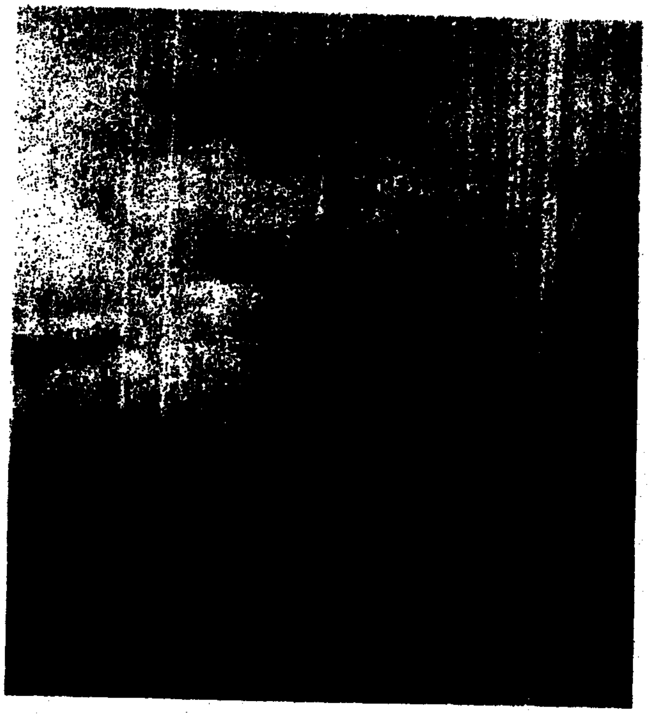


Figure 7. The parachute and capsule about to be pulled aboard Pelican II. The flashing light and beacon transmitter were still operating when the capsule was safely aboard. Another recovery aircraft is visible on the left of the capsule.

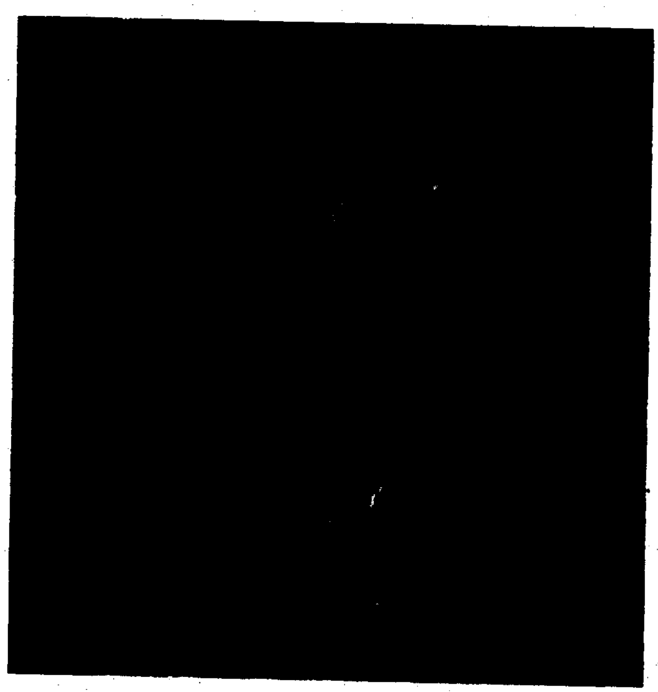


Figure 8. The capsule has been placed in the special container for shipment to the Satellite Test Center. The capsule was undamaged except for some scorching of the cover by aerodynamic heating at re-entry. This was the second aerial recovery of a DISCOVERER capsule and the first to be recovered by air-snatch within the primary predicted recovery area.

• DISCOVERER XIX, which is undergoing subsystem tests in the missile assembly building at Vandenberg Air Force Base, is also scheduled for launch in December. This vehicle will carry a radiometer designed to gather background infrared radiation data for the MIDAS Program. Another radiometric measurement flight is scheduled for early next year. These two satellites will not carry recoverable capsules.

Technical Progress

XLR-81Ba-9 Engine Development

• Several additional tests were completed in the reliability program using engine serial number 306. A new thrust chamber was installed for these tests. The previous chamber was removed after 2,600 seconds of operation so that statistical data can be gathered on more than one thrust chamber.

• Unstable operation has been experienced in the engine turbine pump. The unstable conditions and the power level shift do not occur in any predictable manner. Neither do they always remain with an engine once they have been experienced. All variations except one have been within ±1.5% allowable tolerance. It is thought that an acoustical problem initiated in the turbine manifold is causing gas generator trouble. The installation of a perforated disc damper has proved satisfactory from a performance and weight standpoint.

• The thirty-day coast program is continuing with temperature limit tests being conducted on the turbine pump assembly. A simulated high altitude test of a de-greased gear box, to determine the need for gear box lubrication for delayed restart missions, resulted in failure after 13 seconds running time. Although present flights call for only ten seconds operation after extended coast in orbit, a lubricant injection system to be used prior to restart will be developed.

Biomedical Test Program

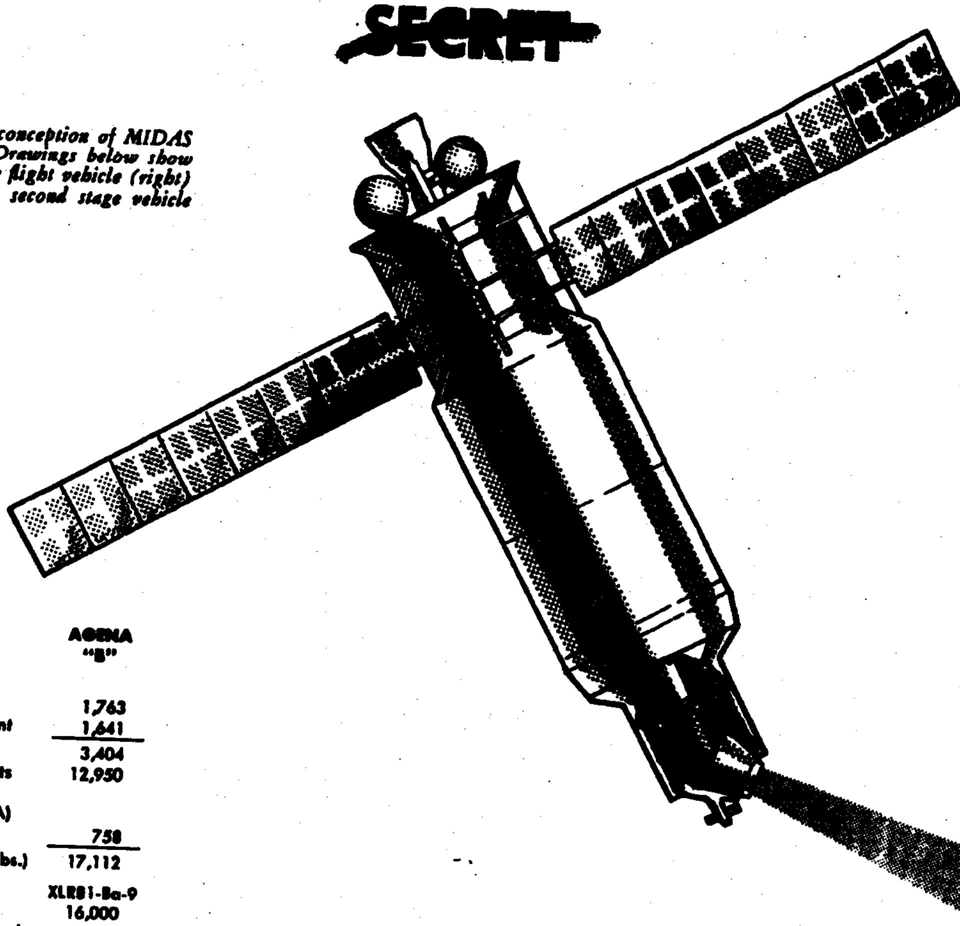
• A test simulating a one-day mission with a live monkey in the life cell of a Mark II biomedical recovery capsule started on 7 November. This was the second such test within a month. Both tests were successful in sustaining the animal in a healthy condition under simulated orbital conditions. Additional information is provided in the BIO-ASTRONAUTICS Section of this report.

Facilities

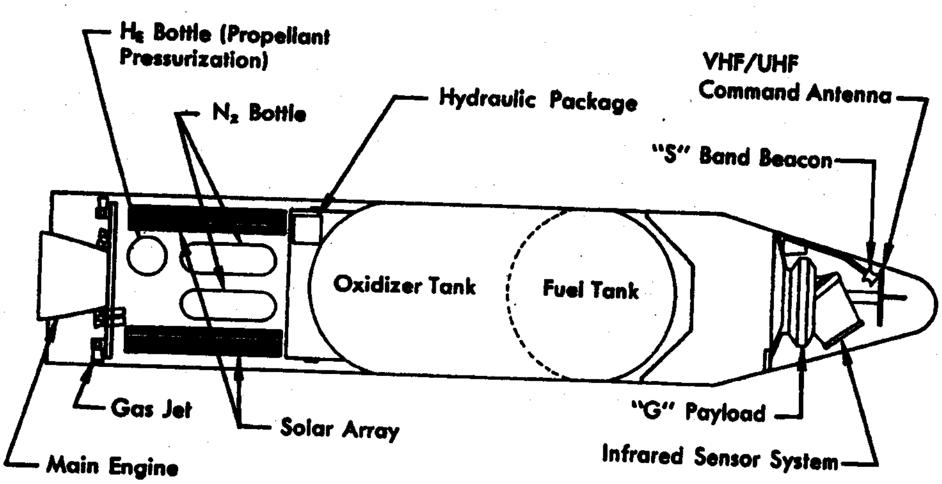
• A tracking station is being built for installation on Tern Island which is located approximately 500 miles northwest of Hawaii. The station will be used for automatic tracking and data acquisition of re-entry vehicles during recovery operations. The initial installation, which is scheduled to be operational by mid-December, will consist of a tracking and data van and a communications and control van. The equipment includes an automatic tracking quadhelix antenna, ground timing system, data conversion system, telemetry receivers, subcarrier discriminators, a tape recording system and communication equipment.

Midas

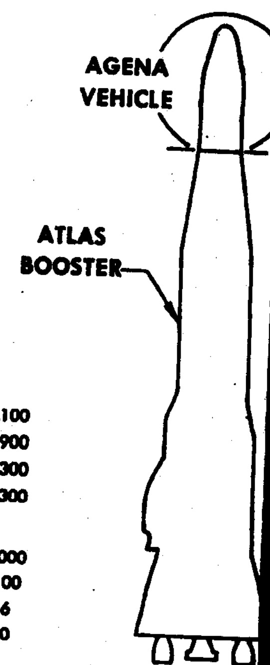
Figure 1. Artist's conception of MIDAS satellite (right). Drawings below show complete two-stage flight vehicle (right) and AGENA "B" second stage vehicle (left).



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



MIDAS, Configuration II, AGENA "B" Satellite



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

~~CONFIDENTIAL~~

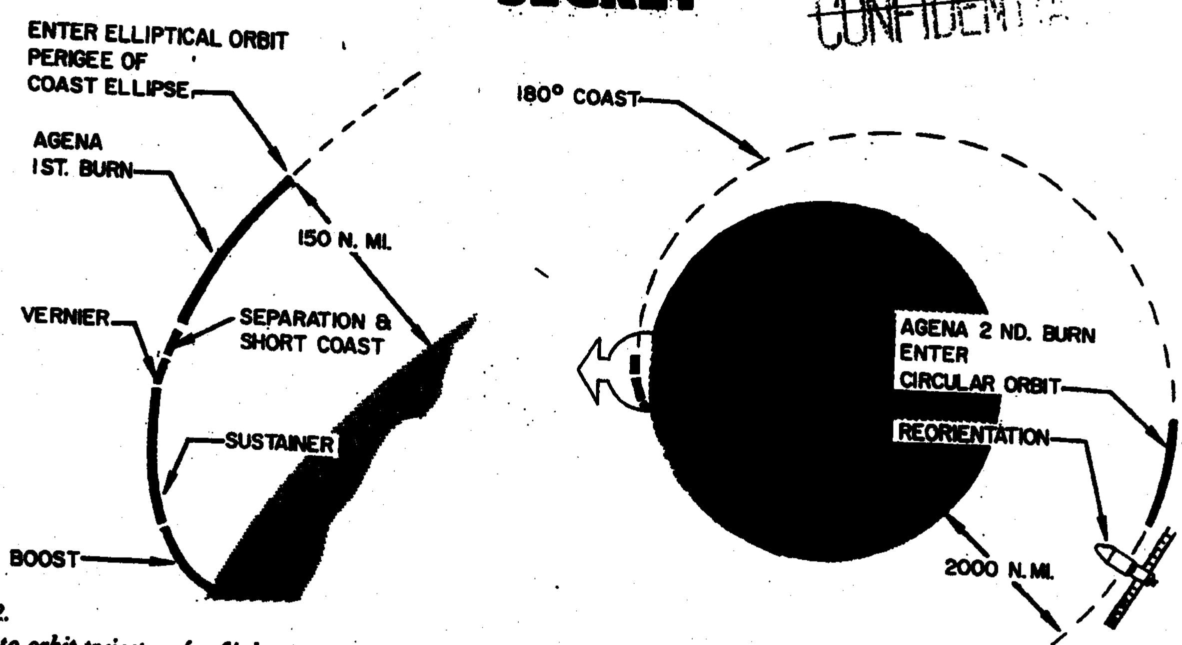


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. From boost through separation, guidance and control is provided by the ATLAS radio inertial system. The AGENA inertial guidance system, with horizon scanner, provides attitude, velocity and directional control to establish the orbit and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

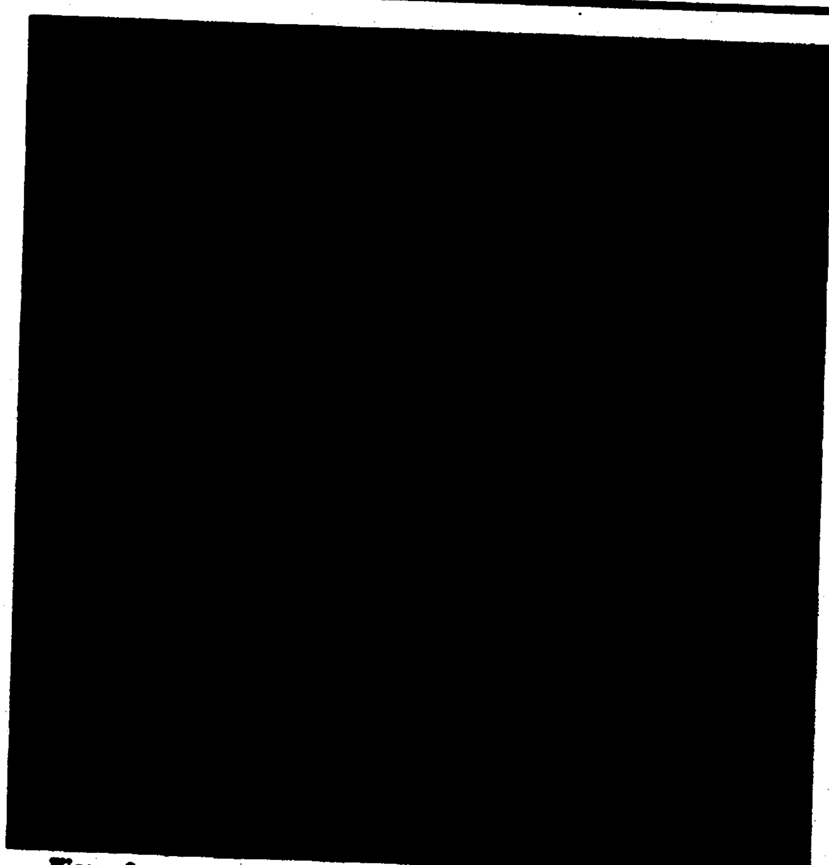


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

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

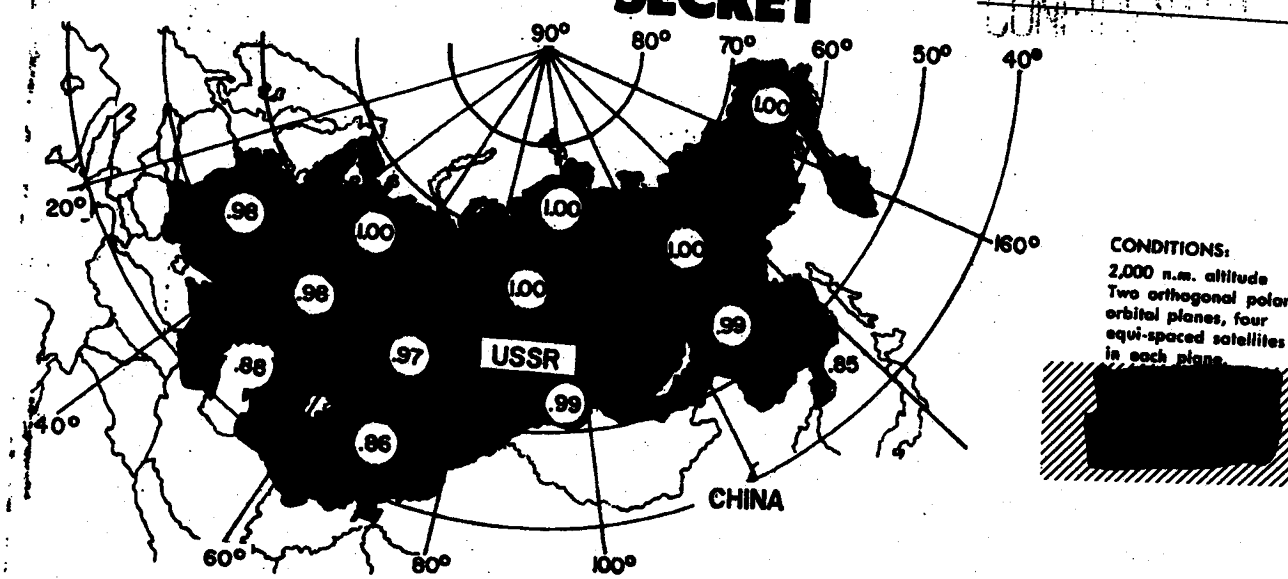


Figure 4.
Orbiting satellites detect infrared radiation emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveal approximately the number of missiles launched and launch location, direction of travel and burning 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.

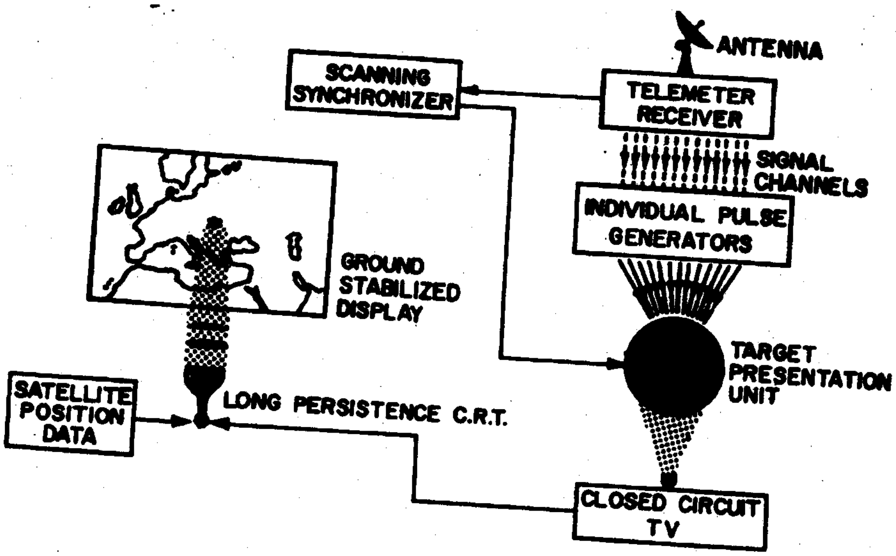
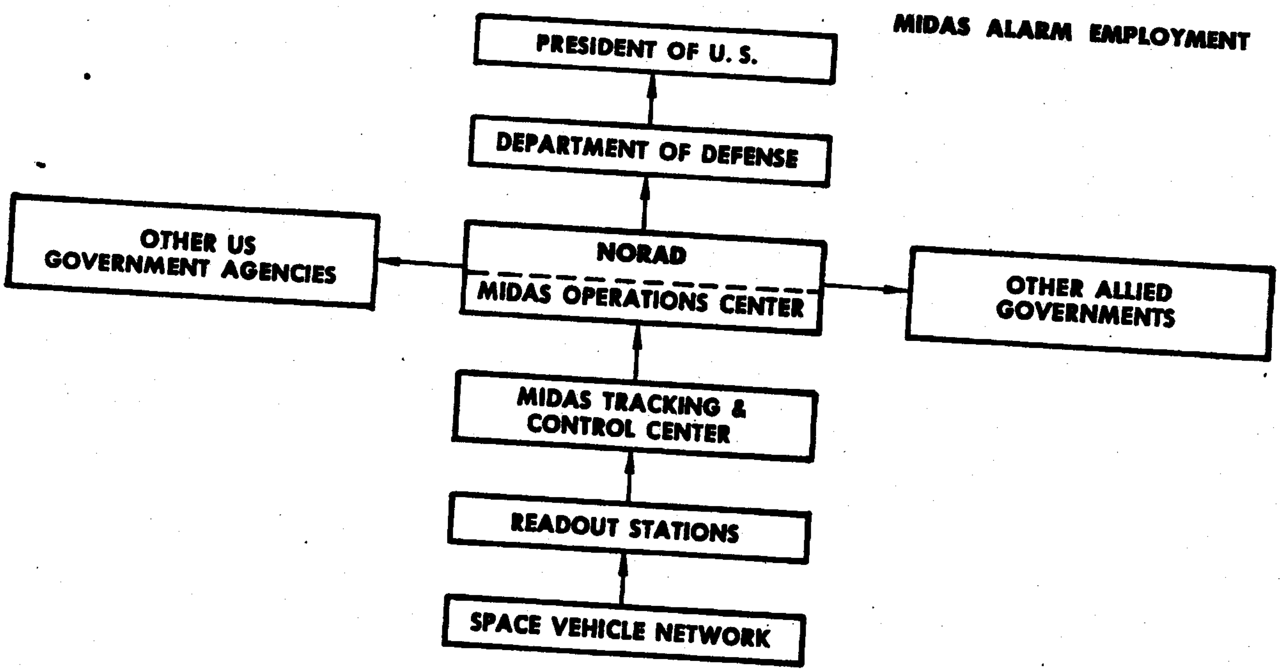


Figure 5.
Simplified version of ground presentation system (left) for display of infrared warning data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having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

[redacted]

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

MIDAS Launch Schedule

MIDAS GROUND SUPPORT FACILITIES

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

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

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

**Equipment*

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

Monthly Progress—MIDAS Program

Program Administration

• The preliminary version of the MIDAS Operational System Description has been completed. This document presents a description of the complete operational system as presently conceived. Following review by AFBMD, the final version will be prepared.

• A proposed MIDAS Development Plan dated 24 October was presented to the Air Force Ballistic Missile Committee on 4 November. Guidance has been received from the Secretary of the Air Force recommending a revised presentation of the Development Plan. The Development Plan will be resubmitted to the Secretary of the Air Force in the very near future.

Flight Test Progress

• Delivery of the AGENA "B" vehicle for the third MIDAS flight from the system test phase of manufacturing has been delayed two weeks because of continued component difficulties. An extremely small number of modifications remain to be accomplished. An intensive schedule recovery program has been developed which calls for completing the systems test activity on 22 December and for shipment from Santa Cruz Test Base on 13 January. This Santa Cruz completion date represents a slippage of two days from the last scheduled delivery date and, if attained, will not appreciably affect the launch schedule for MIDAS III.

• The radiometer for the RM-1 flight (DISCOVERER XIX) was delivered to Vandenberg Air Force Base on 18 November. The radiometer will enter systems testing for compatibility with the satellite vehicle on 29 November. This radiometric measurement flight is presently scheduled for 15 December. A second flight is scheduled for early in 1961. The purpose of these flights is to gather background infrared radiation data.

Technical Progress

Second Stage Vehicles

• The AGENA "B" vehicle for the fourth MIDAS flight was delivered to systems test area on 25 November. This represents a one week schedule slippage. It is anticipated that this time will be recovered during the systems test phase. The horizon sensor is scheduled for delivery on 28 November. The sensor will be installed in the satellite during the system test phase.

• The fifth MIDAS satellite is currently in final assembly and is on schedule. It will be delivered to systems test on 6 December.

• The Design Test Vehicle for MIDAS Series III (MIDAS VI) is in the late-design release, early-fabrication stage, on schedule.

• The first hot firing test of the MIDAS heat shield has been completed at Arnold Engineering Development Center. The shield was designed to eliminate the thermal problem that developed at the innerface of the aft equipment rack and the radiantly cooled nozzle extension of MIDAS vehicles that have an extended aft equipment rack to accommodate the solar array. Preliminary examination of the data indicate that the temperature within the aft equipment rack will be well within the thermal limits established for this area.

• Authorization has been obtained for installation of a 400-mc transmitter beacon in the satellite vehicles for MIDAS III, IV and V. This transmitter, which will have its own battery pack and antenna, will provide approximately a 20-milliwatt signal for antenna acquisition and automatic tracking by the mobile ground station located in South Africa. This

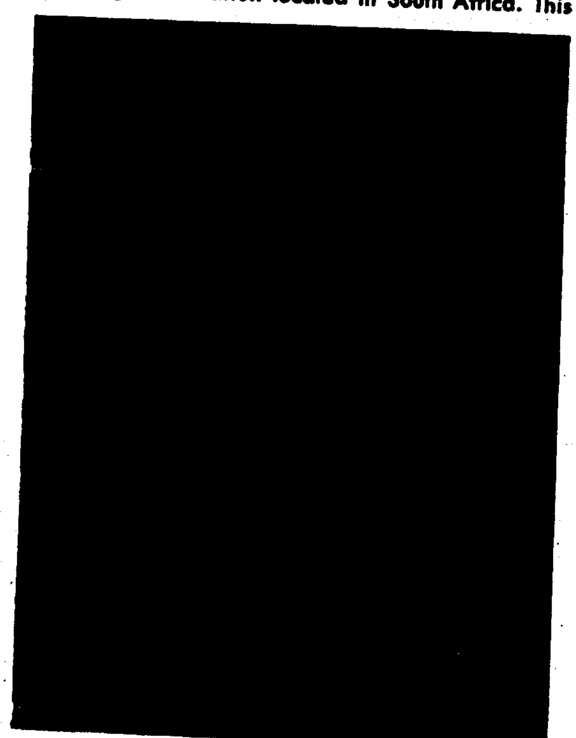
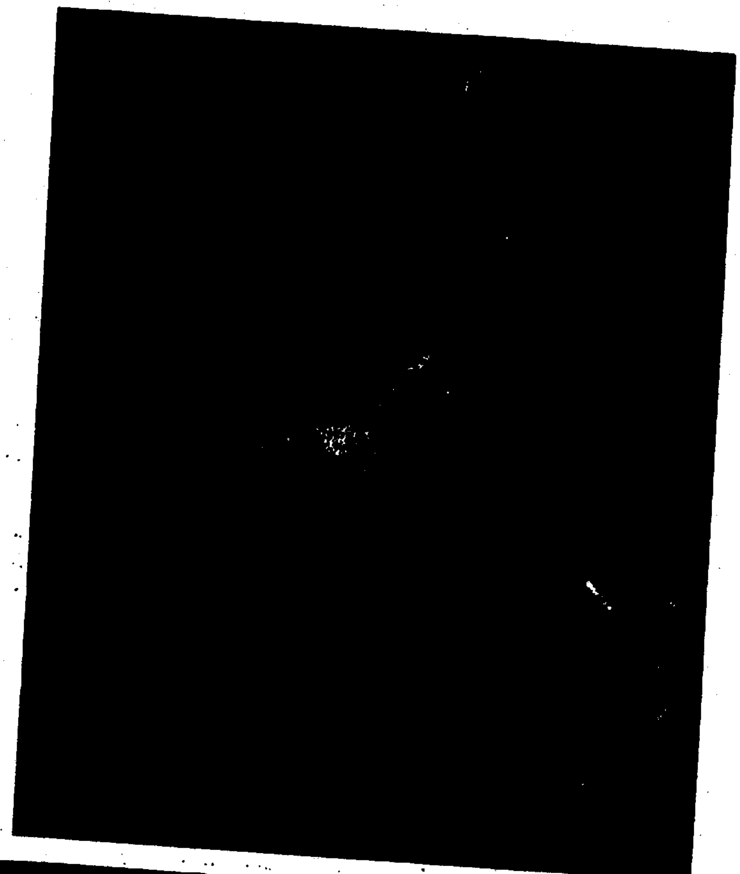
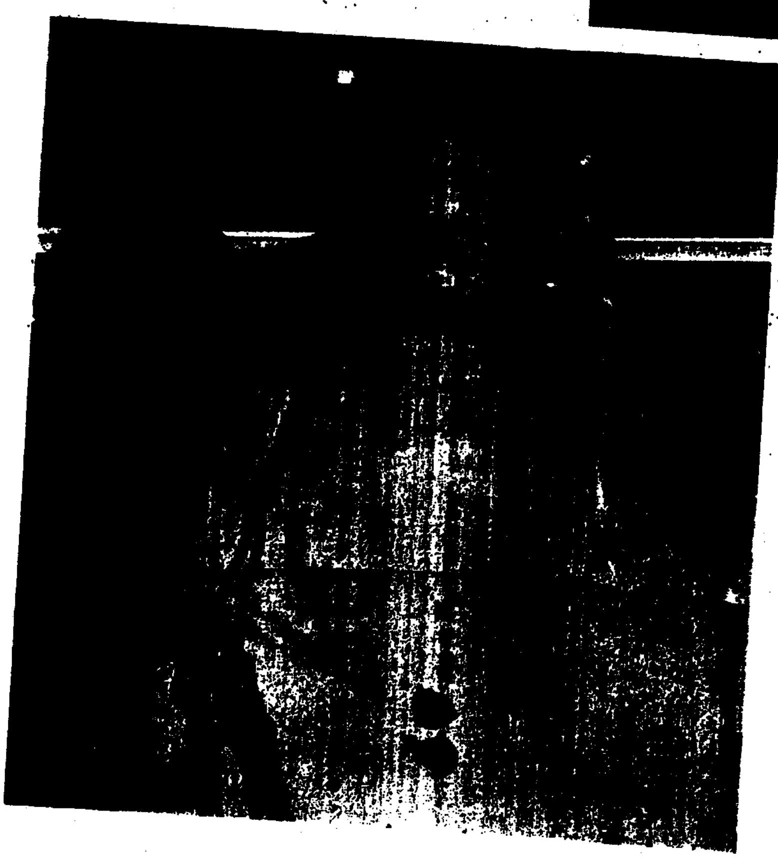


Figure 6. The radiometer which will be carried on the RM-1 flight installed in the payload section of the AGENA satellite. The entire assembly is about to be placed in the high altitude temperature simulation chamber. The lens of the radiometer which will measure background radiation can be seen through the popout window. The sensing element is mounted behind the lens.

Figure 7. The second Baird-Atomic, Inc., infrared payload (right), which will be carried on MIDAS V, is shown in the collimator prior to optical checkout. The unit in front of the lens is the pre-amplifier and the tube projecting behind the lens is the telemetry antenna mount. The various units on the telescope assembly contain the post-amplifiers, the D. C. power supply, the radiometer pre-amplifier, and regulator assembly. The initial Baird-Atomic payload (below), which will be carried on MIDAS IV, is being instrumented by a Lockheed technician prior to being installed in the high altitude temperature simulation chamber. This flight, scheduled for February, will be the first launch of the ATLAS "D" / AGENA "B" vehicle.





station will provide a minimum interim capability for second burn telemetry data readout, which is a mandatory requirement. Establishment of this interim capability was made necessary because of the inability to obtain right-of-entry to establish the Atlantic Missile Range station 13 capability in Southeast Africa.

• Manufacture of the instrumentation package which will measure nuclear radiation in the Van Allen belt is on schedule. This package is scheduled for installation in the MIDAS III satellite vehicle on 15 December.

Infrared Scanner Units

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

• The payload for the third MIDAS flight has satisfactorily completed the test program conducted in the high altitude temperature simulation chamber. The payload for the fourth MIDAS flight is scheduled for delivery in December.

• The infrared detectors to be used on the service test model of Aerojet-General's advanced infrared payload configuration are being provided on a competitive basis by Infrared Industries and Electronic Corporation of America. Delivery of detectors from both contractors continues to be a problem. Aerojet has assigned a resident representative to follow and expedite the program.

• The cost contract has been negotiated for seven payloads of the advanced configuration being developed for MIDAS flights, 6, 7 and 8. Five are programmed as flight articles and spares and two for life testing in the accelerated reliability program.

• The technical and engineering evaluation of the proposed all-electronic infrared scanner system has been completed. The results of this evaluation have been very encouraging, and a final decision is pending on whether to proceed with the development effort on this system.

Ground Support Equipment

• The initial Baird-Atomic, Inc., Ground presentation unit, which will be used in support of MIDAS flights 3, 4 and 5 has been delivered. The equipment is currently being installed in the Satellite Test Center. A second ground presentation unit, for installation at Vandenberg Air Force Base, is scheduled for delivery in December.

Facilities

• Completion of all support facilities at Fort Greely, Alaska, is scheduled during December. The Donnelly Dome microwave relay station is scheduled for completion on 15 December.

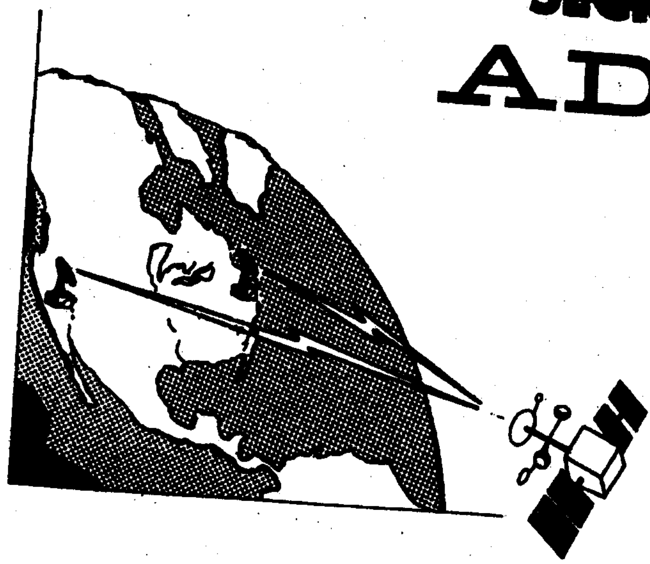
[redacted]

• Construction of facilities at the New Boston, New Hampshire station is proceeding on schedule toward a 30 December completion date.

• All previously initiated construction and/or modification at the Vandenberg Air Force Base station have been completed. A study is underway to validate the requirement for an addition to the Data Acquisition and Processing Building.

• Modifications to the Point Arguello launch stand No. 2 have been rescheduled to accommodate the MIDAS/AGENA "B" launch scheduled for February.

ADVENT



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

PROGRAM HISTORY

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

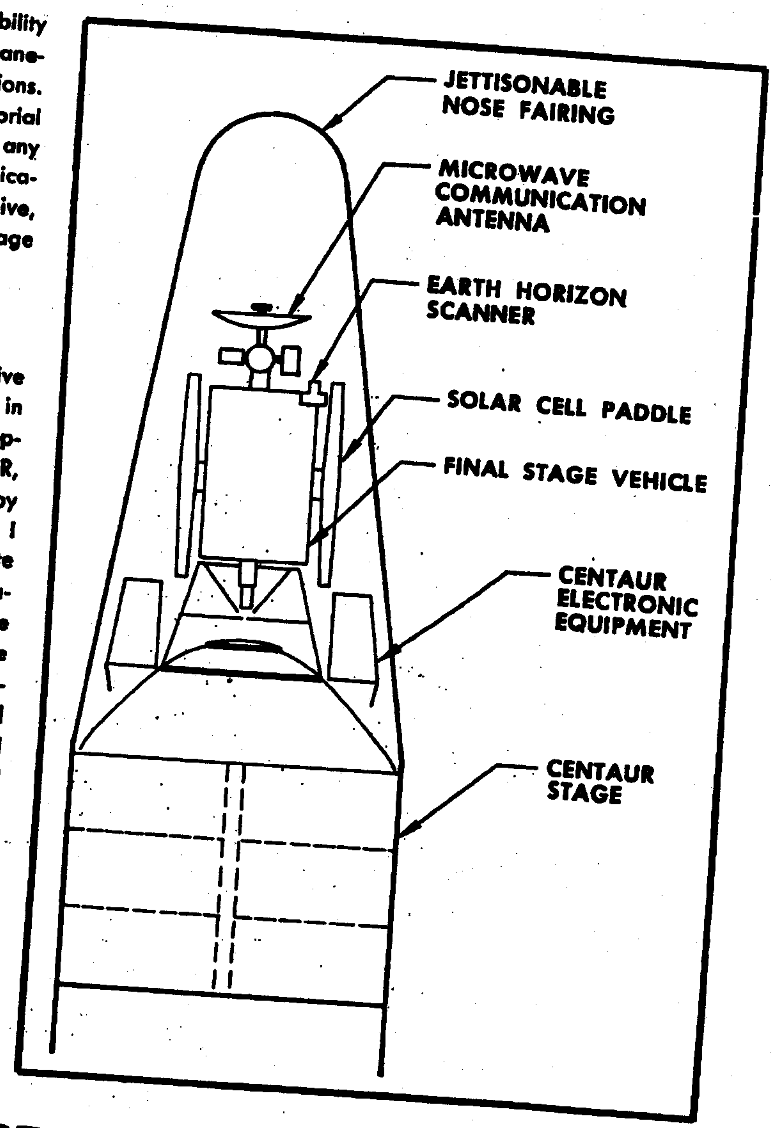


Figure 1. Proposed satellite with jettisonable fairing mounted on CENTAUR second stage.

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

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

PROGRAM OBJECTIVES

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

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

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

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

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

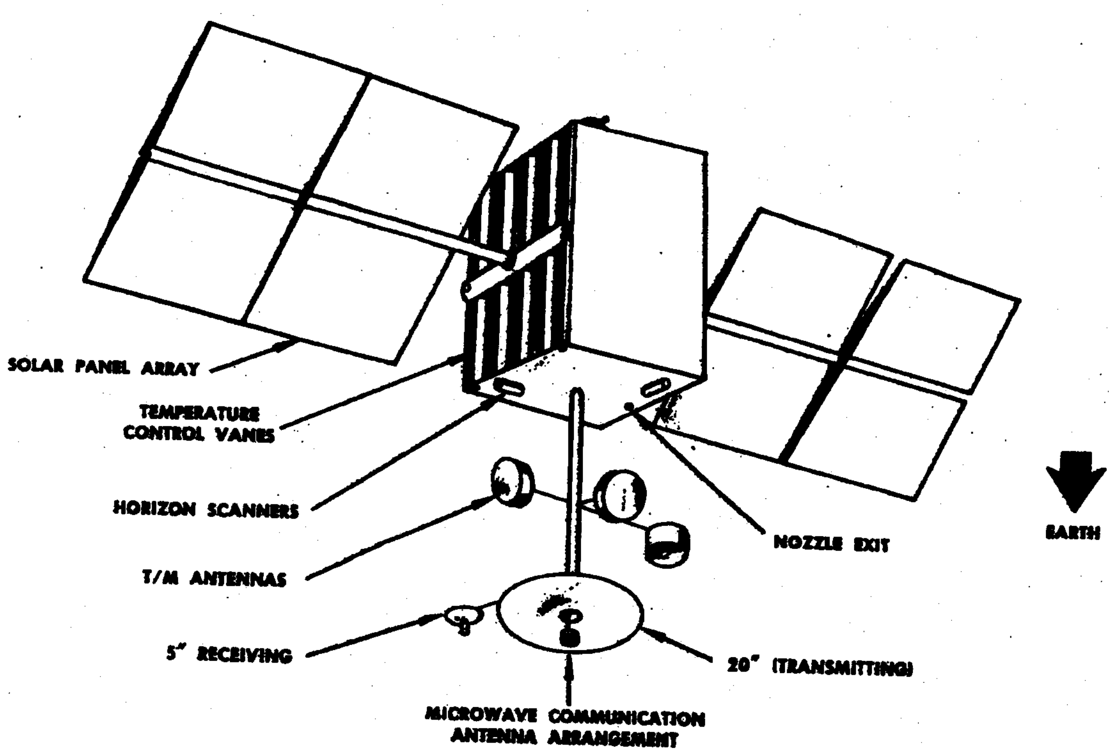
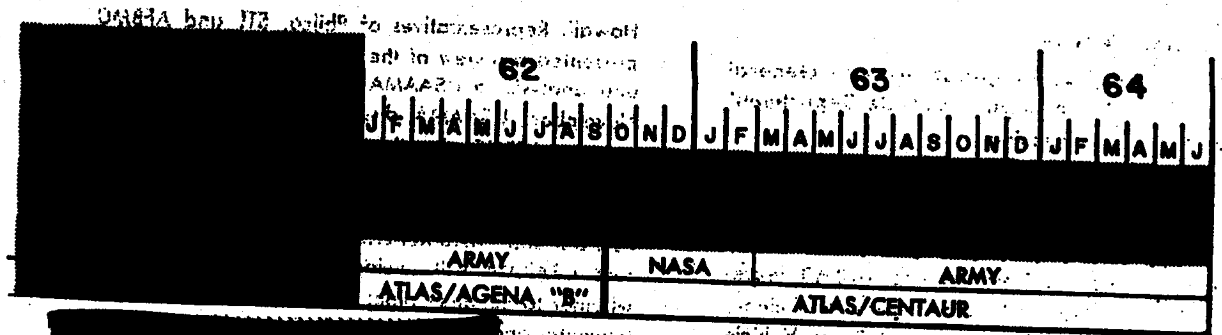


Figure 2. Initial design of final stage vehicle.



[redacted] ADVENT Launch Schedule

Monthly Progress—ADVENT Program
Program Administration

- Brigadier General Thames, Commanding General, US Army ADVENT Management Agency (USAAMA) and members of his staff visited AFBMD on 15 November. A general orientation on the various AFBMD space and ballistic missile programs was presented and the conventional AFBMD/BMC management methods were discussed. General Thames desired that detailed negotiation of a management agreement not be held until 2 December. He will also discuss details with all participating agencies at that time. General Powell and members of AFBMD/BMC will attend the 2 December meeting at USAAMA.

- The contract with Space Technology Laboratories, Inc. (STL) for over-all systems engineering and technical direction was terminated on 11 November. Aerospace Corporation was directed to proceed with vehicle systems engineering and technical direction effective 12 November.

- A teletype message was sent to USAAMA on 18 November requesting $1.5 millions additional funding be made available to AFBMD to cover the final stage vehicle contract through 31 December. The General Electric, Missile and Space Vehicle Department (GE-MSVD) contract will exhaust the funds now available early in December. There has been no indication by USAAMA when FY 61 funds will be released.

- The restriction on the extension of the Philco contract beyond the design study phase has been removed and purchase request action initiated for Philco to continue on additional tasks of the ADVENT tracking, telemetry and command system.

- A review of the AMR/PMR ADVENT Support Plan No. 1600 was accomplished by AFBMD, AMR and 6555th Test Wing personnel on 16-17 November. The plan was approved and interested agencies notified. Presentation of the plan was made to Lt. General Yates, Deputy Director of Defense Research and Engineering (DDRE) on 22 November. USAAMA, on 30 November, recommended to DDRE that the plan be implemented and funded in FY 61.

Technical Progress
Launch Vehicles

- Work statements for AGENA and CENTAUR launch vehicles and for LR-119 (CENTAUR) Rocket Engines, have been completed and forwarded to appropriate contractors with a Request for Proposals. The Proposal for the AGENA has been received and is currently being reviewed. Proposals for the CENTAUR and for the LR-119 Rocket Engine are expected on or before 15 December. ATLAS boosters for the ATLAS/AGENA boosted phase of the program have been ordered under existing AFBMD contracts. Work Statement for the Assembly and Test Operation Contractor for the ATLAS/CENTAUR boosted launches was forwarded to the Atlantic Missile Range (6555th Test Wing) on 8 November. Upon receipt of Atlantic Missile Range coordination, this Work Statement will be forwarded to Convair with a Request for Proposal.

- To preclude the possibility of program slippage caused by prolonged negotiations of definitized contracts, letter contracts have been written with Lockheed and with Convair covering the initial efforts (long lead time requirements) associated with second stage procurement. If necessary, similar arrangements will be made with Pratt & Whitney for the LR-119 rocket engine contract.

Final Stage Vehicle

- Formal contract negotiations with General Electric, Missile and Space Vehicle Department (GE-MSVD) are continuing.

- General Electric has prepared the Program Plan document. They are continuing the design effort of all major final stage vehicle subsystems. During the report period, Aerospace and AFBMD representatives attended a General Electric preliminary design review. A draft of the Final Stage Vehicle Design Criteria has been furnished General Electric. This draft was prepared by STL prior to contract termination.

Tracking, Telemetry and Command

- Philco completed the design study phase (Task 2) of the contract for the ADVENT tracking, telemetry and command ground stations at Vandenberg Air Force Base and Kaena Point, Hawaii. Representatives of Philco, STL and AFBMD presented a review of the Philco preliminary design and analysis to USAAMA on 9 November. On 14 November, USAAMA dispatched a teletype message to AFBMD directing that work on the Philco contract proceed on the condition that tracking, telemetry and command equipment be provided at Fort Dix and Camp Roberts. The message also stated that USAAMA will decide in the near future on whether to continue plans for an ADVENT tracking, telemetry and command installation at Vandenberg.

- A meeting of Philco, Bendix, AFBMD, USAAMA and USASRDL personnel was held at USAAMA on 29 November to review requirements and interface areas concerning the equipments that Philco will supply as GFE for the ground communication stations at Camp Roberts and Fort Dix to provide these stations with a tracking, telemetry and command capability.

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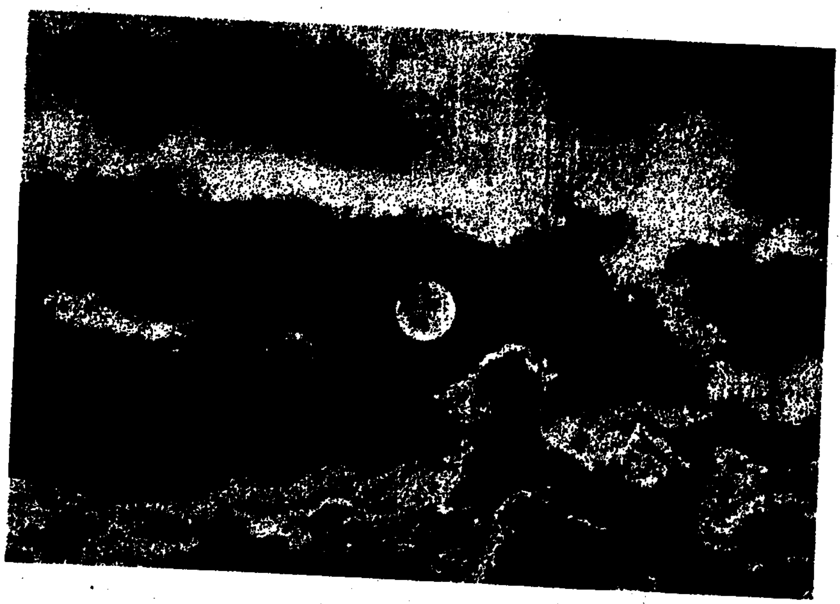
BOOSTER

support programs

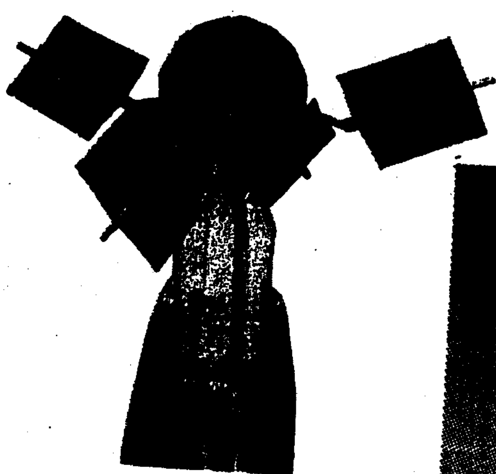


ABLE
TRANSIT
MERCURY
609A
DYNA SOAR
NASA AGENA "B"

BOOSTER SUPPORT PROGRAMS

The ABLE series of space probes was initiated with the ABLE-1 program in March 1958. This program, undertaken by AFBMD under direction of the Advanced Research Projects Agency, had as its over-all objective, the acquisition of data on the extra-terrestrial space environment. The design and construction of a four-stage space vehicle was initiated. The vehicle, consisting of a THOR IRBM first stage, an ABLE second stage, ABL-248 solid propellant third stage and the satellite vehicle fourth stage was successfully demonstrated in the fall of 1958. In October 1958, the National Aeronautics and Space Administration, given cognizance over the space exploration effort, authorized the ABLE-3 and ABLE-4 programs. General objectives included the demonstration of vehicle and communications capability and performance of scientific research experiments over interplanetary distances. An extensive network of ground support stations was simultaneously established, the most powerful of which is the 250-foot antenna at the Jodrell Bank Experimental Station, University of Manchester, England. Central control and data computation is accomplished at the Space Navigation Center, Los Angeles, California, with other military and NASA centers assisting in tracking and telemetry according to the specific requirements of each mission. The ABLE-4 program led to the development of a space booster utilizing the ATLAS ICBM as the first stage, providing a greatly increased payload capacity. A hydrazine engine with multi-start capability was developed for the ATLAS boosted vehicles to permit mid-course vernier control and to provide controlled thrust to inject the vehicle into orbit about another planet. Under the ABLE-3 and 4 programs, a solar cell power supply system was developed and extensive original design of satellite vehicle command, telemetry, and communication equipment was accomplished.

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



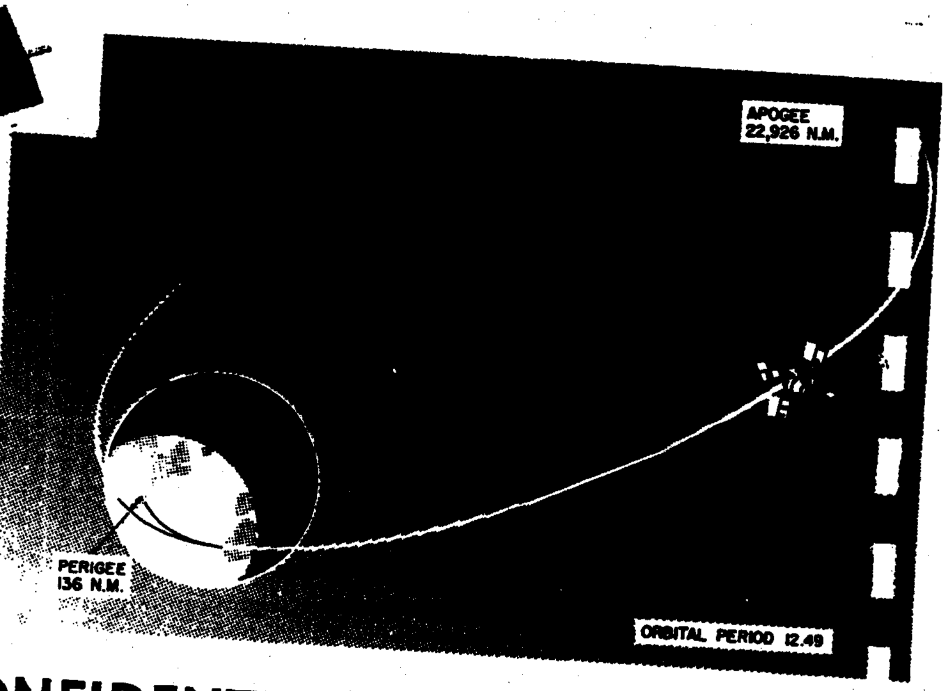


Figure 2. ABLE-3 third stage and payload (above) with solar paddles fully extended. Drawing of extremely elliptical orbit achieved by ABLE-3 (EXPLORER VI).

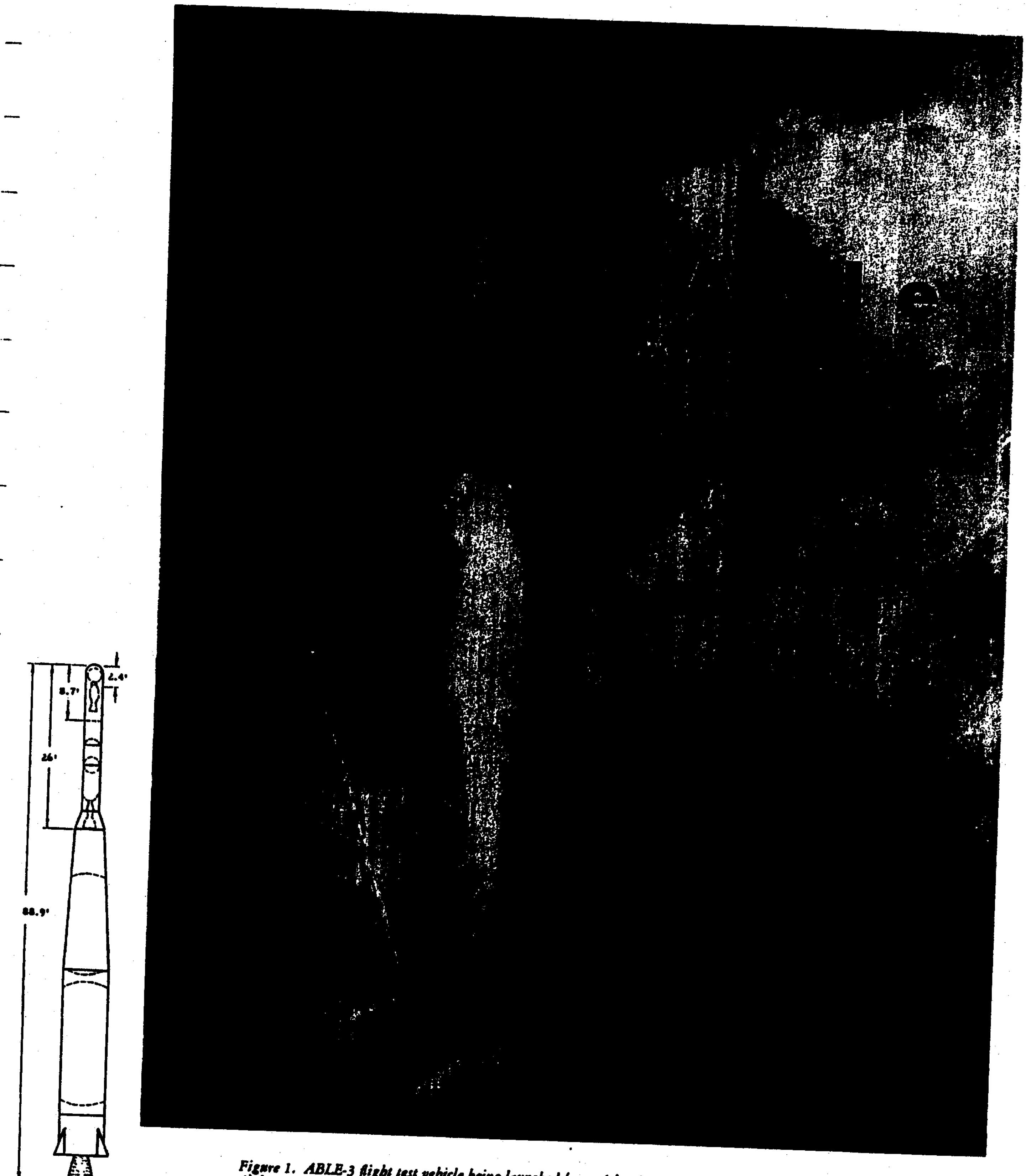
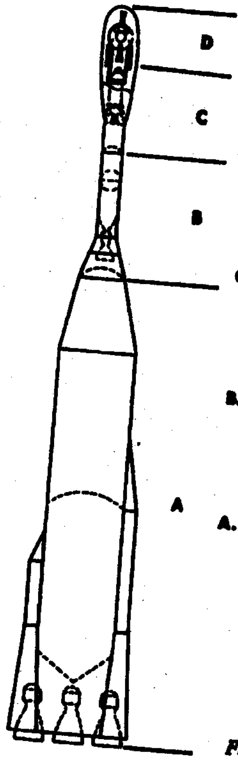


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.



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

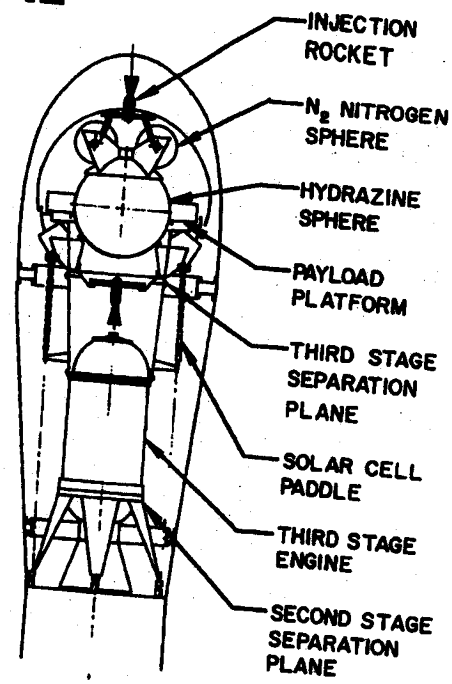
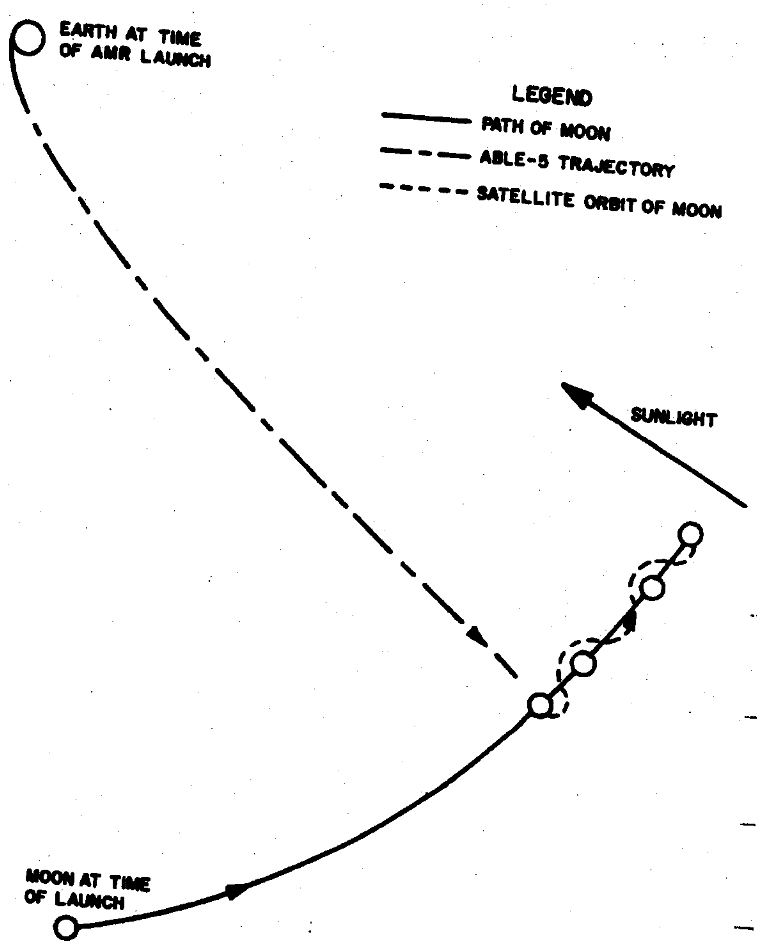


Figure 5. ABLE-5 vehicle configuration drawing and specification list. Third stage and payload configuration (right). Trajectory of ABLE-5 into lunar orbit is shown in drawing (below).

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

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



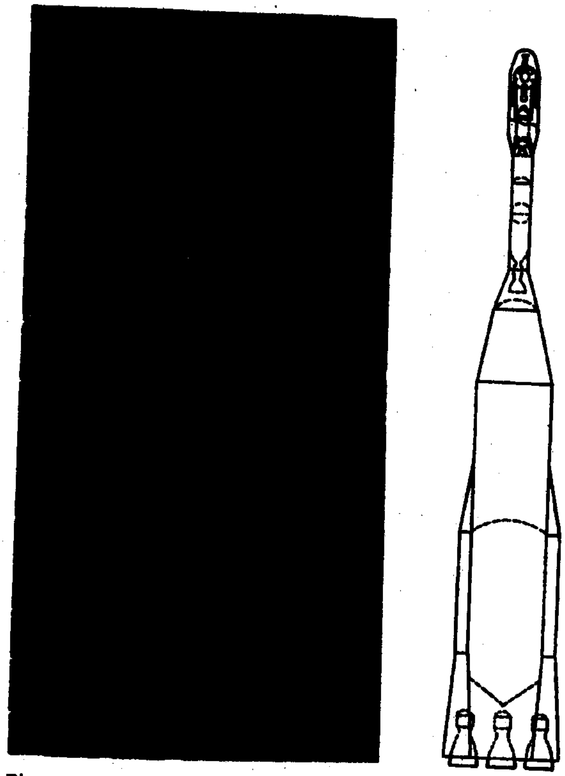


Figure 3. ABLE-4 ATLAS vehicle configuration drawing and photo of vehicle installed on Atlantic Missile Range launch stand 12.

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

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

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

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

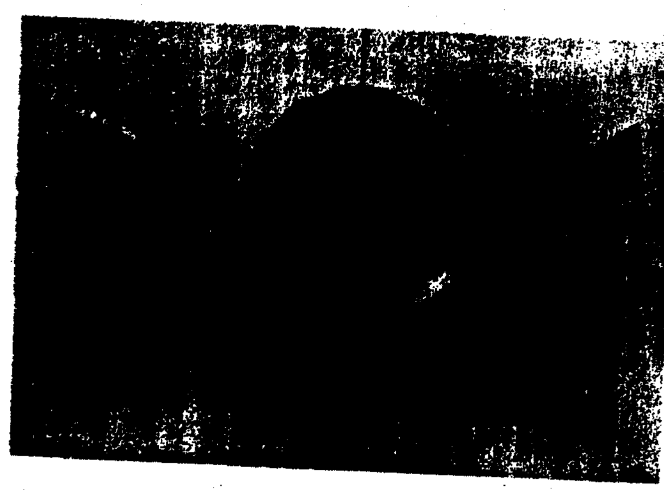


Figure 4. PIONEER V satellite vehicle shown in orbital flight position. This solar satellite was launched from the Atlantic Missile Range on 11 March 1960.

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

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

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

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

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

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

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

Ground Support Program

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

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

South Point, Hawaii—track vehicle for 11 hours starting 6 hours after launch, transmission of commands, including vernier corrections as necessary. Other support stations that will track and record data from the vehicle during periods of tracking by the primary stations include Singapore, Goldstone, Millstone Hill, and NASA minitrack stations. 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 in the second stage propulsion system at ignition, and as a result, the objectives of this flight were not met.

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

1. An interplanetary magnetic field exists with a steady magnitude of more than one Gamma and a peak of up to ten Gamma. This field fluctuates in a manner that is connected to solar flare activity.
2. The planar angle of the interplanetary magnetic field forms a large angle (about 90 degrees) with the plane of the elliptic.
3. The exospheric ring current of 25,000 miles diameter encircles the earth as a giant doughnut at a distance of 40,000 miles from earth. The five million ampere current moves westward around the earth.
4. The geophysical magnetic field extends at times to 65,000 miles and this field oscillates in intensity in the outermost exosphere.
5. The sudden decrease in galactic cosmic rays (the Forbush decrease) always associated with large solar flares does not depend on the presence of the earth's magnetic field. This unexpected discovery will require formulation of a new theory to explain the Forbush decrease.
6. Penetrating radiation in space is not limited to the Van Allen belts. At least during periods of solar activity 5 to 50 Roentgens per hour are incident on the satellite.
7. Energetic particles in the Van Allen radiation belts are not ejected directly from the solar wind. Some process for particle acceleration must exist in the belt.

ABLE-5

The ABLE-5 program provides for launch of two ATLAS-ABLE vehicles to place satellites into lunar orbits late in 1960. A proposed ATLAS/ABLE lunar program was submitted to AFBMD by NASA on 4 February 1960, following discussions between AFBMD and the NASA Goddard Space Flight Center in January.

Program Objectives

1. Place a satellite into lunar orbit with an apolune of 5,000 nautical miles and perilune of 3,500 nautical miles.

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

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

4. Successful conduct of payload experiments.

Program Vehicle (Figure 5.)

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

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

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

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

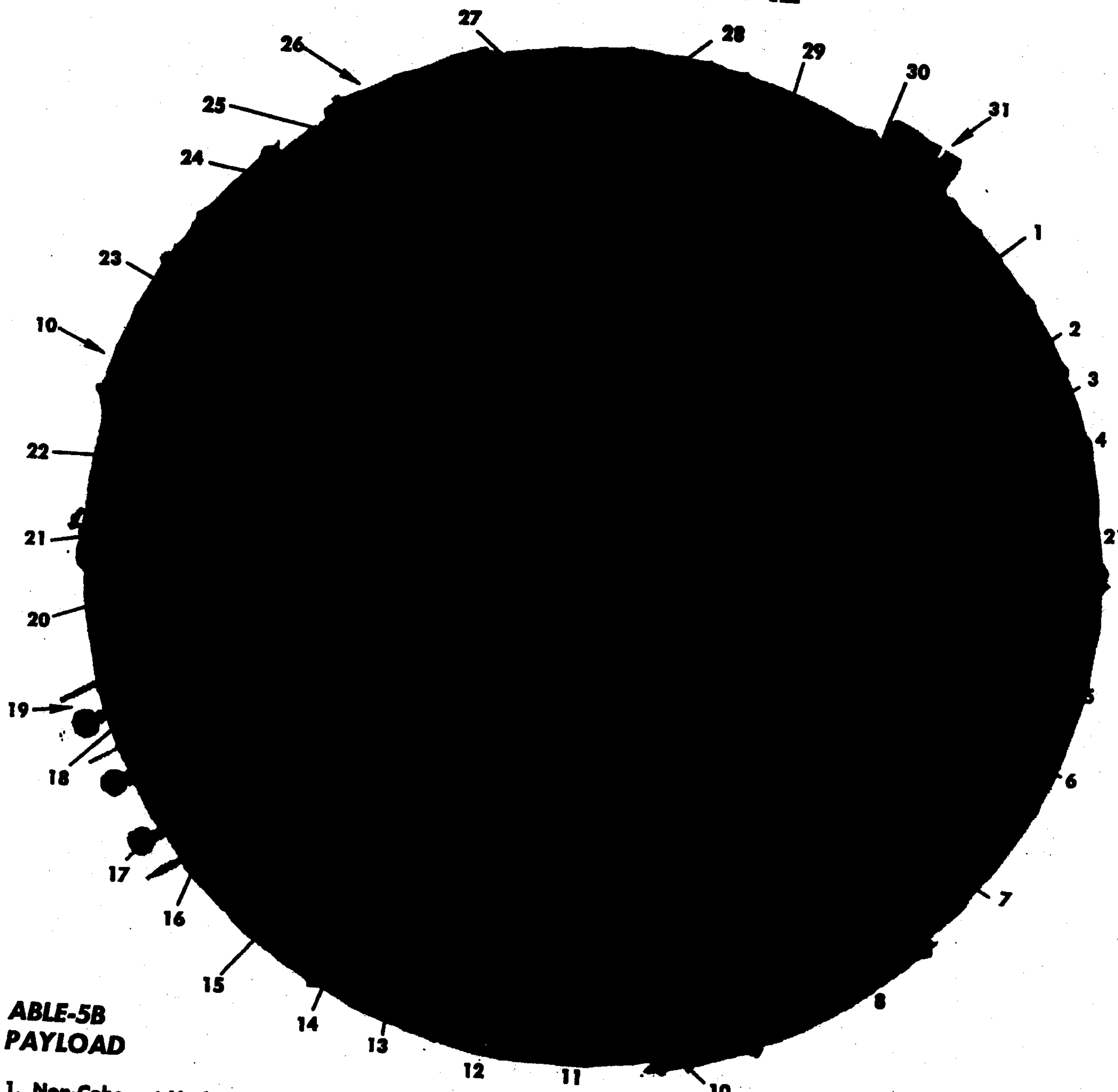
Launch and Powered Flight

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

Orbital Characteristics

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

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



ABLE-5B PAYLOAD

1. Non-Coherent Modulator
2. Non-Coherent Transmitter
3. Coherent Transmitter
4. Battery Pack, 3-4
5. Coherent Modulator
6. Diplexer
7. Power Distribution Box
8. Receiver
9. Digital Decoder
10. Micrometeorite Diaphragm
11. Flux Gate Magnetometer Logic and Amplifier
12. Micrometeorite Amplifier
13. Low Energy Scintillation Counter
14. No. 1 Converter (Experiment Supply)
15. Scintillation Spectrometer Sensor
16. Angular Accelerometer
17. Micrometeorite Scaler
18. Scintillation Spectrometer Logic
19. Material Coating Probes
20. Low Energy Scintillation Logic
21. Nitrogen Tanks (Main Pressurizing)
22. Battery Pack, 1-2
23. Digital Telemetry Unit
24. Phase Comparison Analyzer & Spin Coil
25. Telemetry Signal Conditioner
26. Plasma Probe
27. Cosmic Ray Telescope
28. Solid State Detector
29. Ion Chamber, Geiger-Mueller Counter
30. Coherent and Non-Coherent Converters
31. Sun Scanner
32. Antennas
33. Injection Thrust Chamber
34. Hydrazine Tank
35. Auxiliary Pressurization Nitrogen Tank

Monthly Progress—ABLE Programs

Program Administration

• Representatives from Space Technology Laboratories, National Aeronautics and Space Administration, and the Air Force Ballistic Missile Division met on 21-23 November to review all phases of the ABLE-5B program. The status of the vehicle in preparation for the launch was presented in detail. The program is progressing satisfactorily toward a launch date of 14 December. Alternate launch dates in this lunar period are available from 15-17 December.

Technical Progress

First Stage

• Hangar checkout of ATLAS 91D was initiated on 31 October and completed on 16 November. Electrical and mechanical components of the booster subsystems were inspected and checked out with no significant problems being encountered. The booster was erected on stand on 17 November following completion of autopilot, hydraulic, and electrical systems tests; installation and checkout of the guidance and range safety equipment; and preliminary calibration of the telemetry system. Compatibility checks of the booster and ground support subsystems are progressing satisfactorily with completion scheduled for 2 December. The Flight Acceptance Composite Test is scheduled for completion on 5 December. The Flight Readiness Demonstration will be accomplished on 7 December in preparation for the 14 December launch.

Second Stage

• The fabrication and checkout of the ABLE stage vehicle was accomplished on schedule. Galling of the monoball thrust bearing assembly mating surfaces necessitated an emergency program to develop a solution. A lubricant was found which offered a satisfactory degree of resistance to nitric acid fumes and evaporation during second stage engine operation at altitude. The monoball was ultrasonically cleaned and a lubricated bearing was installed and checked out satisfactorily prior to reinstallation in the vehicle.

• A live firing test of the second stage modifications was completed on 19 November. The test demonstrated the effectiveness of the enlarged blast ports in the Stage I/II interstage structure to reduce pressure build up in the thrust chamber area during second stage ignition. The modified explosive bolt blast shields were determined to be effective in controlling fragmentation of the bolts. The modified Stage I blast shield proved its structural soundness in withstanding the Stage II blast effects.

• The second stage was airlifted to Florida on 21 November. Following receiving inspections and hangar checks, the stage will be mated to the first stage, on stand, on 2 December. A combined first and second stage Flight Acceptance Composite Test is scheduled for accomplishment on 5 December, and the combined Flight Readiness Demonstration will be completed on 7 December.

Third Stage

• The third stage Allegheny Ballistics Laboratory ABL-X248A-9 flight engine was delivered to Florida on 27 November. The flight spare engine is scheduled for delivery on 5 December. These engines are approximately two pounds low on propellant weight due to manufacturing tolerances. Their characteristics are closely matched, providing a maximum degree of interchangeability. The velocity deficiency can be made up by the second stage without significant reduction in mission success probability. After completion of alignment and balance checks at the AMR, the third stage will be attached to the second stage, on stand, on 9 December.

Satellite Vehicle

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

• Thermal vacuum and Environmental Acceptance testing on the satellite vehicle was completed during the month. Additional tests were found necessary to complete the qualification of the University of Chicago solid-state detector and the diplexer for the coherent receiver and transmitter system. These units are being modified as a result of discrepancies observed in the thermal vacuum test program. The modified units will be installed on the satellite vehicle in Florida.

• The satellite vehicle, shipped to Florida on 27 November, will be erected on stand on 12 December. Final integrated systems testing will be accomplished on 10 December.

• A life endurance test on the components and subsystems as designed for the ABLE-5 program was accomplished early in November. The test was designed to investigate the possibility of fatigue failures arising from the necessity for re-testing reworked or modified components. The test was completed successfully indicating a substantial margin of fatigue failure resistance inherent in the design of these units.

Ground Guidance System

• Checkout of the Hughes Ground Guidance Computer has been successfully completed in Florida. The computer interconnection with the Burroughs Mod III first stage guidance computer has also been completed and checked out. The Burroughs Mod I operation was tested concurrently and no interference was found. Guidance equations for the computers have been written and final constants are being determined.

Ground Stations

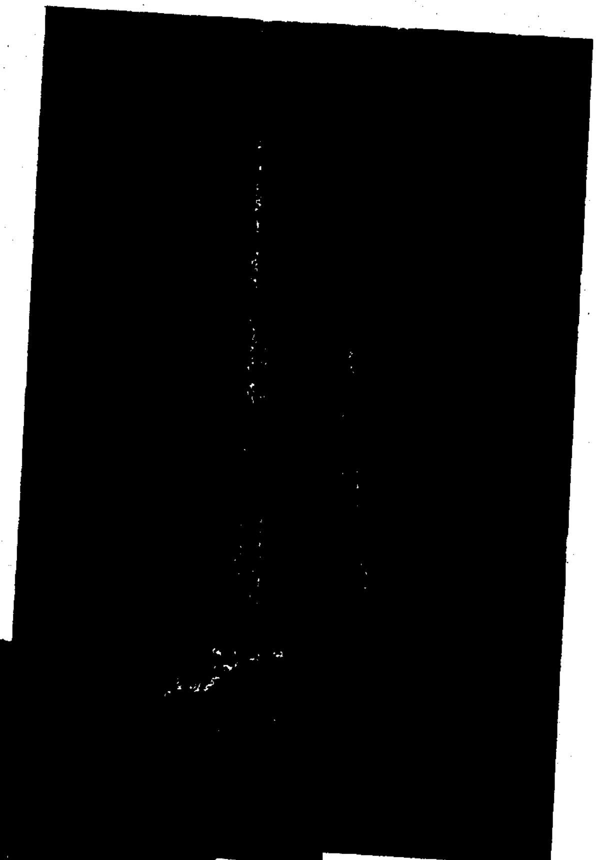
• The Hawaii TLM-18 antenna is undergoing minor repair modification in preparation for the ABLE-5B launch. A new azimuth servo control installation is being readied. After completion of the installation, the antenna will be aligned in azimuth and elevation.

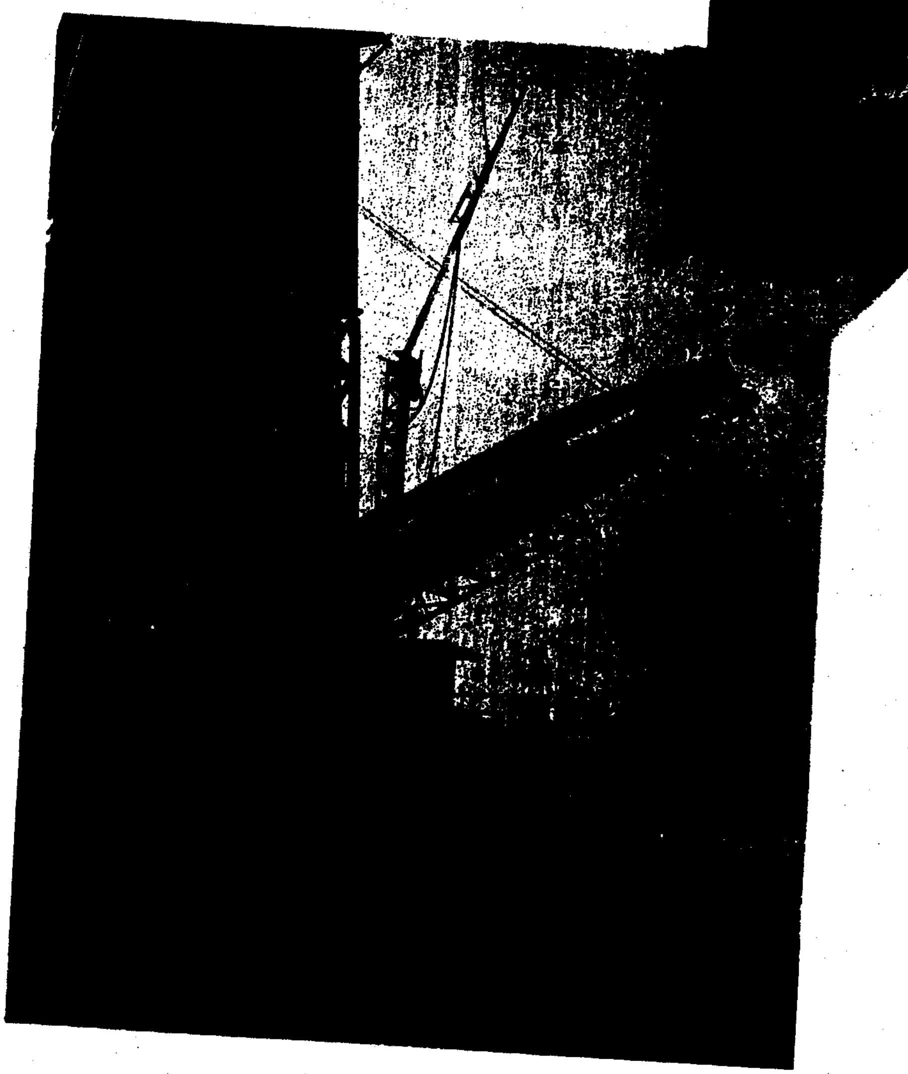
• The Manchester station is in operational standby status.

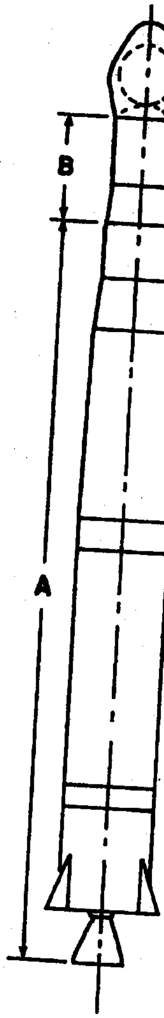
• All AFMTC ABLE station equipment is in operational status. Prelaunch checkout and calibration will be completed with a practice exercise on a launch tracking operation.

• The Singapore Station Rantec antenna drive motor output coupling clutch has been repaired and work is in progress to reduce the noise in the output of the parametric amplifier.

Figure 6. Delivery of ATLAS 91D booster (right) to the launch stand on 17 November. The Flight Readiness Demonstration will be accomplished on 7 December in preparation for the 14 December launch. Booster and transporter (below) during erection on Atlantic Missile Range Stand 12.







B. SECOND STAGE—ABLESTAR (AJ10-104)

Thrust at altitude	8030 pounds
Specific impulse (vac)	278 seconds
Total impulse (min)	2.3 × 10⁶ lbs/sec
Burning time	294 seconds
Propellant	Liquid

A. FIRST STAGE—THOR IRBM

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

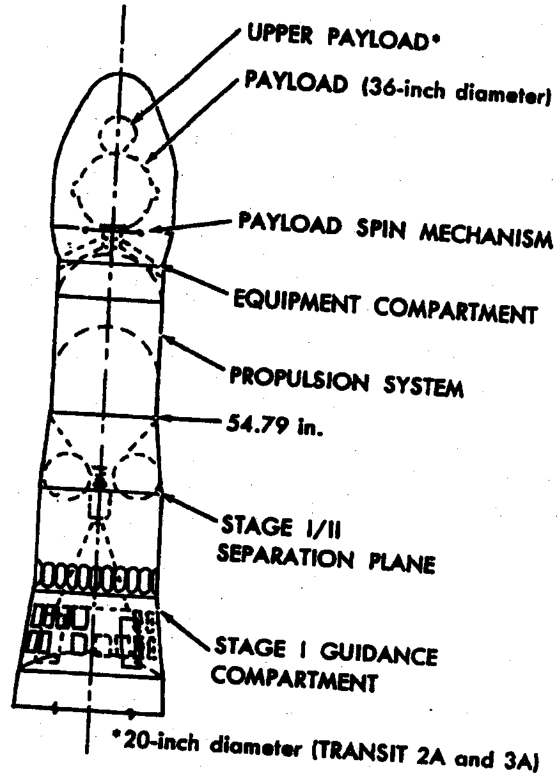


Figure 3. Two stage vehicle used for TRANSIT 1B and subsequent flights.

Program Objectives

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

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

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

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

Transit

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

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

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

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

C. FIRST STAGE—THOR IRBM

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

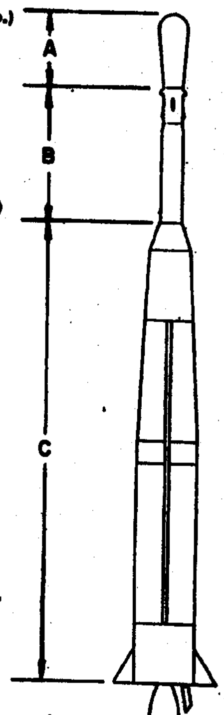
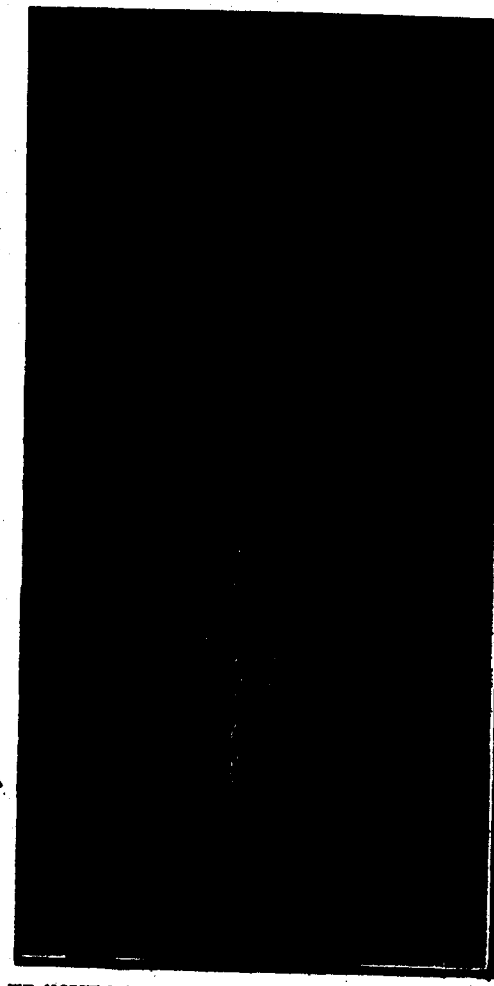


Figure 1. TRANSIT 1A three stage flight vehicle.



TRANSIT 1A launched from Atlantic Missile Range

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

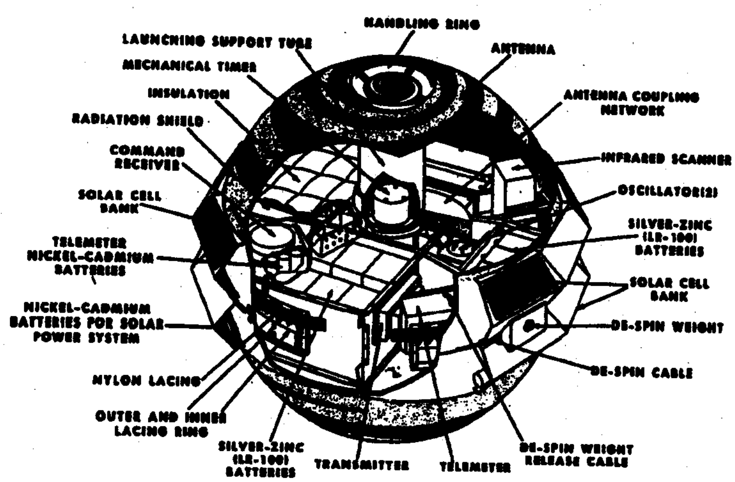
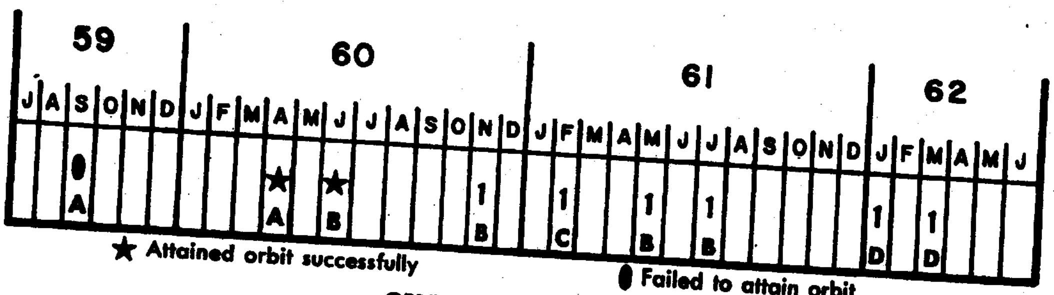


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV 1).

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.



ORBIT INCLINATION ANGLES

A. 50° B. 67.5 C. 28.5

D. 22.5 (unconfirmed)

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 and coasted, then on command fired again.*
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, did not adversely affect the orbit, but has been corrected.*

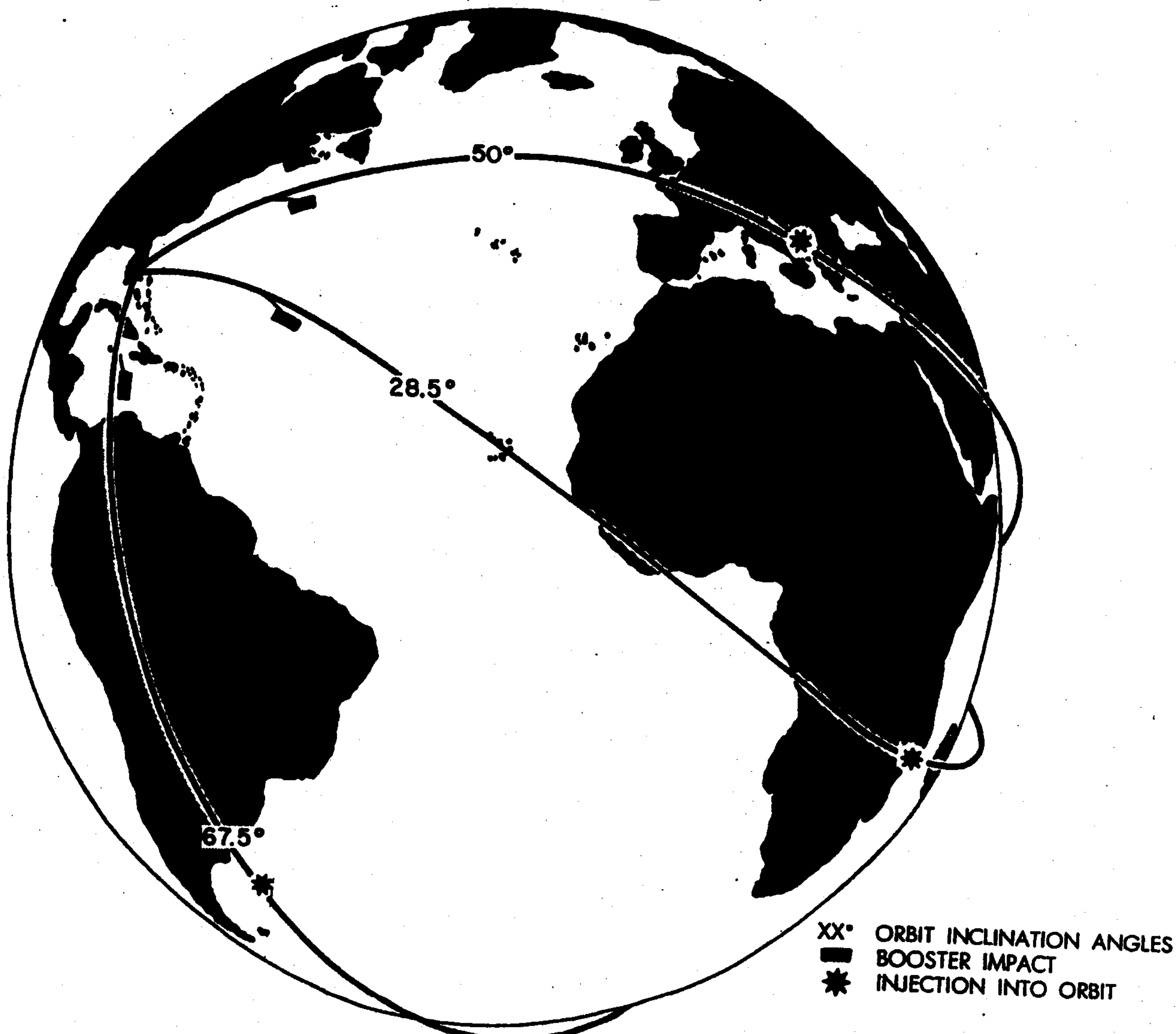


Figure 4. Typical TRANSIT launch trajectories showing flight path, booster impact areas, and orbital injection points.

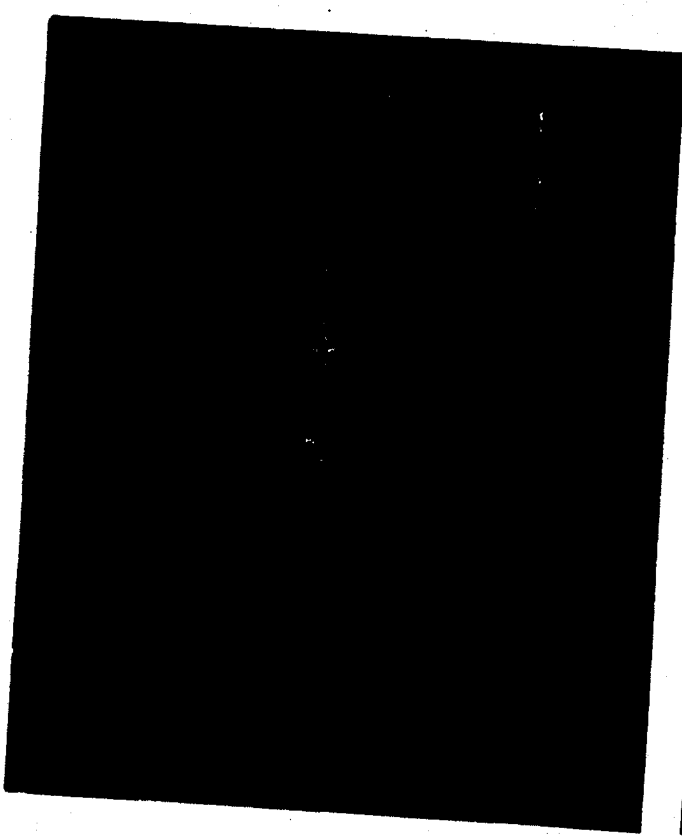
Orbital Performance Achievement of program objectives is based primarily on measuring the doppler shift of satellite transmitted radio signals. During the first three months of flight, the four transmitters will be operated to obtain experimental confirmation of the theoretical mathematical relationship 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.

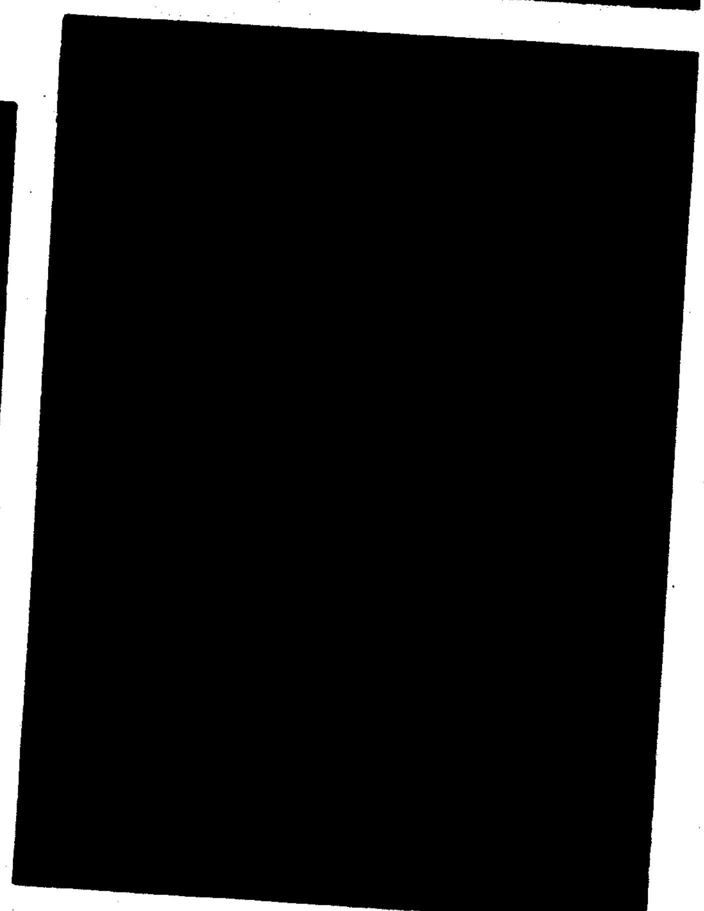
Ground Support and Tracking Stations The Navy Bureau of Weapons payload contractor provides a system of payload tracking stations which obtain information for precise orbit determination. These stations are located in Maryland, Texas, New Mexico, Newfoundland and Brazil. First and second stage tracking 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.

TRANSIT 3A — First Stage

Delivery of THOR booster to gantry for Atlantic Missile Range Launch Complex 17

Lifting THOR booster from transporter trailer onto gantry (below) Gantry positioned over launch stand and booster being lowered into place





Monthly Progress—TRANSIT Program

Program Administration

• The U.S. Navy (BuWeps) has given program approval for five additional TRANSIT launches. The launch schedule and tentative orbit inclinations are shown on the opposite page. Exact launch dates for the last four flights and the orbit inclination angle for the last two flights are as yet unconfirmed. To attain an orbit inclination angle (22.5 degrees) which is lower than the latitude of the launch site (28.5 degrees north latitude in the case of AMR Complex 17) requires a yaw maneuver after launch. The capability of the Thor Ablestar vehicle to produce this orbit with the Navy's requested payload weight has not yet been established. Recent discussions with the Navy indicate that the requirement for a 22.5 degree inclination angle may be changed.

Flight Test Progress

• The launch of TRANSIT 3A was originally scheduled for 29 November, with an orbit inclination angle of 28.5 degrees. On 11 October, the U.S. Navy (BuWeps) requested that the orbit inclination angle be changed to 67.5 degrees. This change required that the downrange tracking station be moved from Pretoria, Union of South Africa, to Punta Arenas, Chile. The launch was slipped one day to 30 November because of the late arrival of the range safety plan at the Atlantic Missile Range.

• At 1950 Z (1150 PST), 30 November, TRANSIT 3A was launched from stand 17B at the Atlantic Missile Range. The flight appeared normal until the THOR first stage shutdown prematurely at approximately T plus 152 seconds. The Ablestar second stage was ignited and separated and operated without incident until approximately T plus 312 seconds when it was shut down by the Range Safety Officer. Both stages were exploded by Range Safety Officer at approximately T plus 325 seconds. The exact cause of the premature shutdown of the THOR is being investigated.

• Objectives of the TRANSIT 3A flight were as follows:

1. Place the satellite into a circular earth orbit with an inclination of 67.5 degrees and a three sigma probability that the perigee and apogee will remain within 400 and 600 nautical miles, respectively.

2. Evaluate performance of the second-stage guidance and flight control systems.

3. Demonstrate satisfactory operation of the payload equipment.

4. Demonstrate the capability of doppler tracking to provide sufficiently accurate orbits for navigation within the limits imposed by present knowledge of geodesy, ionospheric refraction, and present number, location, and instrumentation of the ground tracking stations.

5. Conduct experiments that will provide information about solar emissions.

6. Conduct experiments to determine effects of the ionosphere on radio signals propagated from a satellite.

7. Conduct experiments to accurately determine the shape of the earth and its force field.

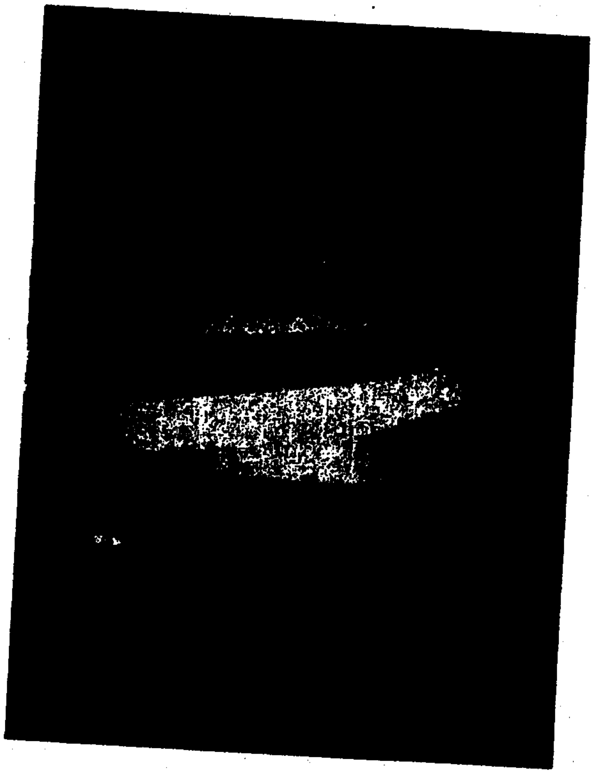
Technical Progress

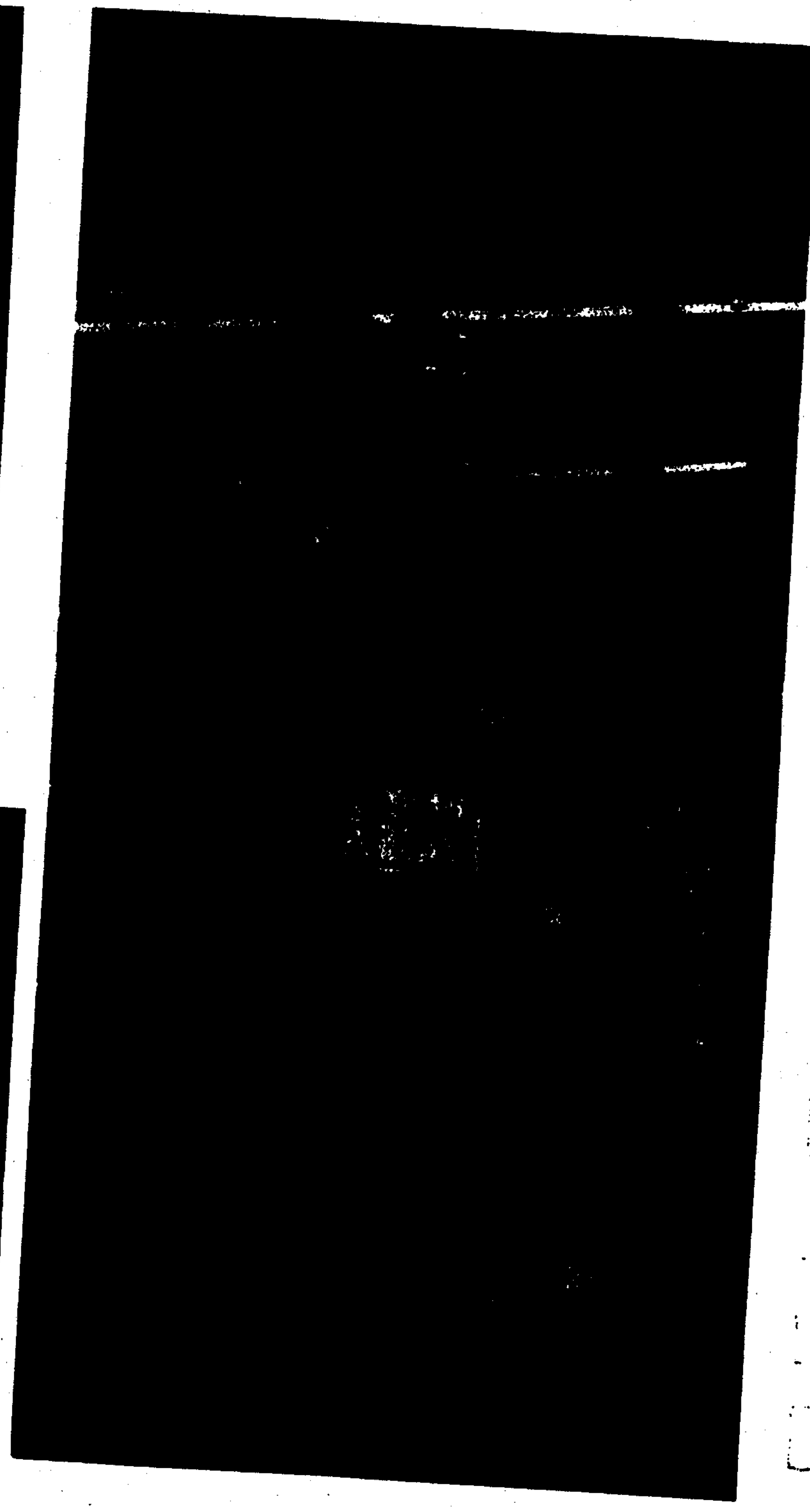
• Thor and Ablestar boosters for future TRANSIT flights are presently being produced and delivered on schedule.

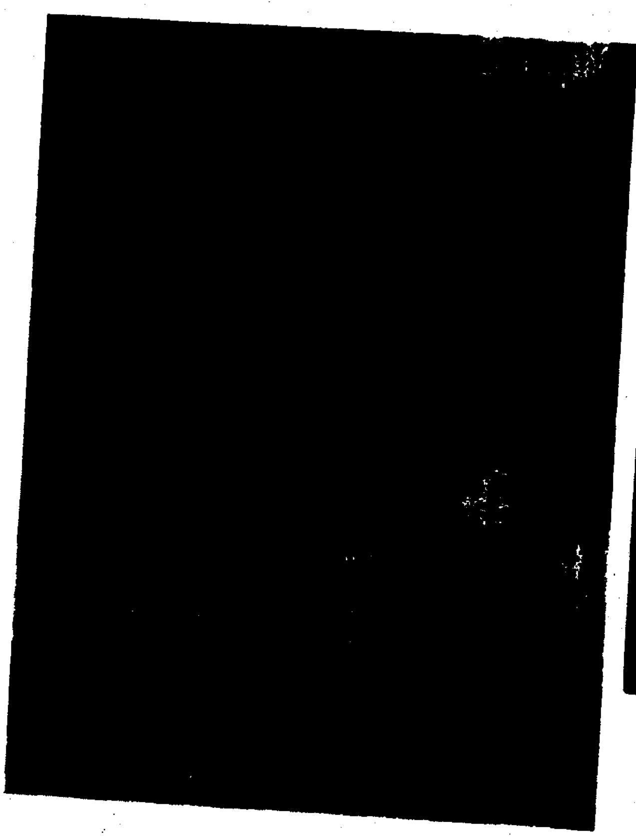
• In accordance with recent high level directives, the mobile downrange tracking station, which was formerly controlled directly by AFBMD, will be turned over to the AMR in early 1961. This station, which is presently located at Punta Arenas, Chile, will be returned to AFBMD to undergo a complete electrical and mechanical overhaul. Modification will be made to allow use of the station by AMR in support of other space programs. Atlantic Missile Range personnel will be trained and checked out in the operation and maintenance of the equipment by the present station contractor.

• Because of the ever-present diplomatic problems associated with a land based mobile tracking and telemetry station, AFBMD is presently investigating the use of an AMR telemetry ship as a primary telemetry receiver during the critical second burn-and-payload injection periods. Modification of a telemetry ship would be required to provide this capability.

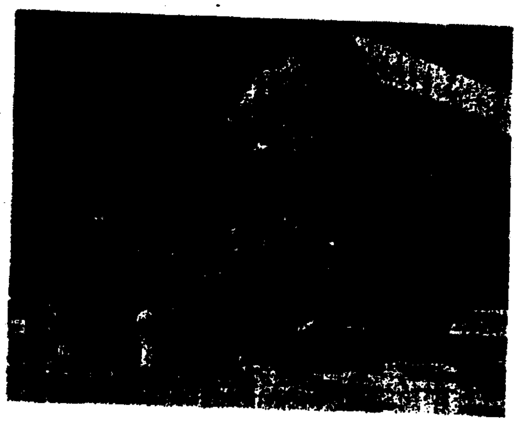
TRANSIT 3A—Payload Installation







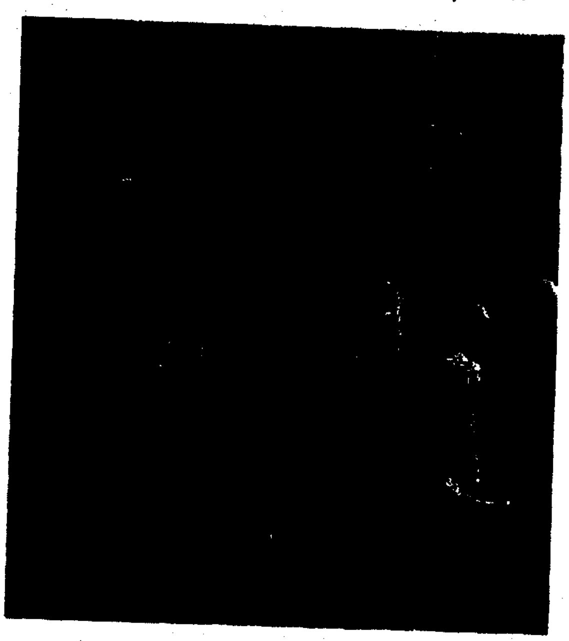
. . . . Second Stage

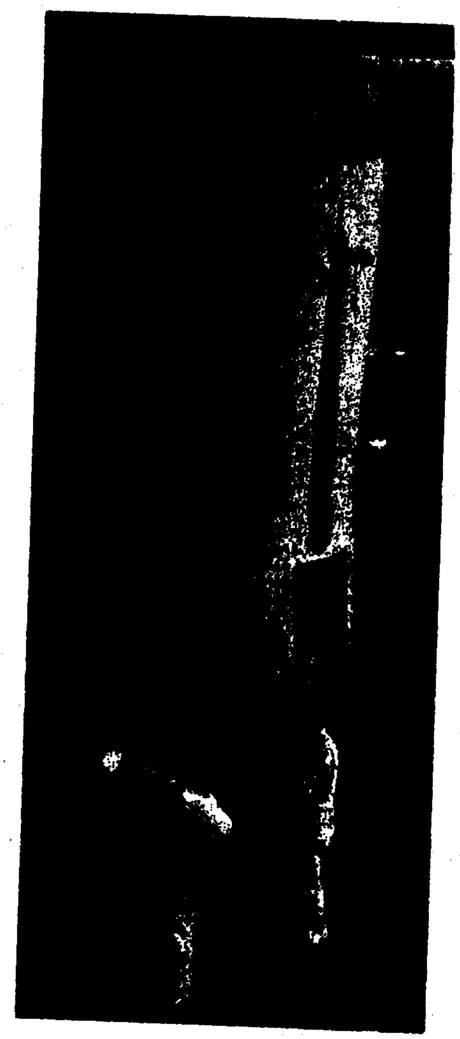


Airlift delivery to Atlantic Missile Range

Hangar checkout of ABLE-STAR second stage vehicle

Delivery of second stage to Launch Complex 17

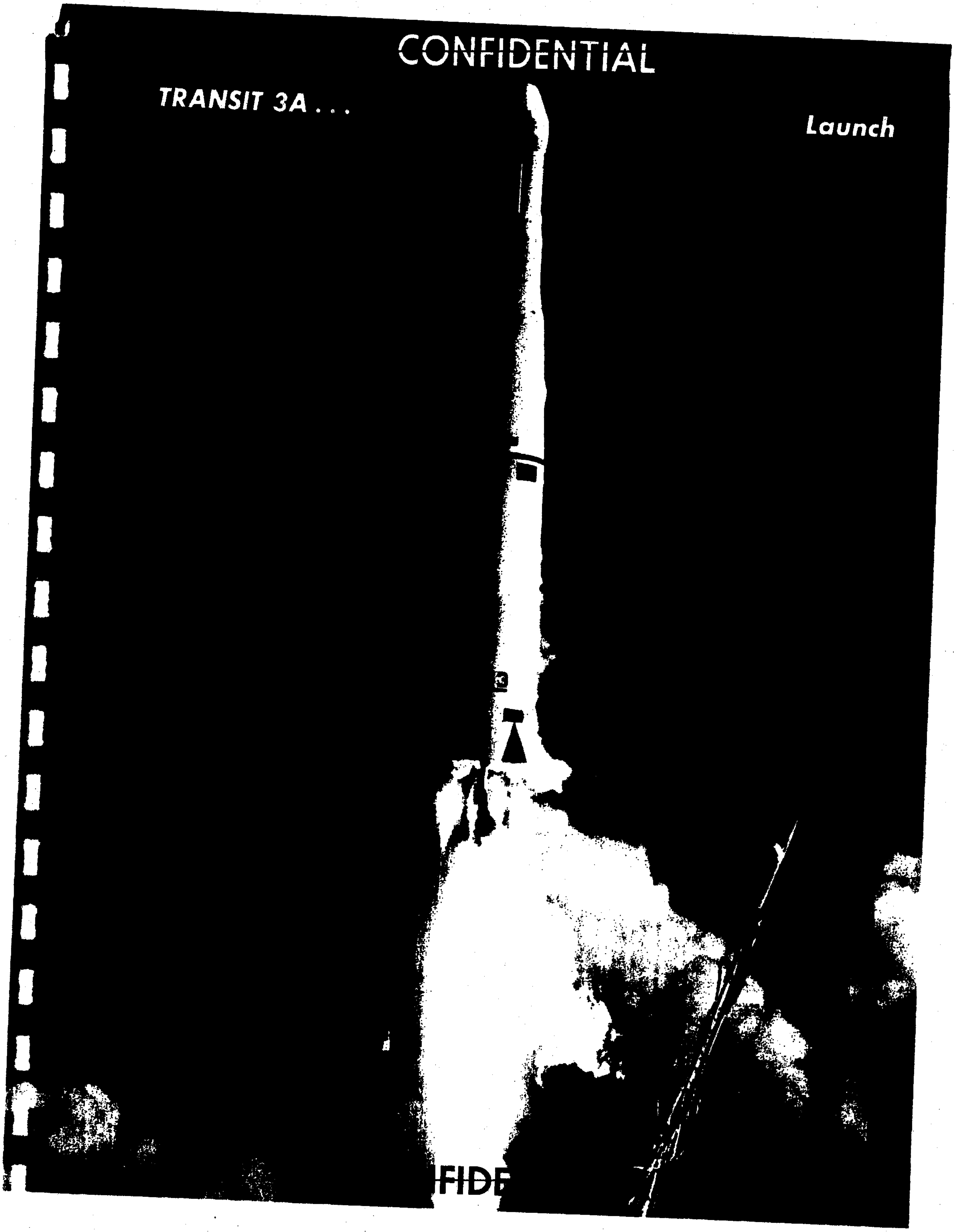




Lifting second stage onto gantry
for installation on THOR booster

TRANSIT 3A . . .

Launch



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.

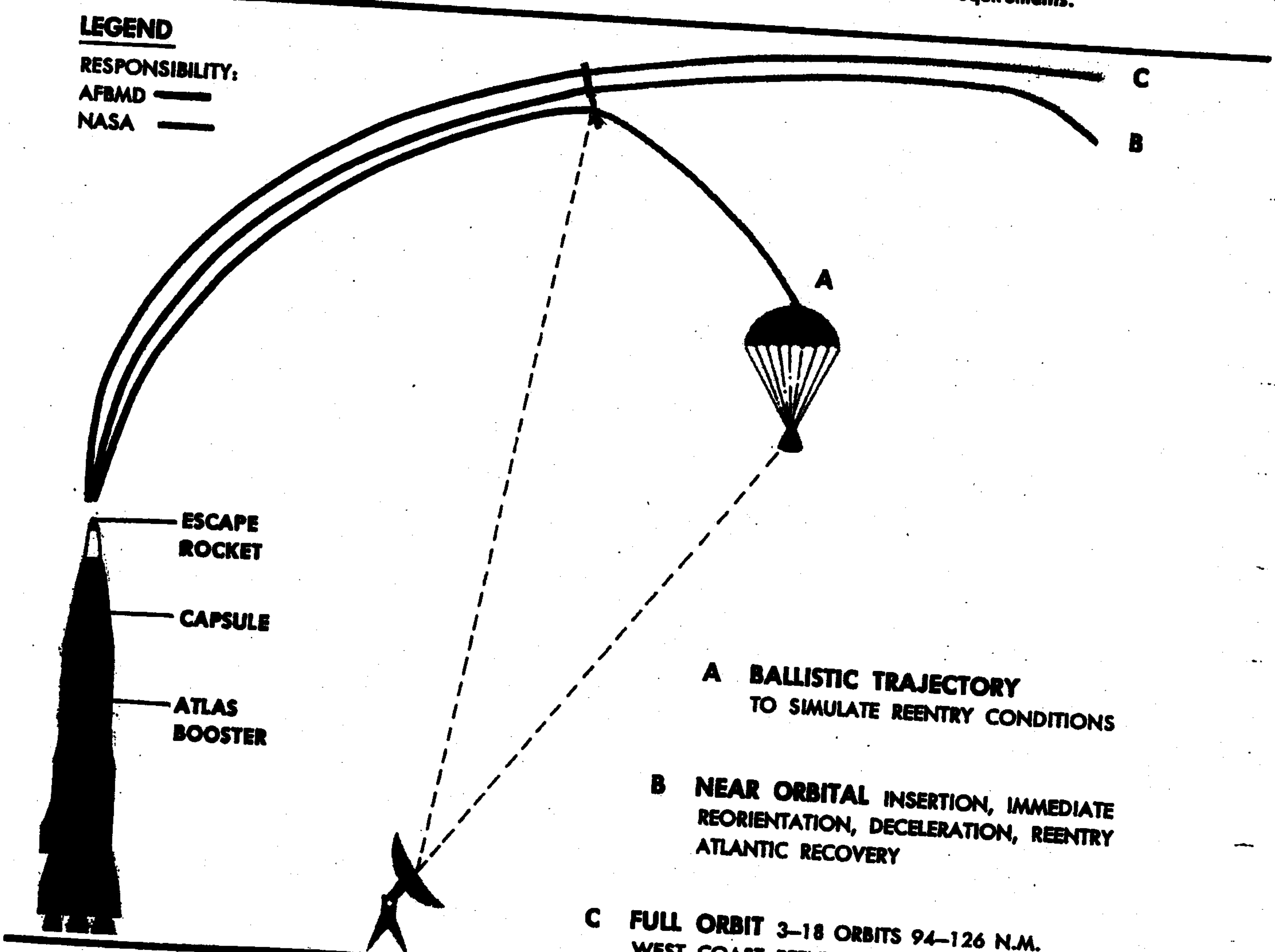
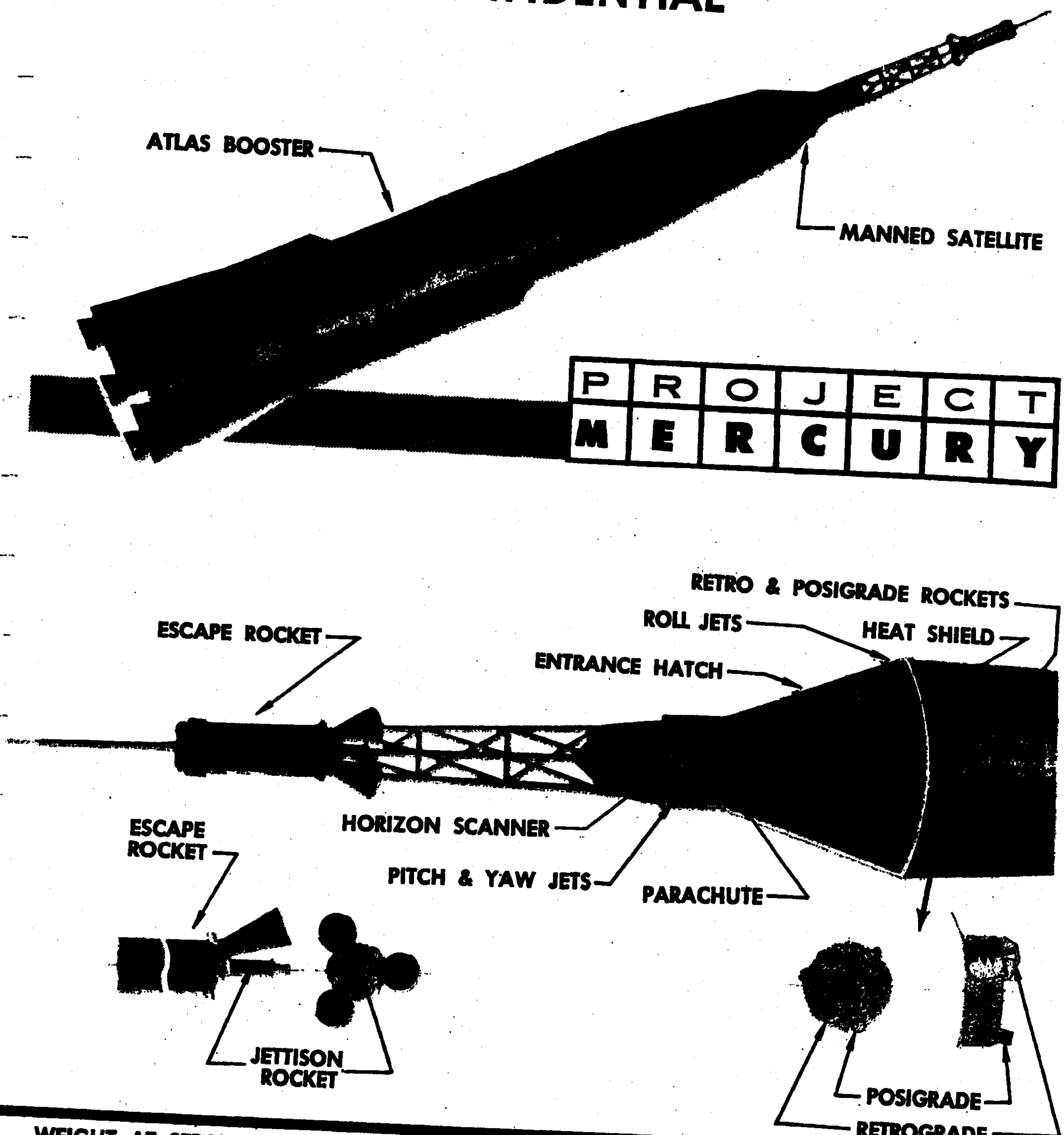


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.



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

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

Design, engineering studies
Equipment modification
Hardware fabrication

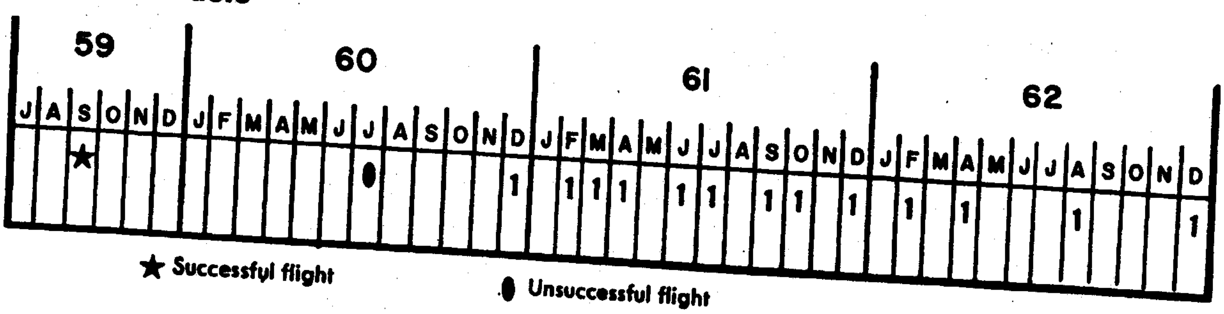
Launch support
Trajectory data
Missile allocation

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



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.*

PROJECT MERCURY

- **NASA Responsibility**
  - Booster-Capsule integration
    Capsule
    Ground support
    Recovery
    - Flight 1
      - NASA Laboratory Capsule
        - Re-entry heating, dynamics, recovery
    - Flight 2 (canceled)
    - Flights 3—16
      - Flight Capsules (McDonnell)
        - Unmanned non-orbital flights
          Manned and unmanned orbital flights
          Launch from AMR
          Earth track 33°N/33°S/Lat. (for orbital flights)
          3—18 orbits
          Orbit altitude:
          Apogee 126 n.m.
          Perigee 94 n.m.
          Automatic pilot safety equipment with manual backup
- **AFBMD Responsibility**
  - Booster
    ATLAS "D"
    - Modified
      - New guidance antennae
        Thin skinned tanks
        Shifted tank bulkheads
        Light weight thrust structure
        Capsule separation mechanism
        Interface electrical connections
        LOX dome protection
        Programmer Modified
        Range safety destruct time delay
        Abort-sensing system
        - (Abort-sensing system) Detects dangerous variations in tank pressures, fuel injector pressure, electrical power, attitude and sustainer hydraulic pressure. Can initiate escape sequence
        - Launch
          - Integrated countdown—including pilot insertion and capsule countdown. AMR launch Stand 14—adapted for pilot and capsule.
            GE ground guidance equipment modified to provide: (a) real time data, (b) additional discrete command signals during powered flight.
            (a) Ballistic trajectory—108°
            (b) Orbital trajectory—072°

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

Monthly Progress — MERCURY Program

Flight Test Progress

- The Flight Readiness Firing of ATLAS 67D (MA-2) booster was conducted on 19 November. The test objectives were to obtain captive test experience on the abort sensing instrumentation system, to investigate effects of vibrations imparted to the booster and to obtain qualitative information from the adapter and upper LOX tank area. Four holds were required for a total of 110 minutes. The holds resulted from (a) capsule hatch installation — 32 minutes, (b) stage II pressurization task — 9 minutes, (c) replace leaking flange gasket in LOX transfer unit — 64 minutes, (d) relay problem in NASA recovery sequence panel — 5 minutes. Ignition, main stage, and shutdown was normal with no resulting abnormal damage to the launch stand. The Flight Readiness Firing was considered successful. A minor discrepancy in the computer loop test was corrected prior to firing and an observed telemetry interference problem has been corrected by changing the frequency of Telemetry No. 1.

- Instrumentation of ATLAS 67D has been reviewed in light of the unsteady airflow test program at Arnold Engineering Development Center and no changes were felt necessary. Strain gauge measurements on the forward LOX tank structure is sufficient to verify the effects on bending moment and should also give an insight into the localized pressure effects.

- The flight test of ATLAS 67D is still scheduled for the week of 5 December although there are indications of a possible slip to January 1961 as a result of the failure of MA-1. Present information indicates a possibility of changes being required in the capsule electrical system to provide additional circuit redundancy. An analysis is being conducted on the ATLAS booster to insure no potential problems of a similar nature exist.

Technical Progress

- The analysis of the unsteady aerodynamic flow over the tower, capsule adapter and forward LOX tank structure has been essentially completed. It was determined that the additional bending moment caused by the unsteady airflow was not of sufficient magnitude to exceed the allowable design bending loads. The effect of localized pressure oscillations on the tank and adapter structure could not be analyzed. However the ratio of internal LOX tank pressure to the measured pressure fluctuations appears to be great enough to preclude localized pressure effects on the LOX tank as causing failure of ATLAS 50D. Results of the test program have been furnished to NASA and McDonnell.

- Space Technology Laboratories had developed a proposal for investigating the effects of pressure and acoustic transients on thin walled structures as a result of the unsteady aerodynamic test program conducted at Arnold Engineering Development Center on the MERCURY configuration. This program is aimed at determining the configuration of the buckling modes and attempting to experimentally determine the relation of certain factors to the buckling phenomena in thin walled pressure vessels. A formal proposal should be forthcoming in early December 1960.

PROJECT 609A

Hyper-Environment Test System

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

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

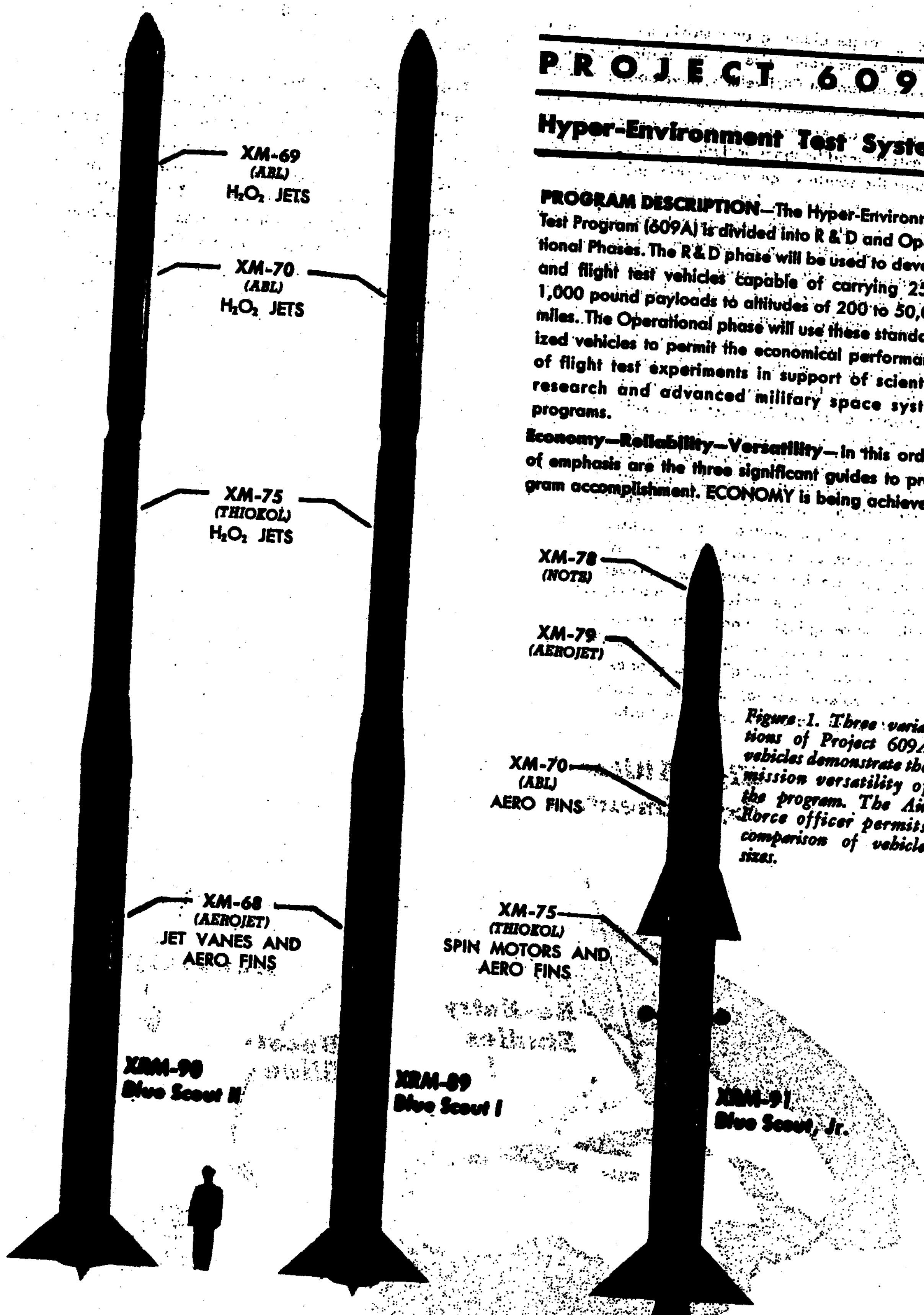


Figure 1. Three variations of Project 609A vehicles demonstrate the mission versatility of the program. The Air Force officer permits comparison of vehicle sizes.

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

Program Management—An abbreviated development plan, covering the R&D phase only, was approved on 9 January 1959. Funds in the amount of $12,651,000 have been made available for this R&D phase of the program only. A letter was issued assigning management responsibility to AFMBD, with emphasis on integrating the program with the scientific and military research experiments conducted on regularly scheduled ballistic missile flight tests (Piggy-back 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.

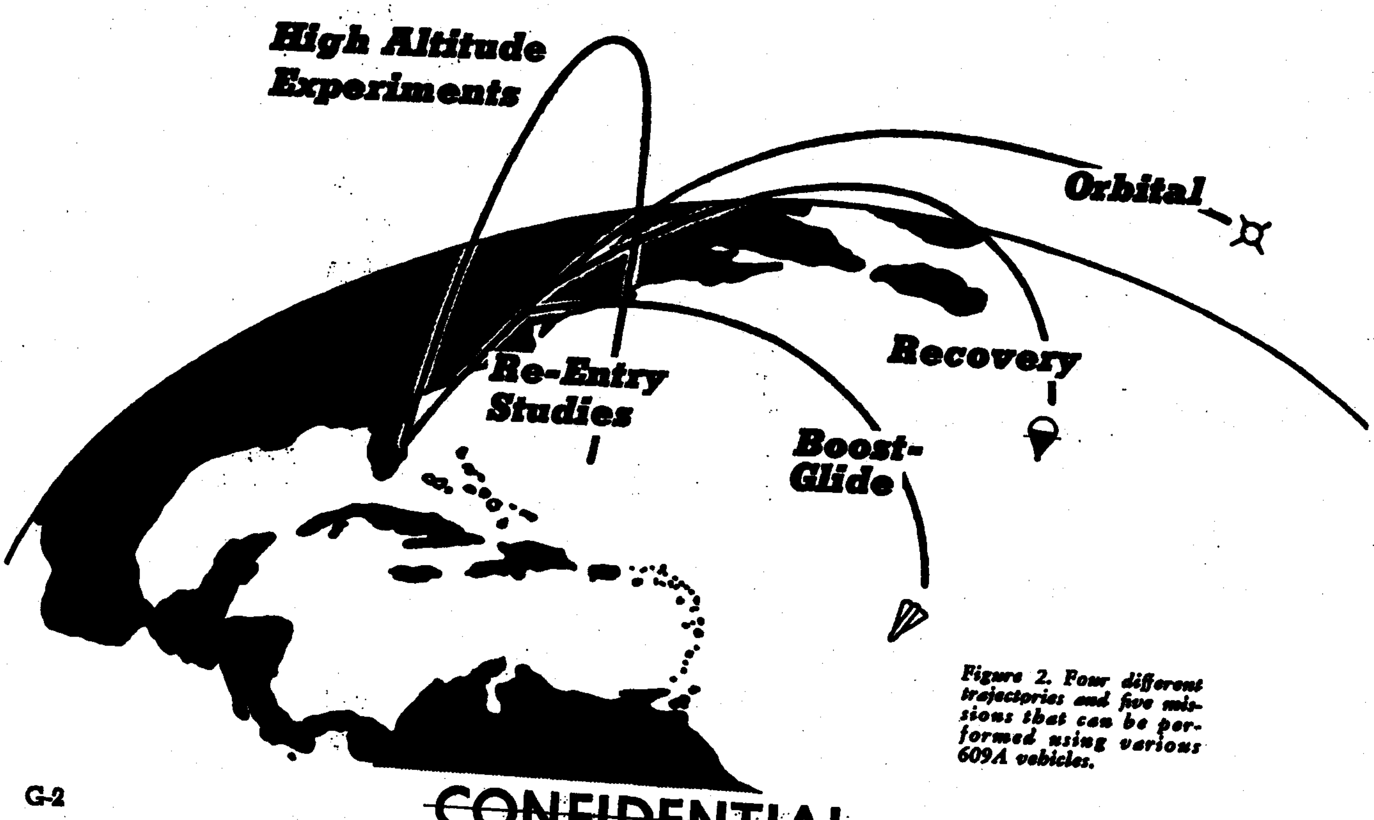
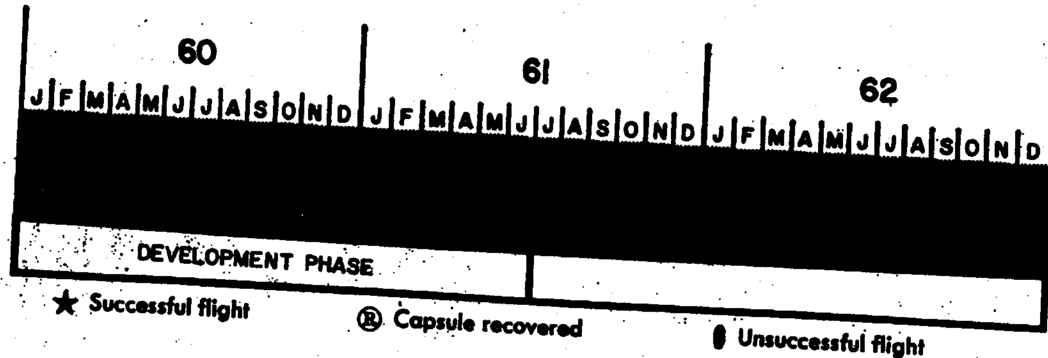


Figure 2. Four different trajectories and five missions that can be performed using various 609A vehicles.

Launch Schedule



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

- Continued requests by interested agencies are being made for performance information, feasibility studies and funding estimates. The Navy Bureau of Weapons plans to develop various payloads which will require boosters with a performance capability similar to that afforded by 609A vehicles. The Navy has requested 609A vehicle configuration and performance data so that they may proceed with payload development. The 609A Project Office is working in close coordination with the ARPA sponsored Vela Hotel Project by providing booster information as needed by the program. Preliminary estimates indicate a requirement for a minimum of four 609A vehicles to support this program. An evaluation has been completed for using an XRM-92 vehicle to boost the Hughes proposed light weight active communication satellite into a 24-hour orbit.

Flight Test Progress

- The second XRM-91 vehicle, with a 29-pound AFSWC payload, was launched from the Atlantic Missile Range at 0817 EST on 8 November. Flight of the booster was normal until after second stage ignition. At T plus 53 seconds the telemetry decayed until the signal became unusable. Long range cameras and radar indicate that an explosion occurred at T plus 62 seconds. There was no evidence of third or fourth stage ignition during the period of telemetry and radar beacon tracking. Tracking continued until vehicle impact which occurred approximately 240 nautical miles downrange.
- Flight data indicate that hot gases escaping from a loose pressure plug in the head of the motor entered the Stage II/III transition section. Continued exposure to these gases would erode the supports for the internal resonant damping paddles which, in turn, could block the nozzle and

cause a pressure increase of sufficient magnitude to rupture the motor case. Telemetry indicated a rapid temperature increase and the long-range cameras recorded the explosion and immediate stoppage of burning. These facts substantiate the failure of the pressure plug.

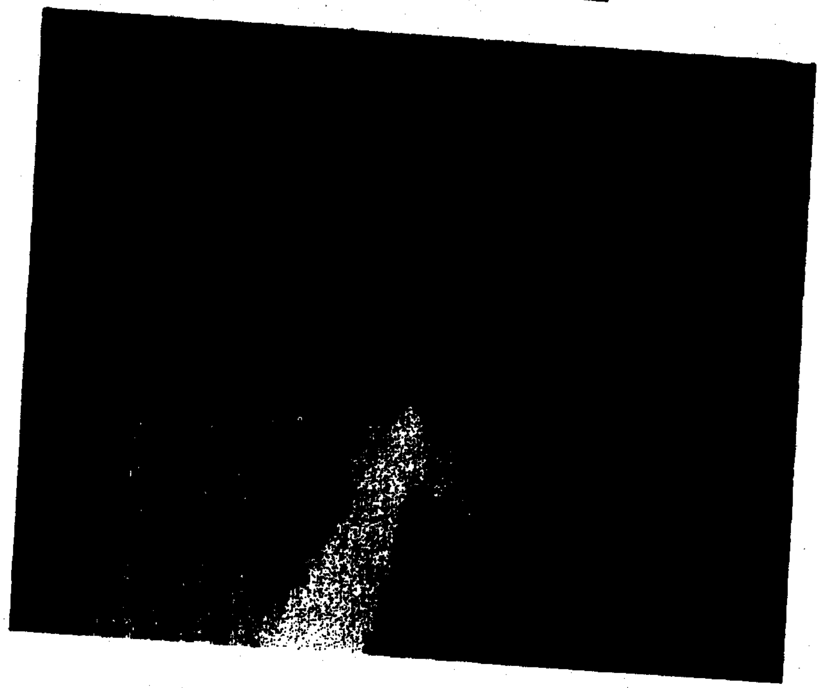
- The third 609A Development Phase launch is scheduled for 8 December. This will be the first launch of a guided XRM-89 vehicle. The "Blue Scout I" vehicle will boost a 500-pound payload to an apogee of approximately 1,000 nautical miles. It is planned that a 90-pound recovery unit will impact near Atlantic Missile Range station number nine thirty minutes after launch.

Technical Progress

- Recovery system drop tests were conducted in support of the 8 December launch on 4, 5 and 9 November. The recovery unit was released from an F-100 aircraft at 40,000 feet altitude and impacted between Atlantic Missile Range stations one and two. Three drops were made; the first and third were successful; the unit was recovered from the ocean during the third test. During the second test the parachute deployed, but the radar beacon and flashing light failed to operate. However, the second unit was recovered. Modification will be incorporated into subsequent recovery units to prevent recurrence of the problems encountered during this series of drop tests.

Figure 3. Air Force Special Weapons Center payload carried on the D-2 "Blue Scout Jr" flight. The XM-78 motor is visible below the payload.

Figure 4. Air Force and Aeronutronic technicians during system checks of the XRM-91 vehicle. This is the smallest vehicle in the 609A Program.



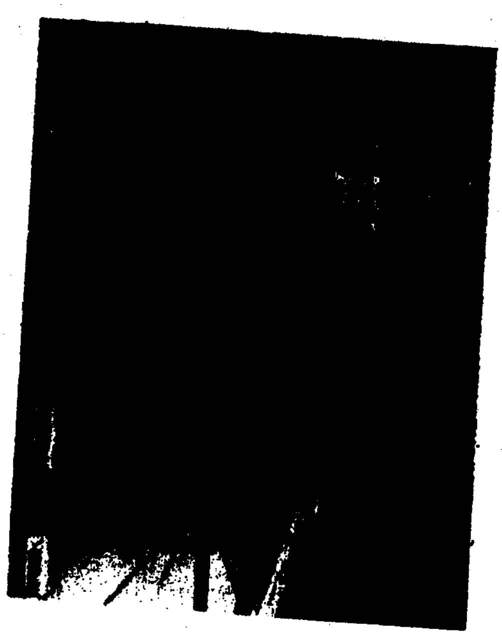
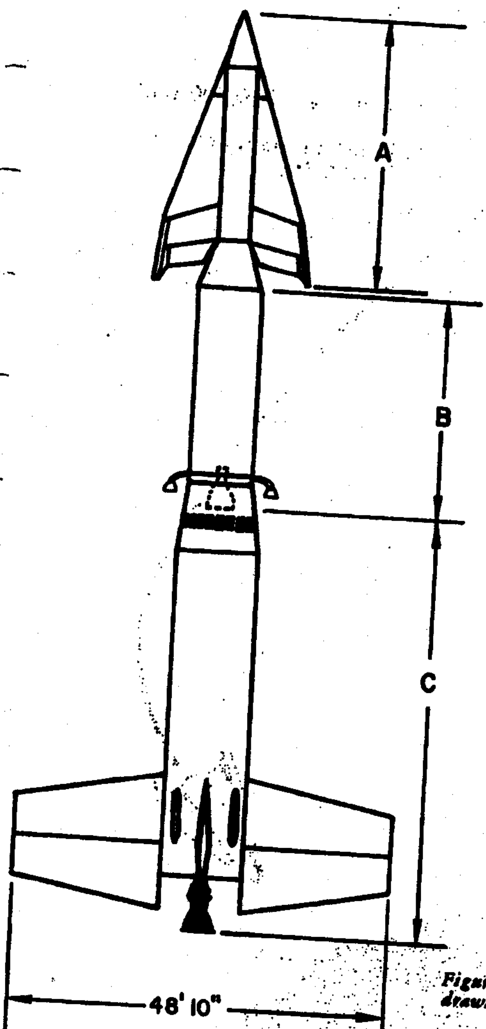


Figure 5. The launch of the second 609A flight vehicle from Atlantic Missile Range launch complex 18. This series of color photographs shows the XRM-91 moving up the launch rail (left) as the payload electrical umbilical (white line to the right of the vehicle) is pulled free. The vehicle (above) just before firing of the spin stabilizing rockets. The "Blue Scout Jr" (top) has cleared the launching rail and the spin stabilizing motors have been ignited.

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

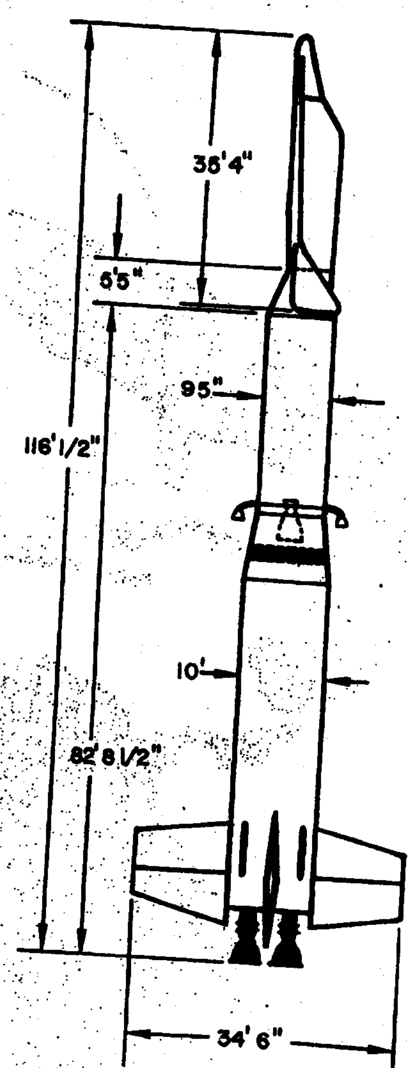
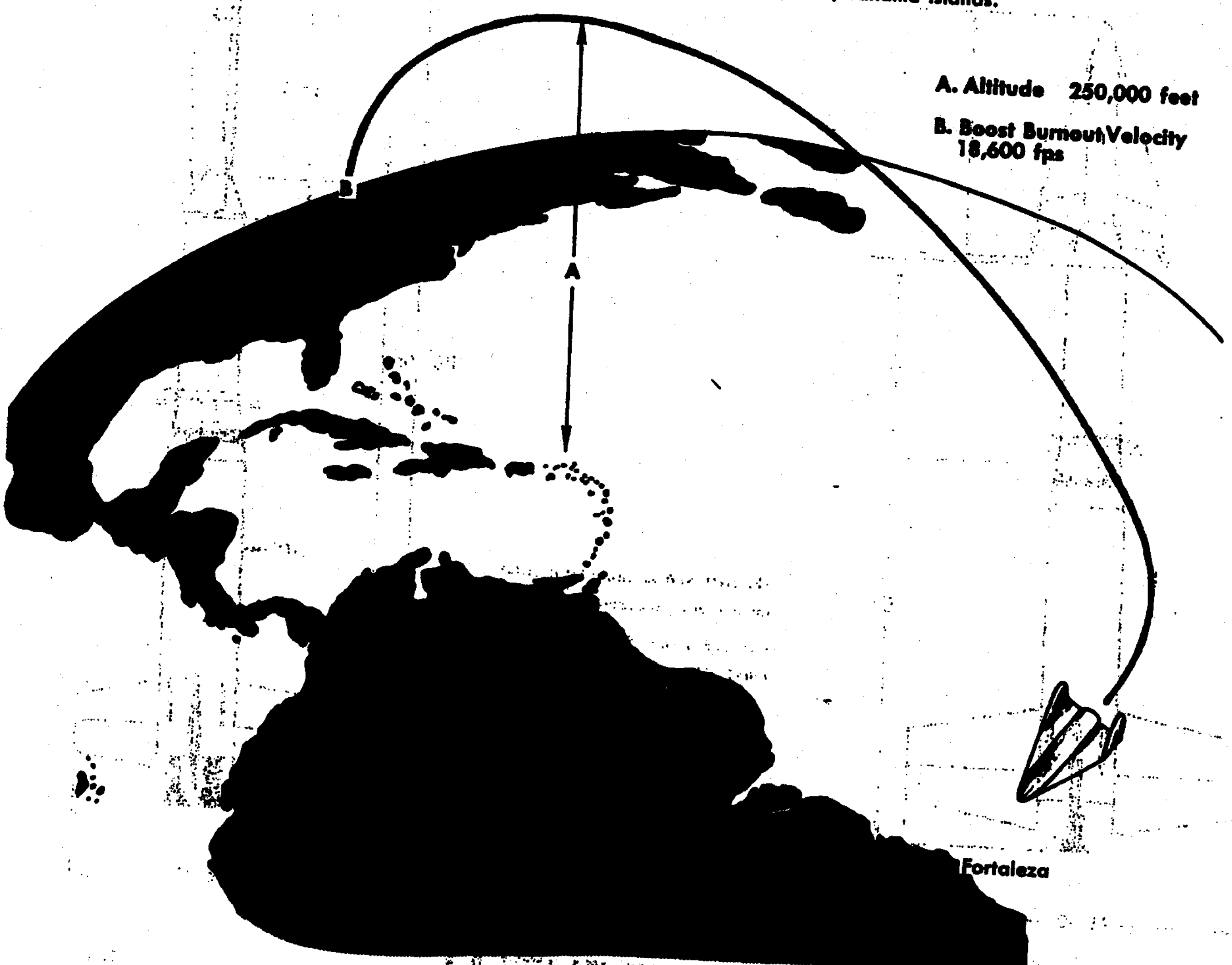


Figure 1. DYNA SOAR vehicle configuration drawing and specification list.

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

- Surplus TITAN ground support equipment (GSE) from Atlantic Missile Range launch complex 15 and 16 will be screened for application to the DYNA SOAR Program. Those GSE items which are excess to TITAN requirements will be made available to the DYNA SOAR Program thereby establishing an economic gain in the GSE area.

- The DYNA SOAR System Program Office has established a Configuration Control Board and the first board meeting is tentatively scheduled on 1 December. AFBMD will have membership on this board.

- A new DYNA SOAR system test philosophy approach calls for two unmanned flights with two air vehicles programmed as backup. Success on these two flights would result in all subsequent flights being manned during Step I. AFBMD position on flight tests is that five (5) unmanned flights are required to gain the necessary level of confidence to permit manned launches.

- NASA representatives from Marshall Space Flight Center visited AFBMD to discuss the NASA proposal for the DYNA SOAR Step II Program which is now under study. NASA desires to have the SATURN booster used for space booster purposes and applied on Step II.

NASA AGENA "B" PROGRAM

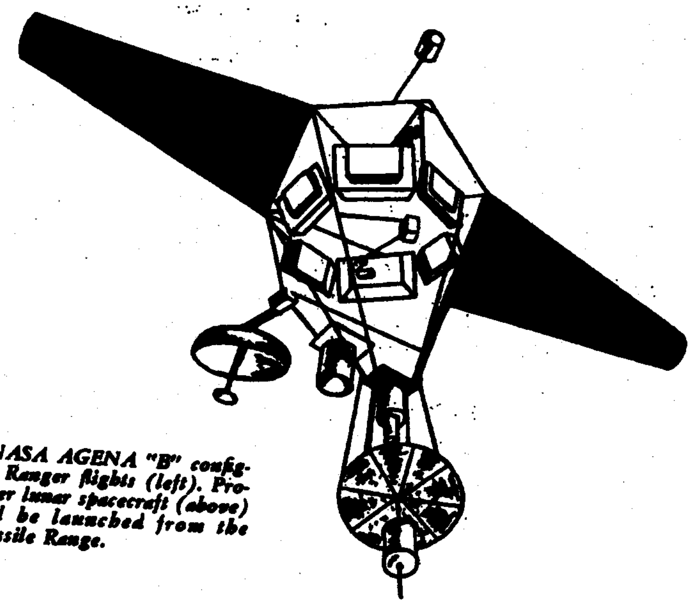
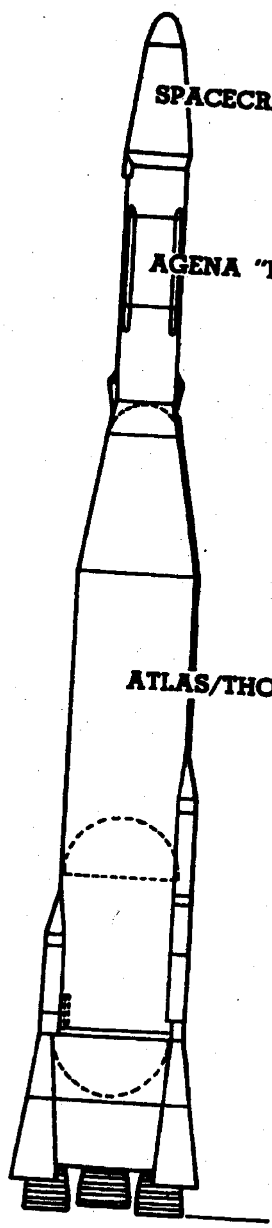


Figure 1. NASA AGENA "B" configuration for Ranger flights (left). Proposed Ranger lunar spacecraft (above) which will be launched from the Atlantic Missile Range.

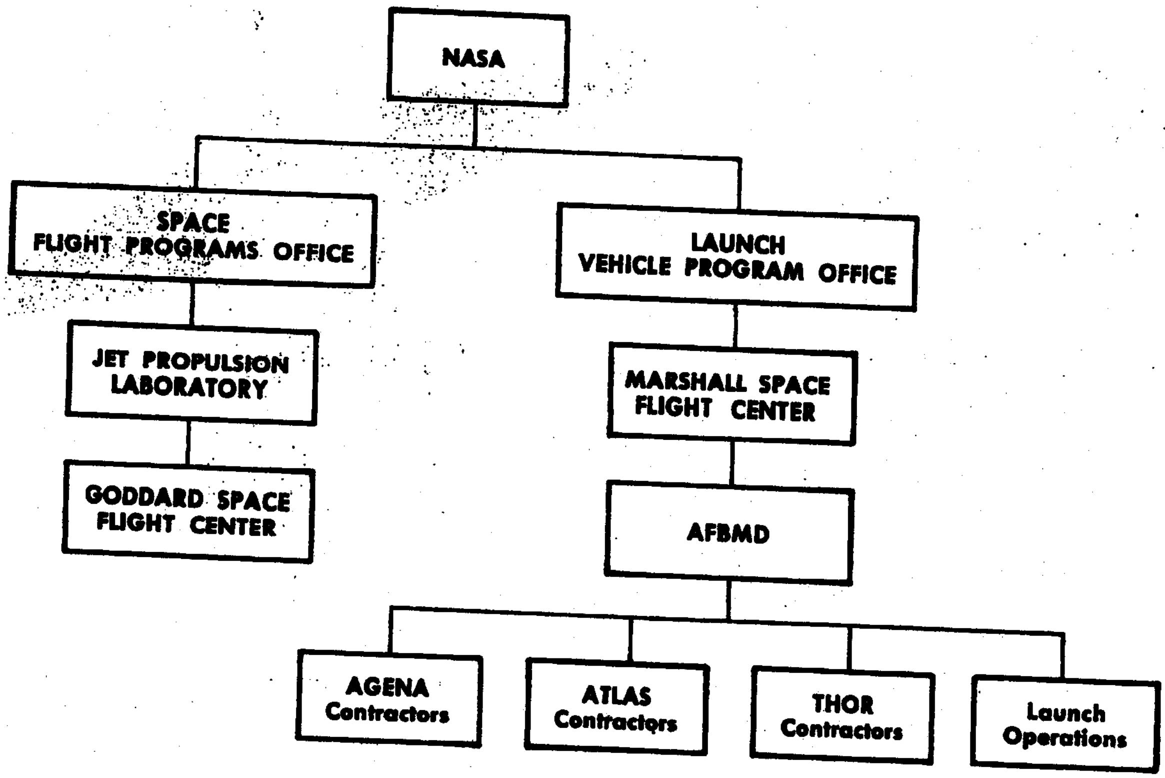


Program Objectives—The basic objective of the NASA AGENA "B" Program is to place a separable spacecraft on a prescribed ballistic trajectory or into lunar orbit to gather scientific information and data. The program will first demonstrate the capability of jettisoning the spacecraft shroud and separating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

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

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

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



NASA AGENA "B" Project Organization Chart

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

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

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

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

3. Allocated eight THOR boosters to NASA.

Monthly Progress—NASA AGENA "B" Program

Program Administration

- A contract for conversion of the POLARIS test stand at Santa Cruz Test Base to accommodate the AGENA "B" vehicle was issued on 17 October. Construction is progressing satisfactorily and will be completed in early April 1961.

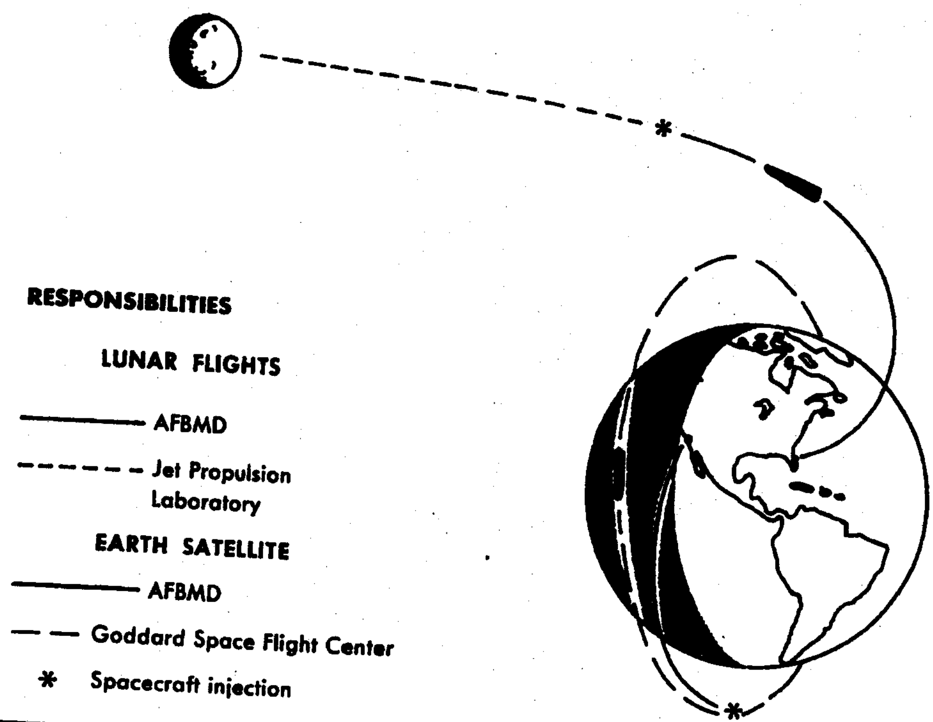
Technical Progress

- The first AGENA "B" vehicle for this program is on schedule and will complete the assembly phase of manufacturing on 27 December.

Facilities

Modification of Atlantic Missile Range Stand 12 to accommodate ATLAS/AGENA "B" vehicles is scheduled to start in January 1961. The contract has been signed and the scheduling of work agreed upon by Lockheed Missile and Space Division, Convair-Astronautics, and Jet Propulsion Laboratory. During this modification a Project MERCURY backup capability will be included in Stand 12.

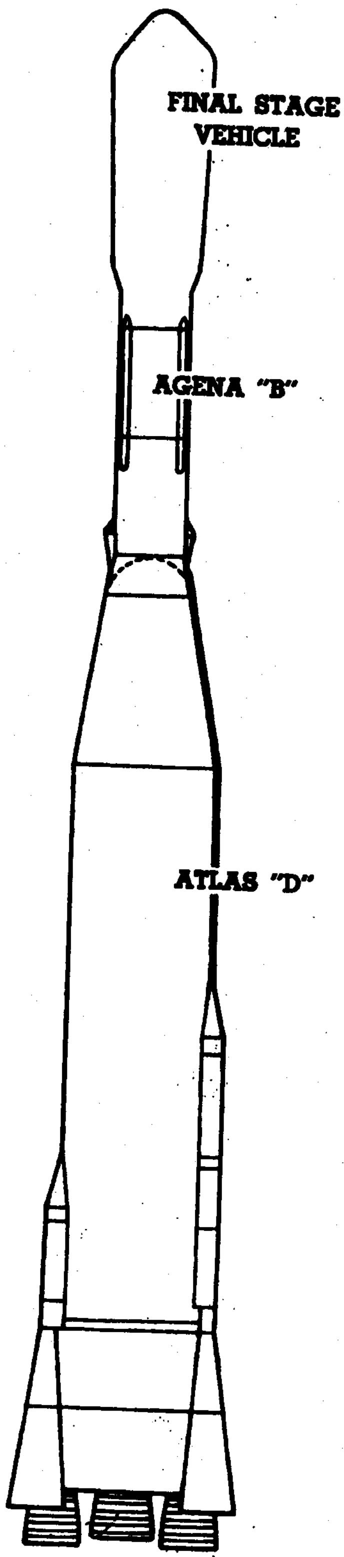
NASA AGENA "B" Program Flights



SPACE
defense programs

SAINT
ORBITAL INTERCEPTOR

SAINT



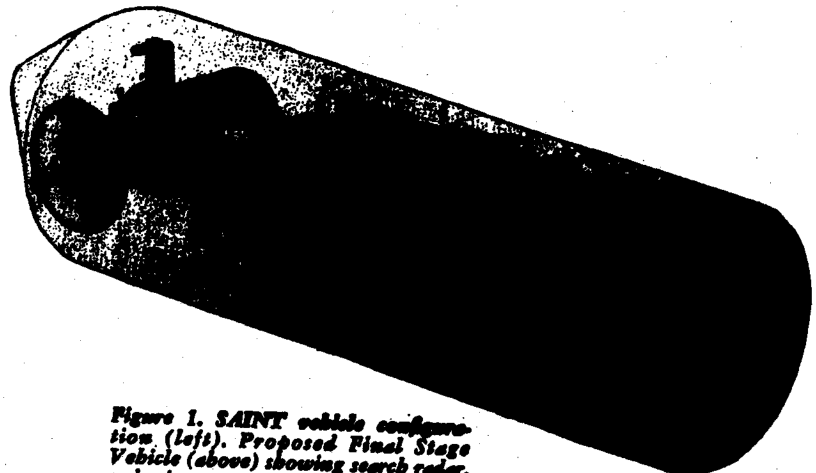


Figure 1. SAINT vehicle configuration (left). Proposed Final Stage Vehicle (above) showing search radar, velocity correction engine nozzle, control-gas storage spheres, and attitude control jets.

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

Program Objectives

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

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

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

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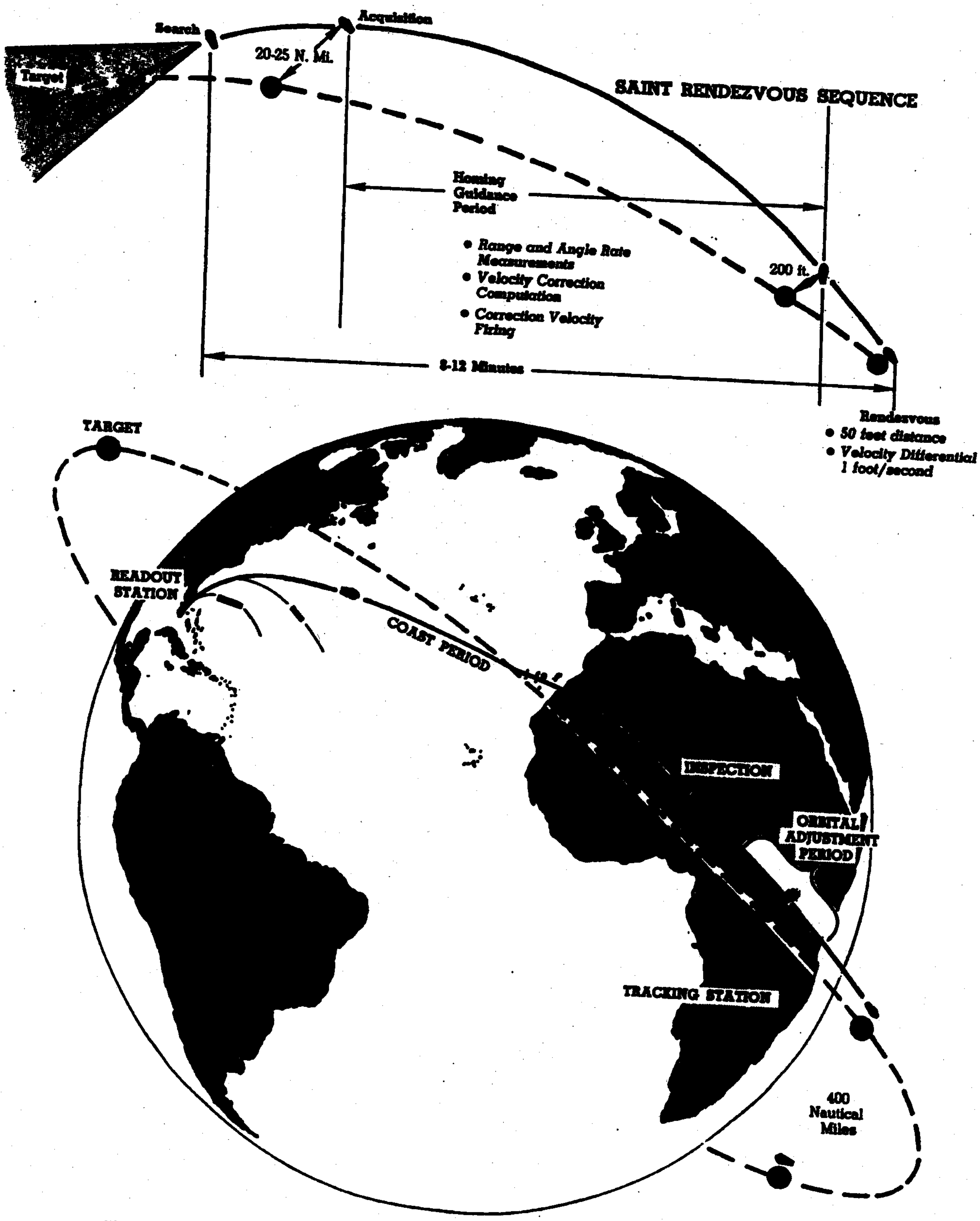

Figure 2. SAINT Program feasibility demonstration flight and rendezvous sequence.

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Program History

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

1. AF System Development Requirement No. 18 published ....21 April 1960
2. AFBMC approval of SAINT Development Plan ....15 July 1960
3. Department of Defense approval of Development Plan.........25 August 1960
4. Air Force Development Directive No. 412 ....17 October 1960
5. Assigned Systems No. 621A..31 October 1960

Concept

Philosophy — The philosophy for development o 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.

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 contractor, 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

- The evaluation of proposals presented by prospective contractors was completed by the Source Selection Board on 25 November. As a result, the Radio Corporation of America has been selected as the contractor to develop the final stage vehicle and the inspection payload. Present planning calls for the contracts to be formalized on or before 1 January 1961.

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 extemely 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 three parts: system design feasibility studies; support system, military analysis, and evaluation studies; and Orbital Interceptor oriented applied research studies.

- 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, infrared radiation, and infrared background measurements 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 this program 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

Program Administration

- A directive was received from ARPA initiating a series of system design feasibility studies for the Orbital Interceptor. A competition will be held to select three contractors to perform system design studies. A Source Selection Board has been established to evaluate contractor proposals and select three who will accomplish orbital interceptor design studies.

- Rand Corporation personnel presented the preliminary results of their analysis of the Orbital Interceptor System to AFBMD on 4 November. This study is being performed under contract to ARPA. The Rand Analysis is scheduled to be completed by 18 November.

- On 15 November, AFBMD presented a proposed hypervelocity kill mechanism program for Fiscal Year 1961 to ARPA. This is a continuation of the present kill mechanism program initiated by AFBMD in July for use in the Orbital Interceptor project.

BIOASTRONAUTICS

BIOASTRONAUTICS

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

Mark II Capsule Tests

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

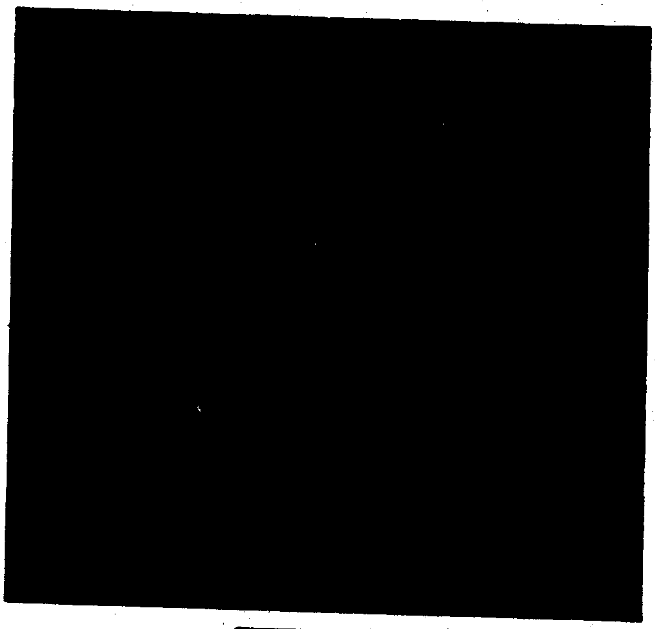
- The primate emerged from the life cell in an exceptionally vigorous condition. She lost about a half-pound in weight, as expected, and exhibited very mild effects of exposure to carbon monoxide. The results demonstrated that the capsule can sustain a primate in satisfactory condition for a longer period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

- A full duration test was conducted beginning 7 November simulating a one-day mission with a live monkey in the life cell of a Mark II biomedical capsule. This test was successful in sustaining the animal in a healthy condition under simulated orbital conditions. On 8 November, after nearly 29 hours in a simulated space environment the capsule was removed from the chamber and, shortly after midnight, the animal was removed from the capsule in good condition. During the test, the nitrogen level in the capsule atmosphere increased above normal because of minor leaks around an electrical-connector. However, the leaks did not result in stopping the operations.

Mark II Cell Operation

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

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



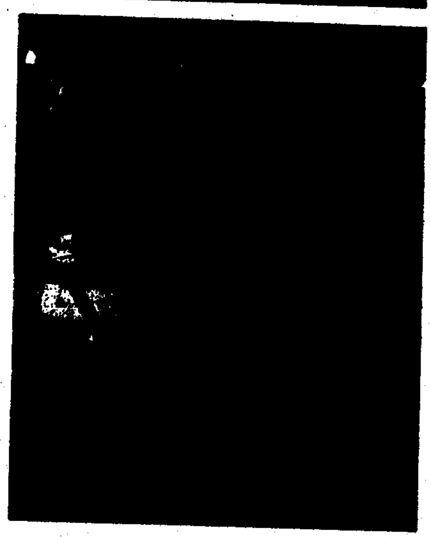
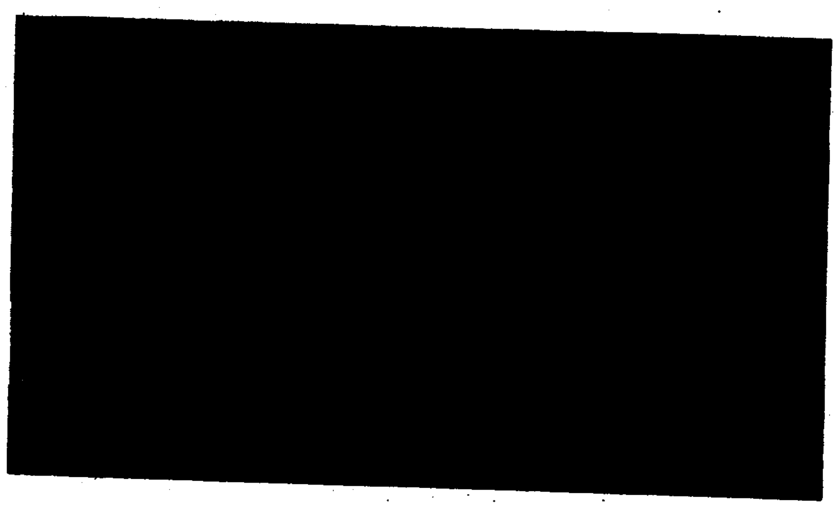
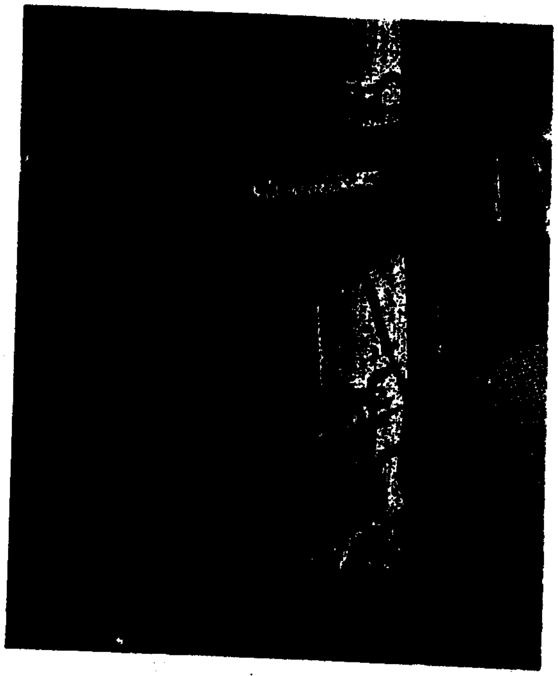
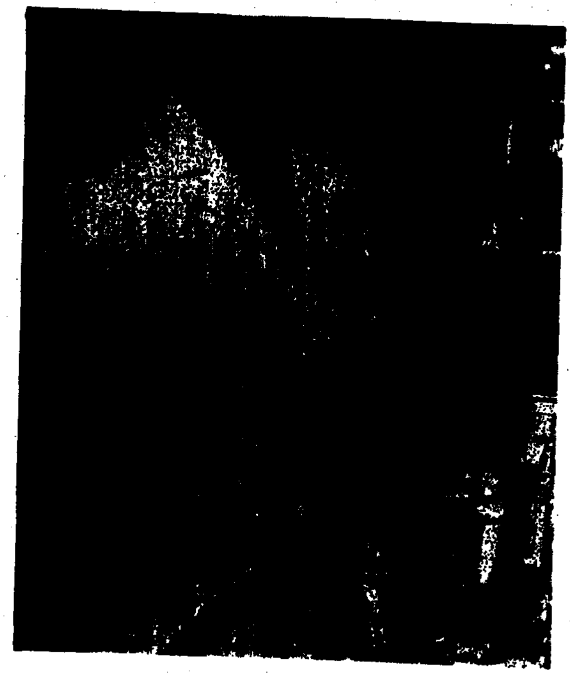


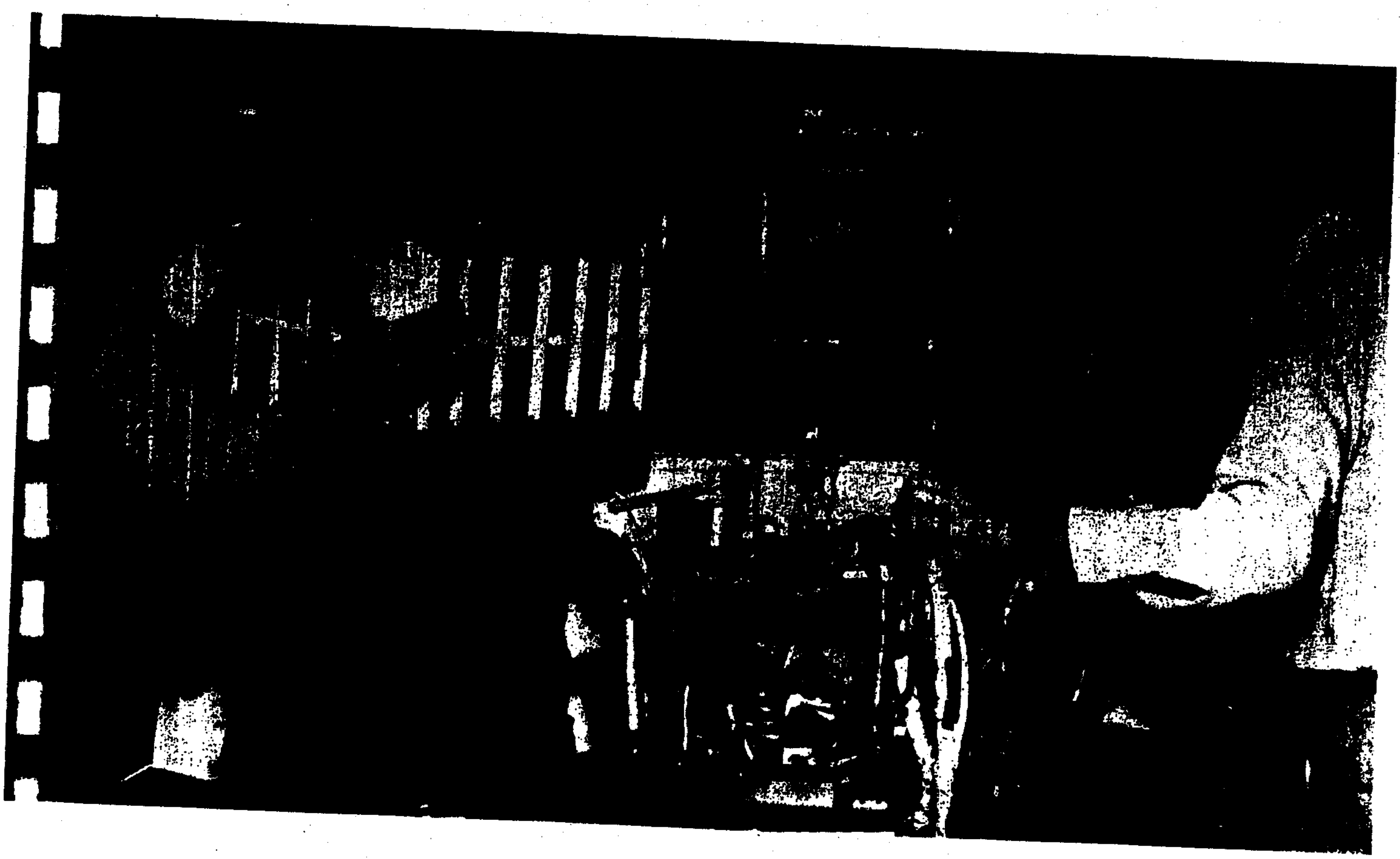
Figure 3. Biomedical recoverable capsule life support system (left) for a six pound monkey. Monkey on support couch, with restraint harness in place during installation into the life cell. When the red light (arrow) flashes, the monkey pulls a lever. The primate is conditioned to respond to the light signal in order to avoid a mild shock. Performance of this psychomotor task provides scientists with information about how well man will be able to perform his duties as pilot of a spacecraft. Center photograph shows the biomedical capsule after its arrival from Vandenberg Air Force Base during the simulated orbital test. Bottom view shows the capsule, encased in its ablative shell, prior to insertion into the high altitude temperature simulation chamber. The consoles in the background record pressures and temperatures inside chamber.

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









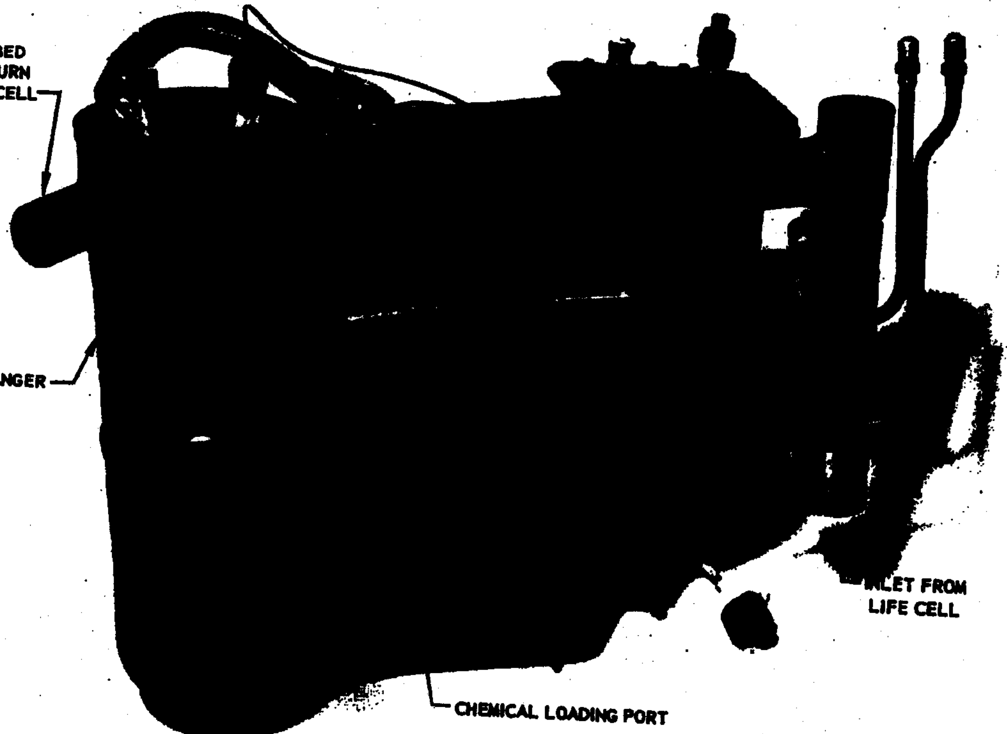


***Figure 4.** The air conditioner assembly from the life cell, with major parts labeled. The air returns from the life cell, passes through a chemical regeneration section, over a coil in the heat exchanger and returns to the cell.*

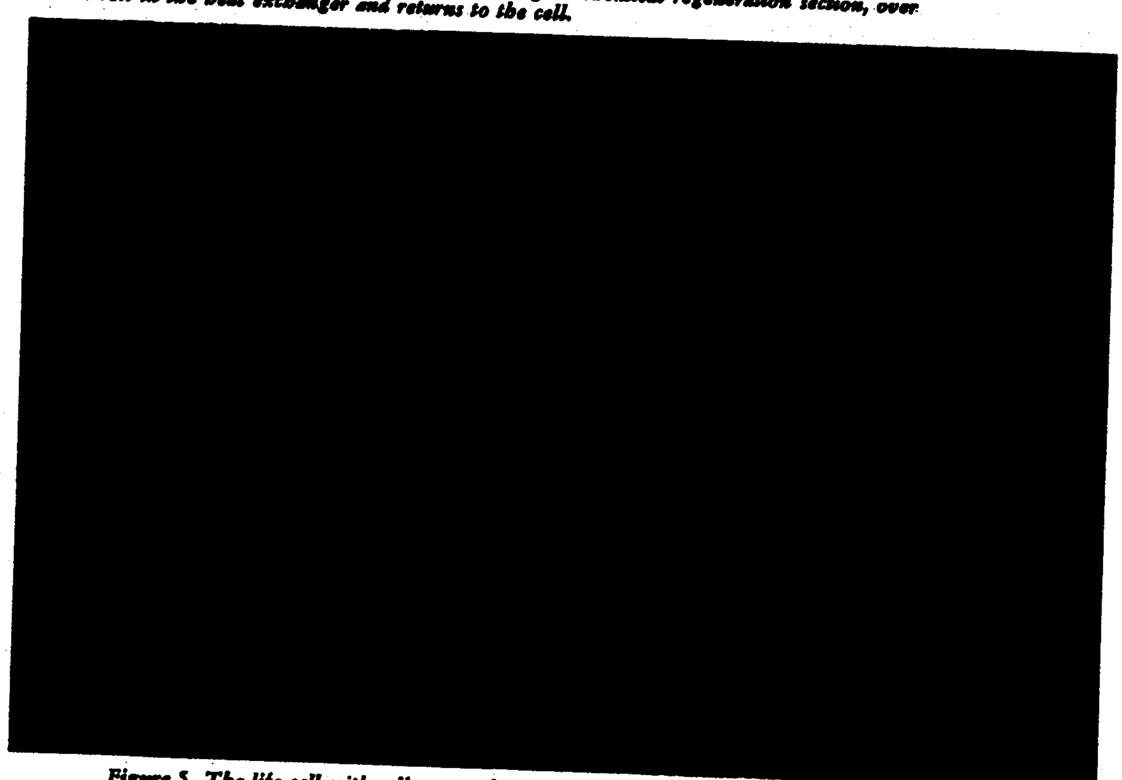
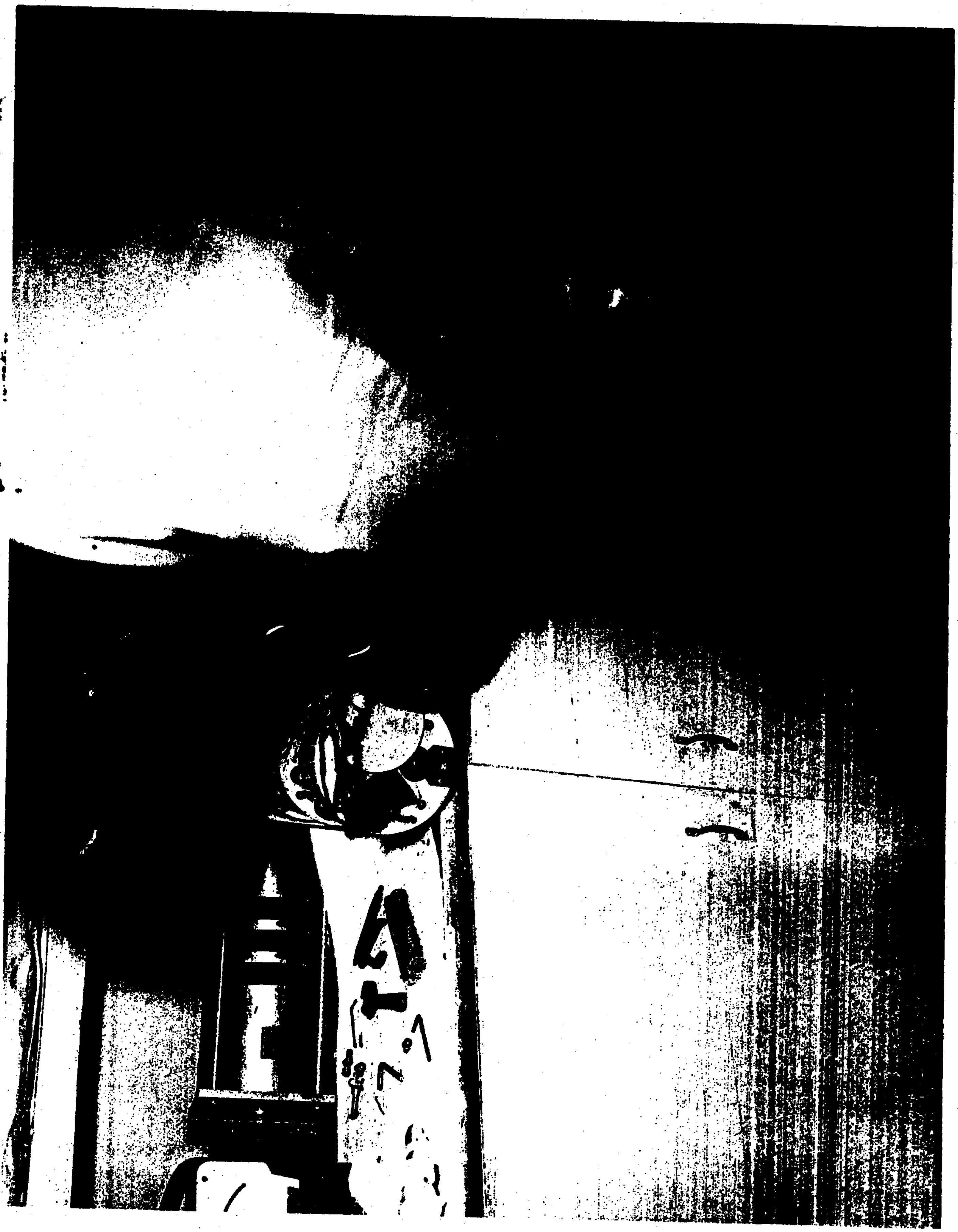
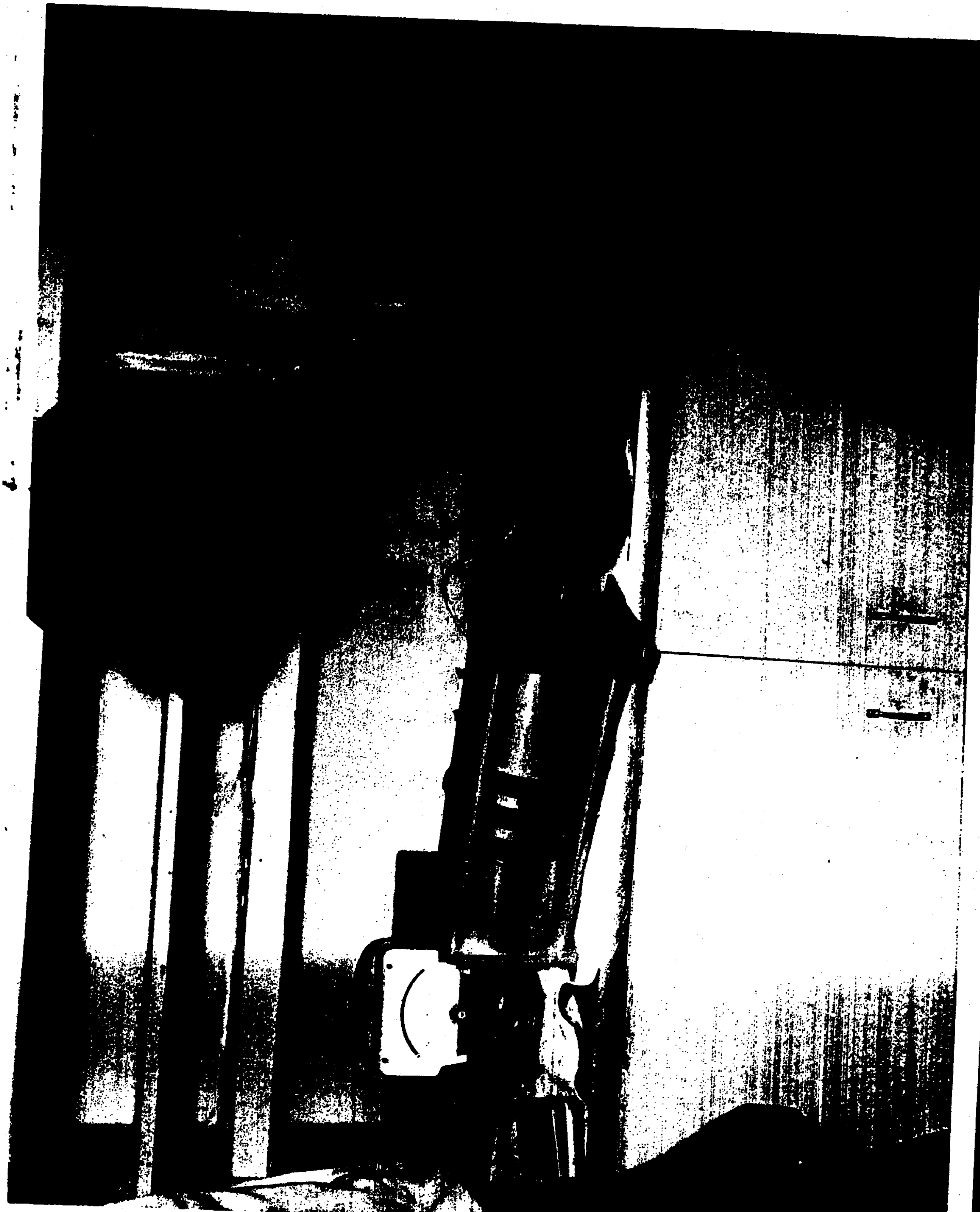


***Figure 5.** The life cell with callouts to show the feeder from which the primate receives pieces of paraffin-covered apple, the fan which circulates the air, the camera which photographs the primate every three seconds, and the film cassette. Water from the water bottle flows through the heat exchanger to cool the recirculated air. The programmer monitors the life cell operation.*





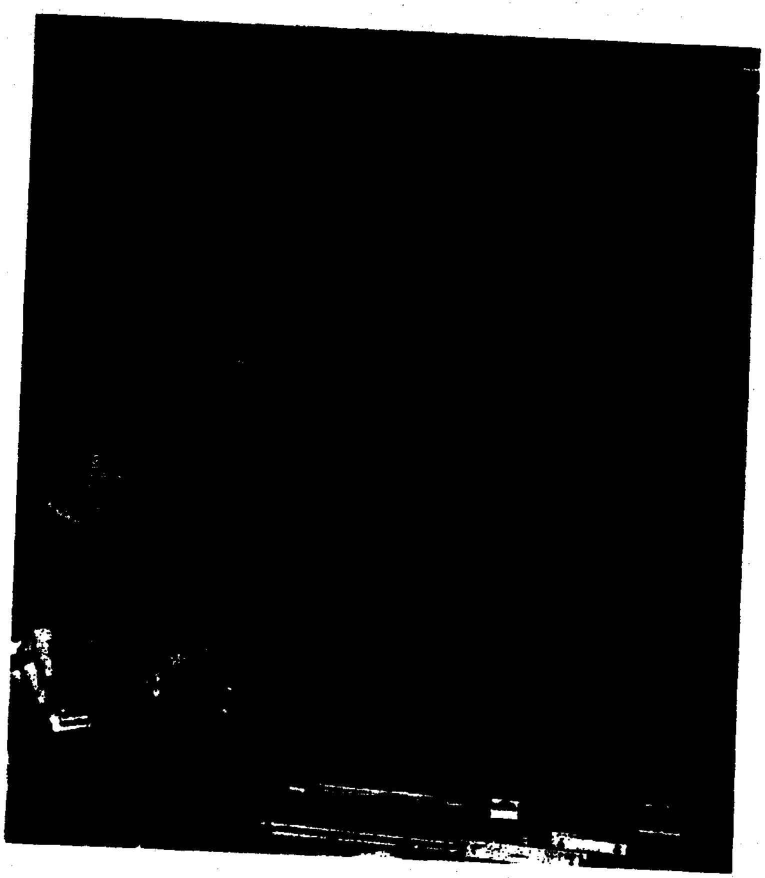
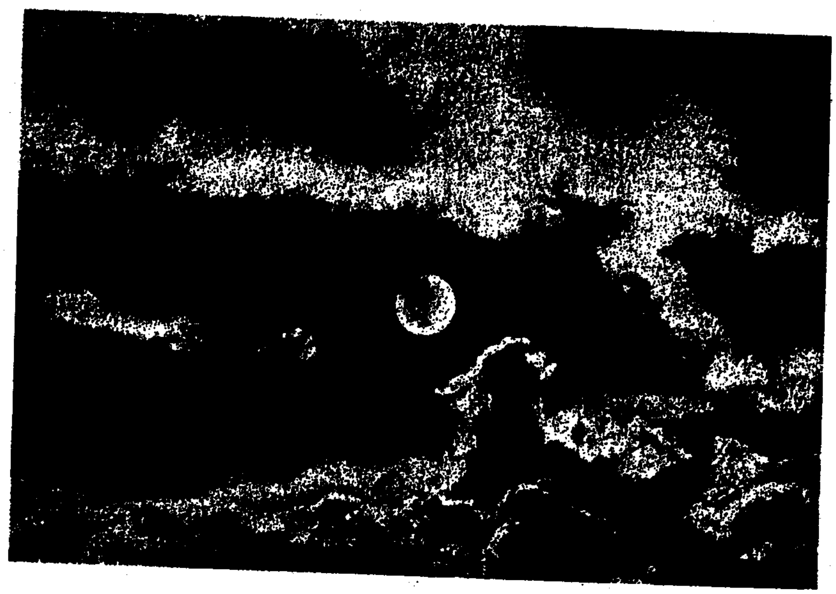


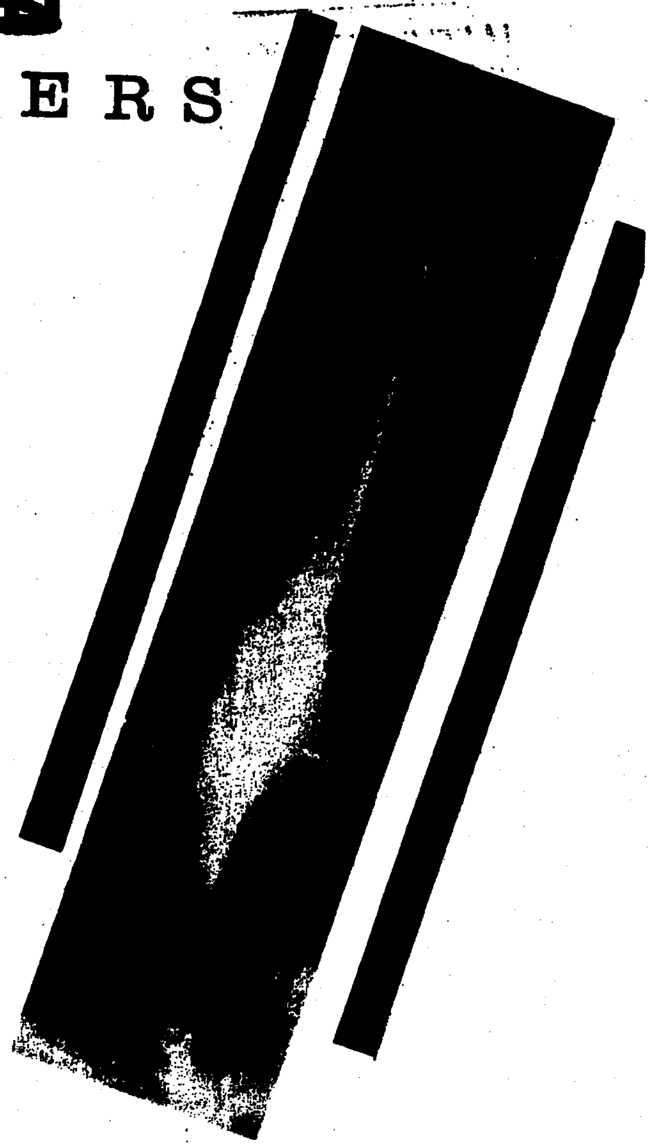
Figure 8. Two recent ATLAS RVX-2A nose cones launched from the Atlantic Missile Range contained mice and tissue equivalent ionization detector packs. Additional flight research packages are complete and are ready for scheduled launches on RVX-2A flights. They are an agravic liquid gas inter-phase experiment and additional ionization detector packs. In addition, a radiation shielding experiment and gravity independent monophasic cryogenic gas storage system are programmed for ATLAS "E" Pod flights. Removal (above) of one of the mice following recovery of an RVX-2A nose cone after a ballistic flight which is expected to yield significant clues to the space radiation bio-environment of the inner Van Allen belt. The animals are presently under study for radiation effects. The animal shown has physiological instrumentation strapped to its back so that information can be relayed through the nose cone telemetry system. Photo at left shows one of the mice and the equipment package (right) which was used for the 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 planning requires close examination of all technological areas wherein advances provide increases in booster and mission capability. This, in turn, has required that space schedules be sufficiently flexible to incorporate rapidly those advances in the state-of-the-art which increase the potential for reliable and predictable space research.

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

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

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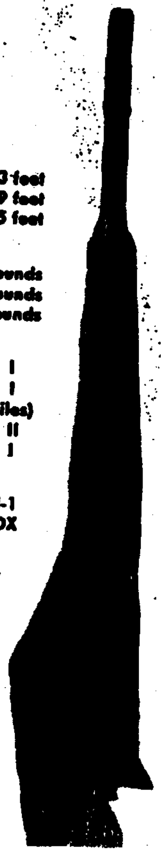
THOR



Prime contractor:
Douglas Aircraft Co.

Engine manufacturer:
Rocketdyne Div., North American Aviation

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

Guidance — Bell Telephone Laboratories or autopilot only

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

Early in 1958, the decision to accelerate the national space effort was made effectively possible only because of the availability of the THOR IRBM. THOR No. 127 was diverted from the R&D flight test program for use as the ABLE-1 space probe first stage. With top national priority assigned to the space research effort, THOR No. 163 was used to boost the DISCOVERER I into orbit on 28 February 1959. Since then, the THOR has become operational as an IRBM and has been very reliable as a space flight booster. During 1959 all THOR boosted space flights achieved successful first stage performance. THOR performance has been increased through weight reduction modifications and use of RJ-1 (instead of RP-1) fuel. A modified THOR, designated DM-21 (used with an AGENA second stage), incorporates a shortened guidance compartment and additional weight reduction changes. A later version of the DM-21 provides an increase in thrust to 167,000 pounds through installation of the MB-3-Block II engine. The DM-21A, used with the ABLE-STAR second stage, has a larger transition section than DM-18/DM-21 and does not incorporate all the weight changes effective on the DM-21.

ATLAS

Prime contractor:
Convair

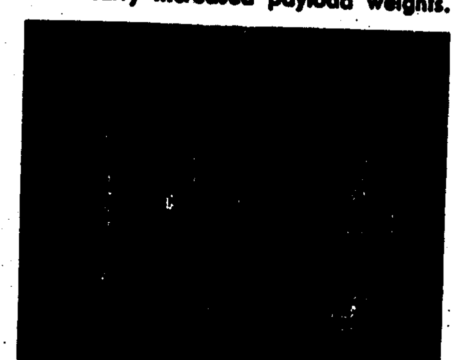
Engine manufacturer:
Rocketdyne Div., North American Aviation

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

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

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

THE ATLAS ICBM, providing over twice the thrust of the THOR, is being used as the first stage booster for the three Advanced Military Satellite Programs and for Project Mercury man-in-space. The first ATLAS boosted space flight was launched from the Atlantic Missile Range on 18 December 1958. Designated Project Score, this vehicle (ATLAS 10B) successfully placed a communications payload into orbit around the earth. In November 1959 the ABLE-4 space probe did not attain its objective, however, ATLAS first stage performance was successful. The first ATLAS-boosted flight test vehicle in Project Mercury was launched on 7 September with test objectives satisfactorily achieved. ATLAS performance on both the 26 February and 24 May MIDAS launches also was satisfactory. Future flights will use modified ATLAS series "D" missiles to carry increased payload weights. Project Mercury boosters also include abort-sensing and other pilot safety features. The success of the ATLAS boosted space flights to date plus the performance and reliability being demonstrated in the ATLAS R&D flight test program, lend confidence in this booster as a reliable means of realizing advanced space objectives.



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AGENA

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

Prime contractor:
Lockheed Missile and Space Division

Engine manufacturer:
Bell Aircraft Corp.

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

Fuel
Unsymmetrical Dimethyl Hydrazine

Oxidizer
Inhibited Red Fuming Nitric Acid

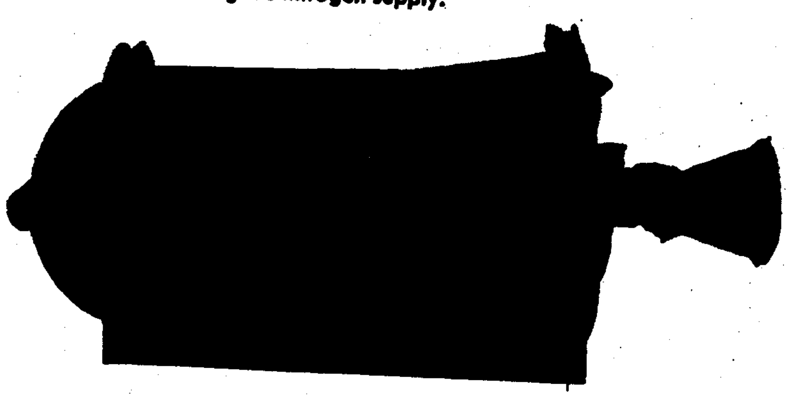
Guidance optical-inertial

Used as second stage for:
DISCOVERER
SAMOS
MIDAS

NASA/AGENA "B"

ABLE-STAR Vehicle

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



Contractor:
Aerojet-General

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

with Restart Capability
Nozzle Expansion Ratio—40.1

Fuel
Unsymmetrical Dimethyl Hydrazine

Oxidizer
Inhibited Red Fuming Nitric Acid

Guidance
STL ABLE Guidance System
Burroughs J-1 Computer

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

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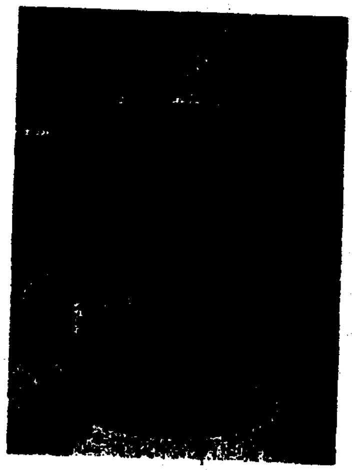
ABLE Vehicle

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

Contractor:
Aerojet-General Corp.

Height	18 feet 7 inches
Diameter	4 feet 8 inches
Weight	
AJ10-42	4622 pounds
AJ10-101	4178 pounds

Fuel
Unsymmetrical Dimethyl Hydrazine

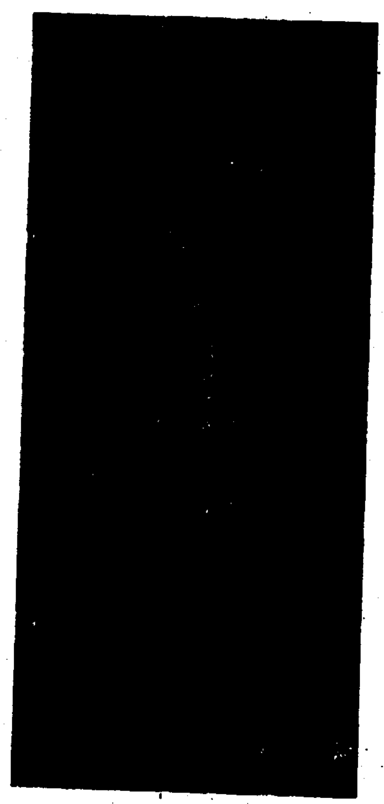


Oxidizer
Inhibited White Fuming Nitric Acid

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

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

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



ABL 248 Vehicle

Contractor:
Allegany Ballistic Laboratory

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

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

Specifications....

THOR

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

ATLAS

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

FIRST STAGE

NOTES

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

AGENA

	E "A"	F "B"	G "B"
Engine Model	YLR81-Ba-5	XLR81-Ba7(3)	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

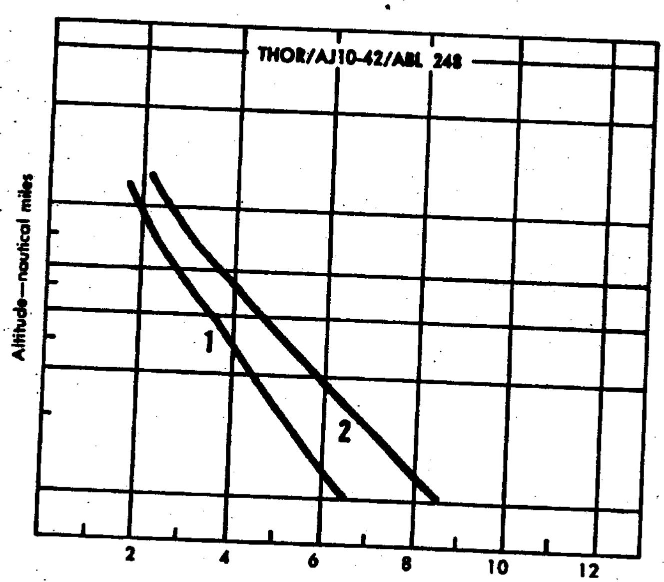
	H AJ 10-42	J AJ 10-101	K AJ10-104 ABLE-STAR	L (5)ABL 248
Weight—wet	1,247.1	847.9	1,297	59.5
Fuel	875.1	869.0	2,247	455.5
Oxidizer	2,499.6	2,461.0	6,227	(solid)
TOTAL WEIGHT	4,621.8	4,177.9	9,771	515
Burnout Weight	1,308.6	944.1	1,419	50.5
Thrust-lbs., vac.	7,670	7,720	7,900	250.5
Spec. Imp.-sec., vac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

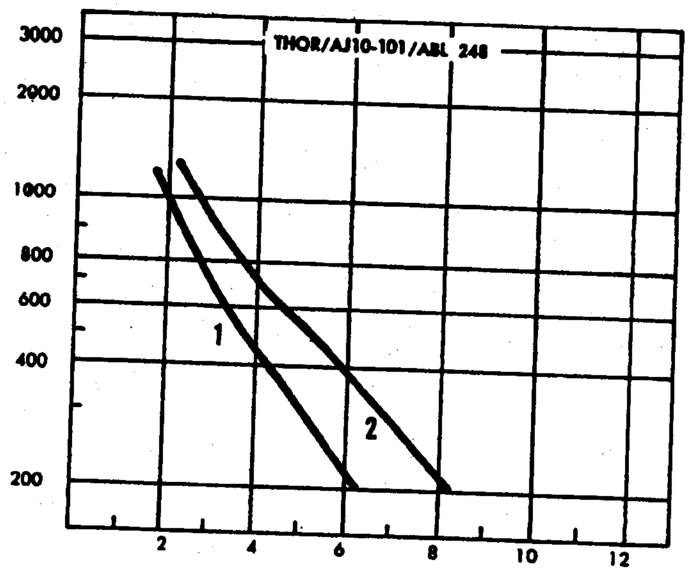
H, J, K: SECOND STAGE — L: THIRD STAGE

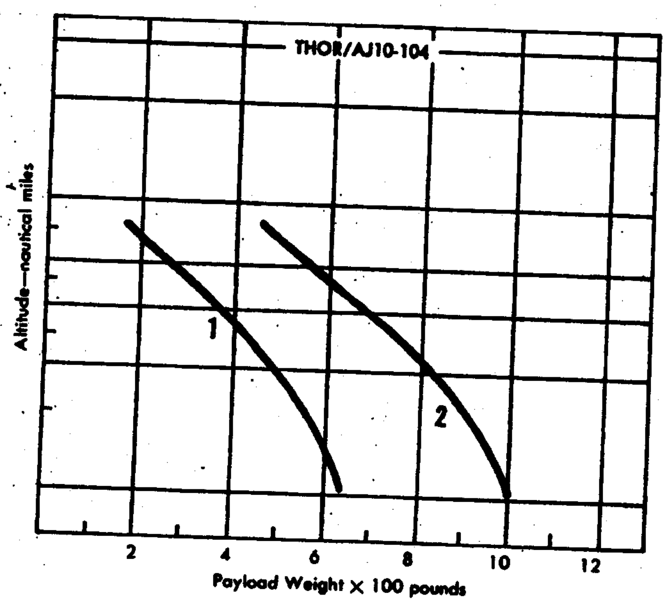
Program Vehicle Combinations

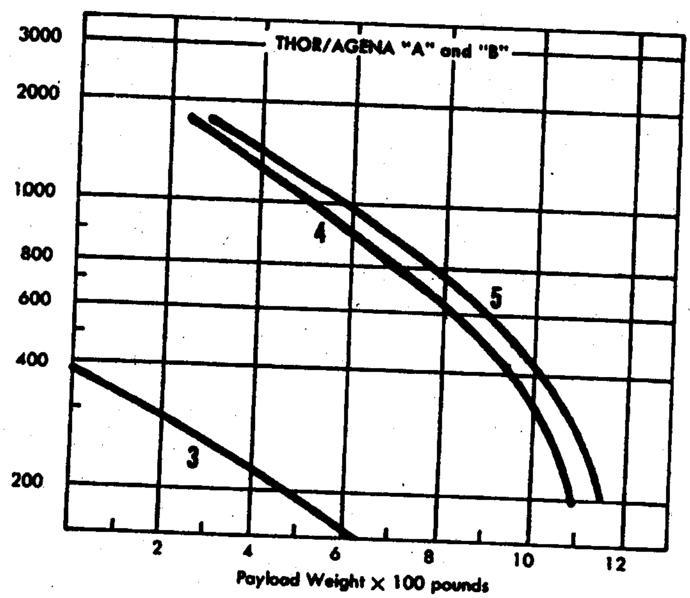
DISCOVERER (1 thru 15) ...... A-E
DISCOVERER (16 thru 19) ..... A-F
DISCOVERER (20 and subs) .... B-G
COMM. SATELLITE .... D-F
COMM. SATELLITE .... D-G
MIDAS (1 and 2) .... D-E
MIDAS (3 and subs) .... D-G
SAMOS (1 thru 3) .... D-E
SAMOS (4 and subs) .... D-G
ABLE-1, -3 and -4 .... A-J-L
ABLE-4 and -5 .... D-J-L
TRANSIT 1A .... A-H-L
TRANSIT 1B, 2A, 3A, 3B, 4A ... C-K
COURIER .... C-K
TIROS .... A-H-L

Performance Graphs — THOR BOOSTED





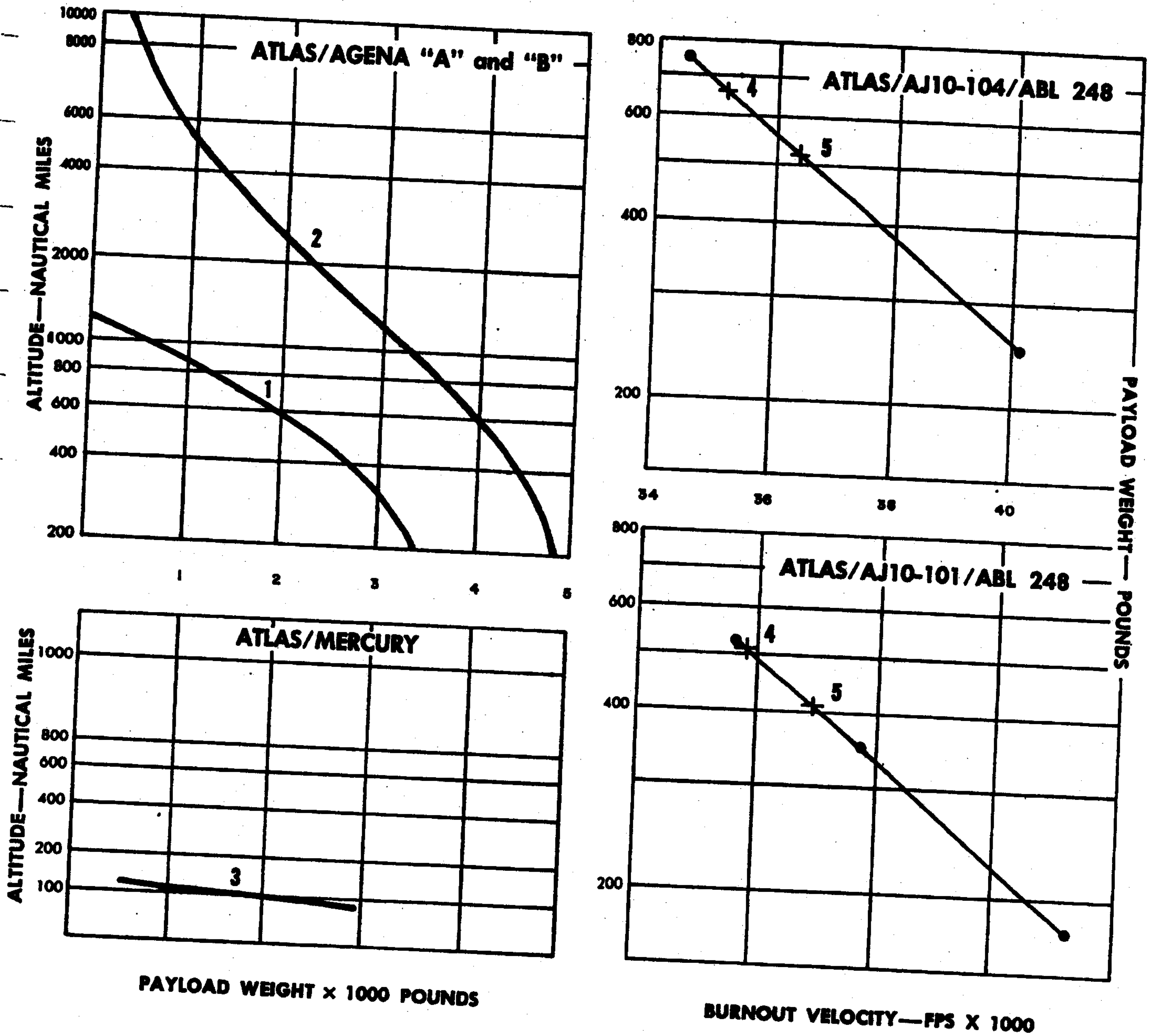




1. Polar—AMR or VAFB
2. AMR—90 degrees
3. VAFB—AGENA "A"
4. VAFB—AGENA "B" (XLR81-Ba-7)
5. VAFB—AGENA "B" (XLR81-Ba-9)

SECRET

Performance Graphs — ATLAS BOOSTED



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

4. Lunar Probe
5. Venus Probe

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