V 4-2

CONFIDENTIAL

AIR FORCE BALLISTIC MIS

SPACE

EXEMPTED FROM DECLASSIFICATION IAW E.O. 12958

REVIEWED BY

DATE

REFER TO Series 4.5.4.3 Box 4

EXEMPTIONS 1 2 3. 4 5 6 7 8 9

PAGES EXEMPT

a foreword to...

SPACE

TDC 61-418

WDLPR-4

12 January 1961

Summary of
AIR FORCE BALLISTIC MISSILE DIVISION
Activities in Space

DECEMBER 1960

FOREWORD

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

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

for Harry B. Krehomar Jr. Col USAF

O. J. RITLAND
Major General, USAF
Commander

SECRET

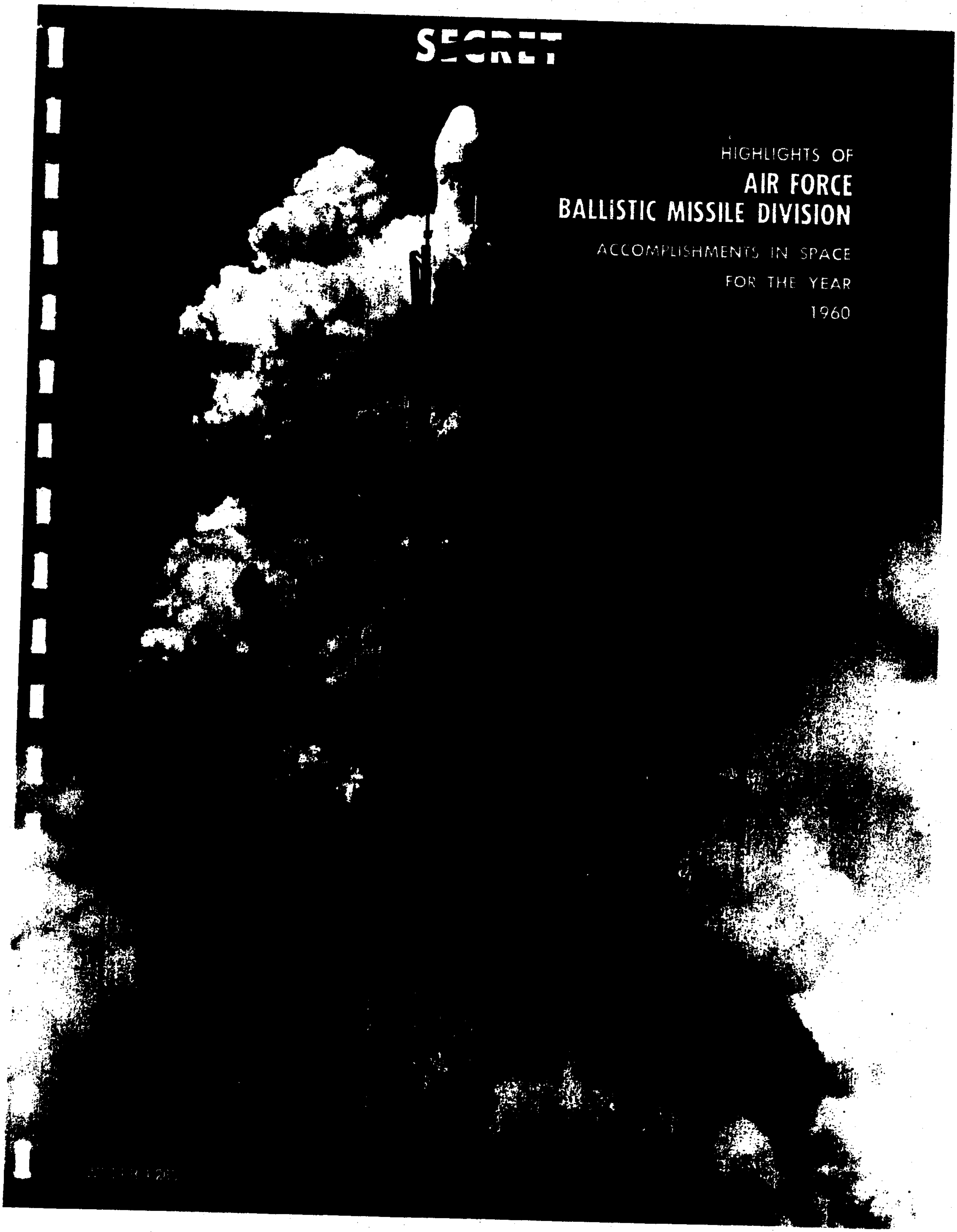
HIGHLIGHTS OF

AIR FORCE BALLISTIC MISSILE DIVISION

ACCOMPLISHMENTS IN SPACE

FOR THE YEAR

1960



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

DISCOVERER

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

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

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

2. Attaining satellite stabilization in orbit.

3. Obtaining satellite internal thermal environment data.

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

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

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

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

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

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

1. Reorientation and stabilization of satellites on orbit.

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

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

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

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

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

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

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

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

MIDAS

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

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

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

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

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

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

Design Verification

1. Basic ATLAS-AGENA compatibility and integrity.

2. Ground support equipment and facilities.

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

4. Demonstration of PAM/FM data link.

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

6. Demonstration of solar auxiliary power unit telemetry.

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

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

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

Problems Disclosed

1. Determined inadequacy of attitude control design.

2. Deficiency of moving belt reticles.

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

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

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

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

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

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

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

5. Test of the second evolution payload package design.

6. Continued verification of ground elements and telemetry links.

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

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

ADVENT

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

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

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

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

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

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

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

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

ABLE Projects

ABLE-4 THOR

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

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

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

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

ABLE-5

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

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

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

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

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

TRANSIT/COURIER

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

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

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

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

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

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

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

MERCURY

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

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

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

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

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

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

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

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

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

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

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

PROJECT 609A

Development Program

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

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

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

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

Operational Program

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

Forecast

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

DYNA SOAR

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

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

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

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

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

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

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

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

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

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

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

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

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

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

NASA AGENA "B"

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

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

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

SAINT

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

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

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

• The 1961 effort will be primarily devoted to the management of tasks necessary to design and fabricate the SAINT feasibility demonstration vehicle. A definitized contract with RCA is anticipated in January 1961 and definitized contracts with Convair for ATLAS "D" boosters and Lockheed for AGENA "B" second stage vehicles following shortly thereafter. Continued study toward definition of an ultimate operational system will be pursued simultaneously with the other phases of the program. This effort will distinguish certain long-lead type items on which development action must be initiated and provide further refinements to the system. Included are extension of the maneuvering capability of the vehicle into 1000 nautical mile orbits with the necessary station keeping and inspections of multiple targets as well as more exotic sensor capability.

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

ORBITAL INTERCEPTOR

• By mid-1960, conceptual studies performed by Convair, Ramo-Wooldridge and Lockheed, had been completed. Following completion of the conceptual studies, an ARDC Technical Evaluation Board was convened at AFBMD to evaluate the technical validity, operational capability, and program feasibility of the system concept and to recommend a follow-on program. Other evaluations were carried on by ARPA, the Air Force Scientific Advisory Board, AFMDC, and the RAND Corporation. As a result of conclusions and recommendations based on these evaluations, a Phase II program, System Design Feasibility, has been implemented.

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

BIOASTRONAUTICS

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

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

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

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

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

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

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

TIROS

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

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

SATELLITE

systems

DISCOVERER
MIDAS
ADVENT

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

PROGRAM OBJECTIVES

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

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

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

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

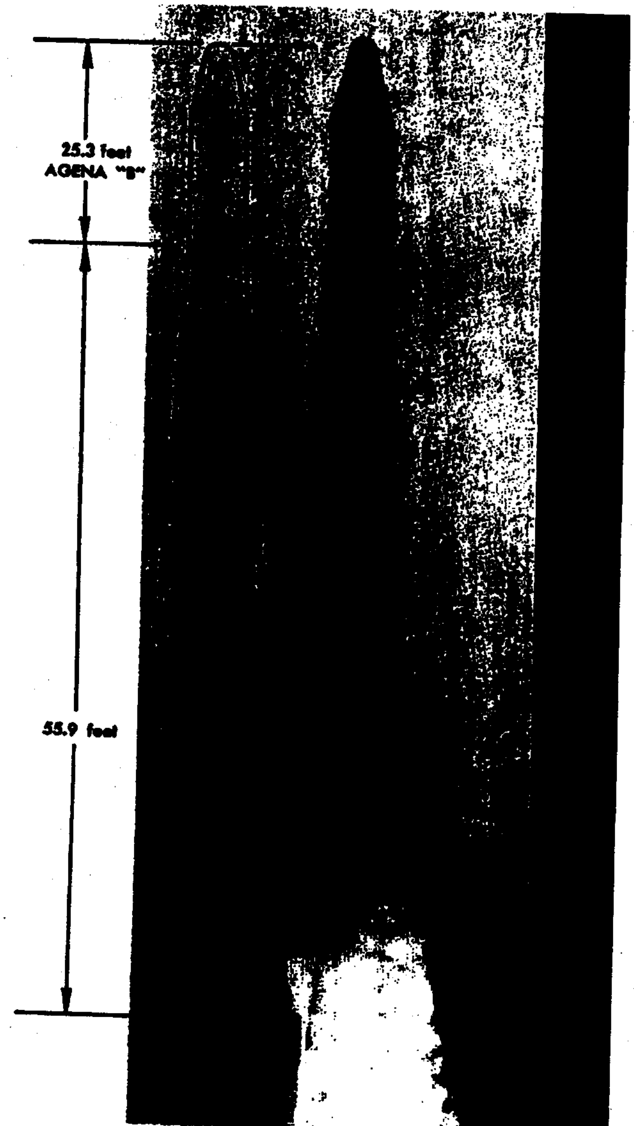
(f) Conducting bio-medical experiments with mice and small primates, including injection into orbit, re-entry and recovery.

PROGRAM SUMMARY

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

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

D i s c o v e r e r



SECOND STAGE		AGENA "B"
Weight—		
Inert	1,328	1,346
Payload equipment	887	915
Orbital	2,215	2,261
Impulse propellants	12,950	12,950
Other	511	511
TOTAL WEIGHT	15,676	15,722
Engine Model	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	16,000
Spec. Imp.-sec., vac.	277	290
Burn time-sec.	240	240

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