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MILITARY SATELLITE PROGRAM PROGRESS REPORT

FOR QUARTER ENDING 28 FEBRUARY, 1961
RCS DD-DR & E (Q) 397

Prepared By Air Force Ballistic Missile Division
Headquarters Air Research and Development Command
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HEADQUARTERS
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UNITED STATES AIR FORCE
Air Force Unit Post Office, Los Angeles 45, California

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14 March 1961

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FOREWORD

Four satellites were placed in orbit during this quarter, including two DISCOVERER recoverable capsules and two MIDAS non-recoverable payloads. One capsule was retrieved successfully following three days in orbit, and provided valuable information on exposure of biological samples to cosmic radiation.

Two "firsts" were achieved during the period, when satellites were injected into orbit on two successive days, and when the DISCOVERER XXI AGENA engine was restarted for approximately one second, following one orbital pass.

O. J. RITLAND
Major General, USAF
Commander

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Discoverer

The DISCOVERER Program consists of the design, development and flight testing of 39 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 Projects Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

PROGRAM OBJECTIVES

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

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

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

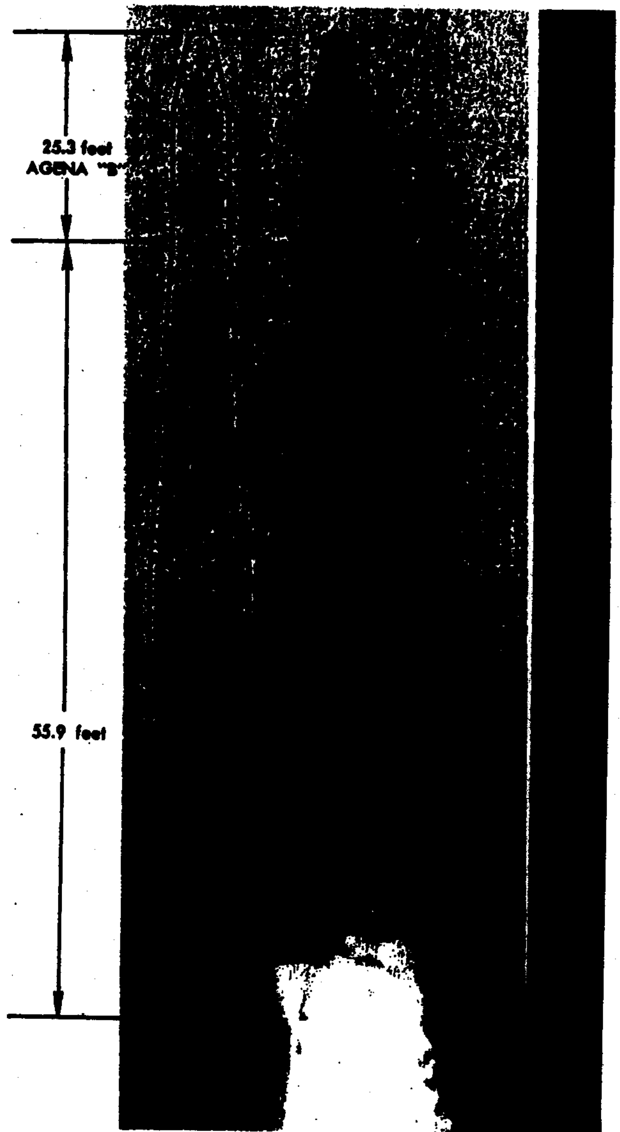
(e) Testing of ground support equipment and development of personnel proficiency.

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

PROGRAM SUMMARY

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

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



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

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

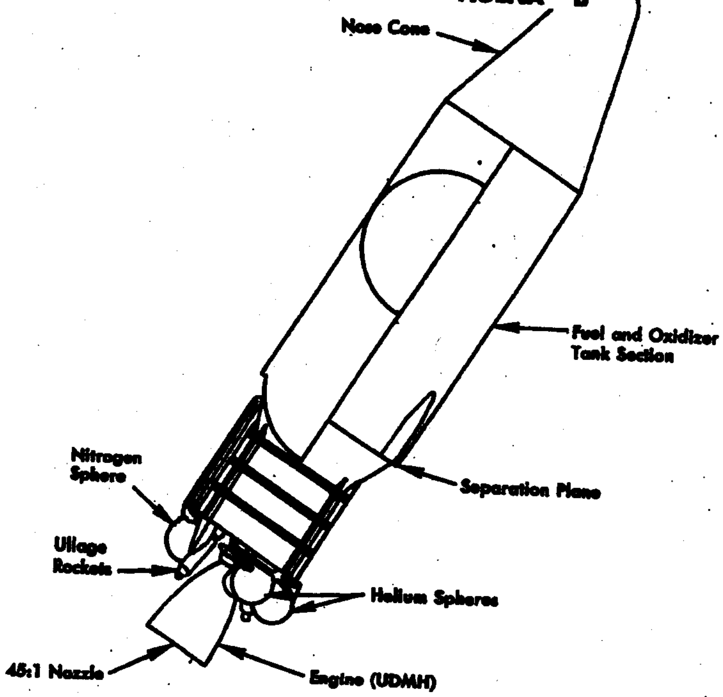
Telemetry ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and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

AGENA VEHICLE DEVELOPMENT

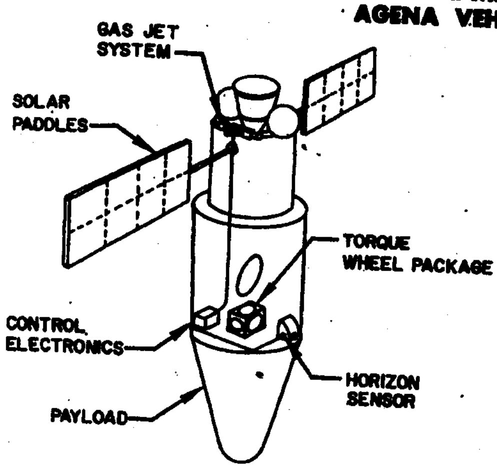
The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. The first AGENA satellites or "A" configuration employed the YLR-81Ba-5 engine which developed 15,600 pounds thrust at altitude. The development of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

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

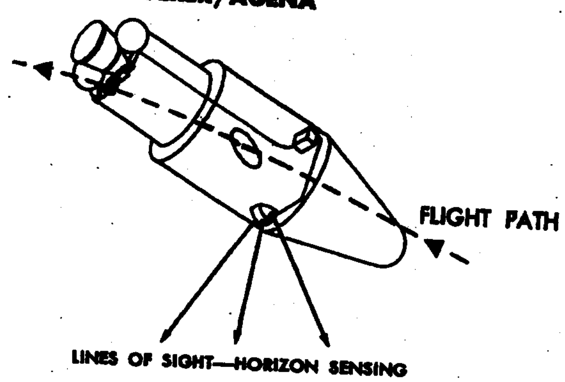
AGENA "B"



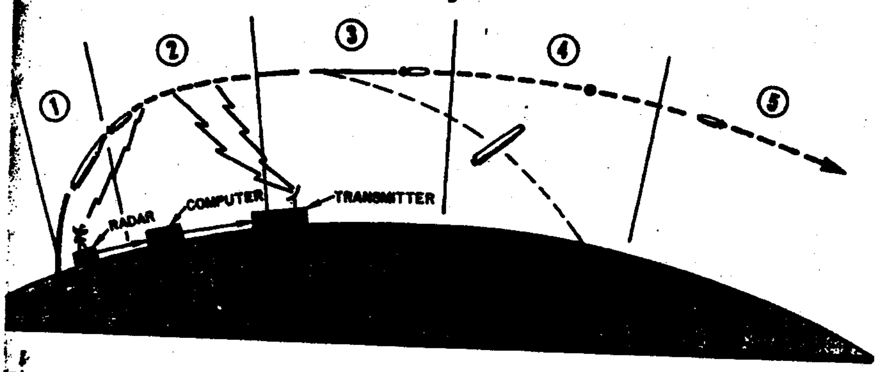
SAMOS and MIDAS AGENA VEHICLE



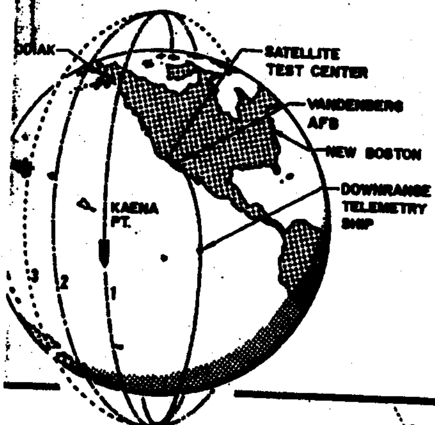
DISCOVERER/AGENA



Powered Flight Trajectory



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

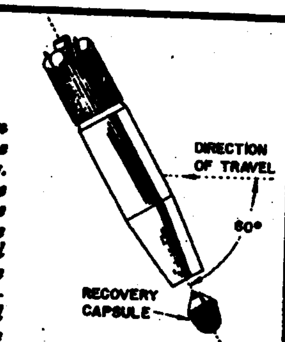


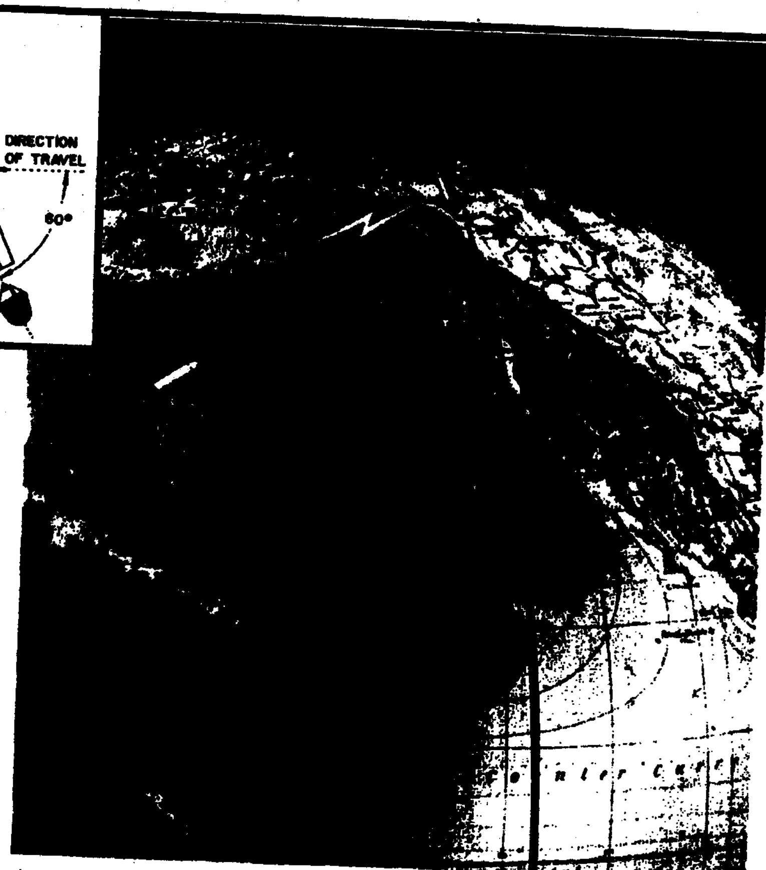
Orbital Trajectory

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

ECOVERY CAPABILITY

'his objective was added to the program fter the first launch achieved vehicle light and orbit objectives successfully. t includes the orientation of the satellite ehicle to permit a recoverable capsule o be ejected from the nose section of the AGENA vehicle. Ejection is programmed o occur on a selected orbit, for capsule mpact within the predetermined reovery area near Hawaii. Aircraft and urface vessels are deployed within the rea as a recovery force.





APSULE RECOVERY EQUENCE

The desired orbit for capsule ejection is selected and programmed into the vehicle prior to launch. If an alternate pass : desirable, an ejection command is sent to the satellite efore this alternate re-entry pass. This command may be ent from any of the primary tracking stations listed on age A-4.

The ejection sequence includes a pitch down maneuver, capule separation, spin-up, retro-rocket firing, de-spin and reatry. Following parachute deployment the aerial recovery orce converges on the descending capsule and snags the arachute. The capsule contains a radio beacon and reflective haff which is dispersed to aid in tracking.

The recovery force consists of C-119, RC-121, WVII and C-54 aircraft supplemented by 2 or 3 surface vessels that eceive and record telemetry data. If it is necessary to retrieve he capsule from the sea, these ships are available.

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

†Primary Tracking Stations (have command capability)

***Equipment**

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

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

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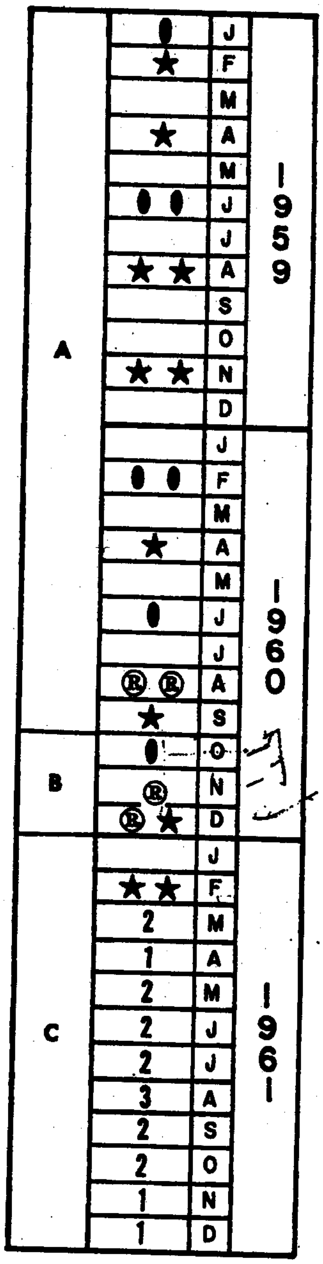
Launch Schedule



★ Attained orbit successfully.

® Capsule recovered.

⬮ Failed to attain orbit.

Flight History

DISCOVERER No.	THOR No.	AGENA No.	Flight Date	Remarks
0	160	1019	21 January 1959	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	163	1022	28 February	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	170	1018	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	174	1020	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	179	1023	25 June	*Same as DISCOVERER III.*
V	192	1029	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	200	1028	19 August	*Same as DISCOVERER V.*
VII	206	1051	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	212	1050	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	218	1052	4 February 1960	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	223	1054	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer. Severe pitch oscillations caused by booster autopilot malfunction.*
XI	234	1055	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
XII	160	1053	29 June	*Launch, ascent, separation, coast and orbital stage ignition were successful. Failed to achieve orbit because of AGENA attitude during orbital stage boost.*
XIII	231	1057	10 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit. Capsule was recovered after a water impact with negligible damage. All objectives except the airborne recovery were successfully achieved.*
XIV	237	1056	18 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit and was successfully recovered by the airborne force. All objectives successfully achieved.*
XV	246	1058	13 September	*Attained orbit successfully. Ejection and recovery sequence completed. Capsule impact occurred south of the recovery forces; located but lost prior to being retrieved.*
XVI	253	1061	26 October	*Launch and ascent normal. AGENA failed to separate from booster and failed to attain orbit.*
XVII	297	1062	12 November	*Attained orbit successfully. Recovery capsule ejected on 31st orbit and aerial recovery was accomplished. All objectives were successfully achieved.*
XVIII	296	1103	7 December	*Attained orbit successfully. Recovery capsule ejected on 48th orbit and aerial recovery was accomplished. All objectives were successfully achieved.*
XIX	258	1101	20 December	*Attained orbit successfully. Non-recoverable, radiometric data gathering MIDAS support flight.*
XX	298	1104	17 February	*Attained orbit successfully. Capsule did not re-enter due to on-orbit malfunction.*
XXI	261	1102	18 February	*Attained orbit successfully. Non-recoverable, radiometric data gathering MIDAS support flight.*

VEHICLE CONFIGURATIONS

A. THOR—DM-18/AGENA "A"

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

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

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A. BRIEF OF PROGRESS

The DISCOVERER XVIII satellite was placed in orbit on 7 December, following a Vandenberg Air Force Base launch. Three days later, the capsule was ejected and an air pickup effected by a C-119. Analysis of radiation information collected by the capsule indicates a low level of exposure under normal conditions (no abnormal solar flare activity).

DISCOVERER XIX, carrying a MIDAS non-recoverable payload, was launched on 20 December from Vandenberg Air Force Base. The payload achieved an orbit nearly as programmed, but a loss of satellite stability interfered with data transmission.

A 17 February Vandenberg launch placed DISCOVERER XX in polar orbit. The recoverable capsule was not ejected due to a programmer malfunction.

On 18 February, DISCOVERER XXI was successfully launched, marking the first time two satellites had been placed in orbit in as many days. Another first was accomplished when the AGENA engine was restarted after one orbital pass.

An improved diffuser plate in the DM-21 booster LOX tank has cut the DISCOVERER terminal count from 15 minutes to about 9½ minutes.

The JC-130B recovery aircraft are due for delivery in May and June.

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B. TOPICAL SUMMARY

1. Flights

a. DISCOVERER XVIII

(1) DISCOVERER XVIII Flight

DISCOVERER XVIII orbited on 7 December.

(a) DISCOVERER XVIII was launched from Vandenberg Air Force Base at 1221, PST, on 7 December. This vehicle was the first combination of the improved DISCOVERER configuration. The booster was the DM-21 with the MB-3, Block 2 engine, and the second stage was an AGENA "B" with the Bell XLR81-Ba-9 engine.

Engines fired as planned.

(b) Liftoff and booster operation were normal. THOR main engine cutoff occurred as planned at an altitude of approximately 46 nautical miles and a velocity of 11,080 feet per second. The AGENA "B" engine ignited as programmed and operated for 234.7 seconds, providing an injection velocity of 25,900 feet per second. The resulting orbit has a 380 nautical mile apogee, a 133 nautical mile perigee and a period of 93.67 minutes.

Capsule ejected after three days.

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

Capsule successfully retrieved in air.

(d) All elements of the recovery force were on station at the time of parachute deployment. C-119J number 3 obtained a bearing on the descending capsule with FLR-2 direction finder equipment. At 1542 PST, aircraft C-119J number 3 at 10,200 feet and 122 knots IAS engaged the parachute on first attempt. The capsule, in good condition, was reeled aboard at 1558 PST. The DISCOVERER XVIII capsule was the fourth to be recovered from orbit and the first to be recovered after more than three days in orbit. Subsequent to capsule ejection, the AGENA vehicle was reoriented to a normal ejection attitude. A stable attitude-on-orbit was recorded through the 89th orbit after which insufficient electrical energy was available to maintain attitude.

(2) DISCOVERER XVII and DISCOVERER XVIII Experiments

Biopack and Emulsion Block experiments.

(a) The capsule recovered from DISCOVERER XVII in November and DISCOVERER XVIII in December each contained a Biopack and an Emulsion Block as part of a special BIOASTRONAUTICS research project. Results of the experiments cannot be considered conclusive as yet.

Emulsion Block measured radiation.

(b) The purpose of the Emulsion Block was to detect and measure cosmic radiation in the space environment. The Emulsion Block carried on DISCOVERER XVII was overexposed because an intense solar flare occurred during the fifty-hour flight.

Biopack exposed biological samples to cosmic rays.

(c) The purpose of the Biopack was to determine the effect of cosmic radiation on biological samples and to correlate biological effects with types and intensities of the measured radiation. Contents of the Biopack (the two DISCOVERER Biopacks were virtually identical) are shown in an accompanying illustration, and included eight nuclear track plates, a neutron film pack, four chemical dosimeters, six analine (ionizing powder) packets, one quartz crystal, two protein samples with track plates, ampules of algae, human amion (embryonic membrane), human carcinoma (cancerous tissue), human conjunctiva (eyelid tissue), human lung tissue, human bone marrow, human synovial tissue (joint cartilage) and human leukemia moncytic cells.

Solar flare exposure to DISCOVERER XVII.

(d) In DISCOVERER XVII, exposure to the solar flare raised the radiation dosage sustained by the Biopack to a 30-to-35 rad level, which remains within the tolerable limits for human exposure. Although the satellite passed through the outer Van Allen radiation belt four times on each orbit, no electrons entered the can due to the shielding effect of the vehicle structure. Dosimeters wrapped in lead showed a higher exposure to dangerous radiation than those protected by aluminum. The experiment suggests that heavy shielding may be dangerous during solar flares.

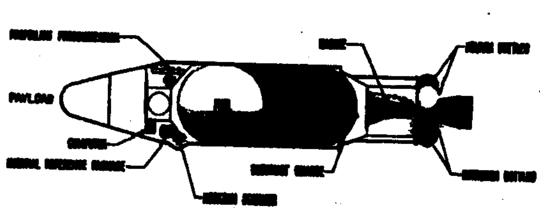
Human cells apparently unaffected by radiation.

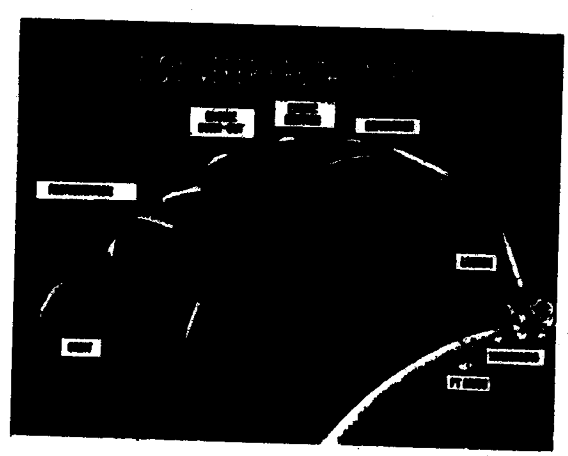
(e) Exhaustion of the nutrient media caused early degeneration of the human cells. Although some cells revived in new media, there is no evidence that the cells were affected by radiation. The cells are being kept alive to determine if any mutations occur in succeeding generations. Algae cells are under consideration as a means of providing oxygen, protein fat, and removal of wastes during human space travel. The algae were virtually unaffected during the flight and did not undergo mutation. Bacteria spores were not harmed by space radiation, but were capable of surviving a postflight treatment which killed unexposed spores. This effect is being investigated as a possible basis for a spore system of radiation measurement.

Low radiation level in DISCOVERER XVIII.

(f) DISCOVERER XVIII during its three-day orbit was not subjected to solar flare radiation. The radiation dose was well below 100 millirads and is lower than the limits prescribed for exposure in Atomic Energy Commission facilities.

DISCOVERER AGENA-INBOARD PROFILE





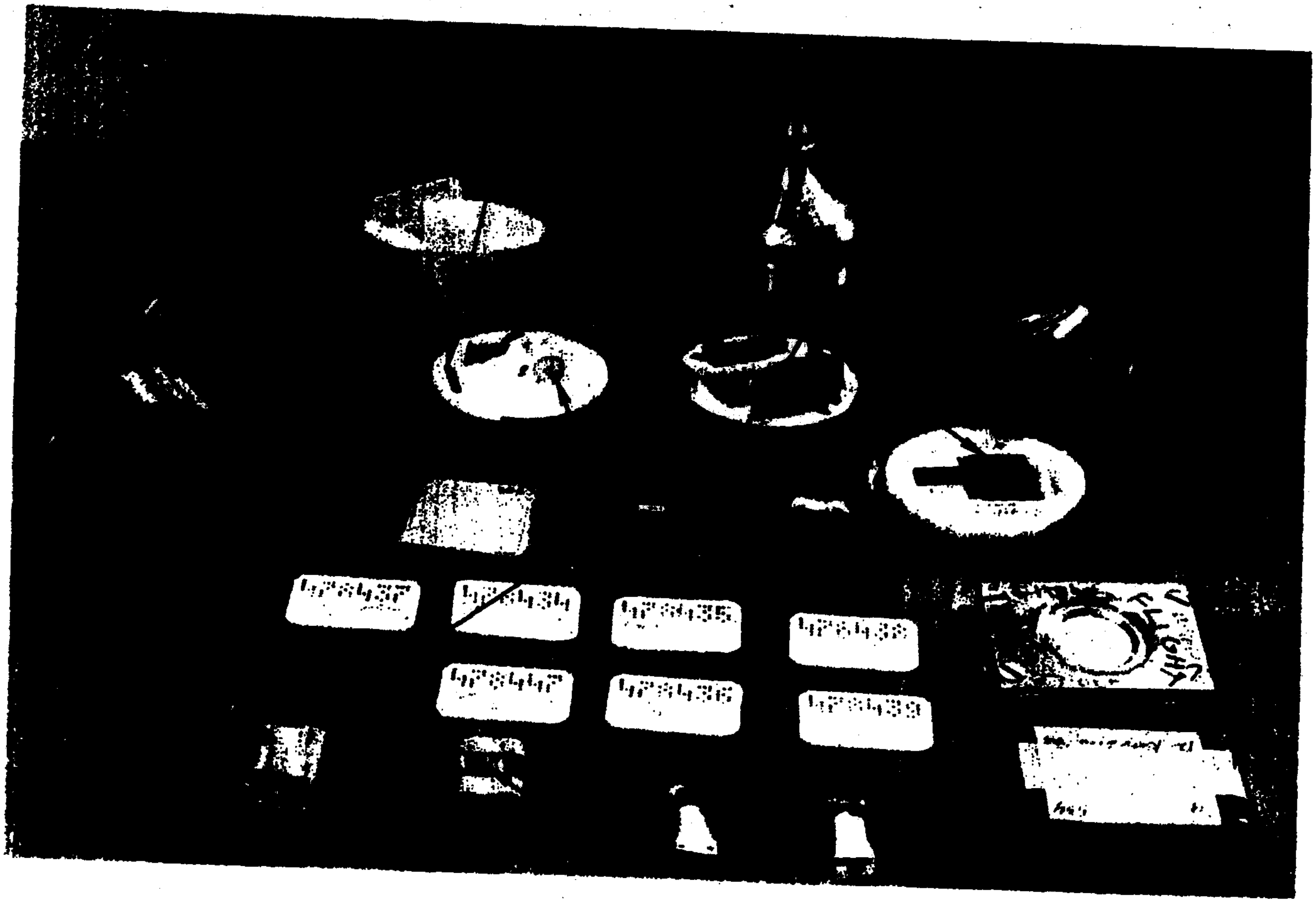
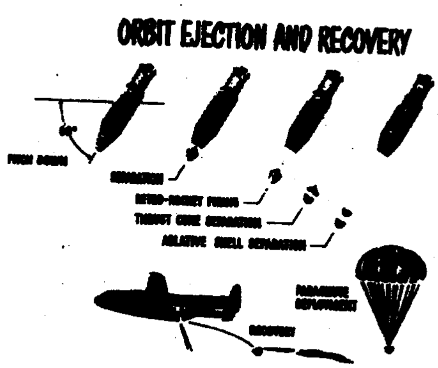
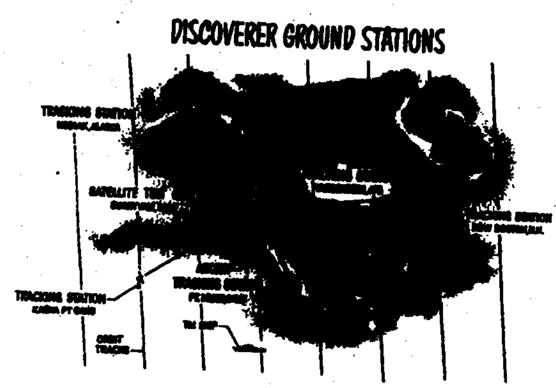


Figure 1. Layout of experiments carried in DISCOVERER XVII and XVIII Biopacks.

Algae, spores and tissue unaffected by orbital environment.

(g) Substantial amounts of alpha and heavier particles were detected. The only dosimeter response was from the photographic type. Primary electrons were not detected. The effect of the orbital environment on the algae, spores and tissue appears negligible. Their condition, as compared with control specimens retained on the ground, is so little changed as to make detection difficult.





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b. DISCOVERER XIX

DISCOVERER XIX orbited on 20 December.

(1) DISCOVERER XIX was launched from Vandenberg Air Force Base at 1237, PST, on 20 December carrying a non-recoverable radiometric payload furnished by the MIDAS Program. Booster and second stage performance were near nominal. A comparison of programmed and actual orbital parameters is shown in Table 1.

Parameter	Programmed	Actual
Period, minutes	92.97	92.86
Eccentricity	0.0313	0.0326
Perigee, nautical miles	113	104
Apogee, nautical miles	343	348
Inclination Angle, degrees	81.82	83.48

TABLE 1. DISCOVERER XIX ORBITAL DATA

Satellite loss of stability.

(2) Telemetry data obtained during the period of reorientation to a nose-aft horizontal attitude indicated a very rapid loss of control gas pressure. A nitrogen-freon mixture is exhausted through reaction jets in response to guidance system signals and provides the motive force to maintain satellite stability on orbit. When the satellite was acquired by Kodiak on its first pass, the gas supply was completely exhausted and the satellite was unstable. Despite the satellite oscillations, sufficient data was obtained for evaluation of the payload operation.

Malfunction traced.

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

Communications difficulties did not preclude data acquisition.

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

c. DISCOVERER XX

DISCOVERER XX orbited on 17 February.

(1) DISCOVERER XX was launched from Complex 75-3, Pad 4 at Vandenberg Air Force Base at 1225 PST on 17 February and was successfully injected into polar orbit. All ascent and orbital injection operations were satisfactory. Orbital parameters for this satellite are shown in Table 2.

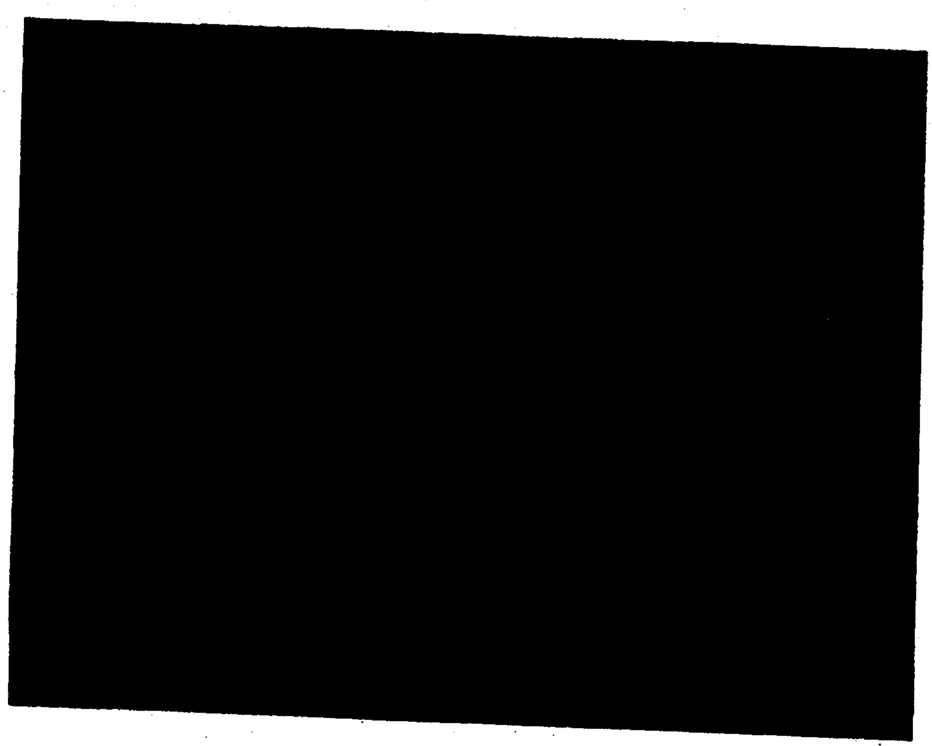
Parameter	Programmed	Actual
Period, minutes	93.4	95.31
Eccentricity	.0202	.0366
Perigee, nautical miles	165.32	162
Apogee, nautical miles	313.80	435

TABLE 2. DISCOVERER XX ORBITAL DATA

Four-day orbit planned.

(2) DISCOVERER XX carried a recoverable payload which was to have been deorbited and picked up by aerial retrieval after four days on orbit. This was the first attempt at a four day mission; one, two and three day missions were successfully accomplished on earlier DISCOVERER flights.

Figure 2. (Left) Master Command Control set at Vandenberg Tracking Station during pass of DISCOVERER XX. (Below) Satellite Test Center status room, where an evaluation of test data for DISCOVERER XX is being made.



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Programmer malfunction prevented recovery.

(3) Behavior of DISCOVERER XX on orbit was satisfactory through pass 31 with all systems operating and sufficient control gas and electrical power remaining for completion of the four-day mission. Because of the slightly long orbital period, it was determined that recovery on alternate pass 62 was more desirable than recovery on the nominal pass 63. Consequently, a skip command was sent to the satellite on pass 31 over Kodiak. Normally, the command would be stored, and halfway through the succeeding orbit the programmer (H-timer) would skip an orbital subcycle. However, the programmer apparently malfunctioned and prevented recovery.

DISCOVERER XXI orbited on 18 February.

d. DISCOVERER XXI

(1) On 18 February, a day following the orbiting of DISCOVERER XX, DISCOVERER XXI was launched from Complex 75-3, Pad 5, at Vandenberg Air Force Base and was successfully injected into orbit. Launch time was 1458 PST. Orbital parameters for this satellite are shown in Table 3.

Parameter	Programmed	Actual
Period, minutes	95.39	94.84
Eccentricity	.0450	.0589
Perigee, nautical miles	126.3	138
Apogee, nautical miles	462.2	583

TABLE 3. DISCOVERER XXI ORBITAL DATA

Radiometric non-recoverable payload.

(2) DISCOVERER XXI carried a non-recoverable radiometric (RM-2) payload designed to measure the infrared background emanating from the earth. The payload was furnished by the MIDAS Program and information on its operation is reported in the MIDAS Program Section.

First engine restart performed.

(3) One of the objectives of this flight was to perform the first experimental restart of an AGENA satellite on orbit. Consequently, the normal yaw-around to an engine-first attitude, which occurs immediately after injection into orbit, was delayed until after the first pass over Kodiak. The restart occurred over Kodiak as programmed and was successful. Planned for a one second burn, the actual burn time was 1.05 seconds. The short burst increased the satellite velocity about 350 feet per second and changed the orbital period from 93.9 minutes to 97.8 minutes.

Satellite stability lost after pass 2.

(4) On the second pass, the satellite was operating satisfactorily but by the seventh pass (the satellite is out of range on passes 3, 4, 5 and 6) the single phase, 400-cycle power amplifier had failed. The 400-cycle power is required by the guidance system in maintaining satellite stability in orbit. As a consequence, DISCOVERER XXI was observed to be unstable on pass 7 and subsequent passes.

Two DISCOVERERS scheduled for March launch.

e. Scheduled Flights

DISCOVERER XXII is planned for a March launch and DISCOVERER XXIII will follow shortly thereafter.

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[redacted]

2. Technical Status

a. Boosters

LOX flow increased.

By incorporation of an improved diffuser plate in the liquid oxygen tank of the DM-21 booster, rapid liquid oxygen load can be initiated immediately and higher flow rates utilized. This modification has resulted in reduction in the terminal count on the DISCOVERER system to a total of nine minutes and 35 seconds from the former time of fifteen minutes.

b. XLR-81Ba-9 Engine Development

2600 seconds of engine operation obtained.

(1) The thrust chamber of one XLR-81Ba-9 engine was replaced after 2600 seconds operation in the reliability program, almost double specification requirements. The replacement will permit gathering statistical data on more than one thrust chamber. One turbine pump assembly was replaced after developing a weld crack following 4,200 seconds operation. The turbine pump assembly specification requires only 2,880 seconds of reliable operation.

Speed fluctuations corrected.

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

Power level drop-offs not resolved.

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

Thirty engine firings completed.

(4) The reliability program is proceeding on schedule at Bell Aircraft: 30 of the scheduled 40 engine firings are complete. The tests have demonstrated that skin temperature of the thrust chamber is unaffected by variations in the solid content of the fuel.

c. Thirty-Day Coast Program

Thirty-second engine start at —10°F accomplished.

(1) The first 30-second firing of an engine conditioned to minus ten degrees Fahrenheit was successfully completed early in December. Another successful firing was conducted with the engine conditioned to plus-160 degrees. These firings were in support of the thirty-day restart program which will provide the capability of restarting the satellite engine after extended periods on orbit. Also included in the program is the evaluation of two methods of solving the turbine pump lubrication problem. One is a 120 cc oil accumulator and a conox explosive valve placed in series with the turbine gear case. The other approach is to apply molybdenum disulphide to the gears and bearings.

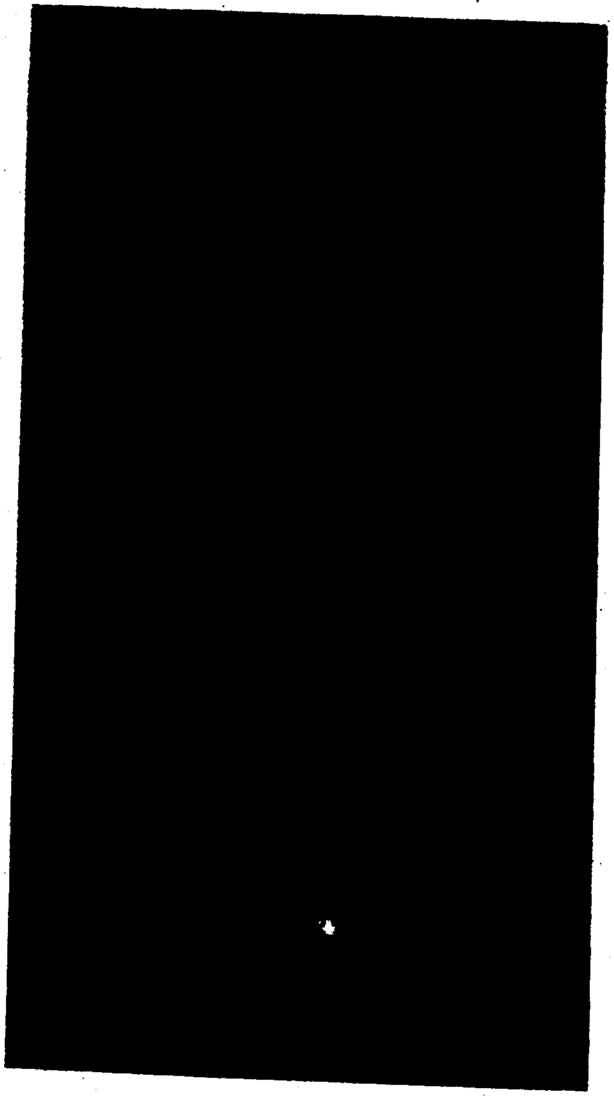

Figure 3. DISCOVERER XXI ignites, commencing successful flight. AGENA vehicle was later restarted in orbit, increasing the orbital period from approximately 94 minutes to 98 minutes.

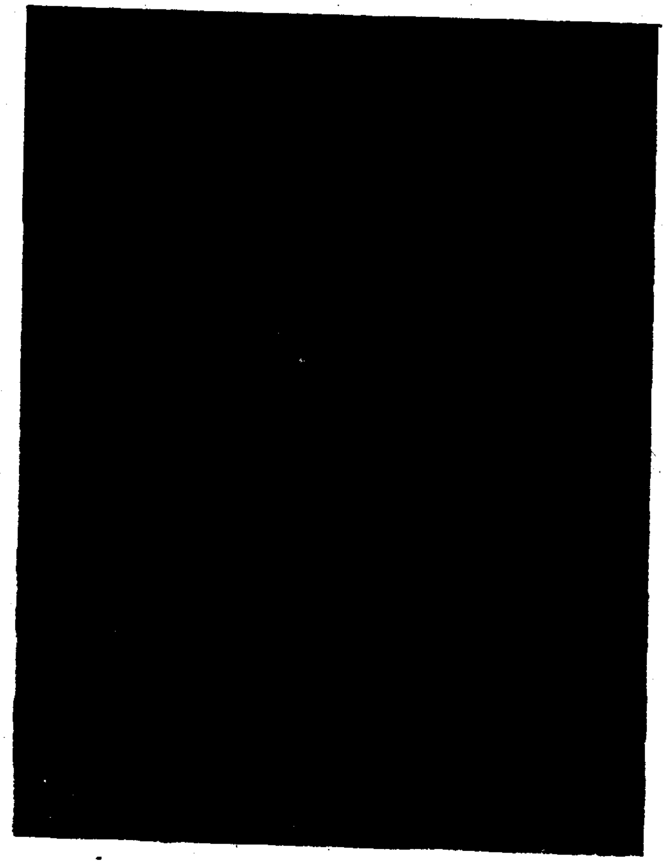

Figure 4. AGENA "B" vehicle 1107 in guidance and flight control test at Sunnyvale. The Inertial Reference Package (IRP) is being tested by a rate table, which is capable of providing precise speed, direction and distance inputs to the IRP. The vehicle is scheduled for an April launch (DISCOVERER XXIV) on a four-day recoverable payload mission.

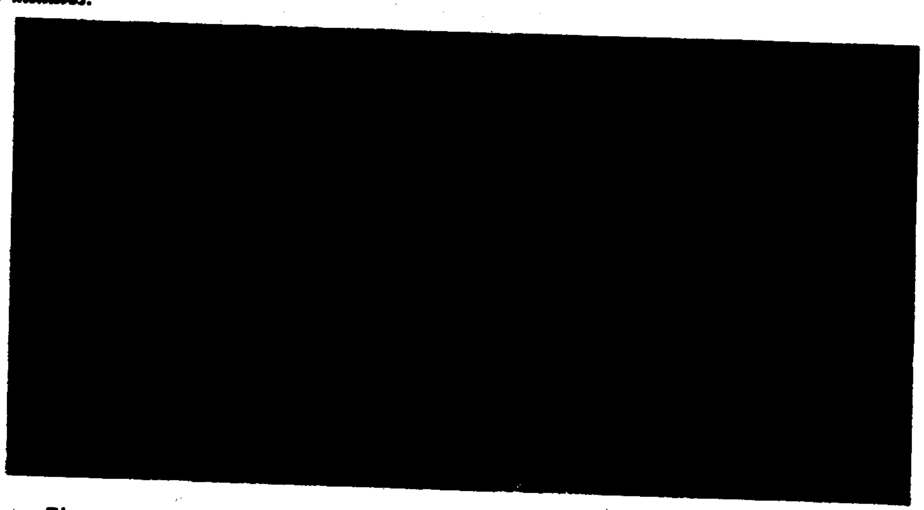

Figure 5. Optical tracking lights installed on DISCOVERER XI. Similar lights have been carried on all subsequent DISCOVERERS. Use of the lights has enabled photographic tracking of vehicles by ground stations.

[redacted]

Starter assemblies fire successfully after 30-day test.

(2) Ten starter assemblies were subjected to temperature and vacuum conditioning for thirty days and fired successfully. Two other assemblies were disassembled and one was found to have a cracked grain. Both units will be fired to determine the effect of the crack.

Oxidizer valve meets seven-day test requirement.

(3) An oxidizer valve performed satisfactorily after being subjected to temperature cycling under vacuum conditions for seven days. An oxidizer filter and venturi system underwent three days in a vacuum after being filled with oxidizer. No residue remained in the system at the end of the test.

d. Balloon Drop Tests

One recovery parachute test satisfactory.

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

Parachute reflectivity tests.

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

e. Optical Tracking Light Experiments

Smithsonian meeting on tracking lights.

A meeting was held at the Smithsonian Astrophysical Organization on 9 January to discuss results and future plans of the DISCOVERER Optical Tracking Light Experiment. Although the organization has successfully photographed the AGENA vehicle on all orbiting flights since DISCOVERER XI, final data reduction has been insufficient to analyze the results completely. The Smithsonian will complete data reduction for DISCOVERER XVII and XVIII and forward the results to Lockheed for comparison with radar tracking systems.

f. Recovery Aircraft

JC-130B recovery aircraft delivery due.

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

3. *Facilities*

a. Complex 75-1

Late delivery of launch control equipment.

Deliveries of AGENA launch control equipment for Vandenberg Air Force Base Complex 75-1, Pad 1, will not be made until 24 March. Efforts are being directed toward regaining scheduled dates.

b. Complex 75-3

Propellant transfer system modification.

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

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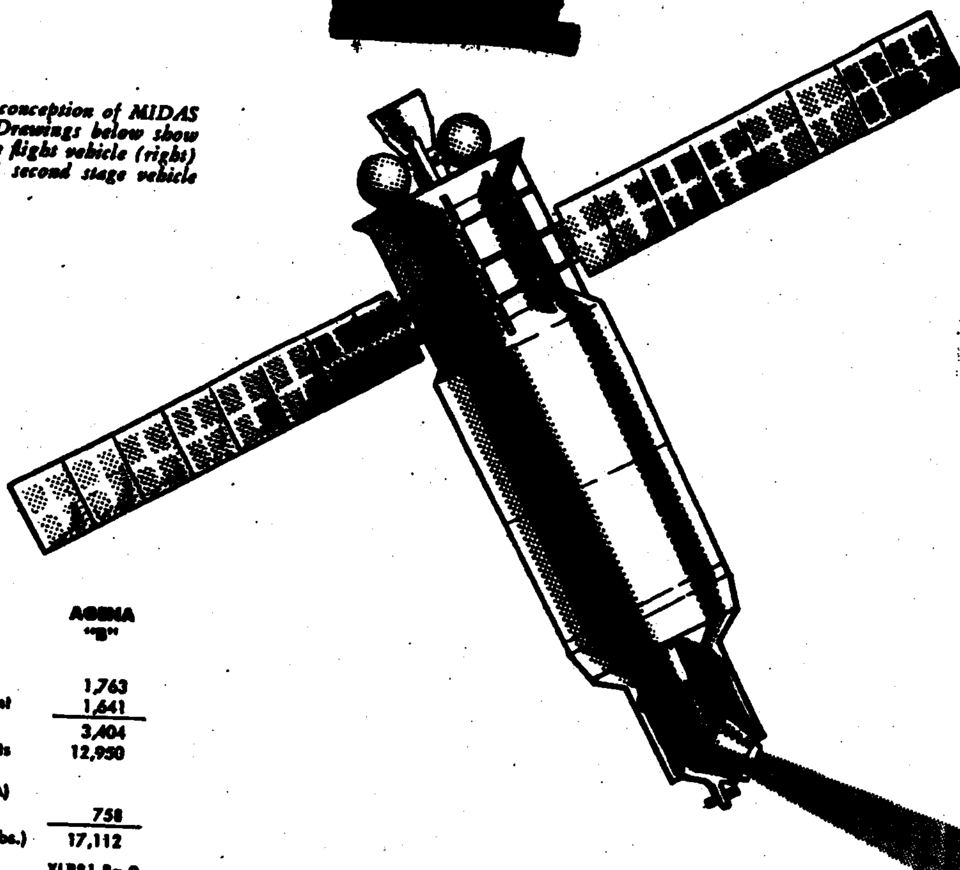
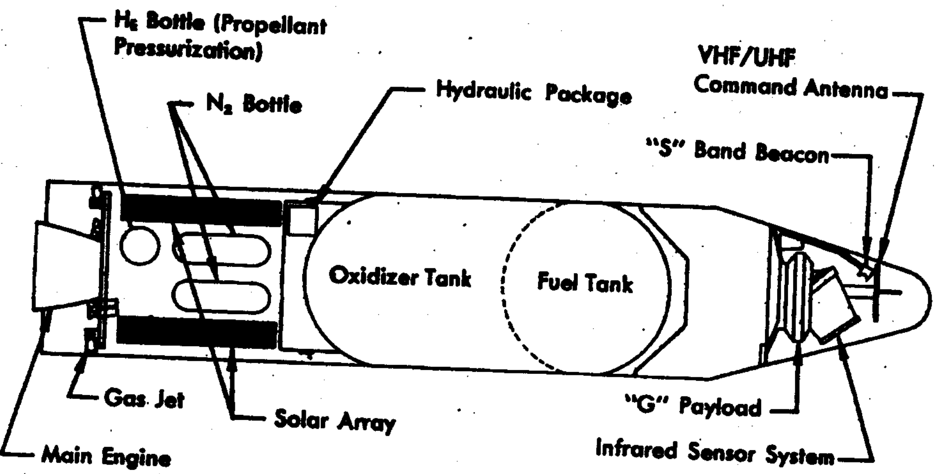
Figure 1. Artist's conception of MIDAS satellite (right). Drawings below show complete two-stage flight vehicle (right) and AGENA "B" second stage vehicle (left).

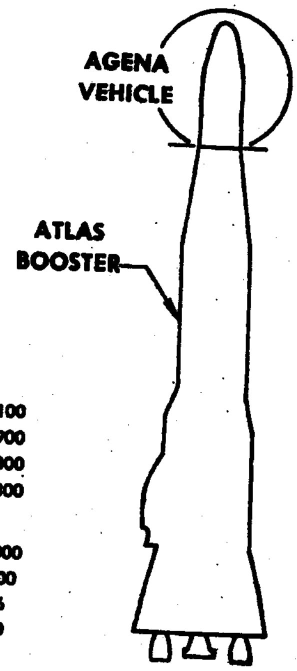


M i d a s

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



MIDAS, Configuration II, AGENA "B" Satellite



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

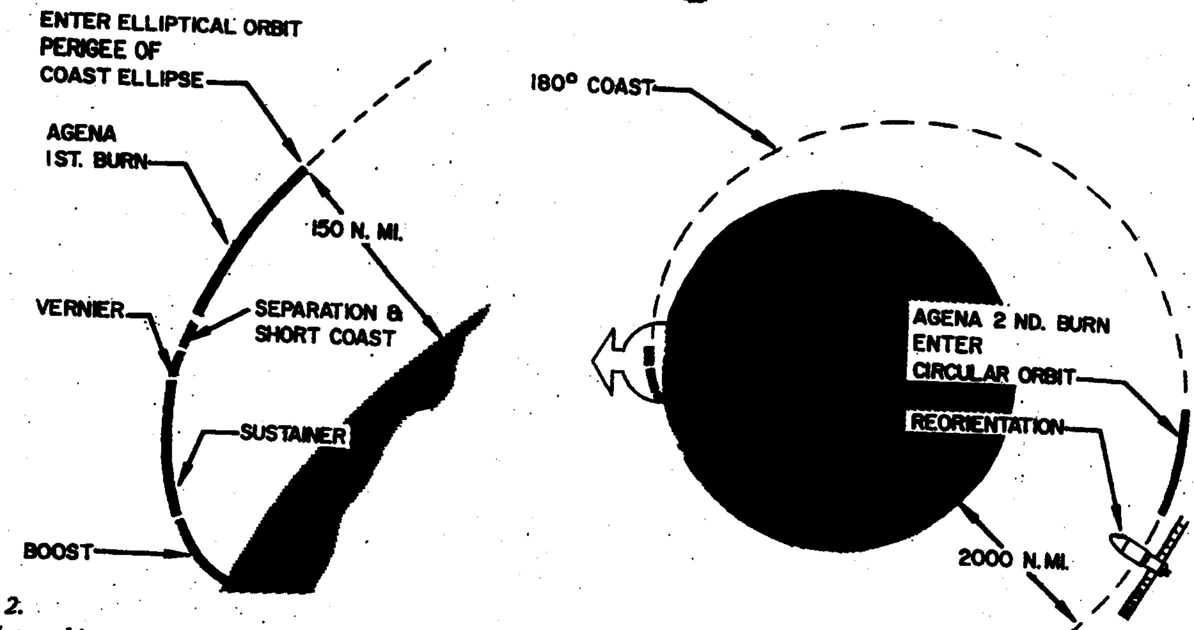


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. From boost through separation, guidance and control is provided by the ATLAS radio inertial system. The AGENA inertial guidance system, with horizon scanner, provides attitude, velocity and directional control to establish the orbit and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

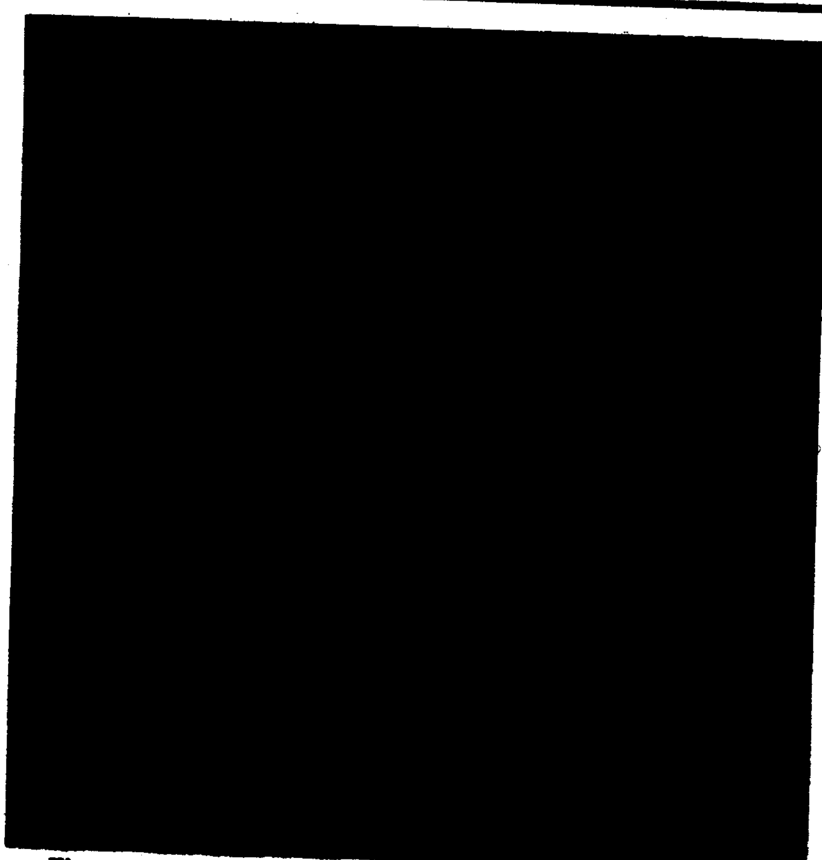
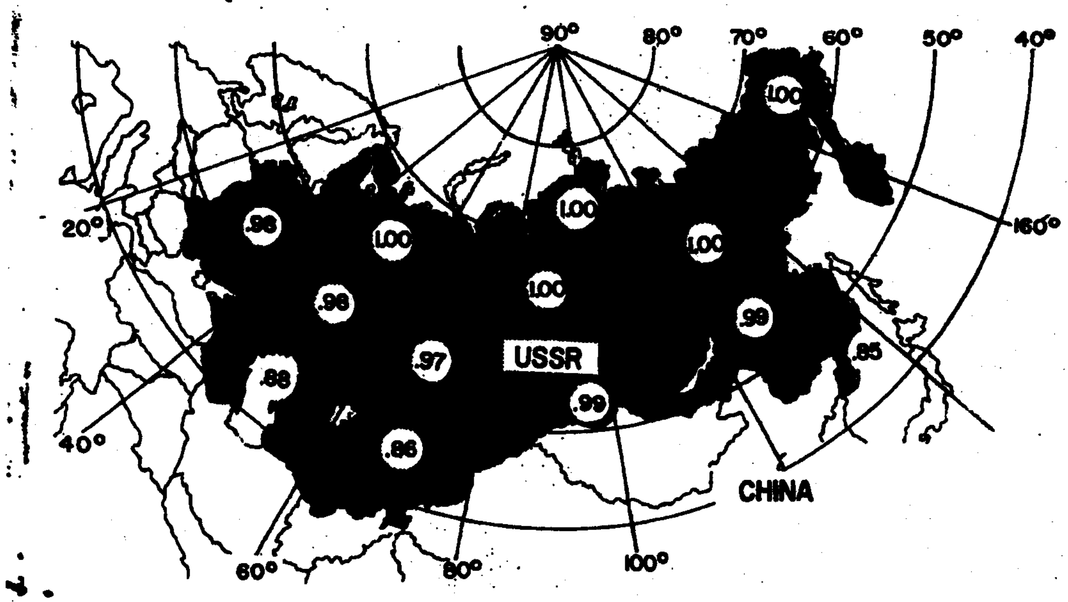


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

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.



CONDITIONS:
2,000 n.m. altitude
Two orthogonal polar orbital planes, four equi-spaced satellites in each plane.
Readout Stations
United Kingdom
North Atlantic
North Pacific

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

TECHNICAL HISTORY

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

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

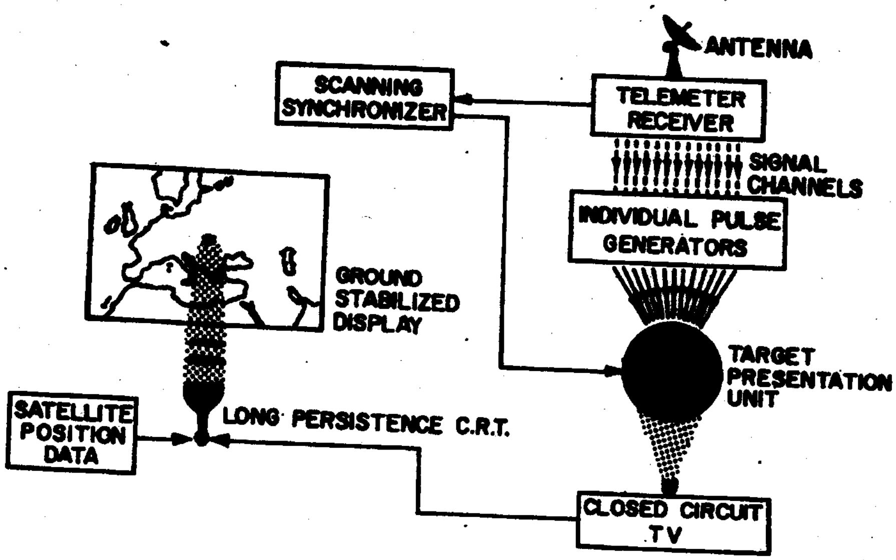
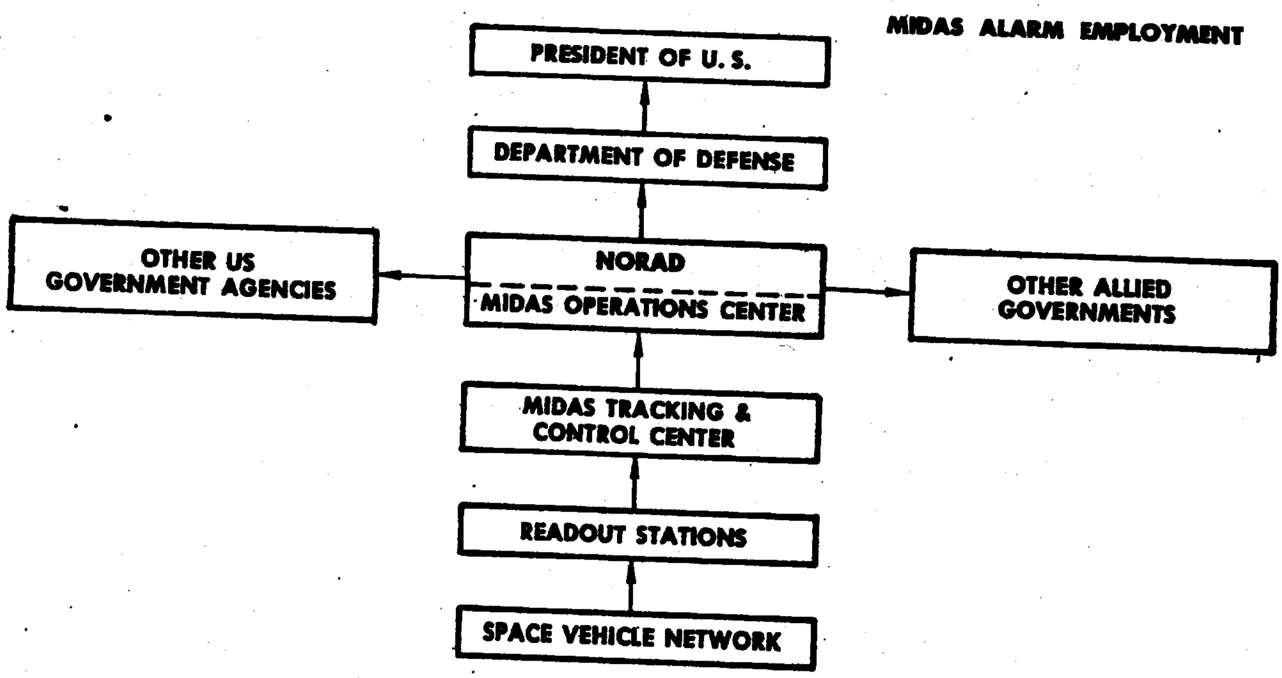


Figure 5.
Simplified version of ground presentation system (left) for display of infrared warning data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having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



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.

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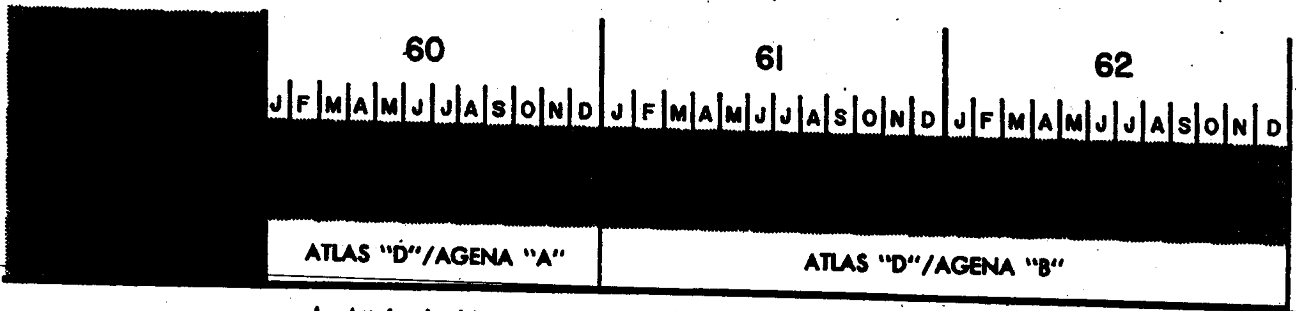


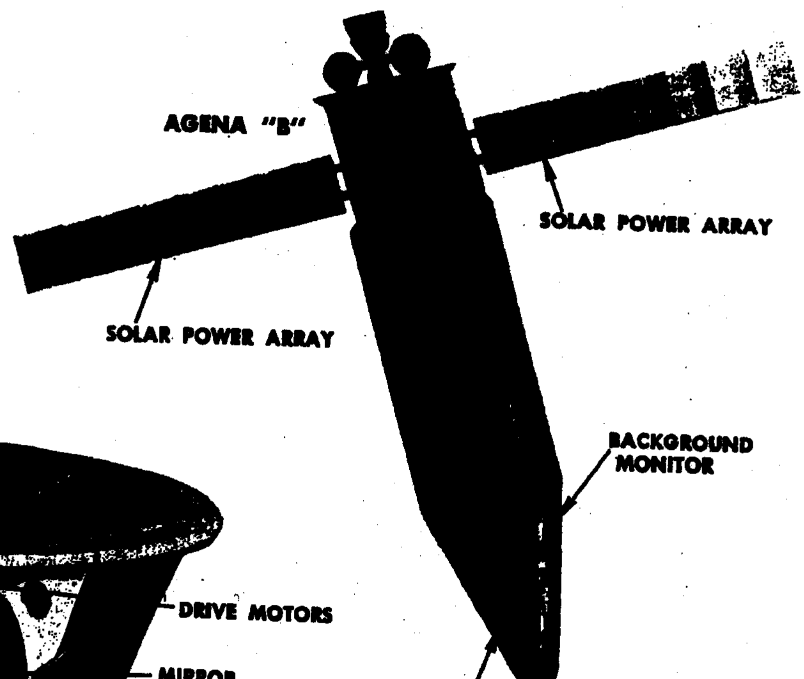
★ Attained orbit successfully ⬮ Failed to attain orbit

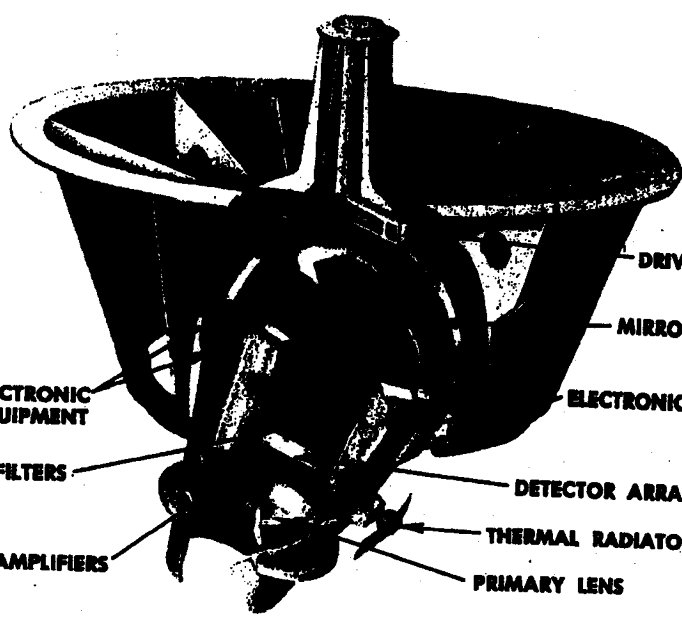
Flight History

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

MIDAS Infrared Detection Payload

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





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MIDAS GROUND SUPPORT FACILITIES

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

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

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

**Equipment*

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