

**MILITARY SATELLITE PROGRAM
PROGRESS REPORT •**

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**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**

**UNITED STATES AIR FORCE
Air Force Unit Post Office • Los Angeles 45, California**

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



WDLPR-4

14 March 1961

MILITARY SATELLITE PROGRAM PROGRESS REPORT
QUARTER ENDING 28 FEBRUARY
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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.

Robert W. Hoffman
for
O. J. RITLAND
Major General, USAF
Commander

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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

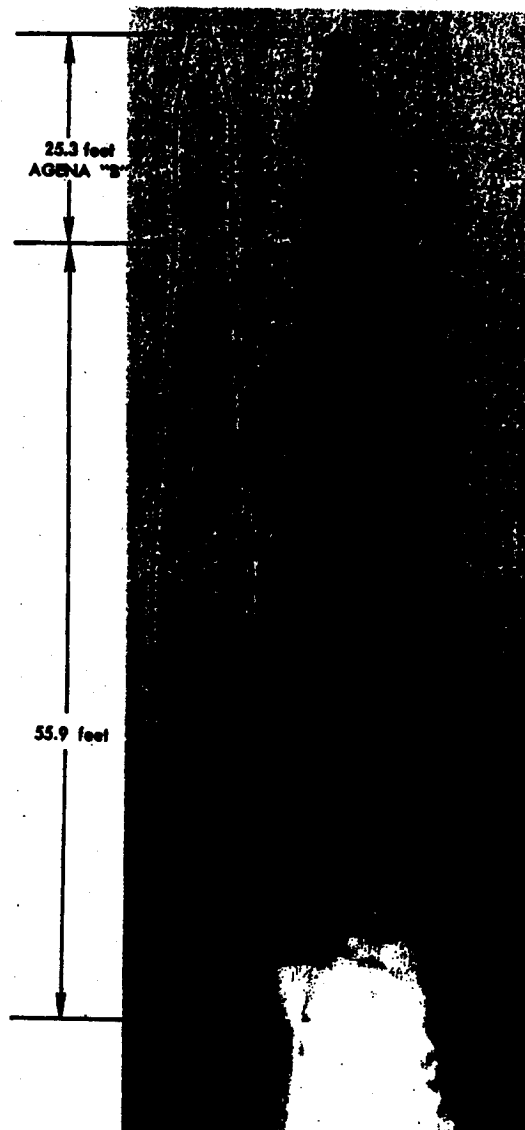
- Flight test of the satellite vehicle airframe, propulsion, guidance and control systems, auxiliary power supply, and telemetry, tracking and command equipment.
- Attaining satellite stabilization in orbit.
- Obtaining satellite internal thermal environment data.
- Testing of techniques for recovery of a capsule ejected from the orbiting satellite.
- Testing of ground support equipment and development of personnel proficiency.
- 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.

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SECOND STAGE

AGENA "B"

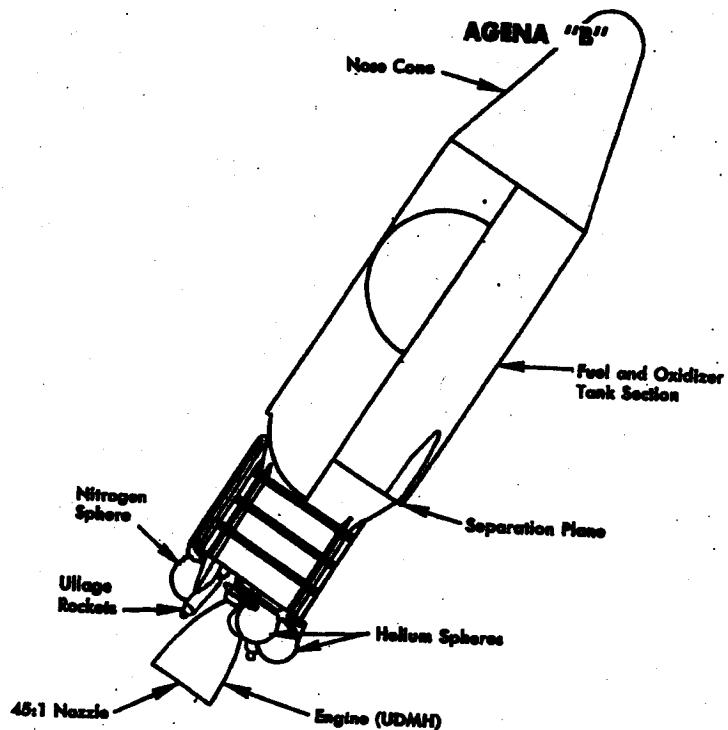
Weight—		
Inert	1,328	1,346
Payload equipment	887	915
Orbital	2,215	2,261
Impulse propellants	12,950	12,950
Other	511	511
TOTAL WEIGHT	15,676	15,722
Engine Model	XLR81-Ba-7	XLR81-Ba-9
Thrust-lbs., vac.	15,600	16,000
Spec. Imp.-sec., vac.	277	290
Burn time-sec.	240	240
BOOSTER		DM-21
Weight—Dry		6,500
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

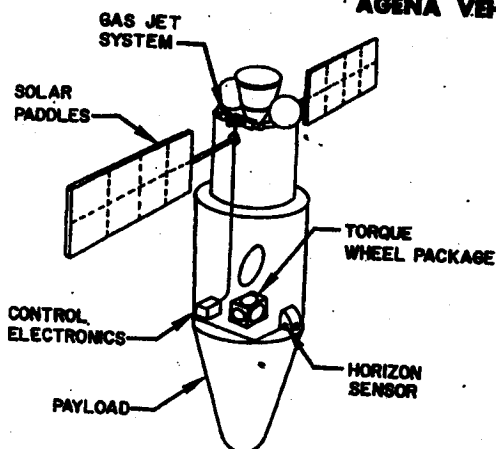
The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. The first AGENA satellites or "A" configuration employed the YLR-81Ba-5 engine which developed 15,600 pounds thrust at altitude. The development of 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

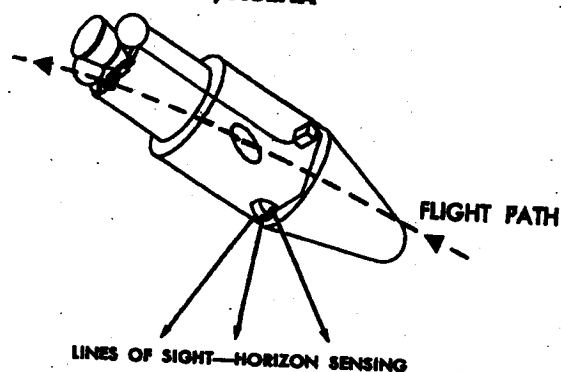


on DISCOVERER XVI. The latest AGENA "B" vehicles use the 16,000 pound thrust XLR-81Ba-9 engine which has a restart capability. This larger vehicle permits achieving higher injection altitudes with equivalent weight payloads and the restart provision permits orbital adjustment.

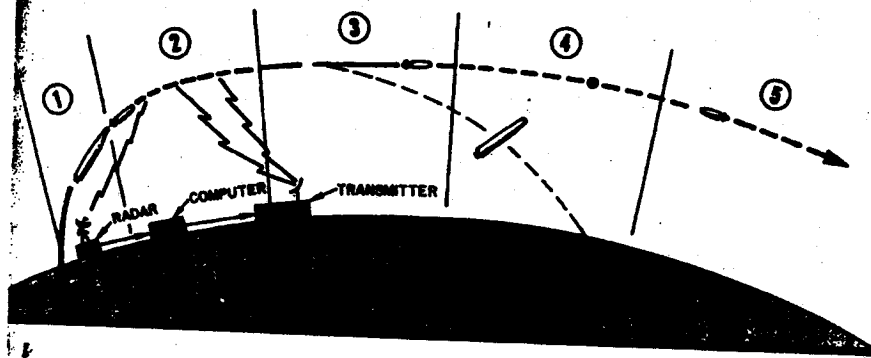
SAMOS and MIDAS AGENA VEHICLE



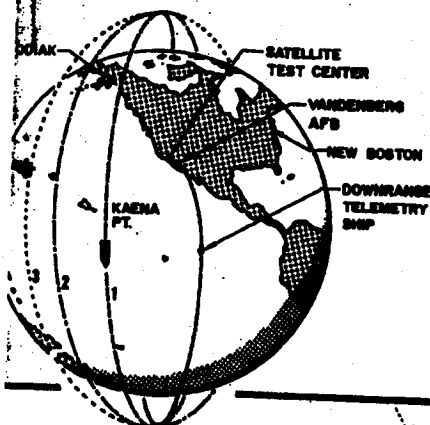
DISCOVERER / AGENA



Powered Flight Trajectory



1. First Stage Powered Flight - 2.5 minutes duration, 78 n.m. downrange, guided by programmed autopilot and STL 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).

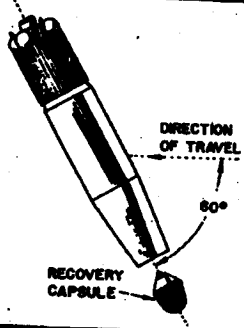


Orbital Trajectory

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

RECOVERY CAPABILITY

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

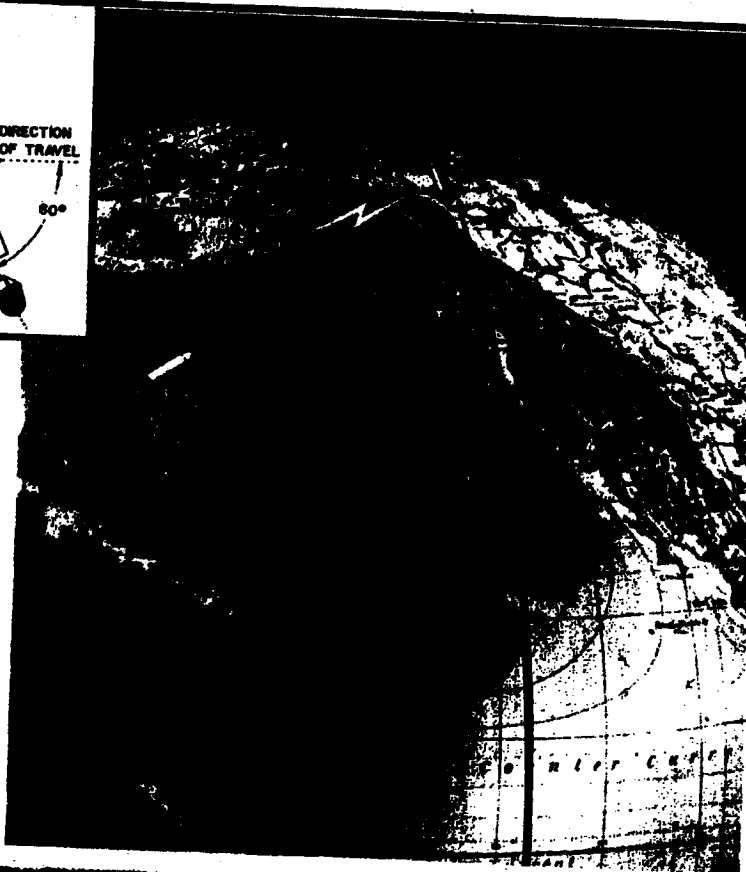


CAPSULE RECOVERY SEQUENCE

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

The ejection sequence includes a pitch down maneuver, capsule separation, spin-up, retro-rocket firing, de-spin and recovery. Following parachute deployment the aerial recovery force converges on the descending capsule and snags the parachute. The capsule contains a radio beacon and reflective flag 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 receive and record telemetry data. If it is necessary to retrieve the capsule from the sea, these ships are available.



GROUND SUPPORT FACILITIES

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

†Primary Tracking Stations (have command capability)

*Equipment

- A. General Purpose Computer(s) and Support Equipment
- B. Data Conversion Equipment
- C. Master Timing Equipment
- D. Control and Display Equipment
- E. Guidance and Command Equipment (DISCOVERER ascent only)

- F. VERLORT
- G. VHF FM/FM Telemetry Station
- H. VHF Direction Finding Equipment
- I. Doppler Equipment
- J. VHF Telemetry Antenna
- K. APL Doppler Equipment

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

Launch Schedule

A	★	J	1959
	★	F	
		M	
	★	A	
		M	
	● ●	J	
	★ ★	J	
		A	
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	2	M	
	2	J	
	2	J	
	3	A	
	2	S	
	2	O	
	1	N	
	1	D	

- ★ Attained orbit successfully.
- Ⓡ Capsule recovered.
- Failed to attain orbit.

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

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.



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.

B. TOPICAL SUMMARY

1. Flights

a. DISCOVERER XVIII

(1) DISCOVERER XVIII Flight

(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.

(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.

(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.

(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

(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.

(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.

DISCOVERER XVIII orbited on 7 December.

Engines fired as planned.

Capsule ejected after three days.

Capsule successfully retrieved in air.

Biopack and Emulsion Block experiments.

Emulsion Block measured radiation.

Biopack exposed biological samples to cosmic rays.

Solar flare exposure to DISCOVERER XVII.

Human cells apparently unaffected by radiation.

Low radiation level in DISCOVERER XVIII.

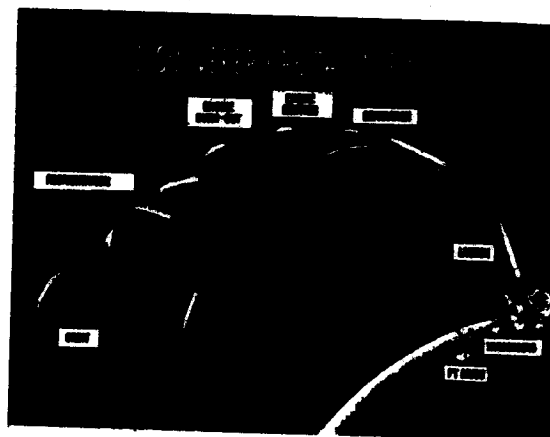
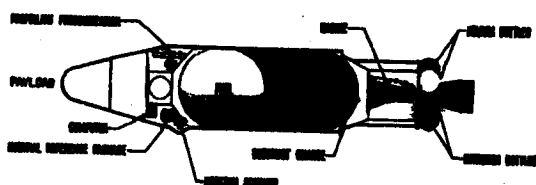
(c) The purpose of the Biopack was to determine the effect of cosmic radiation on biological samples and to correlate biological effects with types and intensities of the measured radiation. Contents of the Biopack (the two DISCOVERER Biopacks were virtually identical) are shown in an accompanying illustration,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

(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.

(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.

(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



DISCOVERER XIX orbited on 20 December.

Satellite loss of stability.

Malfunction traced.

Communications difficulties did not preclude data acquisition.

DISCOVERER XX orbited on 17 February.

b. DISCOVERER XIX

(1) DISCOVERER XIX was launched from Vandenberg Air Force Base at 1237, PST, on 20 December carrying a non-recoverable radio-metric 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

(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.

(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.

(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

(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

Four-day orbit planned.

TABLE 2. DISCOVERER XX ORBITAL DATA

(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.



**Programmer malfunction
prevented recovery.**

**DISCOVERER XXI orbited
on 18 February.**

**Radiometric non-
recoverable payload.**

**First engine restart
performed.**

**Satellite stability
lost after pass 2.**

**Two DISCOVERERS scheduled
for March launch.**

(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.

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

(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.

(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.

(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.

e. Scheduled Flights

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

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LOX flow increased.

2600 seconds of engine operation obtained.

Speed fluctuations corrected.

Power level drop-offs not resolved.

Thirty engine firings completed.

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

2. Technical Status

a. Boosters

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

b. XLR-81Ba-9 Engine Development

(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.

(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.

(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.

(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

(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.

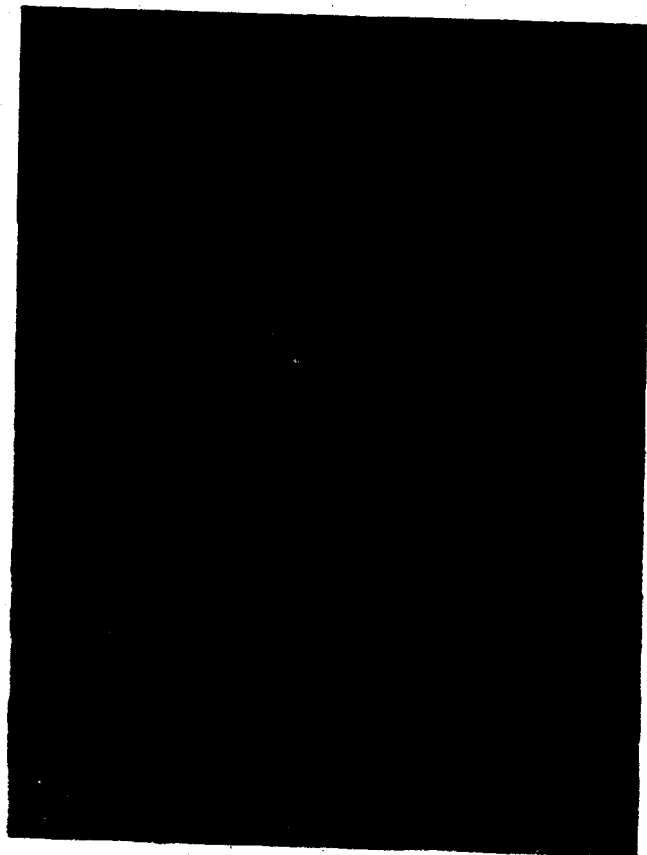
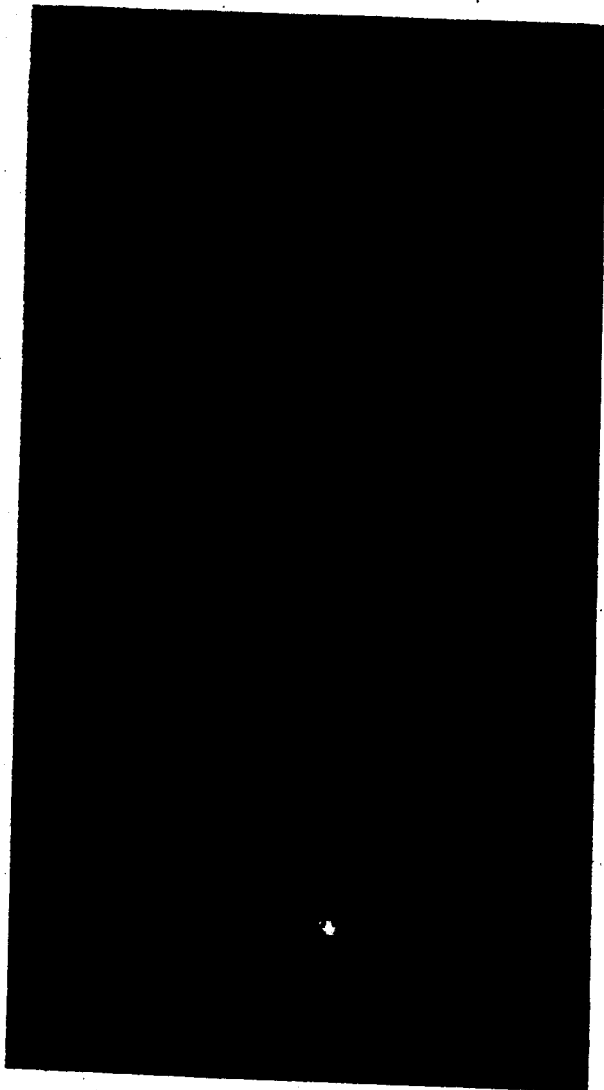


Figure 3. DISCOVERER XXI ignites, commencing successful flight. AGENA vehicle was later restarted in orbit, increasing the orbital period from approximately 94 minutes to 98 minutes.

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.

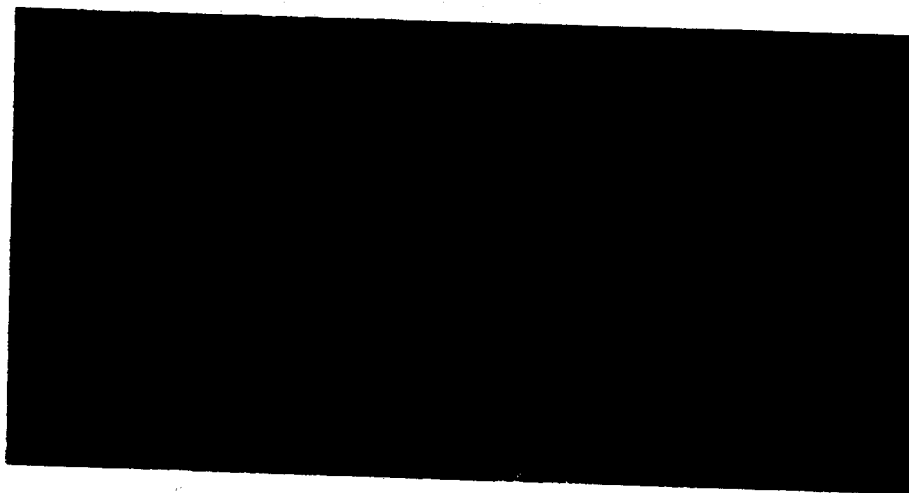


Figure 5. Optical tracking lights installed on DISCOVERER XI. Similar lights have been carried on all subsequent DISCOVERERS. Use of the lights has enabled photographic tracking of vehicles by ground stations.



**Starter assemblies
fire successfully after
30-day test.**

**Oxidizer valve meets
seven-day test requirement.**

**One recovery parachute
test satisfactory.**

**Parachute
reflectivity tests.**

**Smithsonian
meeting on tracking lights.**

**JC-130B recovery
aircraft delivery due.**

**Late delivery of launch
control equipment.**

**Propellant transfer
system modification.**

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(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.

(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

(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.

(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

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

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

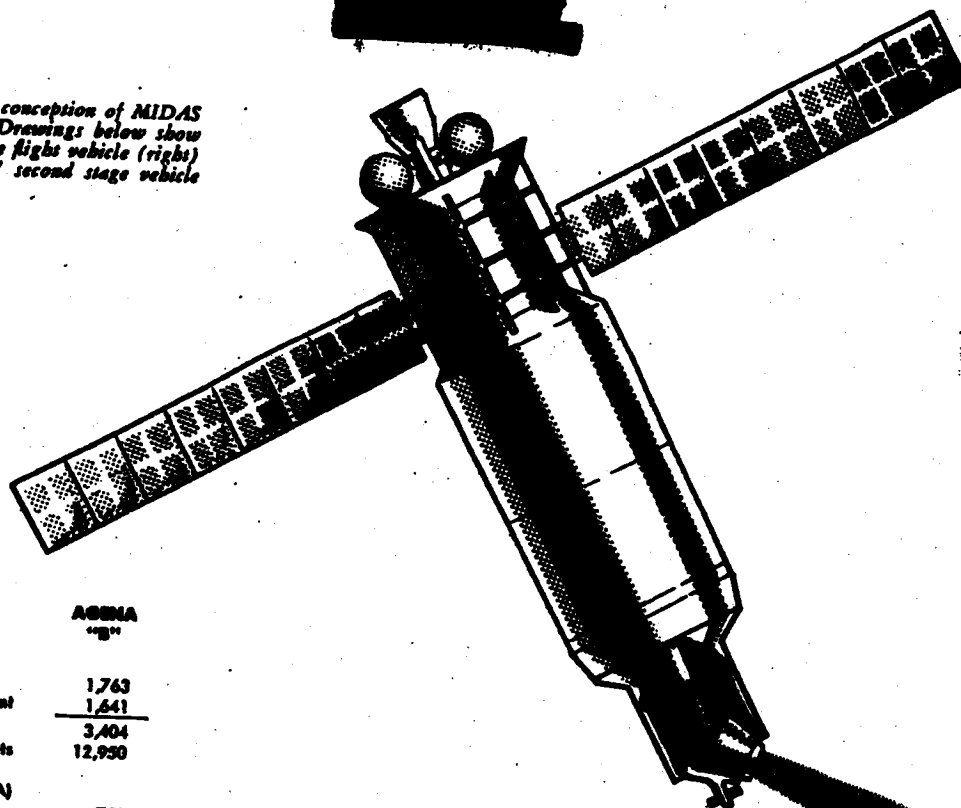
a. Complex 75-1

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

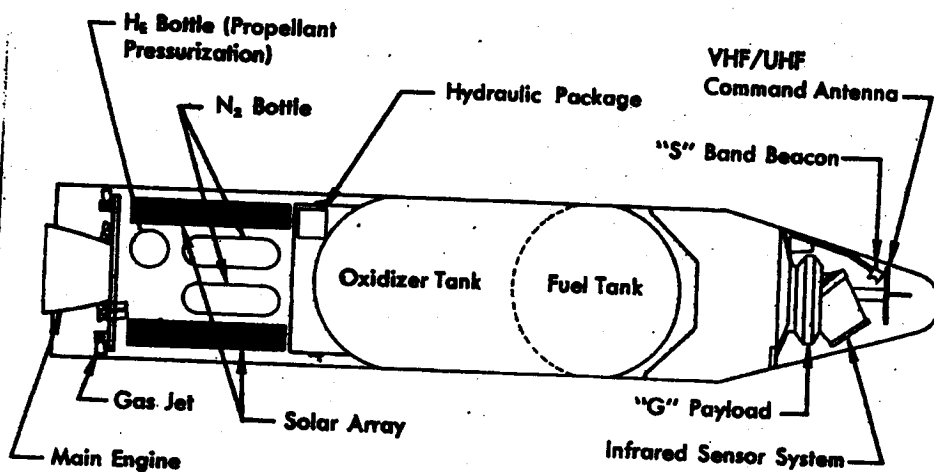
Plans and schedules for conversion of Complex 75-3, at Vandenberg Air Force Base, to permanent propellant transfer systems and launch control modernization have been formulated by Lockheed and Douglas and approved by AFBMD. Design of facilities modification has been completed and some preliminary facility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

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



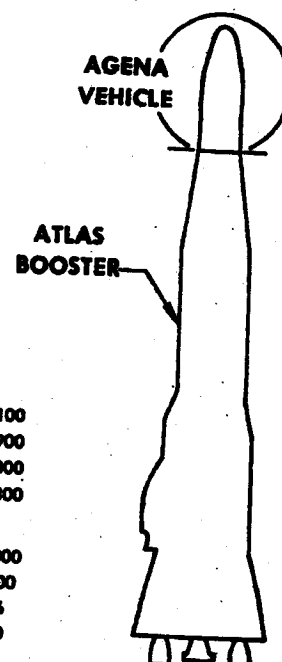
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SECOND STAGE		AGENA "B"
Weight—		
Inert		1,763
Payload equipment		1,641
Orbital		3,404
Impulse Propellants		12,930
Fuel (UDMH)		
Oxidizer (IRPMA)		
Other		758
GROSS WEIGHT (lbs.)		17,112
Engine	XLR81-Ba-9	
Thrust, lbs. (vac.)		16,000
Spec. Imp., sec. (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



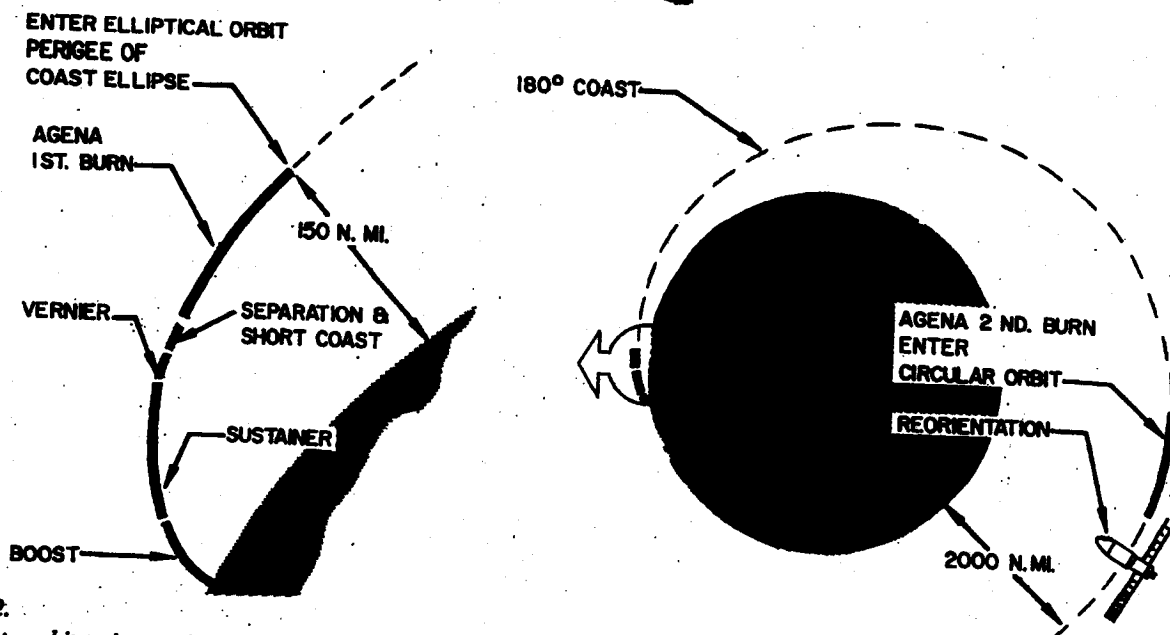


Figure 2.

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.

PROGRAM HISTORY

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

Figure 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.

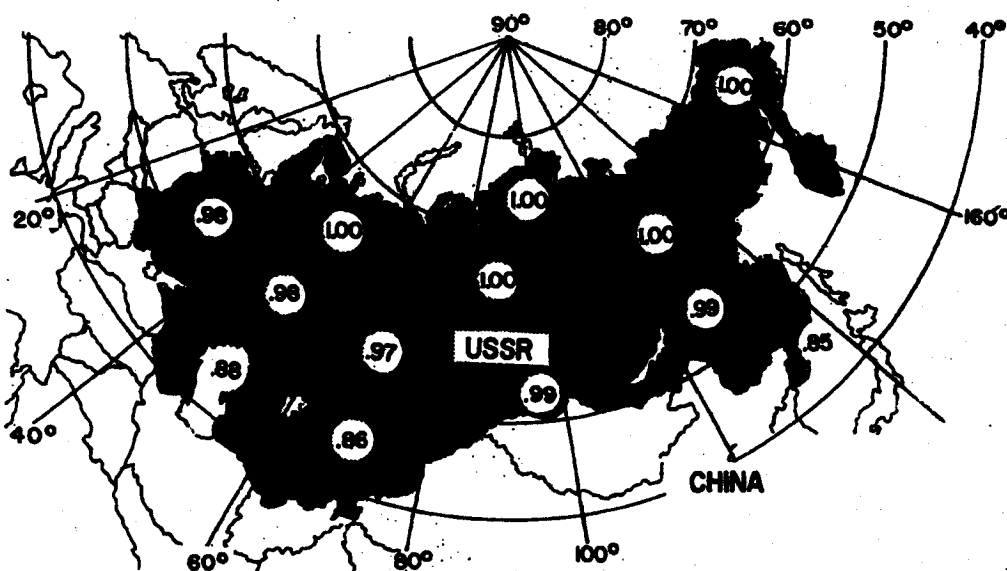


Figure 4.

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



TECHNICAL HISTORY

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

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

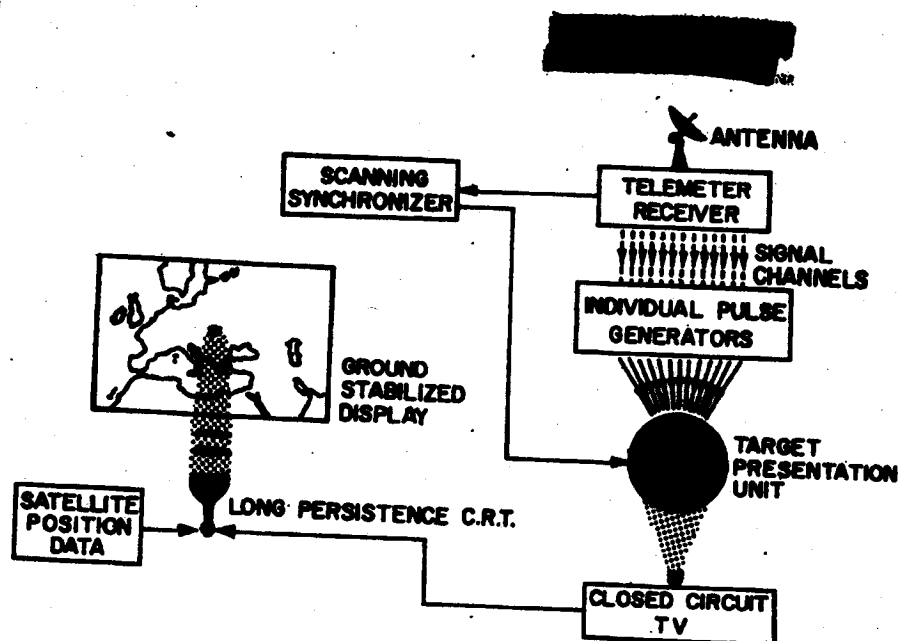
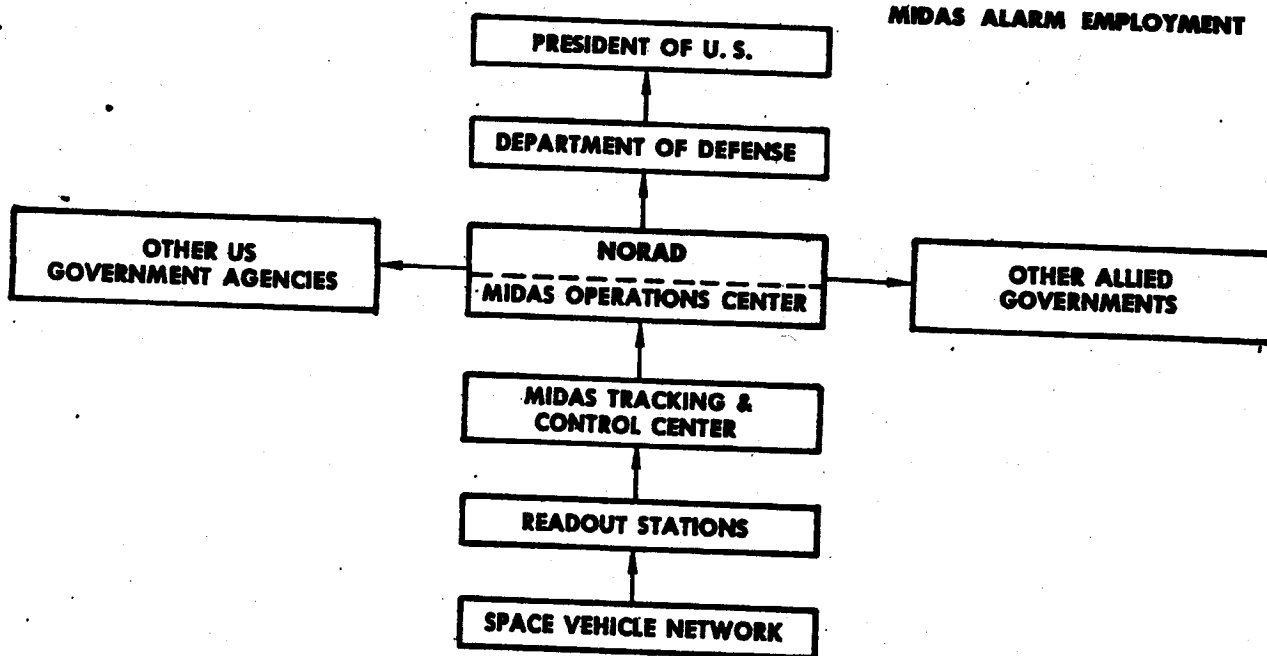


Figure 5. Simplified version of ground presentation system (left) for display of infrared warning data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies having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

MIDAS ALARM EMPLOYMENT



CONCEPT

The MIDAS system is designed to provide continuous infrared coverage of the Soviet Union. Surveillance will be conducted by eight satellite vehicles in accurately positioned orbits (Figure 3). The area under surveillance must be in line-of-sight view of the scanning satellite. Mission capabilities are shown in Figure 4. The system is designed to accomplish instantaneous readout of acquired data by at least one of three

strategically located readout stations. The readout stations transmit the data directly to the MIDAS Tracking and Control Center where it is processed. It is then displayed and evaluated in the MIDAS Operations Center (Figure 5). If an attack is determined to be underway, the intelligence is communicated to a central Department of Defense Command Post for relay to the President and all national retaliatory and defense agencies.

60												61												62											
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D

★ **Attained orbit successfully**

Flight History

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	ABCEFGHIJKLP	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 P&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



A. BRIEF OF PROGRESS

A new MIDAS Development Plan is being prepared in accordance with additional guidance received 23 February.

The successful RM-1 flight on 20 December obtained infrared radiation information in the 2.7 and 4.3 micron regions. Data transmission was handicapped by a tumbling satellite, but preliminary analysis shows a higher structural content in the 4.3 area than had been anticipated.

RM-2, aboard DISCOVERER XXI on 18 February, attained orbit and apparently confirms RM-1 data. Communications transmission was affected, as in the case of RM-1 by a loss of satellite stability.

MIDAS III has been delivered to the Santa Cruz Test Base for captive firing tests. Launch is scheduled for 27 April.

An eight-pound weight reduction has been achieved in development of the MIDAS heat shield.

Aerojet-General is conducting reliability testing of payloads for flights VI, VII, and VIII. The program consists of life and stress testing of parts.

The Baird-Atomic ground presentation equipment has now been installed in both the Satellite Test Center and Vandenberg Air Force Base.

Agreements have been made with the government of Southeast Africa for re-entry of a mobile tracking van. The van will provide interim readout of MIDAS telemetry pending completion of a permanent station now under construction.

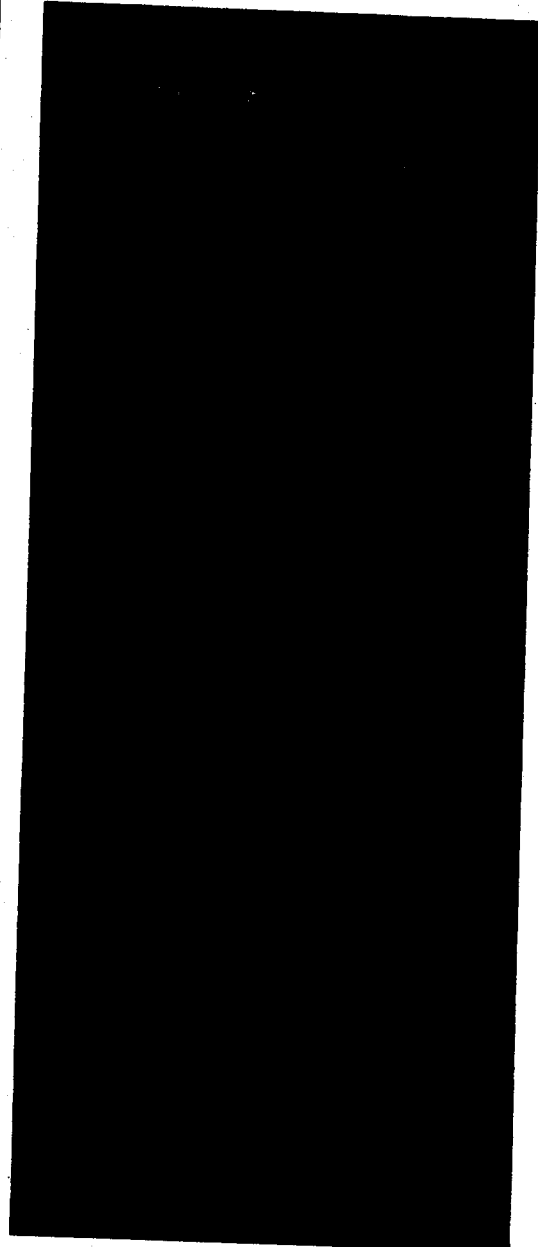



Figure 6. (Above) Model of MIDAS III satellite (AGENA 1201) scheduled for late April launch. The solar array, shown extended, is rotated in flight to permit maximum exposure to sunlight. (Right) Model of vehicle as it appears during flight prior to extension of solar paddles.

B. TOPICAL SUMMARY

1. Program Administration

a. A Headquarters USAF team, composed of members of the Weapons Board and Air Defense panel, reviewed a modification of the MIDAS Development Plan at AFBMD on 20 January. The revised plan was prepared in response to the guidance received upon presentation of the 3 January Development Plan to the Air Force Ballistic Missile and Space Committee and Air Staff on 5-6 January. The Headquarters USAF team accepted the plan as modified and presented the new plan to the committee. On 23 February, direction was received to resubmit a new Development Plan in accordance with additional guidance.

b. Representatives of Lockheed Missiles and Space Division and AFBMD met on 26 January and developed a basis for a projected MIDAS Program costing for the next five years. The proposed program projection was used for the annual cost study which was delivered on schedule, 27 February. The cost study is prepared in such format that it can be used as a basis in preparation of actual programs when finalized.

c. Negotiations regarding the follow-on contract to the basic MIDAS Program were conducted with Lockheed Missiles and Space Division (LMSD) during the latter half of February. The negotiations were limited to the "Minimum Essential" program encompassing 10 launch vehicles. Pending further Headquarters USAF direction, the new contract runs from April 1961 through September 1962.

d. Action to arrest MIDAS Program slippages has resulted in the following:

(1) LMSD has been given authority to increase system test (modification and checkout) capability.

(2) The "test philosophy" for acceptance and checkout has been revised. A block concept of identical vehicles in a series has been initiated to reduced pre-launch testing of flight vehicles. Major slippages in the program have been identified specifically as late delivery of MIDAS III (1201) for captive tests, tardy completion of the Donnelly Flats, Alaska, station, delayed release of Series III design configuration, and a late activation date for the Southeast Africa station.

e. The MIDAS Program launch schedule has been realigned to indicate attainable dates without compromise of program objectives. Launch dates have been reprogrammed to compensate for the delays and slippages incurred due to unanticipated technical problems (horizon sensor, etc.), LMSD system test (modification and checkout) limitations, other satellite program schedule and launch compatibility and additional costs incurred.

**MIDAS Development
Plan reviewed.**

**Program costs projected
for five years.**

**"Minimum Essential"
negotiation held with LMSD.**

**Program delays spur
action.**

**Launch schedules
revised.**

**RM-1 flight transmitted
valuable data.**

**RM-2 orbited but
stability lost.**

**MIDAS III delivered to
SCTB.**

**MIDAS IV, MIDAS V
progressing satisfactorily.**

MIDAS IV payload delivered.

**Payload testing
program underway.**

**Series IV detector
manufactured**

2. Flights

a. The successful RM-1 flight (DISCOVERER XIX) on 20 December carried a radiometer designed to gather background Infrared radiation information. The satellite provided data for approximately four and one-half days, as planned. The radiometer functioned well and valuable data was acquired; however, because of a tumbling satellite, data analysis has been made more difficult. Background data was obtained in both the 2.7- and 4.3- micron regions. Preliminary evaluation of information indicates agreement with earlier data obtained from balloon-borne radiometric equipment in the 2.7 region. The 4.3 micron region is somewhat higher in structural content and average level than had been anticipated from theoretical studies.

b. RM-2, successfully orbited via DISCOVERER XXI on 18 February, was identical equipment-wise to RM-1. At some point between the second and seventh passes, the satellite became unstable and tumbled. All six data channels functioned and data will be processed as in the case of RM-1. A preliminary scanning of 4.3 micron data substantiates RM-1 findings.

3. Technical Status

a. Second Stage Vehicles

(1) On 10 February, MIDAS III was delivered to the Santa Cruz Test Base (SCTB) following completion of the systems test phase of operations. MIDAS III launch is scheduled for 27 April.

(2) MIDAS IV and MIDAS V are progressing through systems tests satisfactorily. Completion date of MIDAS IV is set for mid-April with launch rescheduled for late in June.

(3) Testing of the MIDAS heat shield has been completed at Arnold Engineering Development Center. Evaluation of data indicates that the temperature within the aft equipment rack will be well within established specifications. An eight pound weight reduction was accomplished in development of the shield.

b. Infrared Scanners

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

(1) Baird-Atomic's infrared detector payload for MIDAS IV was delivered on 20 February. Two further Baird payloads of the Series II configuration will be delivered.

(2) Aerojet-General is conducting a reliability testing program in connection with the development of the advanced payloads to be used on flights VI, VII and VIII. The program consists of accelerated life testing and stress testing of payload parts and will continue for an extended period.

(3) Negotiations are in progress with Aerojet-General on their

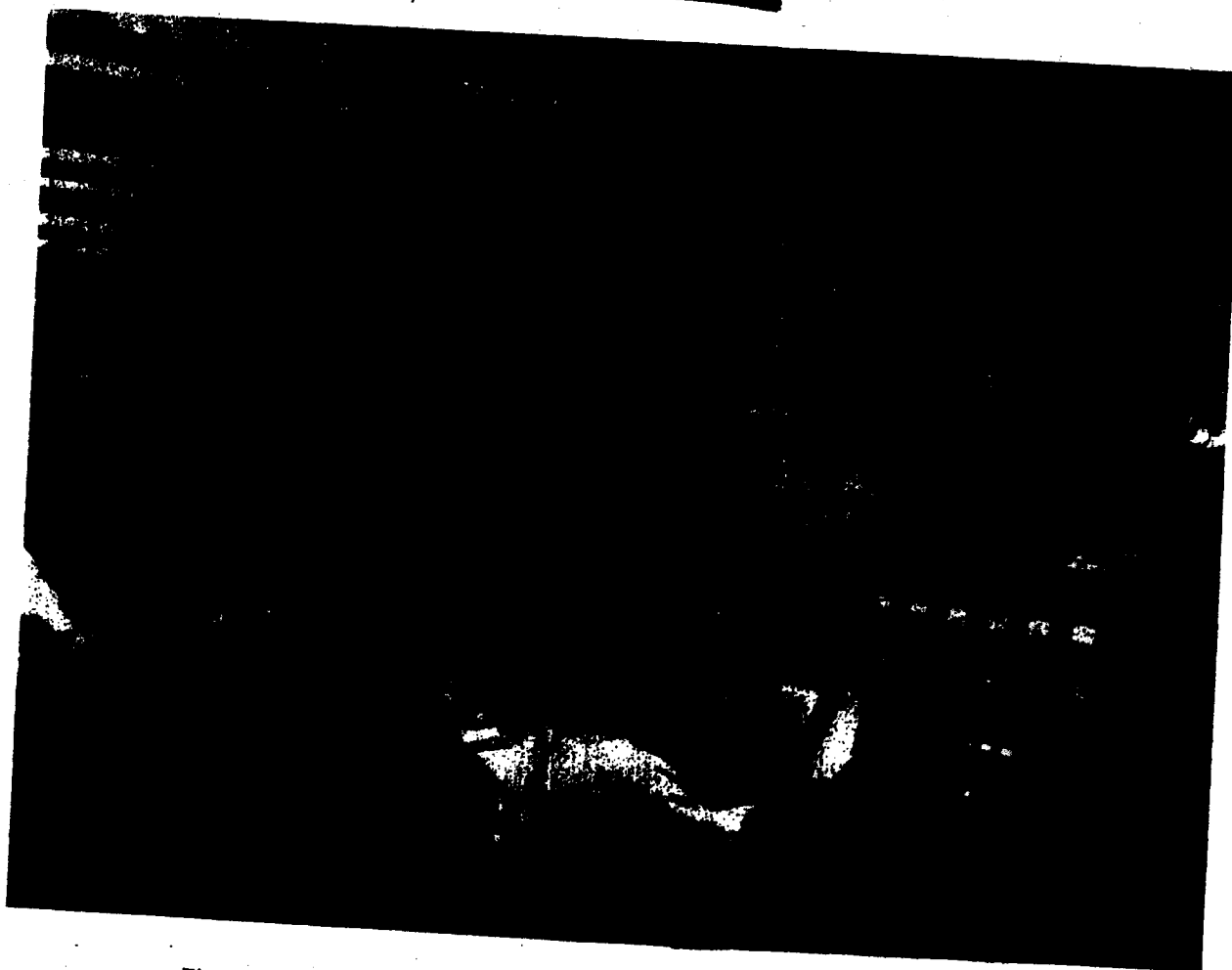


Figure 7. Interior of Vandenberg Air Force Base blockhouse during DISCOVERER XIX launch. Closed circuit monitoring of pre-launch and launch operations is provided by TV screens.

**Ground presentation set
checked out.**

MIDAS III GSE readied.

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c. Ground Support Equipment

(1) Installation and checkout of the initial Baird-Atomic ground presentation equipment in the Satellite Test Center has been completed. This equipment consists of a ground stabilization unit and a command and monitor console. In addition to providing a ground-stabilized presentation of the payload readout, the equipment permits direct visual observation of the non-stabilized image transmitted by the scanner. A second set of equipment has been installed at Vandenberg Air Force Base.

(2) Orbital tracking, telemetry, and control station equipment will be ready at the Vandenberg Tracking Station, the Northeast Station, and the Hawaiian Station to support MIDAS III. The mobile tracking van, which will receive telemetered data on engine restart performance will be ready in March. Readiness to support MIDAS at the Satellite Test Center is expected by 22 April.

Series II test set completed.

Philco to "prime" communications at Donnelly Flats.

Horizon sensor tested aboard U-2.

Mobile van agreement with Southeast Africa.

[REDACTED]

(3) Test equipment to demonstrate the compatibility of the Series II payload and the R-F link was completed in mid-February. Field tests at Vandenberg Air Force Base were to begin in March.

(4) The Donnelly Flats, Alaska, communications requirements were finalized in January. Philco Corporation was selected as the prime contractor and Western Electric as a sub-contractor for installation of equipment. This procedure will permit a better interface of all facilities.

d. Horizon Sensor Flight Test Program

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

e. Facilities

(1) Agreements have been made with the government of Southeast Africa for re-entry of a mobile tracking van. The van will provide an interim emergency capability for readout of MIDAS orbit injection telemetry. Government-to-government agreements for establishment of a permanent station (AMR Station 13) were completed during the latter part of December. The station is now being constructed under supervision of the USN Bureau of Yards and Docks. All equipment including the Eglin TLM-18 antenna has been shipped. Installation and checkout schedules are being established toward meeting an operational date of 17 May.



Figure 8. Radiometer for RM payload, prior to installation in DISCOVERER vehicle. Unit is designed to measure earth's background infrared radiation.



Figure 9. View of portion of master control room in Satellite Test Center (STC). Launch, tracking, and simultaneous control of several satellites can be directed from the STC. Data is displayed on closed-circuit TV screens (foreground), and movie screens (background).

**Point Arguello
developments.**

**Storm damage repaired
at Ottumwa.**

**Fort Greely dorm
accepted.**

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(2) Modifications to accommodate either a SAMOS or MIDAS configuration AGENA "B" at Point Arguello Complex #1, Pad 2, are progressing satisfactorily and should satisfy program need dates. The checkout equipment modifications within the Vandenberg Air Force Base missile assembly building are proceeding on schedule and will meet the MIDAS satellite vehicle schedule.

(3) A preliminary integrated milestone schedule has been prepared regarding the acceleration in the construction and activation of Point Arguello Complex No. 2. The schedule will be adjusted and approved by the applicable programs in accordance with funding capabilities.

(4) Design of the Ottumwa, Iowa, MIDAS Tracking and Control Center was authorized by Headquarters USAF on 27 January. Rehabilitation of storm damaged buildings has been completed and the buildings were accepted on 20 January.

(5) The combined dormitory and dining hall building at Fort Greely, Alaska, was accepted on 8 February. Final area cleanup will be completed by August 1961.

[REDACTED]

DISTRIBUTION

Headquarters USAF	21
Headquarters ARDC	5
Strategic Air Command	1
Air Defense Command	14
6555 Test Wing (Development)	2
6594 Test Wing (Satellite)	5
San Bernardino Air Materiel Area	1
Air Force Command and Control Development Division	1
Air Force Ballistic Missile Division	15

[REDACTED]