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

WDLPM-4

30 April 1960

FOREWORD

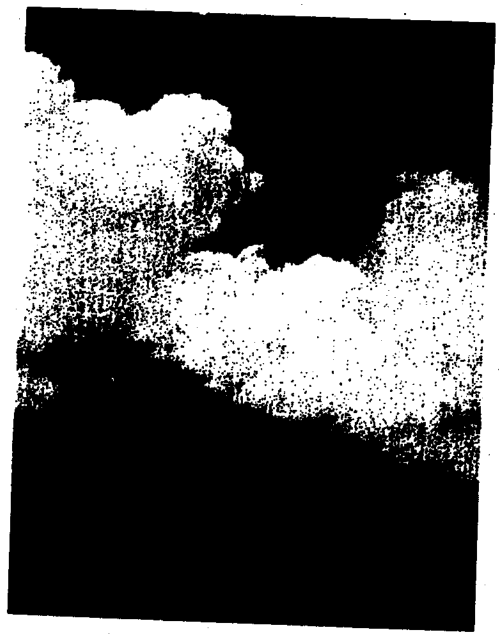
Activities summarized in this report include the major space systems, projects and studies for which the Air Force Ballistic Missile Division is wholly or partially responsible. Each space system and project is preceded by a concise history of administration, concept and objectives, making the monthly progress more meaningful in terms of total program objectives. The programs will be revised monthly to reflect major technical and administrative changes. Publication of this months report has been delayed slightly to permit the inclusion of information on the DISCOVERER XI, TRANSIT 1B and TIROS launches, and also to give an up-to-the minute report on the ABLE-4 THOR (PIONEER V). Information contained in these four sections only has been updated to include activities into the month of April. These programs must be sufficiently flexible to permit continuous and effective integration of rapidly occurring advances in the state-of-the-art.

This months report includes a Space Booster section containing program information, vehicle configurations, performance data and photographs of boosters used to support the programs covered in this report. This information will be revised when vehicle design changes occur or as new boosters are developed.

~~R W Curtin~~ for

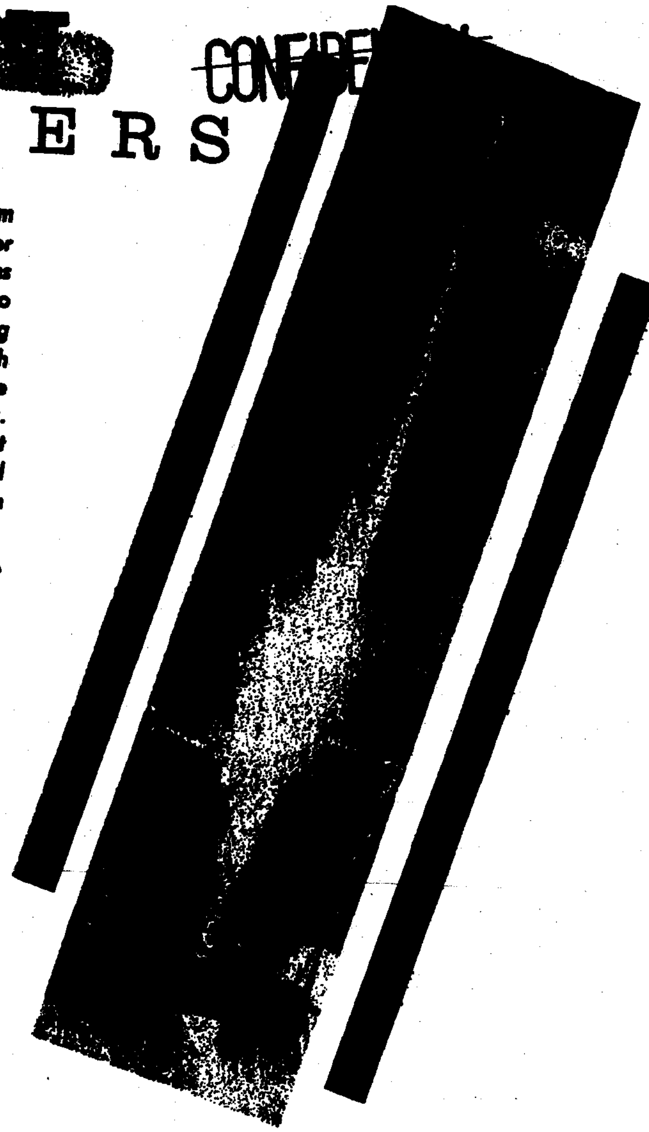
O. J. RITLAND
Maj. Gen., USAF
Commander

a foreword to...



SPACE

Space Program BOOSTERS



Planning time schedules for the accomplishment of Space Program missions is based largely, at present, on the availability of booster vehicles. IRBM, ICBM, and upper stage development programs must be closely monitored. As modifications are incorporated into these programs: reducing weight, increasing thrust, lengthening burning periods, using improved fuels; in short, any change which improves overall performance, the use of the vehicle must be re-evaluated in terms of use as a satellite or space probe booster. As breakthroughs are achieved which advance the state-of-the-art in propulsion, guidance, re-entry; in more durable materials and more reliable components, new doors are opened through which additional space capabilities are made possible.

Because of the wide variety of space research missions which must be accomplished the problem of accommodating a maximum number of experiments within a given payload becomes very complex. Among other factors, solving this problem involves the selection of the most effective booster combination, the maximum use of booster subsystems, and the maximum use of existing ground tracking and support facilities and equipment.

Because of its signal success in providing the nation with an operational THOR IRBM and ATLAS ICBM within an unbelievably short period of time, as well as for its advanced work in TITAN and MINUTEMAN programs, AFBMD possesses a distinct advantage in evaluating booster capability in terms of specific space payloads or missions. The following pages are devoted to a brief presentation of the various boosters currently being used to support AFBMD space programs. Performance charts are given which make possible a comparison of several booster combinations now in use. Specific performance figures for each vehicle are given in the table of specifications. All data shown is nominal, with individual qualifications indicated where necessary.

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THOR

Prime contractor:
Douglas Aircraft Co.

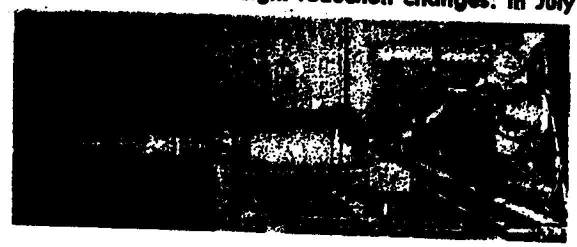
Engine manufacturer:
Rocketdyne Div., North American Aviation

Height (without re-entry vehicle)	64 feet 10 inches
Weight (no residual propellants)	
SM-75	106,546 pounds
DM-21	108,395 pounds
Engine	
SM-75	MB-3 Block I
DM-21	MB-3 Block II
Fuel	RJ-1
Oxidizer	LOX

Guidance — removed on space booster flights

Used as first stage for:
DISCOVERER
ABLE-3 and -4
TRANSIT
COURIER
TIROS

Early in 1958, the decision to accelerate the national space effort was made effectively possible only because of the availability of the THOR IRBM. THOR No. 127 was diverted from the R&D flight test program for use as the ABLE-1 space probe first stage. With top national priority assigned to the space research effort, THOR No. 163 was used to boost the DISCOVERER I into orbit on 28 February 1959. Since then, the THOR has become a reliable operational IRBM and highly reliable also as a booster for space vehicles. During 1959 all THOR boosted space flights achieved completely successful first stage performance. THOR performance has been increased through weight reduction modifications and use of RJ-1 (instead of RP-1) fuel. In April 1960 a modified THOR, designated DM-21, will be available, incorporating a shortened guidance compartment and additional weight reduction changes. In July 1960 THOR thrust will be increased to 167,000 pounds through installation of the MB-3-Block II engine. The first DM-21 vehicle will be used to boost DISCOVERER XVII.



ATLAS

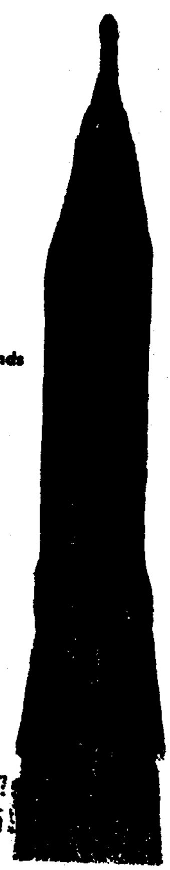
Prime contractor:
Convair

Engine manufacturer:
Rocketdyne Div., North American Aviation

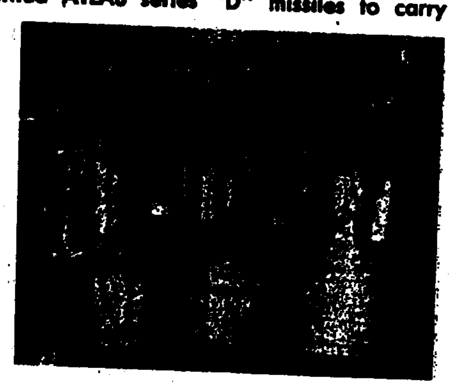
Height	69 feet
Diameter	10 feet
Weight	261,206 pounds
Engine	
Series D ATLAS	MA-2
Fuel	JP-4
Oxidizer	LOX

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

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



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



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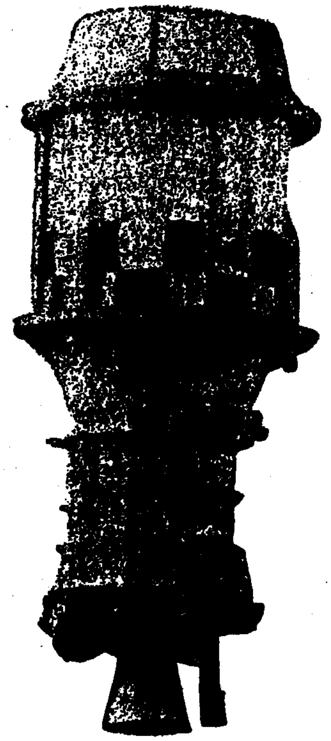
AGENA



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

Prime contractor:
Lockheed Missile and Space Division

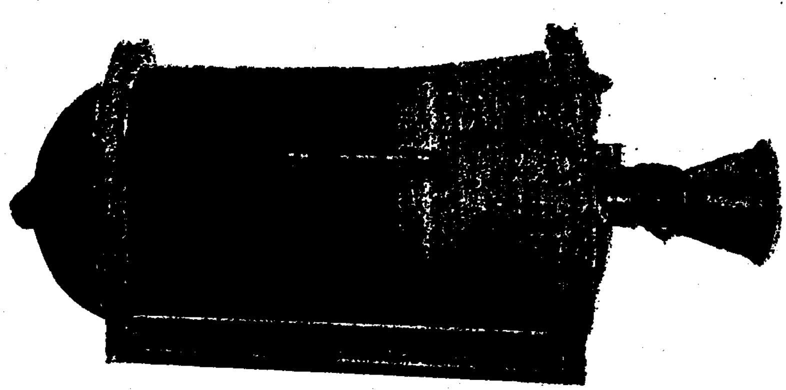
Engine manufacturer:
Bell Aircraft Corp.

Length	
"A" version	14 feet
"B" version	19.5 feet*
	21 feet**
Diameter	60 inches
Weight	
"A" version	7,987 pounds
"B" version	14,800 pounds
Engine	
"A" version	YLR81-Ba-5
"B" version	XLR81-Ba-7*
	XLR81-Ba-9**
Fuel	UDMH
Oxidizer	IRFNA
Guidance	optical-inertial

Used as second stage for:
DISCOVERER (XVII & subs)
SAMOS (flight 4 and subs)
MIDAS (flight 3 and subs)

ABLE-STAR Vehicle

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



Contractor:
Aerojet-General

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

with Restart Capability
Nozzle Expansion Ratio—40.1

Fuel
Unsymmetrical Dimethyl Hydrazine

Oxidizer
Inhibited Red Fuming Nitric Acid

Guidance
STL Advanced Guidance System
Burroughs J-1 Computer

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

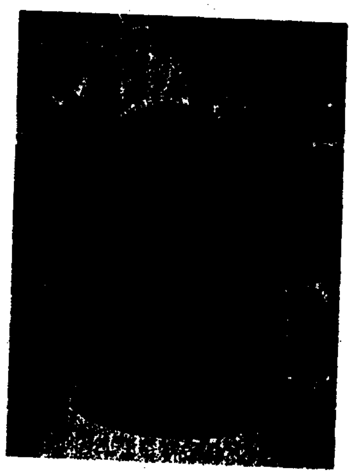
ABLE Vehicle

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

Contractor:
Aerojet-General Corp.

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

Fuel
Unsymmetrical Dimethyl Hydrazine



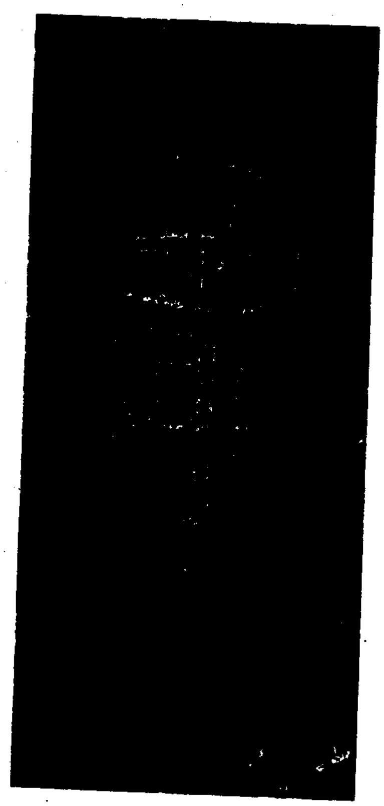
Oxidizer
Inhibited White Fuming Nitric Acid

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

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

ABL 248 Vehicle

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



Contractor:
Allegany Ballistic Laboratory

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

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

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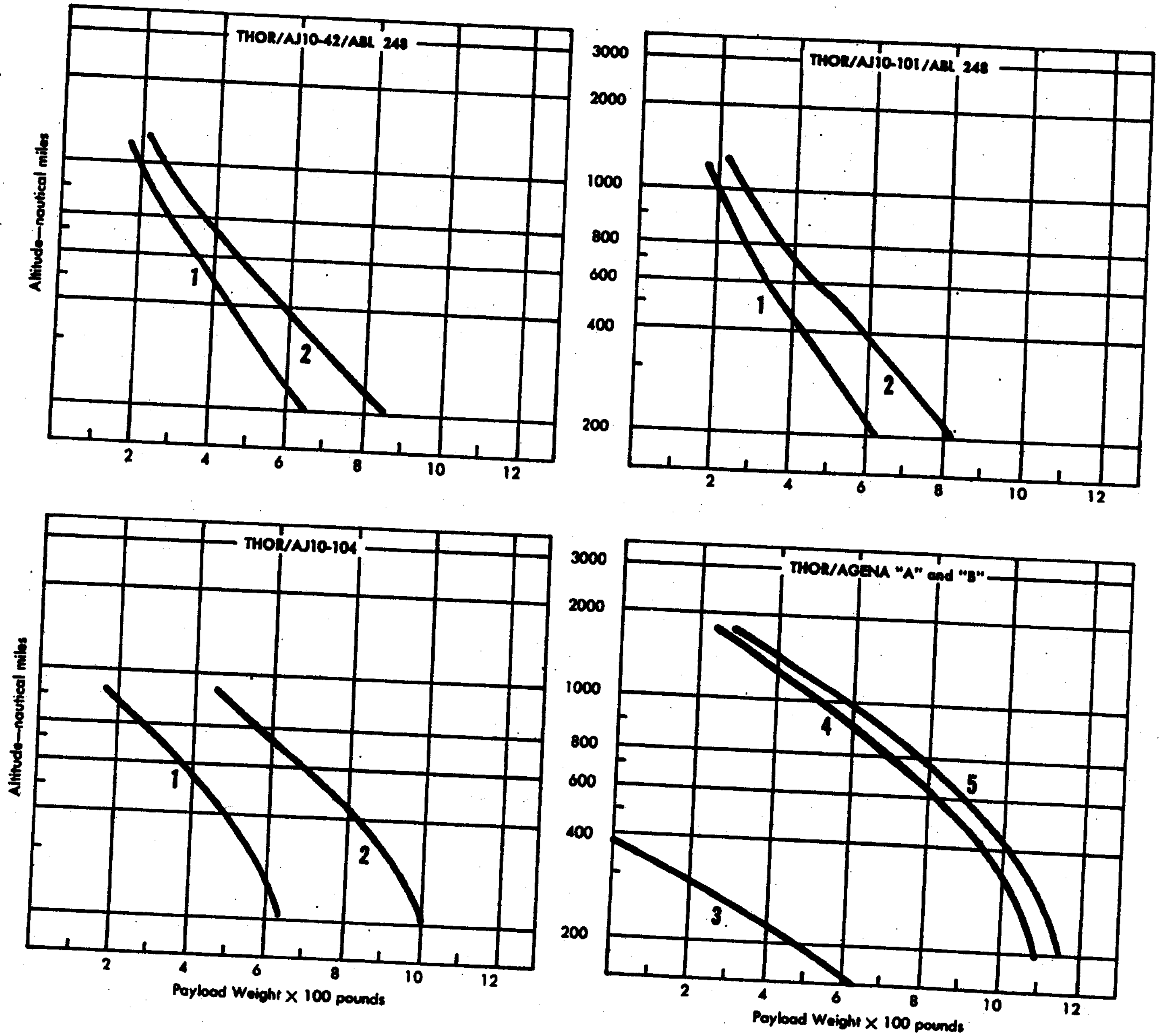
Performance Graphs — THOR BOOSTED



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

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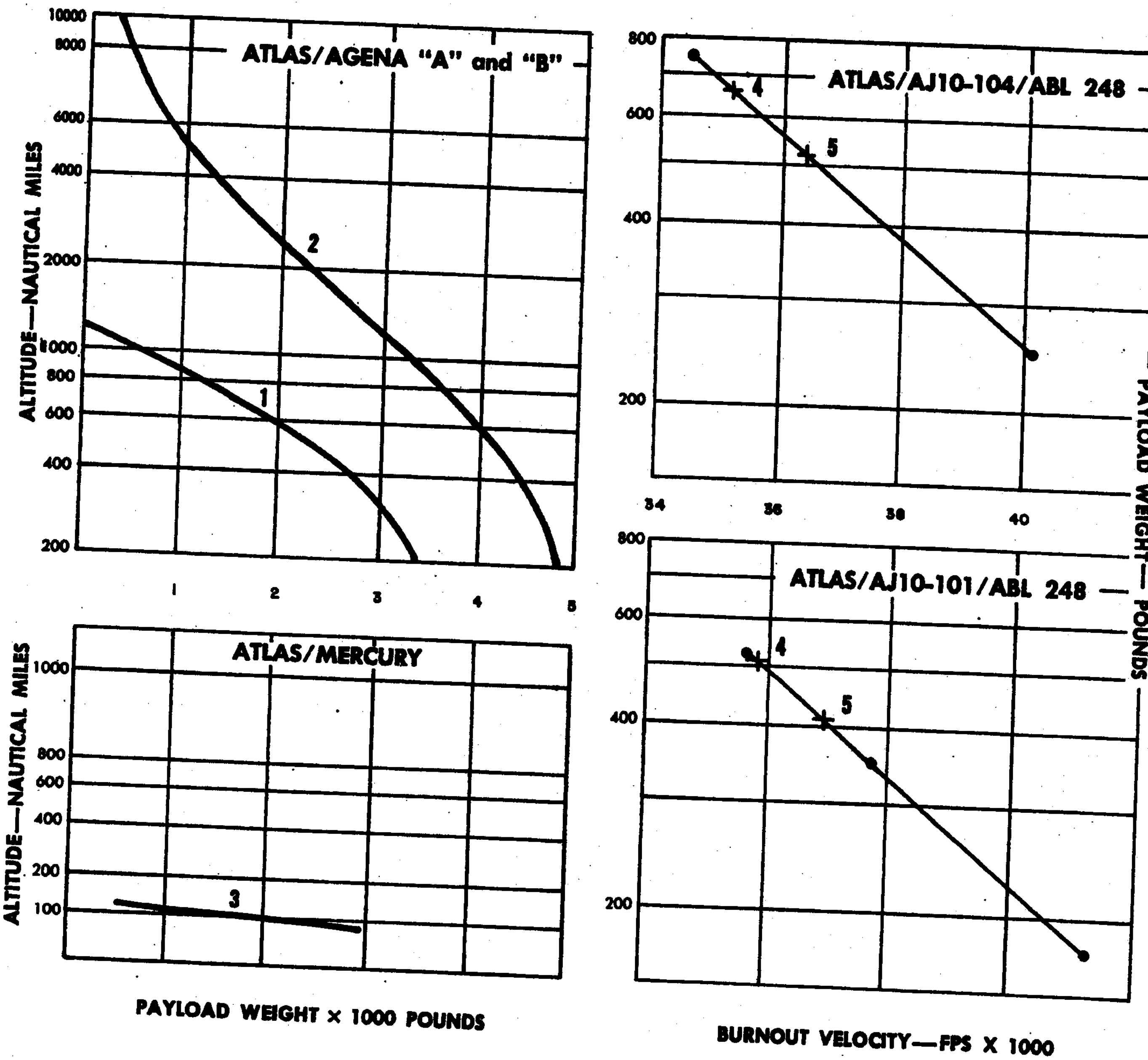
Performance Graphs — ATLAS BOOSTED



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

4. Lunar Probe
5. Venus Probe

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Specifications....

THOR — FIRST STAGE

THOR	A SM-75	B DM-21
Weight—dry	7,746	6,510
Fuel	30,500	33,695
Oxidizer	68,300	68,190
TOTAL WEIGHT	106,546	108,395
Thrust-lbs., S.L.	152,000	167,000
Spec. Imp.-sec.	246.42	248.3
Burn Time—sec.	163.59	148.0

ATLAS — FIRST STAGE

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

AGENA — SECOND STAGE

AGENA	D "A"	E "B"	F "B"
Engine Model	YLR81-Ba-5	XLR81-Ba-7③	XLR81-Ba-9④
①Weight—inert	1,155	1,370	1,400
Impulse propellants	6,550	13,100	13,100
Pyrotechnics	67	108	108
②TOTAL WEIGHT	7,772	14,578	14,608
Separation Weight	7,746	14,552	14,582
Thrust-lbs., vac.	15,000	15,000	15,000
Spec. Imp.-sec., vac.	277	277	290
Burn Time—sec.	120	240③	240④

NOTES

① *Payload weight not included. Does include controls, guidance, APU and residual propellants.*

② *Does not include THOR adapter (225 lbs.) or ATLAS adapter (315 lbs.).*

③ *Single restart capability.*

④ *Dual burn operation.*

⑤ *Allegany Ballistic Laboratory.*

AEROJET-GENERAL — SECOND STAGE

AEROJET-GENERAL	G AJ 10-42	H AJ 10-101	J AJ10-104 ABLE-STAR
Weight—wet	1,247.1	847.9	1,297
Fuel	875.1	869.0	2,247
Oxidizer	2,499.6	2,461.0	6,227
TOTAL WEIGHT	4,621.8	4,177.9	9,771
Burnout Weight	1,308.6	944.1	1,419
Thrust-lbs., vac.	7,670	7,720	7,900
Spec. Imp.-sec., vac	267	267	278

⑤ABL 248 — THIRD STAGE

ABL 248	K
Weight—wet	59.5
Fuel	455.5
Oxidizer	(solid)
TOTAL WEIGHT	515
Burnout Weight	50.5
Thrust-lbs., vac.	3,100
Spec. Imp.-sec., vac	250.5

Program Vehicle Combinations

DISCOVERER (1 thru 16)......A-D
DISCOVERER (16 thru 21).....A-E
DISCOVERER (21 thru 29).....B-F
COMM. SATELLITE ....C-E
COMM. SATELLITE ....C-F
MIDAS (1 and 2).............C-D
MIDAS (3 and subs)..........C-F
SAMOS (1 thru 3)............C-D
SAMOS (4 and subs)..........C-F
ABLE-3 ....A-H-K
ABLE-4 ....C-H-K
ABLE-4 ....A-H-K
TRANSIT IA ....A-G-K
TRANSIT IB, 2A, 2B ....A-J
COURIER ....A-J
TIROS ....A-G-K

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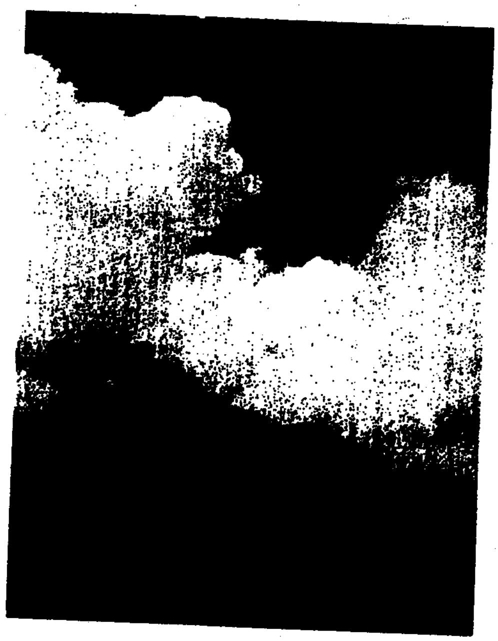


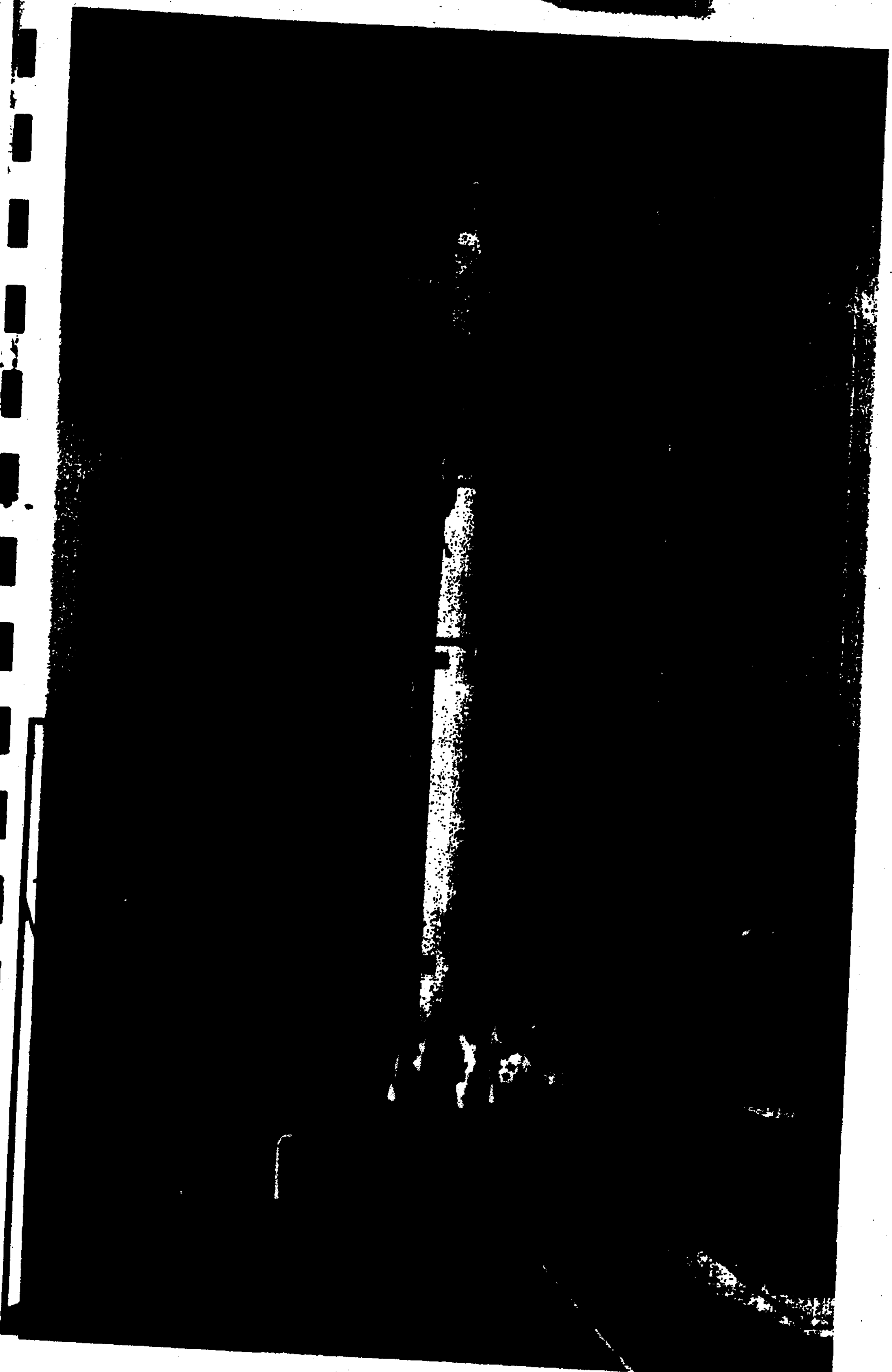
systems

DISCOVERER

SAMOS

MIDAS

COMMUNICATIONS SATELLITE



Discoverer

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—Inert	1,370	1,600
Impulse Propellants	6,550	13,100
Fuel (UDMH)		
Oxidizer (IRFNA)		
Pyrotechnics	67	100
GROSS WEIGHT (lbs.)	7,987	14,800
Engine	YLR81-Ba-5	XLR81-Ba-7
Thrust, lbs. (vac.)	15,000	15,000
Spec. Imp., sec. (vac.)	277	277
Burn Time, sec.	120	240
Restart Provisions	No	Yes
THOR BOOSTER	SM-75	DM-21
Weight—Dry	6,950	5,950
Fuel	33,750	33,750
Oxidizer (LOX)	68,300	68,300
GROSS WEIGHT (lbs.)	109,000	108,000
Engine	MB-3 Block 1	MB-3 Block 2
Thrust, lbs. (S.L.)	152,000	167,000
Spec. Imp., sec. (S.L.)	247.8	247.8
Burn Time, sec.	163	163

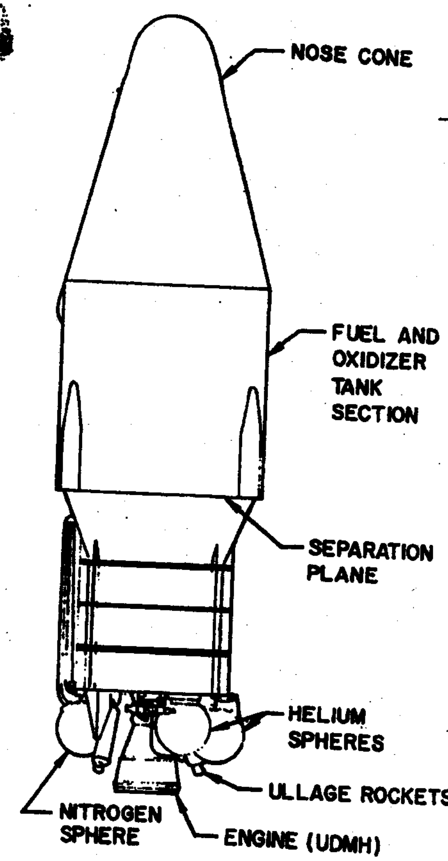


Figure 1. Photograph of two-stage DISCOVERER vehicle (left) and detailed drawing of AGENA, second stage (right).

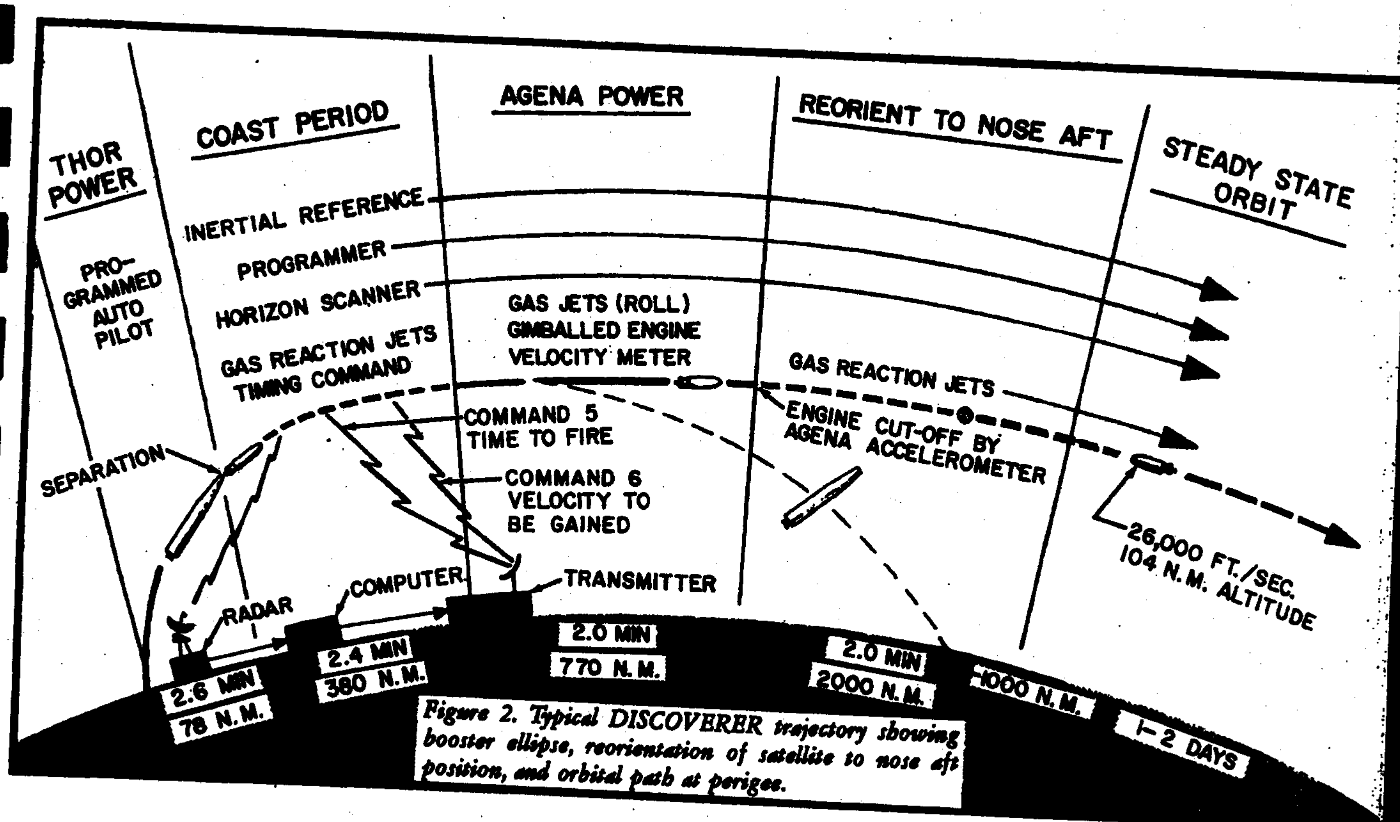
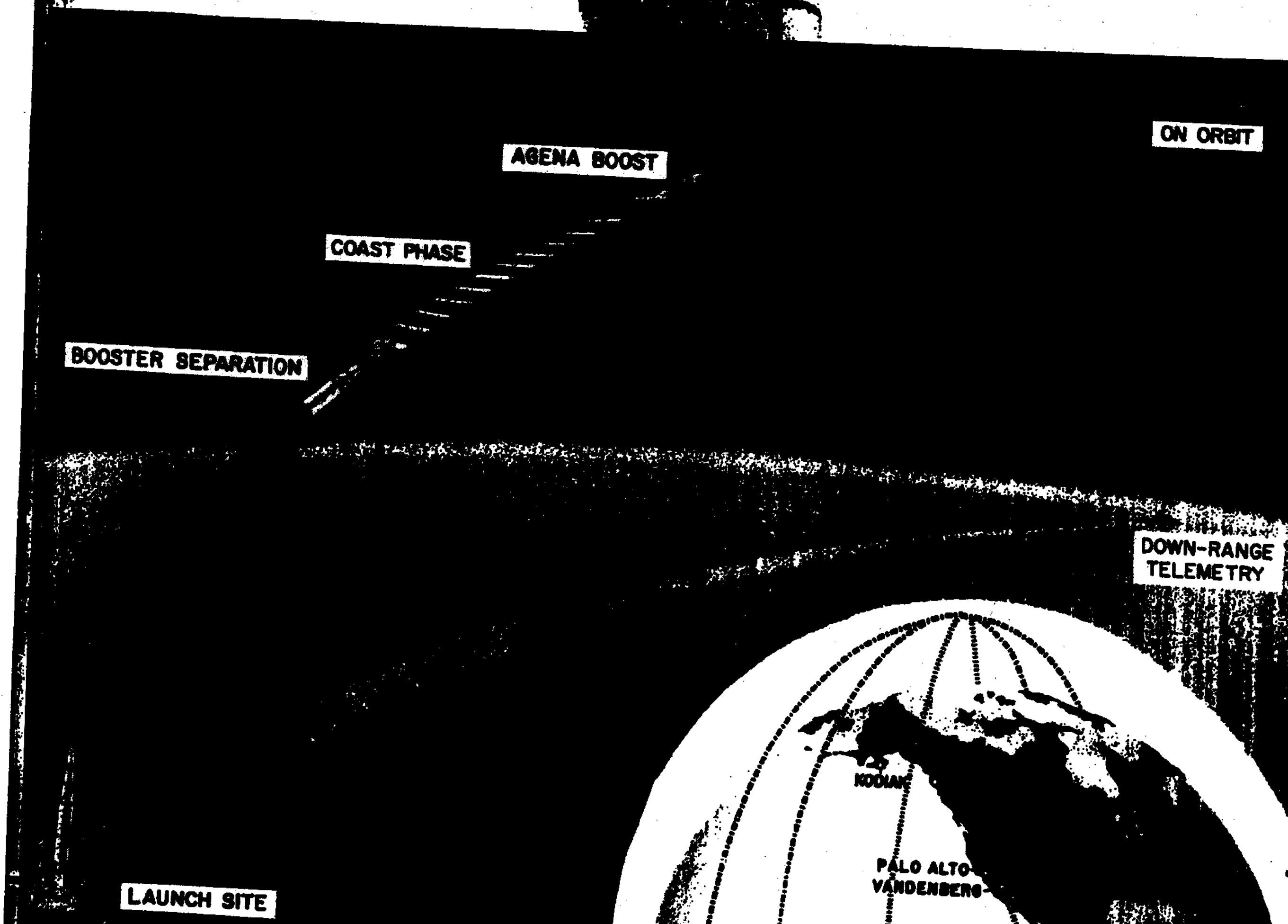


Figure 2. Typical DISCOVERER trajectory showing booster ellipse, reorientation of satellite to nose aft position, and orbital path at perigee.



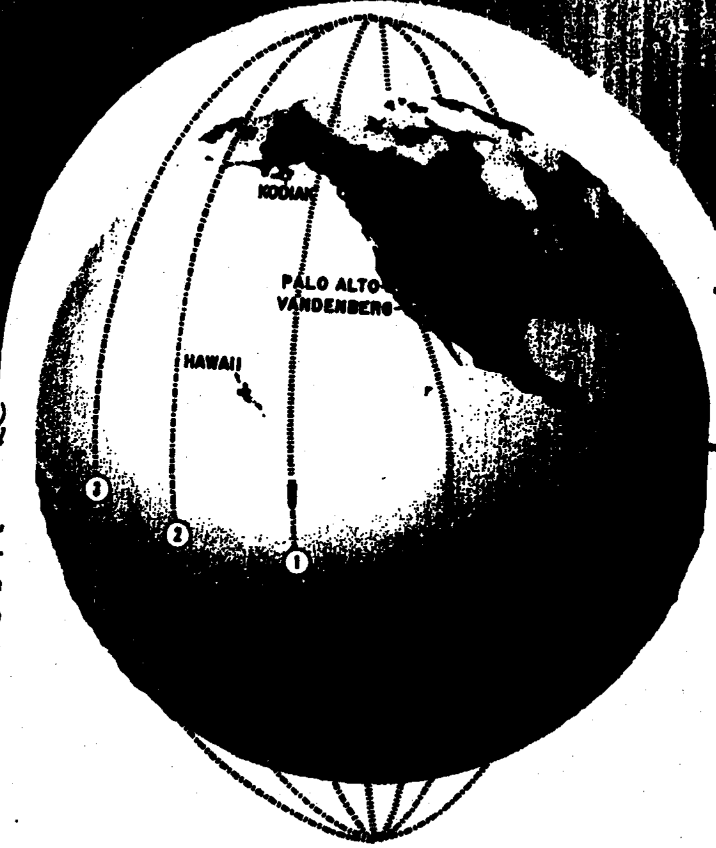


Figure 3. Typical DISCOVERER trajectory (above) from launching at Vandenberg AFB to orbit. Typical satellite orbital path around the earth (right).

The DISCOVERER Program consists of the design, development and flight testing of 29 two-stage vehicles (Figure 1), using the THOR IRBM as a first stage booster and the AGENA vehicle, powered by the Bell LR81 rocket engine series as the second stage satellite. The DISCOVERER 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 provide: (a) space research in support of the advanced military reconnaissance satellite systems programs, (b) test of the ground communications and tracking network for these programs, and (c) flight testing of the AGENA second stage vehicle.

Primary objectives include:

(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.

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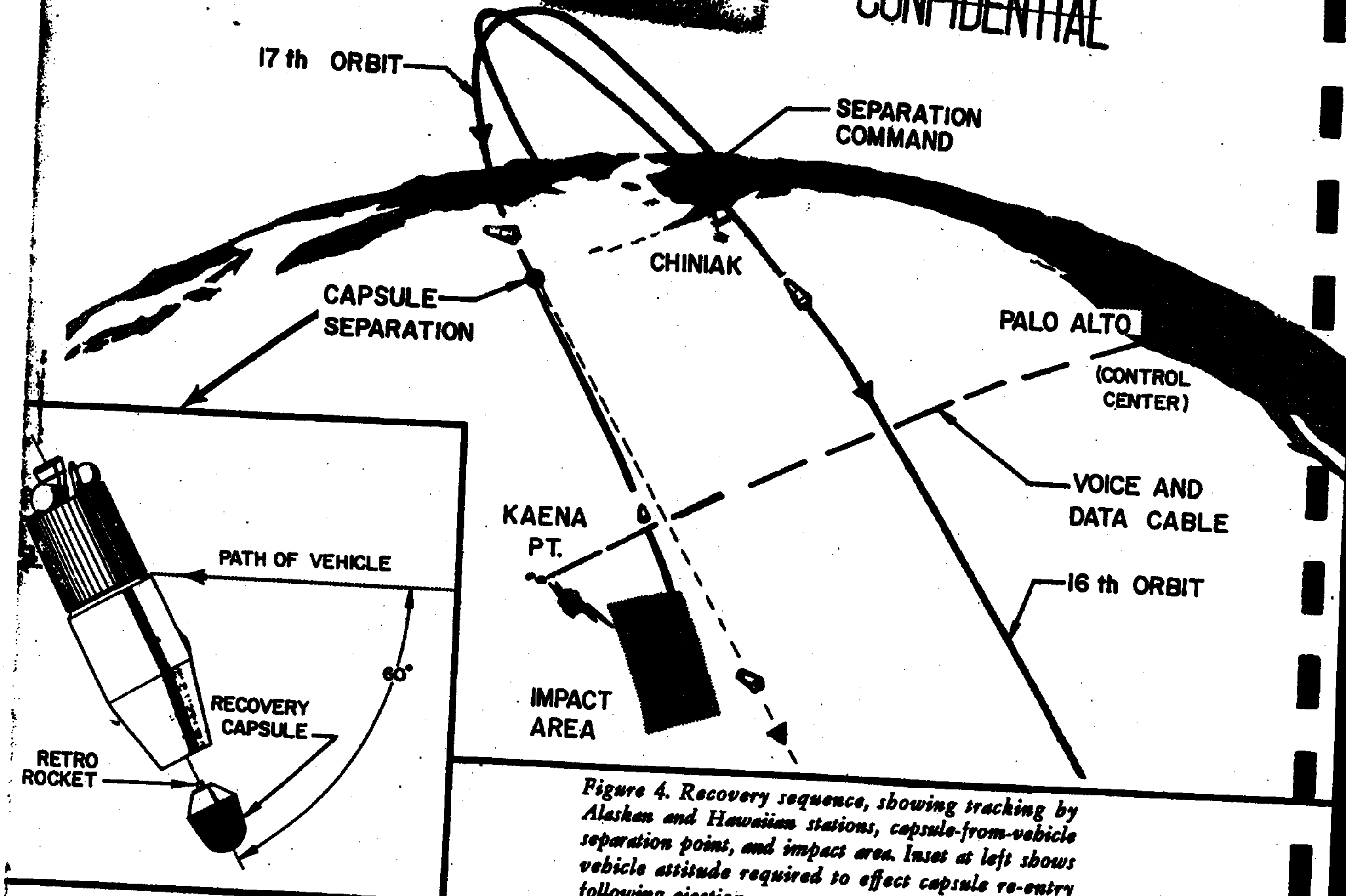


Figure 4. Recovery sequence, showing tracking by Alaskan and Hawaiian stations, capsule-from-vehicle separation point, and impact area. Inset at left shows vehicle attitude required to effect capsule re-entry following ejection.

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

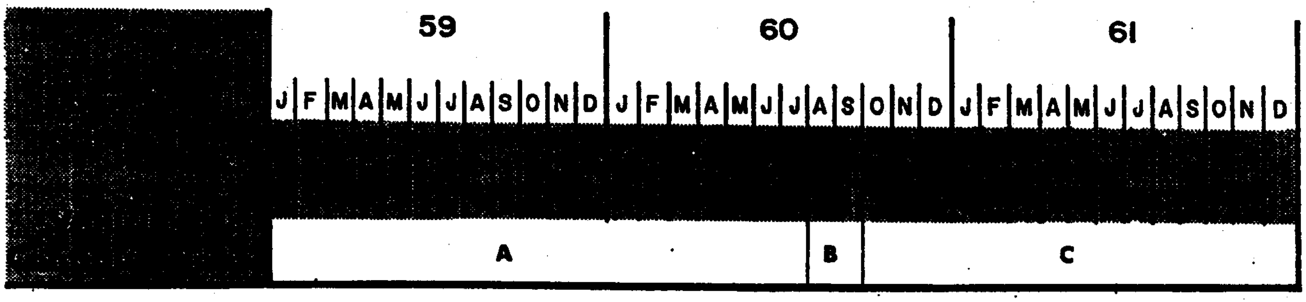
(e) Testing of ground support equipment and development of personnel proficiency.

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

Early tests confirmed vehicle flight and satellite orbit capabilities, developed system reliability and predictability, and established ground support, tracking, and data acquisition requirements. Subsequent flights are planned to acquire scientific data for design of advanced military reconnaissance payload components. Typical data gathering objectives include: cosmic and atomic radiation, magnetic field, total electron density, auroral radiation, micrometeorite measurement, Lyman alpha from space (or stars), solar radiation, and atmosphere density (drag) and composition.

A world-wide network of control, tracking, and data acquisition stations has been established. Overall operational control is exercised by the Control Center in Palo Alto, California. Blockhouse and launch operations are performed at the Vandenberg Air Force Base Control Center.

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.



A. THOR—SM-75 / AGENA "A"

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

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

Flight History

DISCOVERER No.	AGENA No.	THOR No.	Flight Date	Remarks
0	1019	160	21 January	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	1022	163	28 Feb 1959	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	1018	170	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	1020	174	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	1023	179	25 June	*Same as DISCOVERER III.*
V	1029	192	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	1028	200	19 August	*Same as DISCOVERER V.*
VII	1051	206	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	1050	212	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	1052	218	4 February	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	1054	223	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer.*

Monthly Progress—DISCOVERER Program

Flight Test Progress

● DISCOVERER XI was launched from pad 5, Vandenberg AFB, at 1230 PST on 15 April. The countdown proceeded very smoothly despite high winds. No technical holds were encountered, but the launch, scheduled for 1100 hours, was delayed one and one-half hours by mandatory holds while trains passed through the area. Terminal countdown time was only 12 minutes, 45 seconds. Launch, first stage THOR performance, separation, AGENA ignition, and orbital injection were excellent. Damage to the launch pad was unusually light.

● THOR mainstage and vernier cutoff were very near nominal. AGENA separation was clean and positive. After the proper delay, AGENA engine ignition occurred as planned. Data confirmed that the AGENA engine was shut down by the integrator-accelerometer at a total velocity gain very close to nominal. The resulting orbit has a perigee of 109.5 statute miles, an apogee of 380 statute miles, an eccentricity of .033, and an orbital period of 92.3 minutes. Acquisition of the satellite on the first pass was within 2 seconds of the time predicted from ascent tracking.

● Orbital performance was outstanding. Acquisition was accomplished by every station on every pass. All commands were received and verified (a total of fifteen). The horizon scanner, inertial reference package, and gas jet control system functioned extremely well, resulting in excellent satellite attitude stabilization. The satellite power supply, including the two advanced design static inverters, performed efficiently. The main batteries lasted through the 26th orbit.

● This was the most completely instrumented DISCOVERER flown to date. Telemetry transmission was excellent and all stations acquired valuable data on satellite equipment functions. Telemetered satellite internal temperatures were well within specified limits, confirming modifications made to satellite thermal control design.

● In addition to a completely equipped AGENA and recovery capsule, an experiment was flown with a precision dual-frequency doppler beacon from the TRANSIT program. The beacon was accompanied by a programmed continuous-burning light visible at night as a seventh-magnitude star. This light was

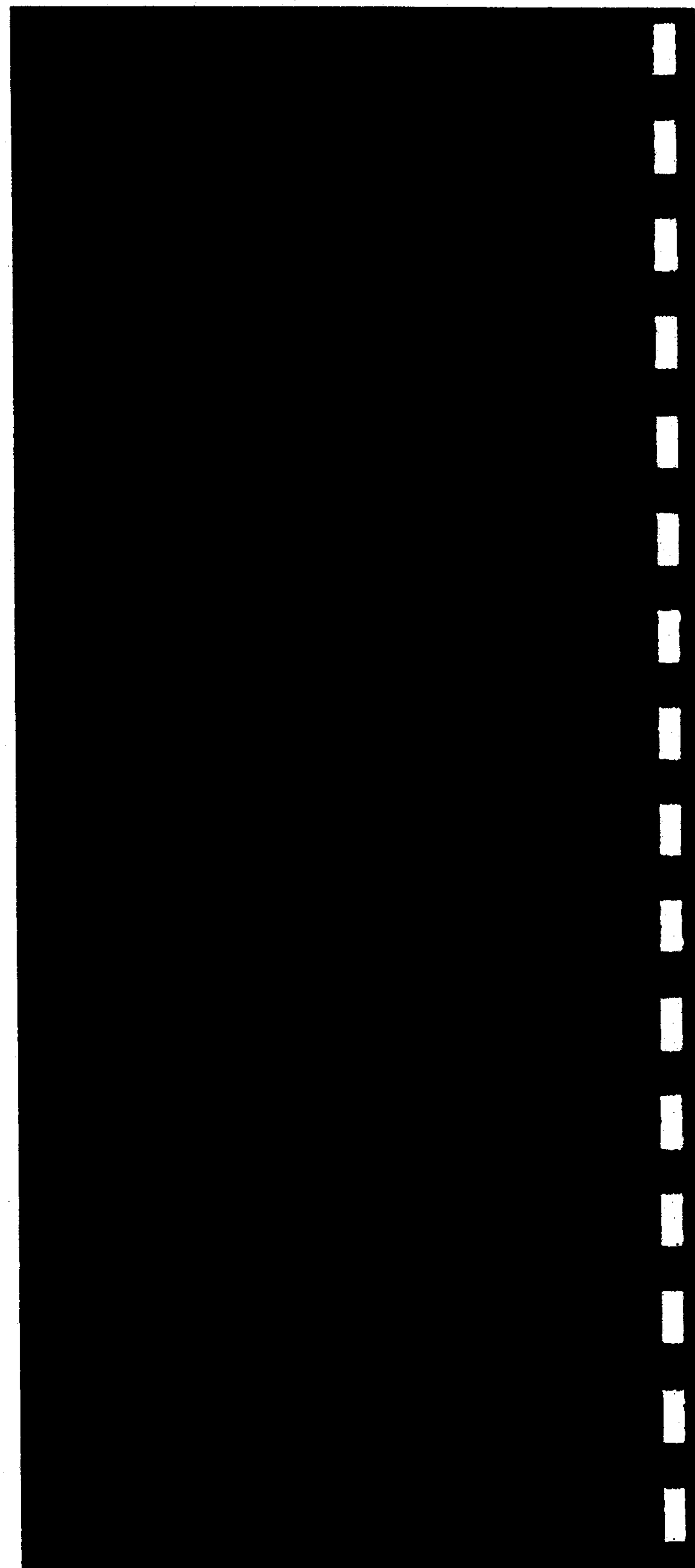


Figure 5. DISCOVERER XI just after liftoff.

successfully photographed by Baker-Nunn cameras of the Smithsonian Astrophysical Observatory, providing the most precise satellite tracking data ever obtained. Accuracy of the TRANSIT beacon and DISCOVERER verlort radar stations can now be closely determined by checking against this optical data. Both frequencies of the doppler beacon operated and were tracked. Photos of the light were made by the Cadiz, Spain camera station.

● Although capsule separation and retro rocket ignition took place, the capsule did not descend in the recovery area. Verification of the ejection for re-entry sequence was indicated by telemetry, although there was considerable noise at this time and values are somewhat difficult to determine. The capsule telemetry transmitter was tracked by the Hawaiian station and the recovery aircraft received brief signals. Intensive efforts are underway to determine what occurred and take corrective action prior to the launch of DISCOVERER XII.

● This flight is of great significance to the SAMOS and MIDAS programs. The components that are critical for success of SAMOS and MIDAS functioned extremely well. The modifications made in the past, based on results of previous DISCOVERER flights, were proven to be very effective. The flight accomplished the outstanding feat of achieving near-perfect performance of all components except the de-orbit function. Since an advanced version of this satellite vehicle will be used for both SAMOS and MIDAS programs, the development and refinement of the complex satellite vehicle and subsystems at this point in time lends confidence to the success of these programs.

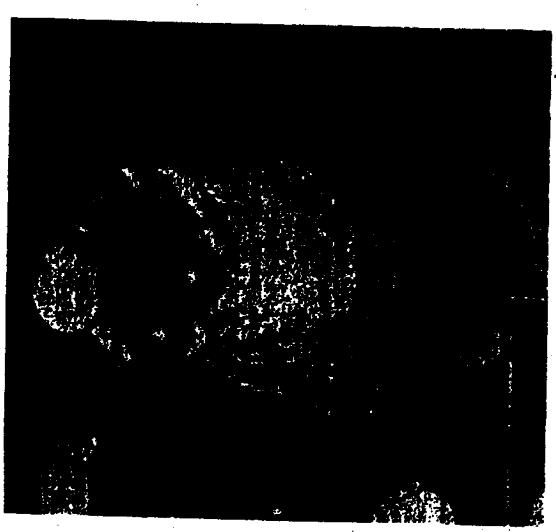


Figure 6. AGENA "B" vehicle being loaded on transporter for shipment to Santa Cruz Test Base. This is the initial AGENA "B vehicle for the DISCOVERER program (DISCOVERER XVIII).

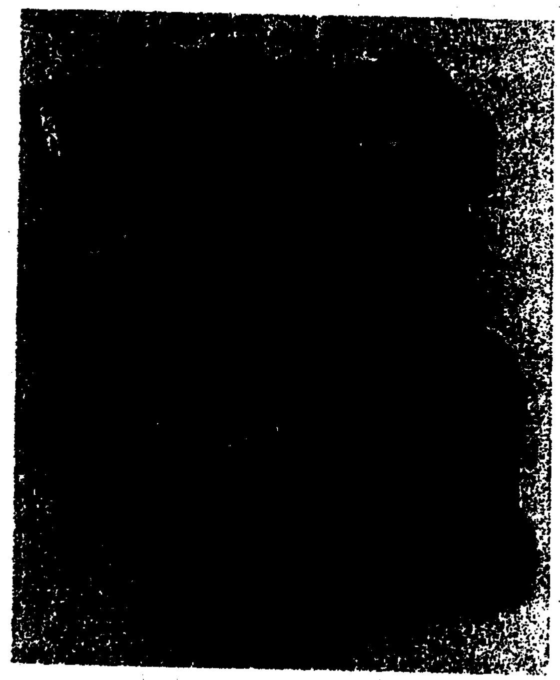


Figure 7. Hydraulic control package for gimbaling the XLR-81Ba-9 engine. This fuel-powered system will be used on DISCOVERER flight XVII.

Technical Progress

Second Stage Vehicles

Differences in DISCOVERER vehicle configurations are defined on page A-5.

● All AGENA "A" vehicles (for use on DISCOVERER flights XI through XV) have been delivered to Vandenberg AFB.

● The first AGENA "B" vehicle (XLR-81Ba-7 engine) was delivered to the Santa Cruz Test Base on 1 March. The vehicle has been installed in test stand 2 and preparations are being made for hot firing tests. The other three AGENA "B" vehicles using this engine model are in the LMSD Systems Test Area (formerly Modification and Checkout Center). Systems checks of the three vehicles are 90, 65 and 60 percent complete.

● The test firing program for the XLR-81Ba-9 engine was completed during March at the Santa Cruz Test Base. This engine, installed in an AGENA "B" vehicle, will be used on DISCOVERER flights XVII and subsequent. The test program consisted of nine firings, several of which were restart operations. An additional primary objective of the program was the testing of the fuel pressure powered hydraulic system, also planned for initial use on the DISCOVERER XVII flight.

● Testing of nozzle extensions for the XLR-81Ba-9 engine continued during the month at Bell Aircraft and Arnold Engineering Development Center (AEDC). The extensions are designed to increase the nozzle ratio from 20:1 to 45:1. Two successful firings of a titanium extension were conducted at Bell Aircraft. The extension has been sent to AEDC for additional testing and evaluation. Stainless steel test extensions providing area ratios of 45:1 and 60:1 were test fired with favorable results at AEDC during March.

Antennas

● The manufacturing of two transistorized S-band beacons was completed during the month. In order to expedite delivery of these items, formal acceptance testing was started by LMSD representatives on 14 March at the manufacturer's plant. One of the beacons will be used for type testing and the other will become the flight article for the first AGENA "B" flight.

Recoverable Capsule

● Intensive efforts were continued during the month to obtain additional data on which reliability studies and capsule recovery probability analyses could be based. Sufficient component data has not been received from the capsule contractor (General Electric Co.) to establish firm reliability estimates. LMSD reliability engineers are reviewing this problem with General Electric Co.

Ground Support Equipment

● Countdown time will be decreased and fabrication and checkout procedures standardized by the replacement of the present 200 pin umbilical system with a 100 pin system beginning with the launch of DISCOVERER XVII. The new system also will provide increased reliability by the simplification of checkout procedures, and will reduce over-all manhour requirements. Existing wiring in the vehicle is being divided according to launch countdown or component checkout function. The countdown wiring will make up the 100 pin umbilical system. The remaining wiring will be led into test plugs for simplification of component checkout. Blockhouse and trailer wiring will remain unchanged.

● Revised testing and component selection procedures for Fairchild programmers were completed during the month and given to the contractor. The new procedures will expedite future deliveries of this critically short component.

Facilities

● Interim measures to reduce personnel hazards related to propellant storage and handling methods at Vandenberg AFB launch sites have been incorporated until permanent facilities can be provided. These measures include: improved lighting facilities (including standby lighting power provisions), a water distribution and tanking system (including emergency showers and eye wash facilities), a reinforced flushing and dumping pit for IRFNA areas, improved water drainage around propellant shelters, and improved methods of maintaining access roads.

● Modifications to the Hawaiian tracking station, in support of the NASA TIROS project, were completed prior to the launch of that vehicle. Fly-by tests were completed successfully and exercises run to determine the time required to convert the radar equipment from DISCOVERER to TIROS use. Changeover time was determined to be approximately 20 minutes.

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S a m o s

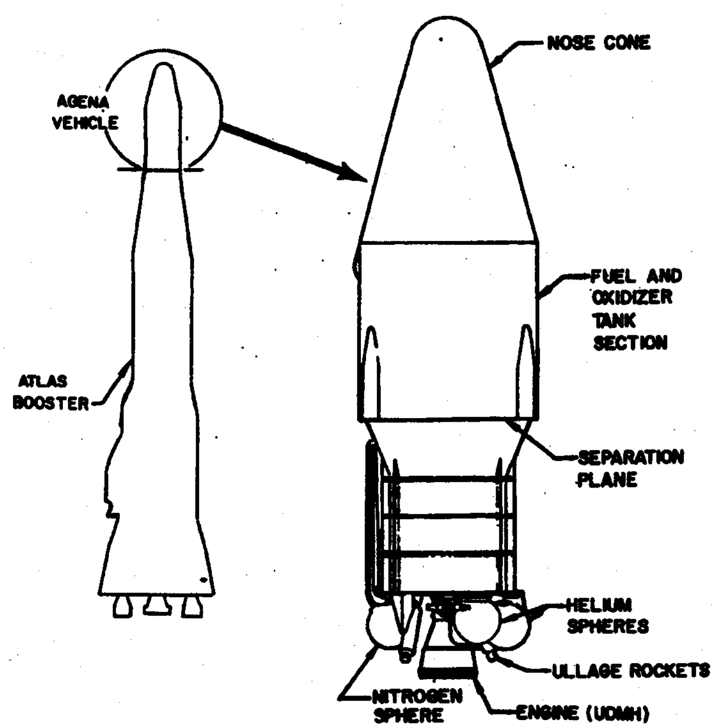
BOOSTER—ATLAS ICBM

Weight—Wet	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

SECOND STAGE	AGENA "A"	AGENA "B"
Weight—Inert	1,370	1,600
Impulse Propellants Fuel (UDMH) Oxidizer (IRFNA)	6,550	13,100
Pyrotechnics	67	100
GROSS WEIGHT (lbs.)	7,987	14,800
Engine	YLR81-Ba-5	XLR81-Ba-7
Thrust, lbs. (vac.)	15,000	15,000
Spec. Imp., sec. (vac.)	277	277
Burn Time, sec.	120	240
Restart Provisions	No	Yes

Figure 1.

Artists' concept of SAMOS satellite. Line drawing of complete flight vehicle (right) and detailed view of basic AGENA upper stage (left).



PROGRAM HISTORY

The SAMOS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency early in 1958. ARPA separated WS 117L into the DISCOVERER, SAMOS and MIDAS programs with the SAMOS objectives based on a visual and ferret reconnaissance system. On 17 November 1959 responsibility for this program was transferred from ARPA to the Air Force by the Secretary of Defense.

PROGRAM MISSION

The primary mission of the SAMOS advanced reconnaissance system is to provide continuous visual, electronic (and other) surveillance of the USSR and its allied nations. Efforts include development of hardware to permit:

a. Determination of characteristics of enemy electronic emissions.

b. Verification of known targets, detection of unknown targets.

c. Location and evaluation of defenses.

d. Evaluation of military and industrial strength.

e. Assessment of high-yield weapons damage.

f. Reconnoitering of troop movements.

g. Location of naval forces throughout the world.

CONFIDENTIAL

SECRET

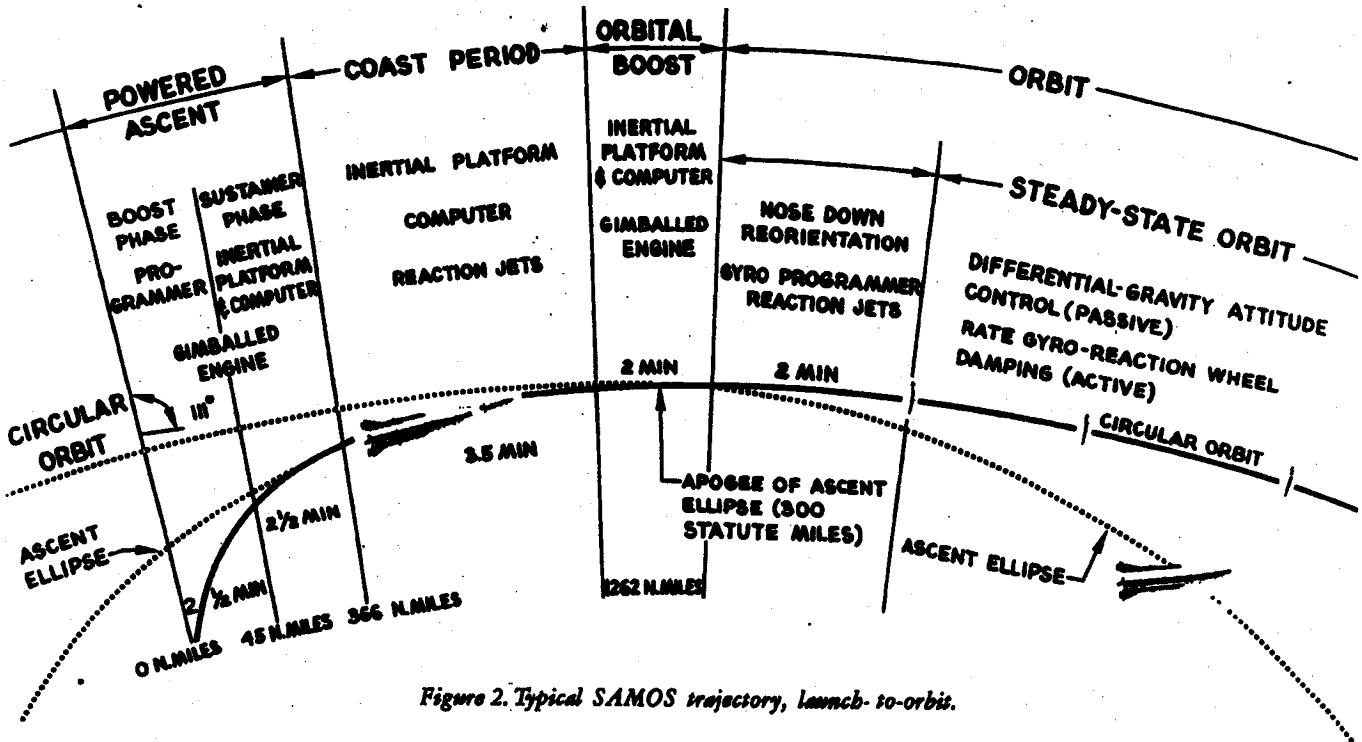


Figure 2. Typical SAMOS trajectory, launch- to-orbit.

- ***Ferret Reconnaissance . . .***

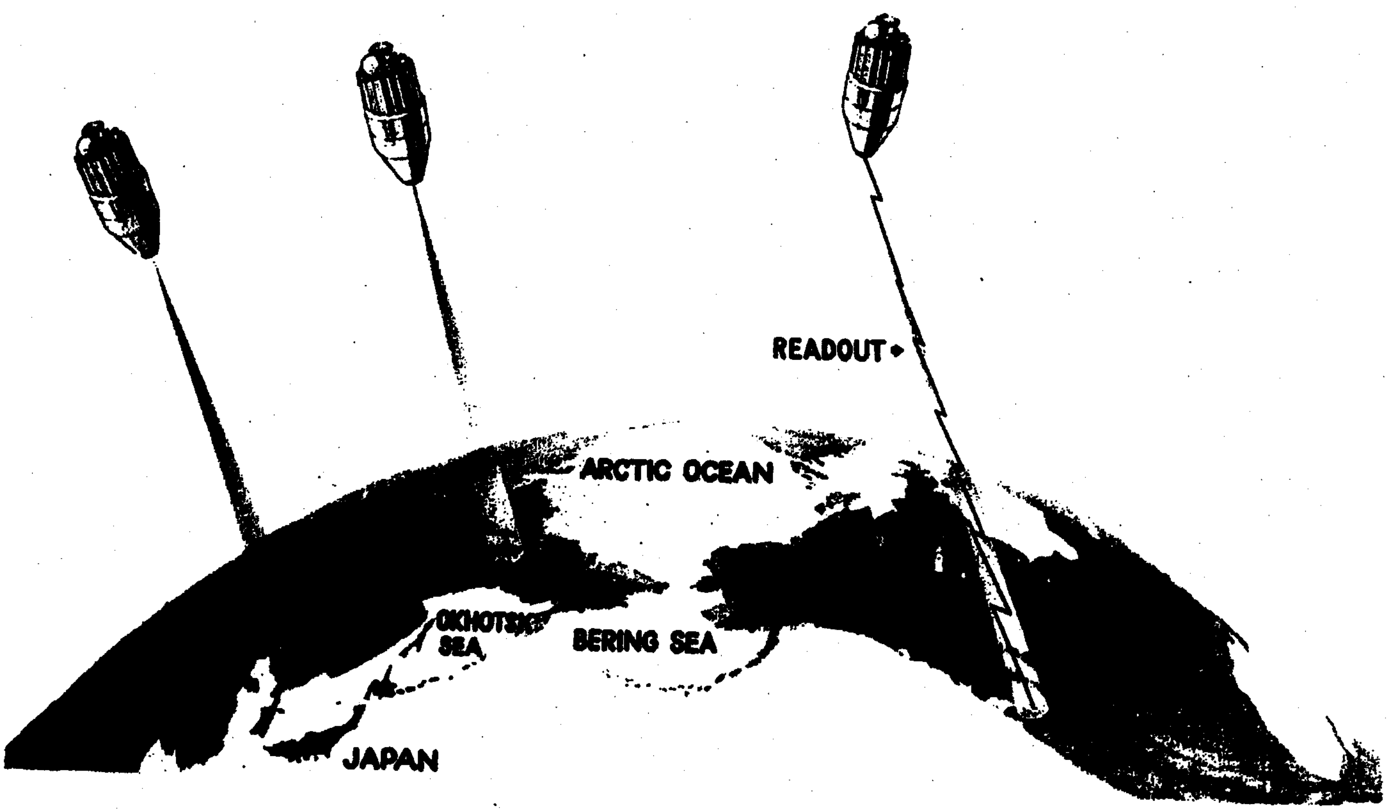


Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over unfriendly territory.

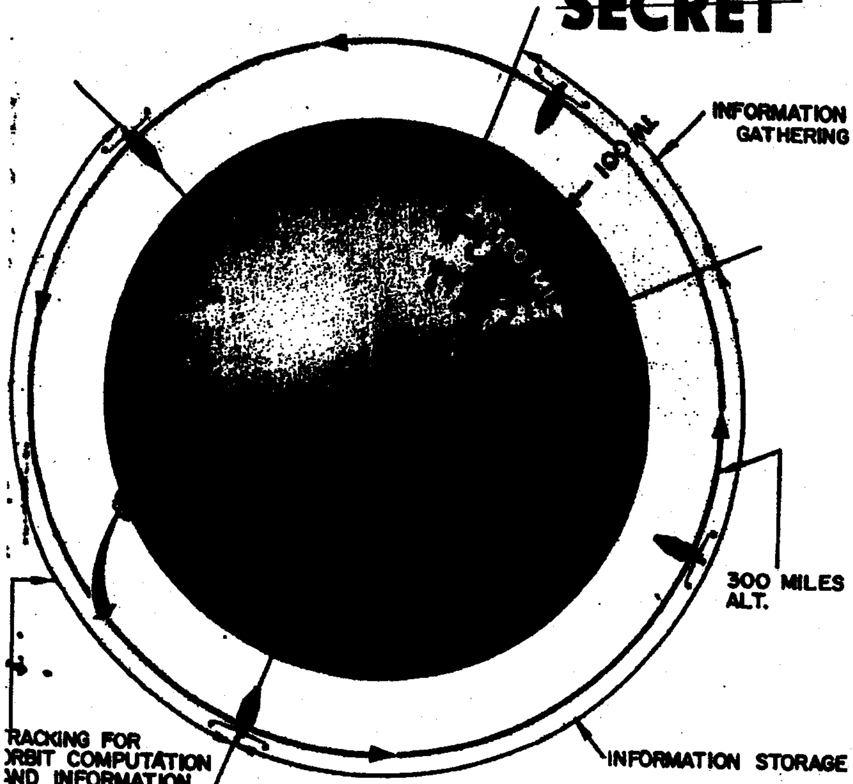


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over unfriendly territory the sensing equipment is turned on (Information gathering). When it leaves unfriendly territory the sensing equipment is turned off and the sensing data is processed (Information storage). When the vehicle comes within range of a ground receiving station, the data will be read-out upon command for processing and transmittal to using agencies. This process is continuously repeated during the useful lifetime of the vehicle.

VISUAL AND FERRET

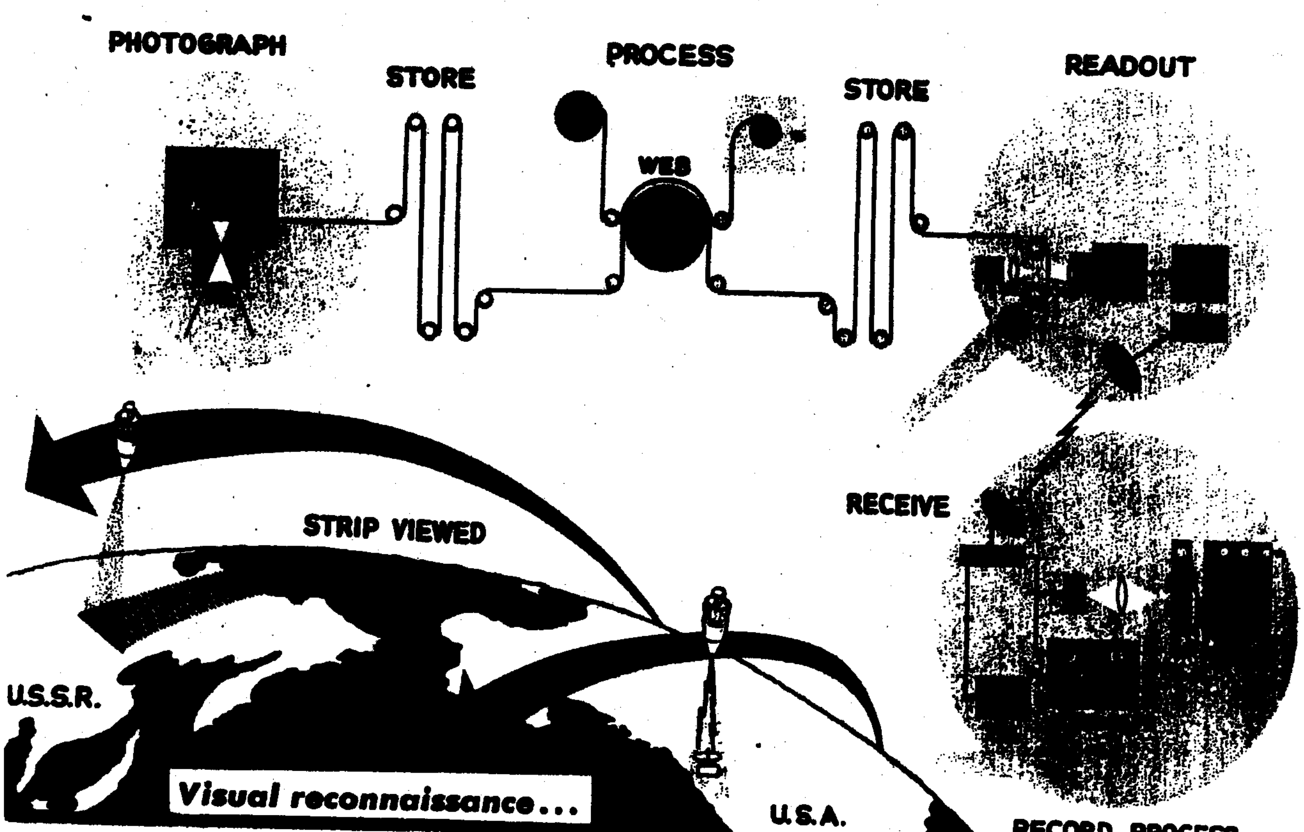


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects 20 feet in length.

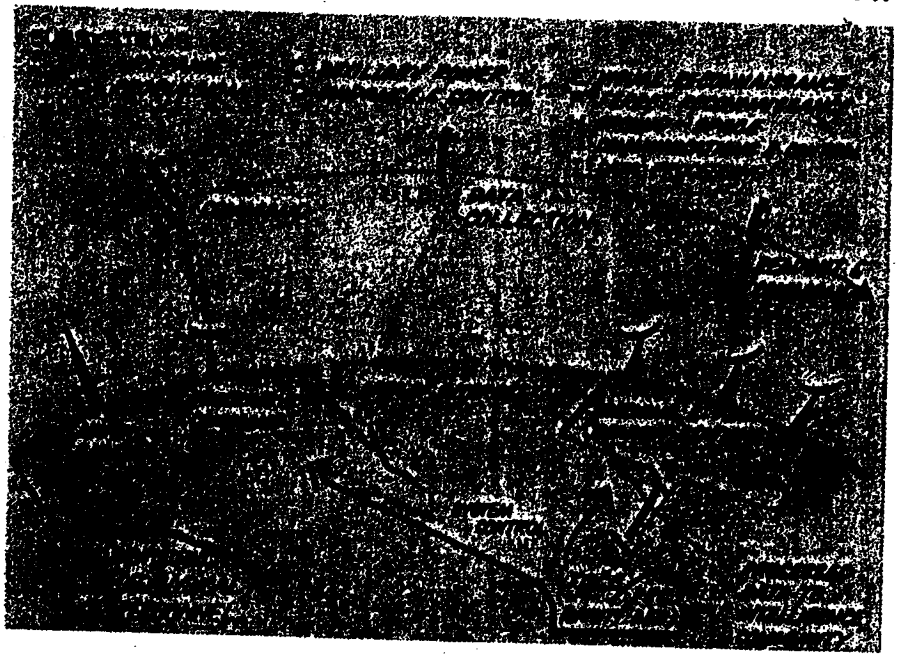


Figure 6. SAMOS concept, showing reception of commands and transmission of data between satellite and ground station; and subsystem functions (schematic).

For economical testing of components a dual-capability visual and ferret payload will be used during the early development phase. On later flights only a visual or ferret system payload will be carried. These payloads will be housed in the AGENA vehicle (Figure 1).

Data collected by the visual payloads will be electronically transmitted in the readout system and retrieved in the recovery system. Ferret data will be transmitted electronically. These systems are composed of the AGENA vehicle, ATLAS booster, launch facilities, tracking facilities, and a communications and data processing network. The recovery system will also include a re-entry capsule and a recovery force.

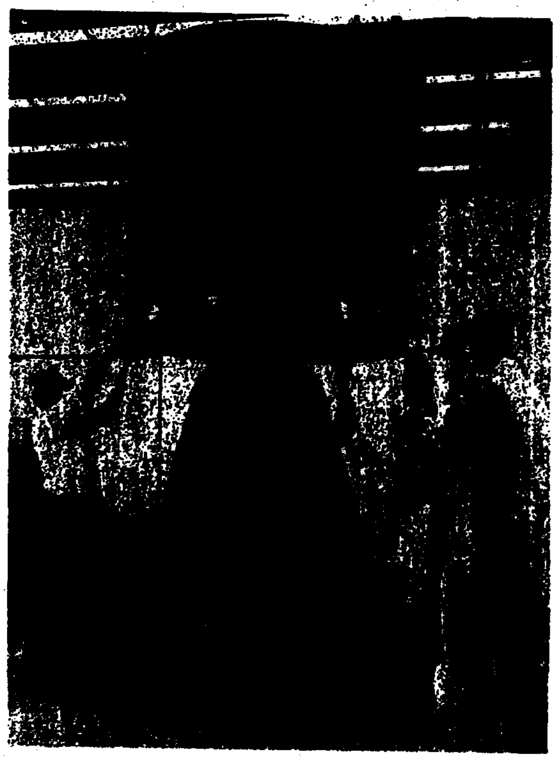
CONCEPT

ATLAS Series D missiles launched from VAFB will boost the AGENA vehicle into polar orbits. Injection into near-circular orbits (Figure 2) will be accomplished by the AGENA vehicle rocket engine. A self-contained guidance system using a horizon reference scanner will provide altitude stabilization. As the satellite travels in an orbit essentially fixed in space the earth rotates inside the orbit (Figure 3). Each successive orbit is displaced laterally approximately 23½ degrees at the equator, permitting one vehicle to observe the entire earth in a time period dependent upon the width of the area under surveillance. Early versions will have a useful life of approximately ten days. The readout systems will have a useful life of four months with a design objective in certain configurations of one year; recovery systems will have a useful life of fifteen to thirty days.

TECHNICAL DESCRIPTION

Visual Program—Payload camera, film processor and electronics readout equipment are being developed by Eastman Kodak Co. Cameras having a 36-inch focal length are being used. The payload equipment includes automatic film processing, film transport and take-up, electronic readout and temperature controls. The recoverable system will retain both the exposed film and the 66-inch local length camera.

Ferret Program—Ferret payloads are being developed on a progressively more advanced basis from R&D (F-1) to advanced systems (F-4). The F-2 all-digital, general coverage payload will use super-heterodyne scanning receivers in conjunction with directional antennas, an analog to digital converter and tape recorders (for storage). A programmer will be used to control read-in over areas of interest and readout over tracking stations. The F-3 payload will use similar receivers with stop-scan capability and controllable antennas added. Recording of the actual signal intercepted (rather than the digital representation) will be possible with a bandwidth up to 6mc. A complex programmer will permit satellite search of a given area or frequency range.



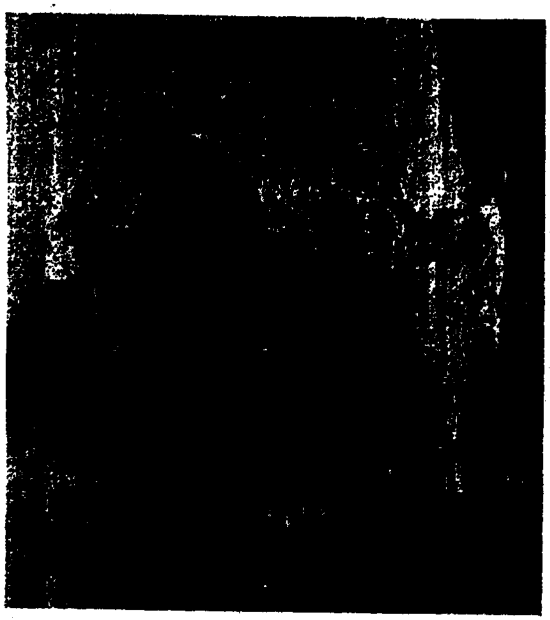


Figure 7. Removing shipping container cover from the first flight article payload, preparing to transfer payload from shipping container to handling dolly, and cleaning payload prior to inspection in "ultra-clean" area.

MONTHLY PROGRESS—SAMOS Program

Second Stage Vehicles

● Systems checkout of the AGENA vehicle for the first SAMOS flight is in progress at the System Test Area (formerly Modification and Checkout Center). Shortage of a satisfactory flight article UHF narrow band transmitter will cause a delay in shipment of this unit to Santa Cruz Test Base for static hot firing tests. This delay will not cause a rescheduling of the 2 September 1961 launch date. The AGENA vehicle for the second SAMOS flight was delivered to the System Test Area for systems testing late in March. Assembly of the major structural components of the AGENA vehicle for the third flight was accomplished on 9 March. The vehicle is now in the final assembly phase of manufacturing. The facilities checkout vehicle for the AGENA "A" (dual payload configuration) was shipped to Vandenberg AFB early in March. Design of the AGENA "B" vehicle for the fourth SAMOS flight is proceeding on schedule. This vehicle will carry an E-2 camera and will be the first single payload flight in the SAMOS program. Design requirements are being established for the AGENA vehicle programmed to carry the E-5 (recoverable visual) payload. Seven such flights are scheduled at this time.

Visual Reconnaissance Systems

● Visual Reconnaissance System payloads are being developed in a minimum number of configurations to attain readout and recovery mission objec-

tives. The designation and purpose of each configuration is as follows:

Readout:

- E-1—Component Test Payloads
- E-2—Steerable Reconnaissance Payloads (with 20-foot ground resolution)

Recovery:

- E-5—High Resolution, Steerable, Recoverable Payload (with 5-foot ground resolution)

Payloads

● **E-1 Payloads**—Subsystem testing of the first E-1 payload has been completed successfully and payload compatability with the AGENA vehicle has been established. Systems testing is now underway. Both the E-1 and F-1 payloads will be included in static hot firing tests at Santa Cruz Test Base. Acceptance tests of the second E-1 payload were started on 17 March at Eastman Kodak, with delivery to LMSD scheduled for early April. A 48-hour operating test performed during the modification and checkout procedure revealed a high voltage power supply deficiency. A back up development has been initiated on this item.

● **E-2 Payloads**—Fabrication and assembly of components for the first two E-2 payloads is nearing completion. Component testing has been underway since mid-March and is scheduled for completion by mid-April.

● **E-5 Payloads**—Design review meetings are being held on the E-5 system functional requirements to establish firm definitions of camera design, capsule configuration and recovery sequence. Preliminary design of the 66-inch lens camera continues at the Itek Corporation. A contract was let to AVCO Corporation for the recovery capsule ablative shield plus other required heat shielding, and preliminary work has been started. Several recovery capsule configurations are being evaluated and wind tunnel and ballistic range tests are being performed. Both overland and over-water recovery capability will be included.

Ground Support Equipment

● All payload support equipment functioned successfully during a subsystem test with the E-1 payload mounted on the 40-inch optical collimator. Satisfactory operation was also experienced during a subsequent preliminary system test with the payload mated to the AGENA vehicle.

Ferret Reconnaissance System

● Ferret Reconnaissance System payloads are being developed in a minimum number of configurations. The designation and purpose of each configuration is as follows:

- F-1—R&D Test Payloads
- F-2—Digital General Coverage Payloads
- F-3—Specific Mission Payloads—Analog Presentation
- F-4—Technical Analysis (study stage only)

Payloads

● **F-1 Payloads**—Subsystem tests of the first two F-1 payloads have been completed. The first F-1 payload has been aligned with the first E-1 payload and the dual package installed in the AGENA vehicle. Systems testing of the complete installation were started late in March.

● **F-2 and F-3 Payloads**—Design and modification of the reoriented F-2 and F-3 systems are in progress. Delivery of the first F-2 flight article payload is scheduled for October and the first F-3 is scheduled for 1962 delivery.

● **F-4 Payloads**—Studies of the F-4 System are being continued at Airborne Instruments Laboratory, based on 1965 intelligence requirements.

Ground Support Equipment

● Mechanical inspection by the Air Force of the F-1 data conversion equipment was completed on 22 March. This equipment will be installed in the Satellite Test Center, Sunnyvale, California. The checkout equipment for subsystem testing of F-1 payloads was shipped to LMSD on 25 March. This equipment will be installed in the missile assembly building at Vandenberg AFB.

Communications and Control Equipment

● The UHF ground system is being dismantled by the contractor for shipment to Vandenberg AFB. Included in the system are the angle tracker, command tracker, command transmitter, and the tracking and acquisition system. The 60-foot tracking and acquisition antenna will be dismantled and transported by police escorted truck to the dock at Moffett Field, California. It will then be loaded on a barge for shipment to Vandenberg AFB.

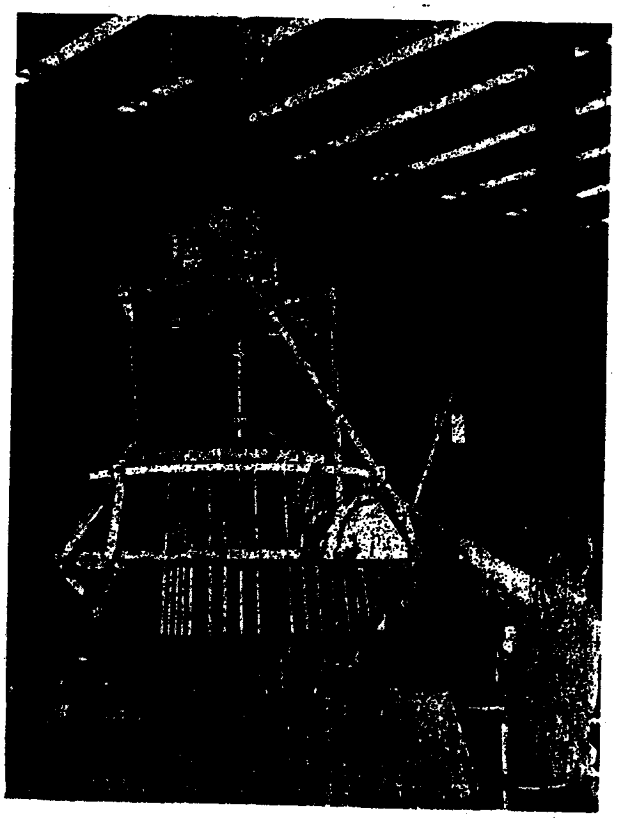
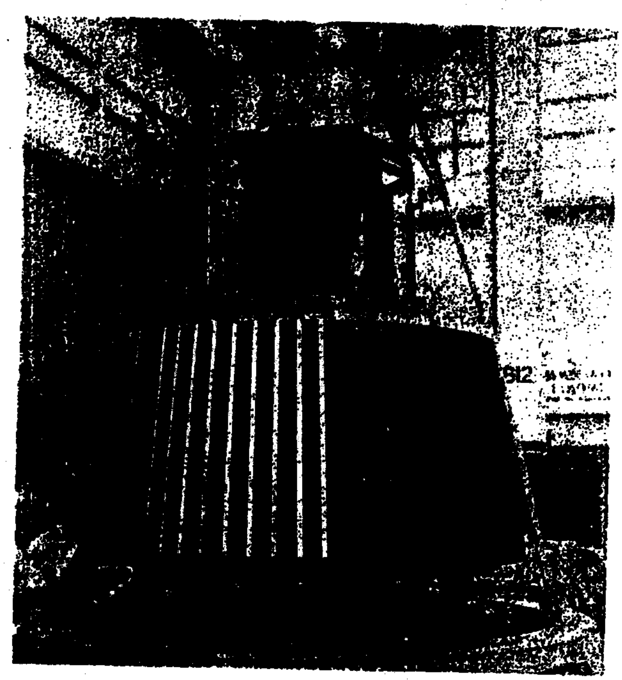


Figure 8. E-1 payload (above) mounted on first SAMOS flight vehicle. Aligning F-1 payload above E-1 payload. First SAMOS flight payload installation (S-band receiver and transmitter and UHF command receiver on upper right).



● The first Model 1604 computer will be delivered to the Satellite Test Center on 1 April. Checkout is scheduled for completion by 15 April. The second computer will be delivered to Vandenberg AFB on 15 June.

Facilities

● **Vandenberg Air Force Base**—Missile Assembly Building final acceptance inspection was completed 16 March. The technical support and laboratory buildings construction contract has been awarded. Additional LMSD requirements for the data acquisition and processing building have resulted in a slippage of the beneficial occupancy date which could affect the launch schedule. Construction is being expedited and installation of equipment concurrently with building construction being considered.

● **Point Arguello**—Launch pad 1 first acceptance inspection was completed 18 March, and the facility is ready for occupancy. Technical support building plans and specifications were released to the construction agency on 18 March, with a beneficial occupancy scheduled for late July.

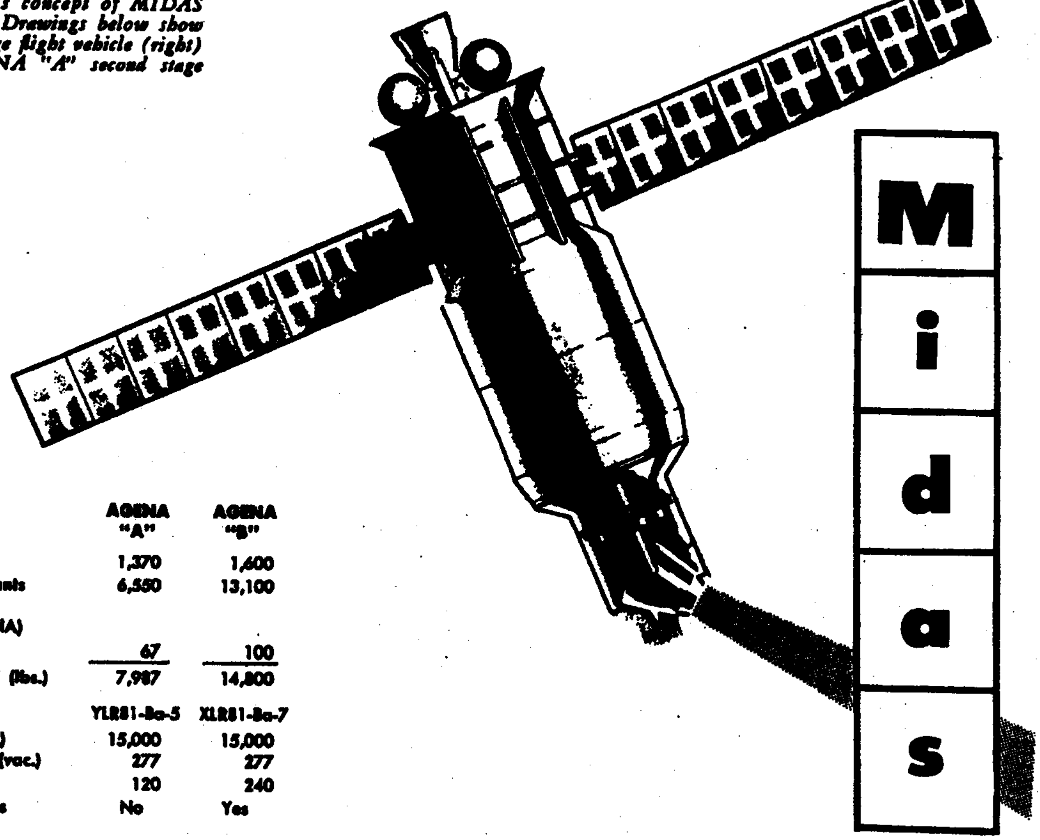
● **Satellite Test Center**—Construction of increment 2 is scheduled for completion during mid-June. Design of a modification to this facility that will accommodate a revised equipment configuration has been initiated. Completion of construction is scheduled for October.

● **Offutt Air Force Base**—Construction of the interim data processing facility will be advertised in April. Construction of the interim facility is scheduled for September completion. Design of the complete SOC/DPF is being held in abeyance until a firm SAMOS program justifying this facility is established.

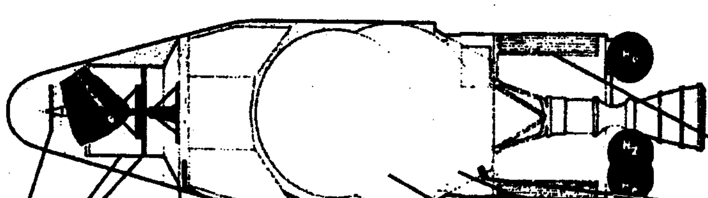
● **New Boston, New Hampshire, Tracking and Data Acquisition Station**—Construction of technical facilities for this station is complete and ready for installation of equipment. Equipment deliveries will not be made during 1960 for planned interim activation of this station in late 1960.

● **Ottumwa, Iowa, Tracking and Data Acquisition Station**—Plans and specifications for the technical facilities for this station are complete and ready for advertising. Design of support facilities for this station is being held in abeyance until a firm SAMOS program requiring the Ottumwa station is established.

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



SECOND STAGE	AGENA "A"	AGENA "B"
Weight—Inert	1,370	1,600
Impulse Propellants	6,550	13,100
Fuel (UDMH)		
Oxidizer (IRFNA)		
Pyrotechnics	67	100
GROSS WEIGHT (lbs.)	7,987	14,800
Engine	YLR81-Ba-5	XLR81-Ba-7
Thrust, lbs. (vac.)	15,000	15,000
Spec. Imp., sec. (vac.)	277	277
Burn Time, sec.	120	240
Restart Provisions	No	Yes



NOTE: AGENA "A" configuration except for solar paddles (AGENA "B" only).

BOOSTER—ATLAS ICBM

Weight—Wet	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

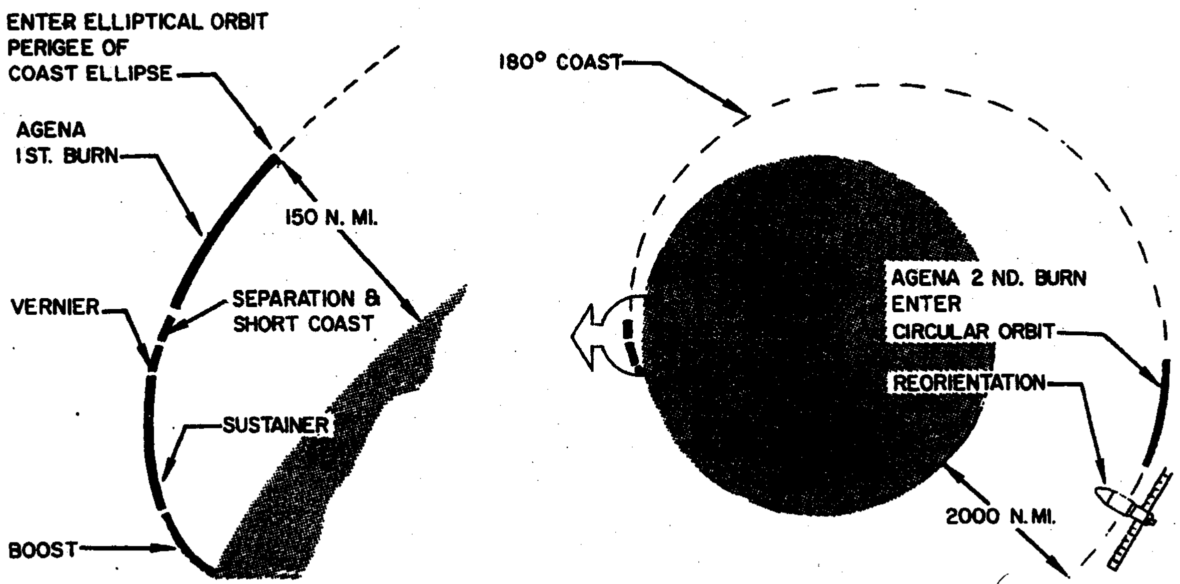


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. Optimum ATLAS boost, guided by radio-inertial system. AGENA ascent (coast, burn, coast, second burn) provides attitude reference. Also governs velocity magnitude and direction by inertial guidance system monitored by horizon scanner. Orbital attitude maintained by reaction wheel and gas jets.

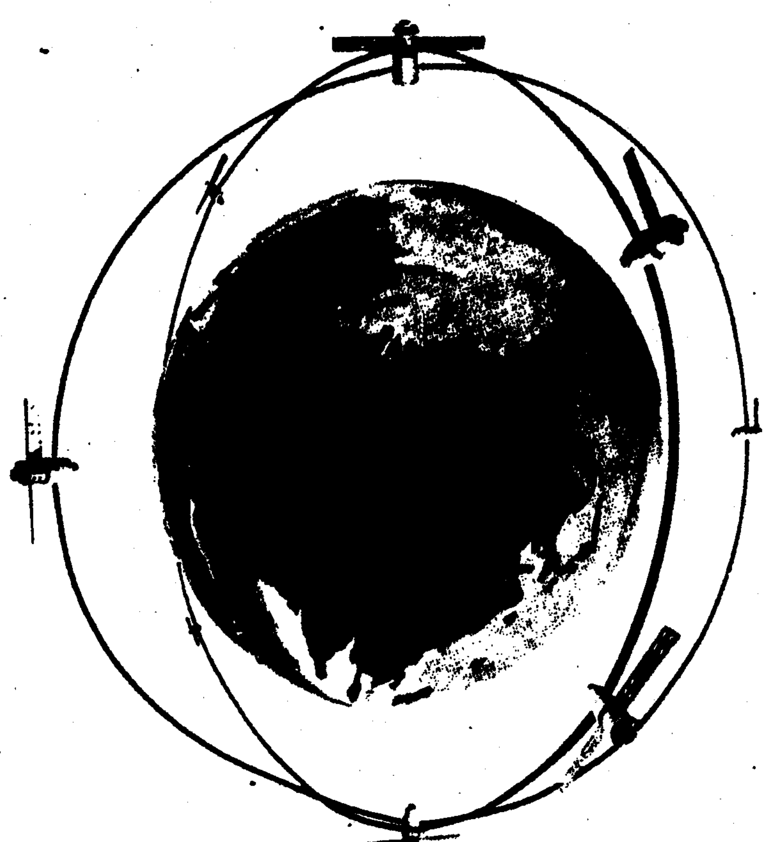


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satelli[redacted]

PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency early in 1959. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared reconnaissance 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. An ARDC development plan for a ten flight R&D program has been approved. This R&D program will make possible the achievement of a reliable operational system by 1963.

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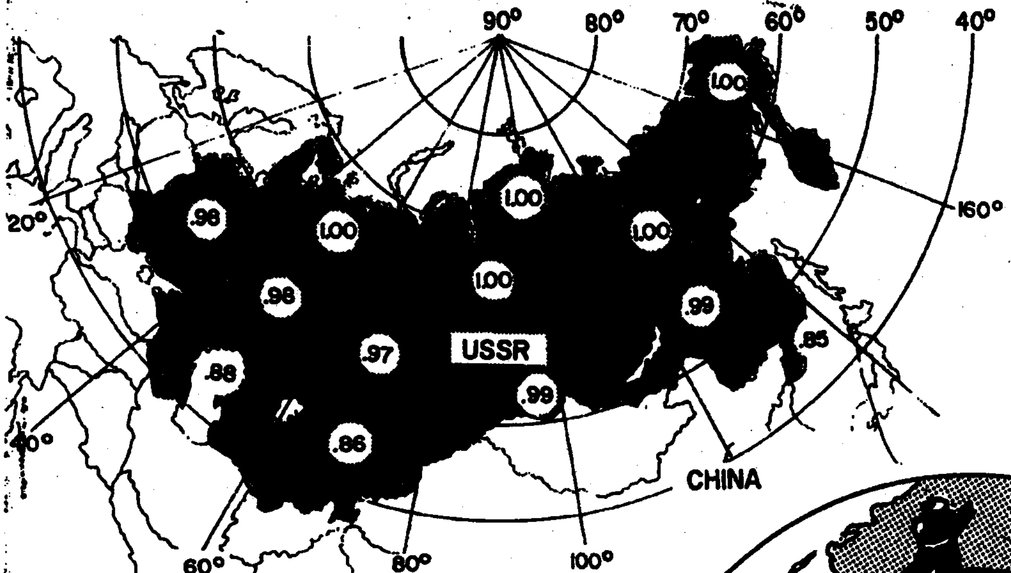


CONDITIONS:
2,000 n.m. altitude
8 vehicles in polar orbit
Readout stations
England
North Atlantic
North Pacific

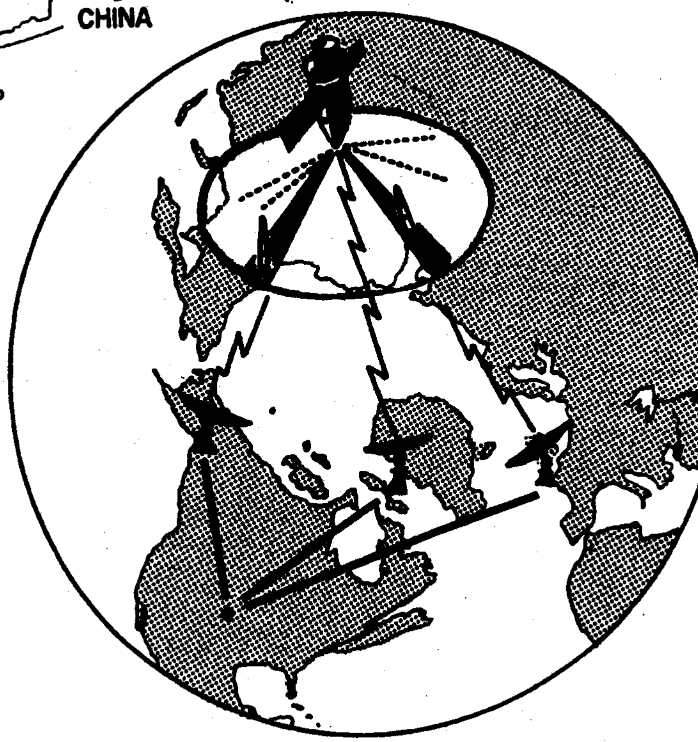


Figure 4.
Orbiting satellites detect infrared radiations emitted by Soviet ICBM's in powered flight. Data telemetered instantaneously to MIDAS Control Center via far north readout stations. Decoded data reveals approximately the number of missiles launched and launch location, direction of travel and burning characteristics. Map above shows percentage of detection probabilities over USSR.

TECHNICAL HISTORY

The MIDAS infrared reconnaissance payload is engineered to use a standard launch vehicle configuration. This consists of a "D" Series 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 total payload weight is approximately 1,000 pounds.

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

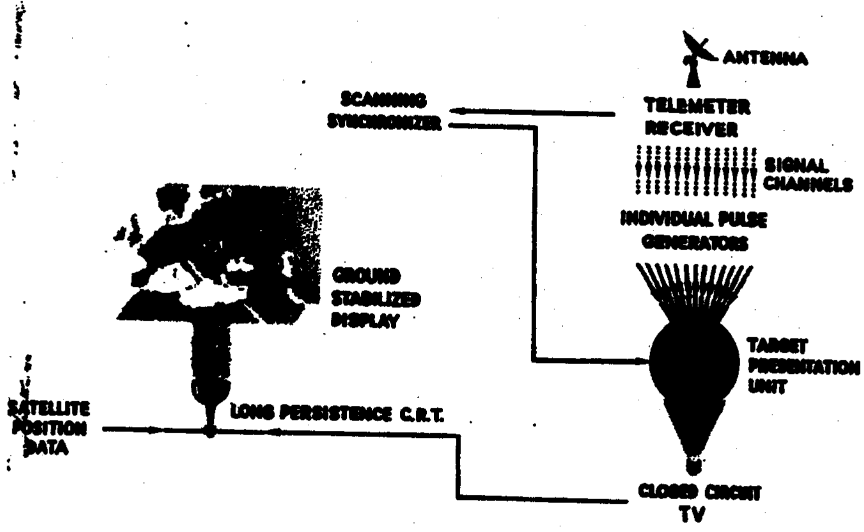
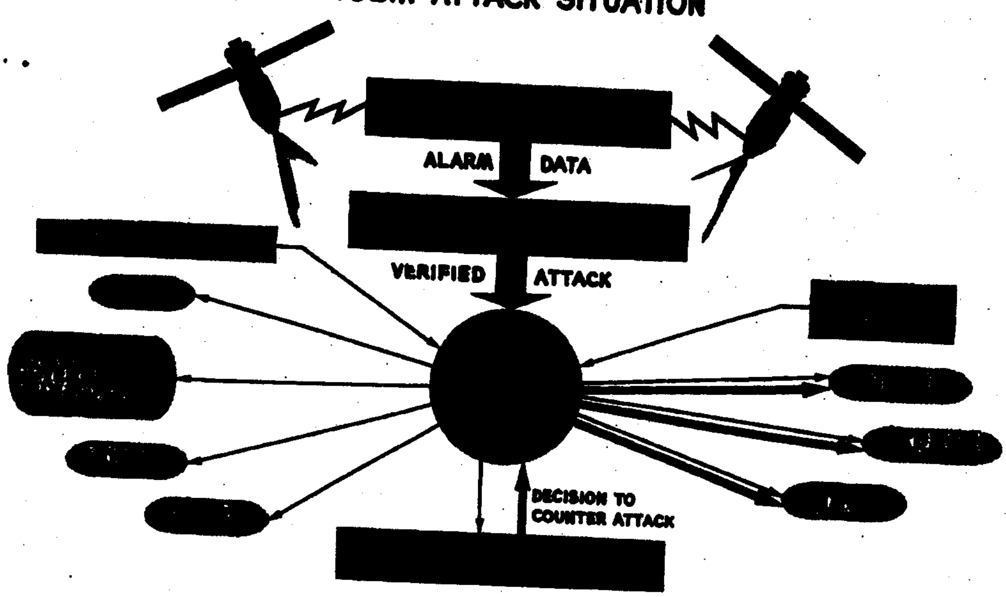


Figure 5.
Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies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

ICBM ATTACK SITUATION



CONCEPT

The MIDAS system is designed to provide continuous infrared reconnaissance 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 Control Center where it is processed, displayed, and evaluated (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.

MONTHLY PROGRESS—MIDAS Program

Flight Test Progress

First MIDAS Flight Test

● As reported last month, the first MIDAS flight test vehicle was launched on 26 February from the Atlantic Missile Range. Analysis of flight data indicate that an event occurred at the approximate time of first and second stage separation which damaged the AGENA vehicle and prevented the attainment of a successful orbit. Significant events occurred in the following sequence:

a. Final countdown was smooth and liftoff normal.

b. ATLAS performance was normal up to the time of ATLAS/AGENA separation.

c. AGENA separation command was received at T plus 258 seconds, following ATLAS vernier engine cutoff.

d. AGENA telemetry signals were lost temporarily at T plus 258 seconds, then received intermittently and with highly degraded quality until approximate T plus 325 seconds.

e. ATLAS telemetry, at reduced signal strength, continued until T plus 989 seconds.

f. Radar tracking data confirmed that the AGENA did not attain orbit.

Second MIDAS Flight Test

● The second MIDAS flight test has been rescheduled to 20 April. The vehicle will be launched from Atlantic Missile Range pad 14. The MIDAS infrared payload will be placed into a 261 nautical mile orbit. Orbital time will be 94 minutes (nominal) and

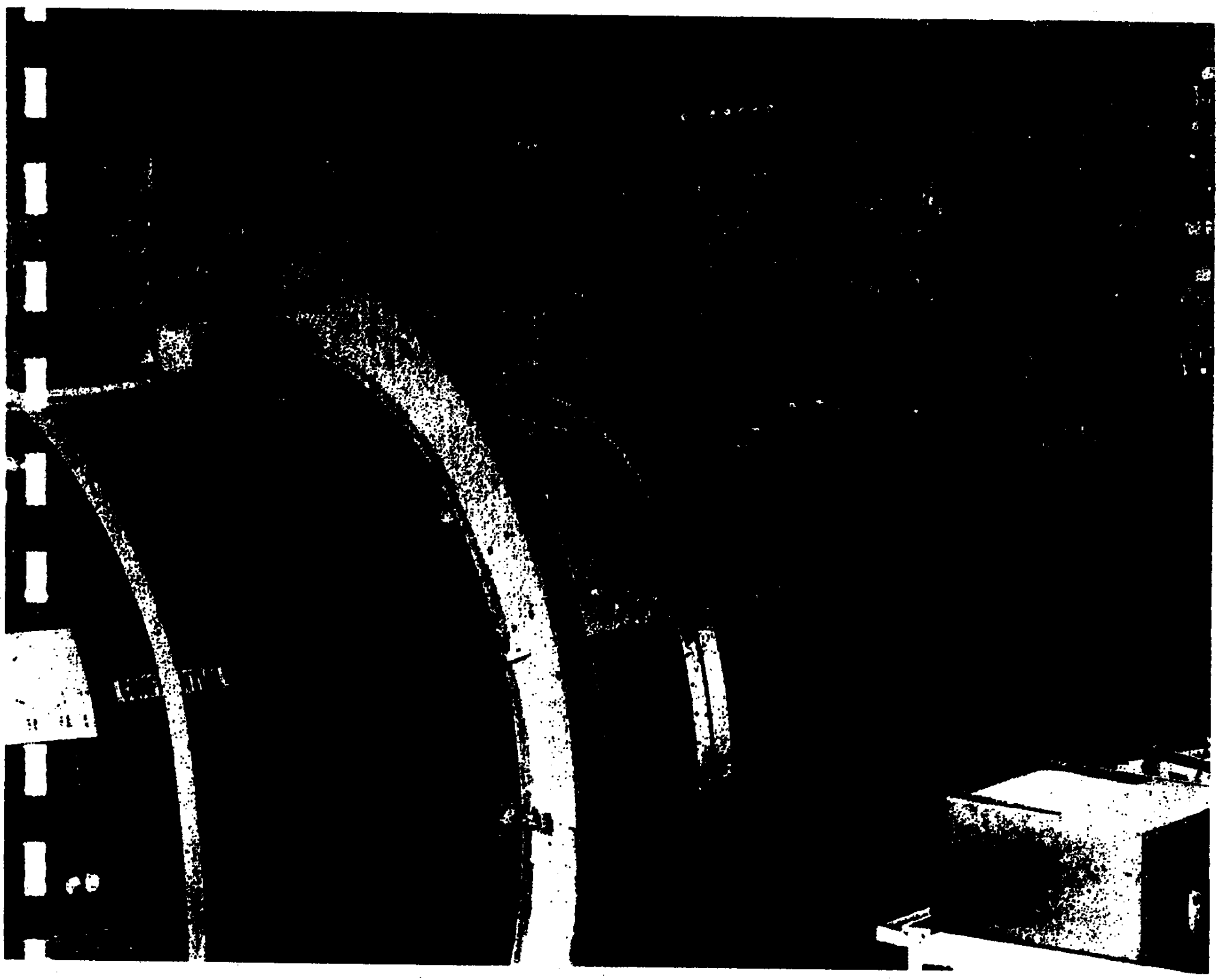
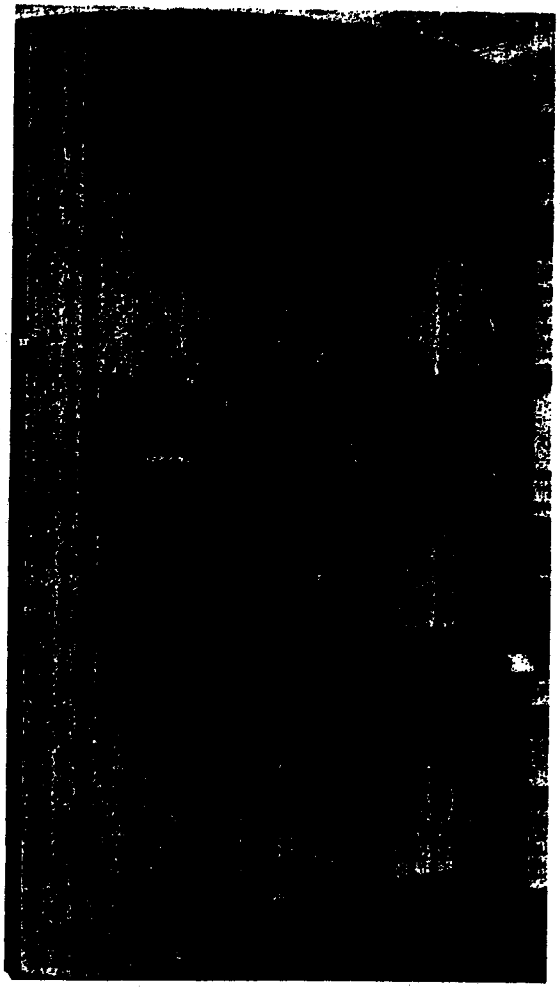


Figure 6. AGENA vehicle for the second MIDAS flight during covers-off checkout.



useful (primary power) lifetime will be 24 days. A launch azimuth of 107 degrees will be used. Launch must take place between 10 a.m. and 3 p.m. EST.

● Analysis of data obtained from the first MIDAS flight has resulted in the following modifications being made to the second MIDAS flight test vehicle:

a. Destruct system circuitry modified.

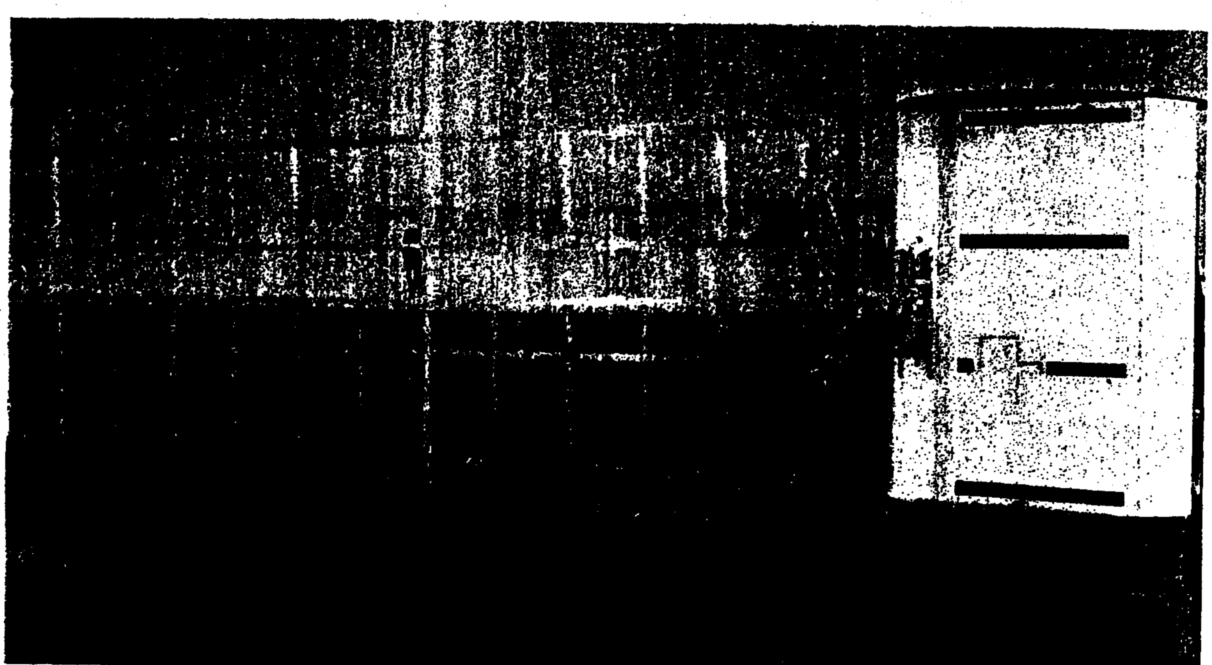
b. Separation sequence modified.

c. Instrumentation added in the ATLAS adapter section to provide flight information on components associated with separation.

d. Transmission of adapter information changed from AGENA to ATLAS telemetry.

● In response to a Hq USAF request to evaluate methods of conducting additional MIDAS program flight tests between the presently scheduled second and third MIDAS flights, AFBMD has proposed the use of two DISCOVERER vehicles. MIDAS payloads, using the backup infrared scanner units from the first two MIDAS flight vehicles, would be modified to permit installation in the DISCOVERER (THOR/AGENA "B") vehicles. This diversion of vehicles

Figure 7. Full-scale solar auxiliary power array mockup, less solar cells, in folded position (left) and fully extended (below). The zero gravity condition of the array in orbit was effected by using the support (far left of photo).



would not delay or otherwise affect the DISCOVERER flight test program. The first of these vehicles would be launched into circular polar orbits from Vandenberg AFB around mid-September. No changes in the DISCOVERER command circuitry or procedures would be necessary. The AGENA vehicles would provide extended burn capability, and would orbit in a nose-aft, horizontal position, with the scanner unit mounted vertically. The payload would have a useful life of four days (eight passes per day). Each pass would provide an average payload readout time of four minutes.

Technical Progress

Second Stage Vehicle

- Manufacture of the AGENA "B" vehicle for the third MIDAS flight test has been started, with completion scheduled for 11 July. Launch is programmed for December. A full scale mockup of the solar auxiliary power array for this vehicle was completed in March. Several functional tests of the mockup have been completed successfully. Solar cell manufacture is in progress.

Infrared Scanner Units

Infrared scanner units for the first two MIDAS flights are being manufactured by Aerojet-General Corporation, and for flights 3, 4 and 5 by Baird-Atomic, Inc.

- Thermal and altitude tests of the third Aerojet-General Corporation infrared scanner unit were conducted in the high altitude temperature simulation chamber between 7 and 10 March. The scanner unit was mounted in a specially designed collimator during the tests. A black box source of infrared radiation also was installed inside the chamber. Readout of infrared signals was performed successfully at various temperatures and pressures, and over the full range of scanner head positions. Scanner unit operation also was satisfactory throughout the tests.

- Tests of the thermomechanical equivalent model of the Baird-Atomic scanner unit were completed in the high altitude temperature simulation chamber on 4 March. At low temperatures some binding in the main bearing occurred. A low temperature testing program has been initiated as an effort toward solving this problem.

- The first Baird-Atomic scanner unit is undergoing optical testing and the third unit is being assembled.

Communications and Control

- Qualification testing of the engineering test model of the 256 channel (Model B) PAM multiplexer is in progress. This unit will be used on the third MIDAS flight test. The multiplexer is essentially an electronic commutator for the telemetry system, per-

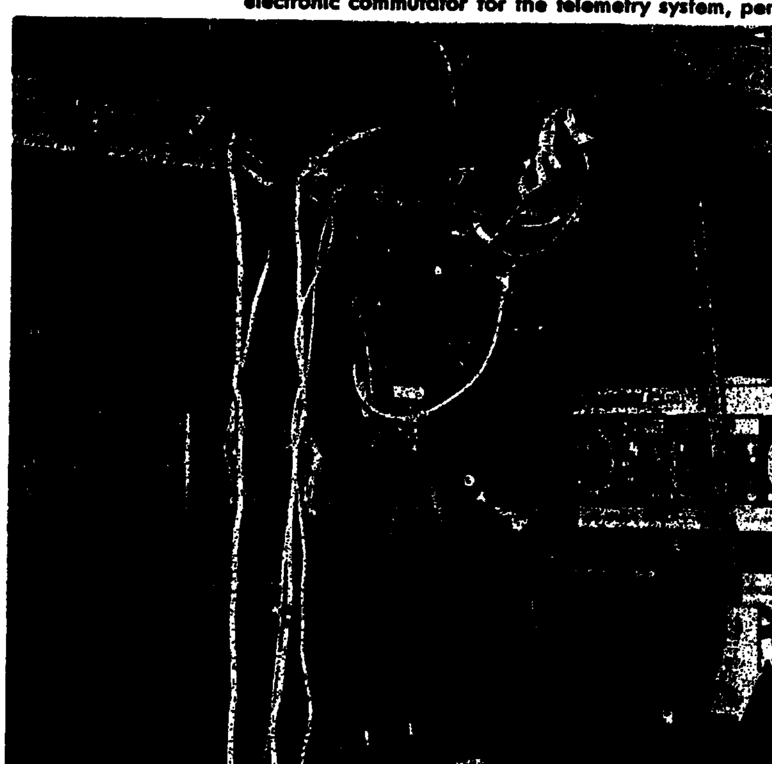


Figure 8. Infrared scanner No. 3 (Aerojet-General) shown mounted with the special collimator in the high altitude temperature simulation chamber prior to testing.

mitting a substantial increase in the amount of data that can be transmitted over a single transmission link because of its extremely fast sampling rate (40,000 samples per second). Data quality also is better than conventional telemetry commutation systems.

● A study has been made of a deflection monitor for radar antennas. The monitor would permit a reduction in the highly rigid design requirements for radar mounts by providing a deflection correction system for less rigid mounts. This would permit the use of lighter metals and simpler designs, and result in lower antenna mount costs.

● Each radar beacon for flights 2 and subsequent will be adjusted to respond to an individual interrogation or command signal transmitted by the Verlort radar. This procedure will permit individual communication with each MIDAS satellite when more than one satellite is within range of a tracking station at the same time. The Verlort radar, designed to operate simultaneously with six different beacon addresses, will require no modification.

Facilities

● The MIDAS Program addition to the Vandenberg AFB data processing and acquisition building will be completed on 15 April.

● During March, an Air Force site survey team held conferences with local authorities in Salisbury, Northern Rhodesia, Africa, regarding possible locations for MIDAS Program tracking sites. The survey of Northern Rhodesia will take approximately 4 weeks. This station will provide data on the AGENA "B" restart portions on flights 3 and subsequent.

~~CONFIDENTIAL~~

Communications Satellite

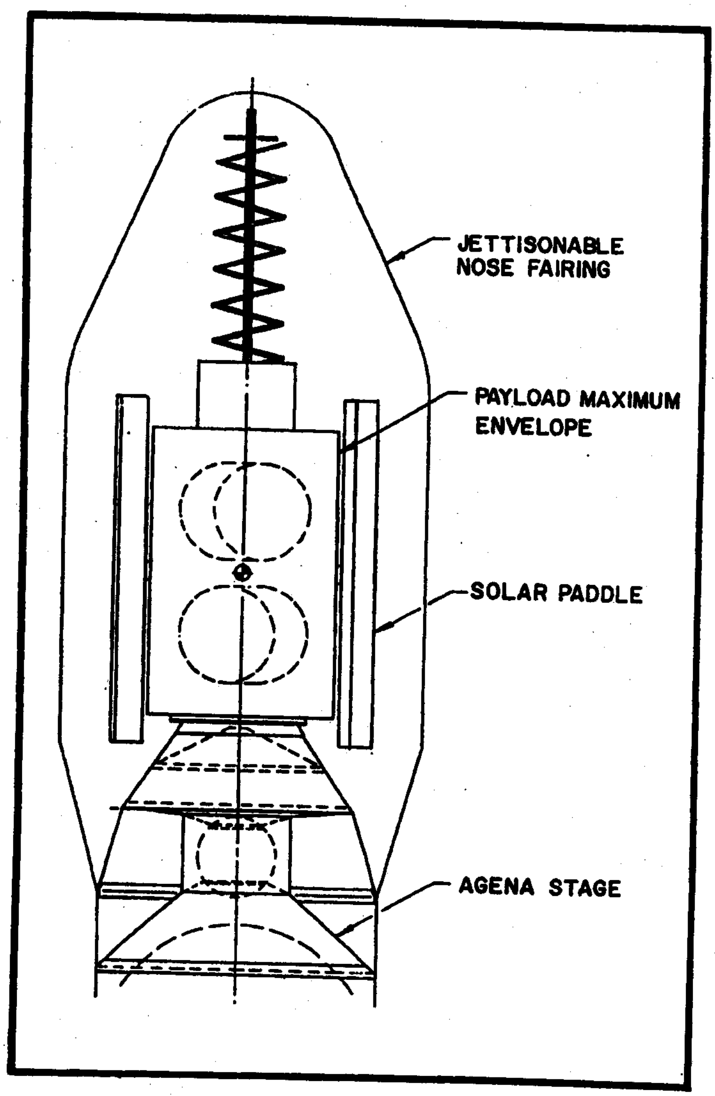


Figure 1. Proposed satellite with jettisonable fairing mounted on AGENA second stage.

The Communications Satellite Program will investigate the feasibility of using synchronously spaced satellites as instantaneous repeaters for radio communications. Under ARPA Order No. 54, as amended, AFBMD is responsible for the design, development, and flight testing of the complete system, including launch, satellite tracking and control, and necessary support facilities and ground equipment. The Army Signal Research and Development Laboratory has been delegated development management responsibility for the microwave communications subsystem as directed by ARPA Order 54.

The Communications Satellite Program is currently being conducted in accordance with amendment 5, (dated 11 April 1960) to ARPA Order No. 54. Under this amendment the previous method of accomplishing the program objectives in three progressively

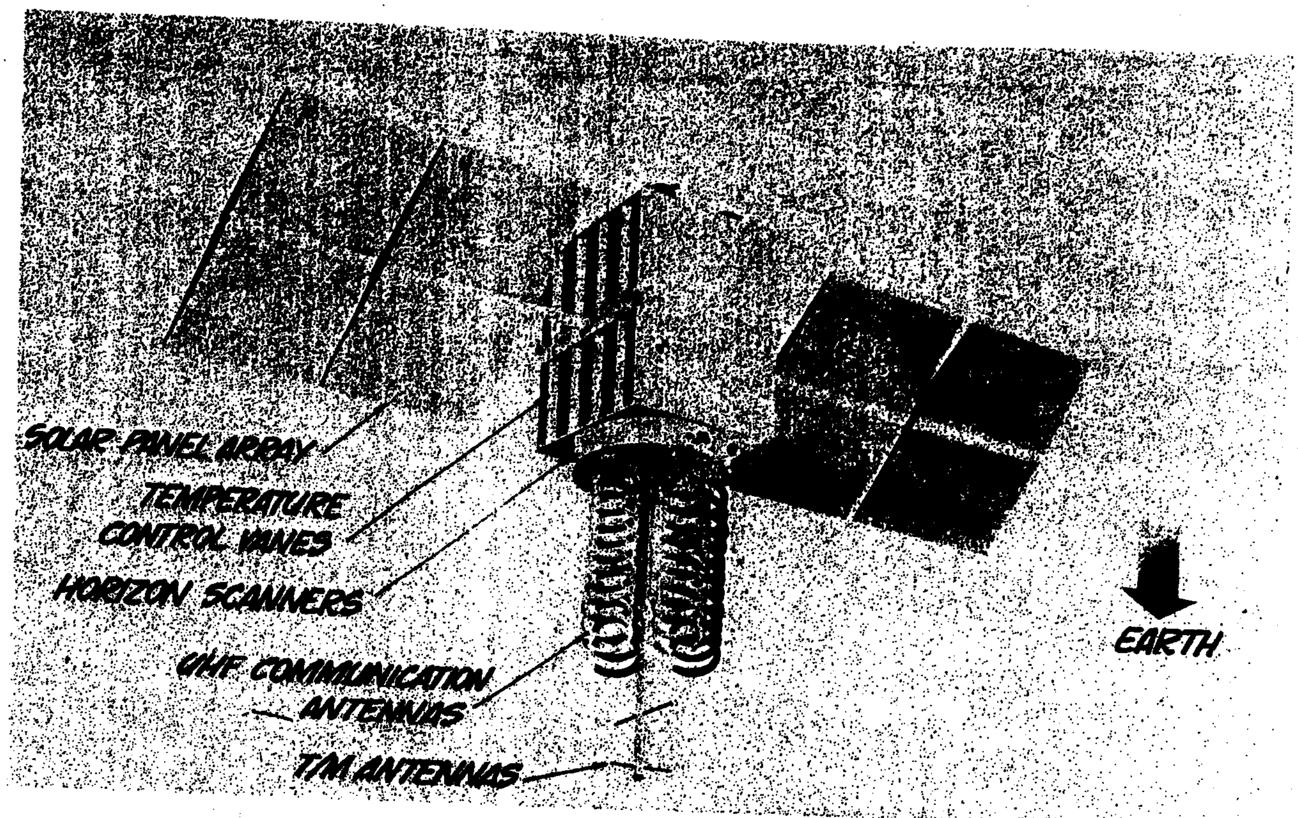


Figure 3. Artist's concept of proposed UHF communications satellite.

MONTHLY PROGRESS— COMMUNICATIONS SATELLITE Program

Program Administration

● AFBMD is preparing a new development plan in accordance with the requirements defined in amendment 4 (dated 29 February 1960) to ARPA Order No. 54. It is anticipated that this plan will be submitted to ARPA early in May.

Technical Progress

● As directed by amendment 4, a preliminary system analysis and design study has been made as the first step toward providing for the interchangeable installation of UHF or microwave equipment in a single final stage vehicle compatible with either AGENA or CENTAUR stages. It is considered that, in accordance with this requirement, a similar final stage vehicle could be boosted into a 6-hour polar orbit using the ATLAS/AGENA "B" combination, providing the following modifications were made:

a. Redesign the aerodynamic fairing to provide 70-inch maximum diameter final stage vehicle.

b. Provide a minimum velocity increment capability of 1,200 ft/sec. for the final stage vehicle following separation from the AGENA stage.

● General Electric Missile and Space Vehicle Department is continuing a minimum sustaining effort pending full approval and funding of the ADVENT program. Preliminary design studies and laboratory testing are being continued. In addition, radiation testing of bearing lubricants has been initiated and several preliminary test reports, specification and related documents have been issued. Preliminary design of subsystems is also being continued.

● A temperature analysis of the final stage vehicle solar array reveals that temperature gradients in the array caused by entry into and exit from an eclipse are negligible.

● Results of an eclipse study reveal that in a 24-hour equatorial orbit, the satellite is in the umbra and penumbra a maximum 74 minutes. The eclipse season is 48 hours long, followed by a period of 135 days during which there is no eclipse.

UHF Communications Equipment

● A new subsystem description has been prepared based on the concept of using a similar final stage vehicle for both UHF and microwave communications repeater equipment.

● WADD/Bendix visited Sylvania Corporation on 15-16 March to observe and discuss progress under a WADD contract covering development of ultra-reliable micor-miniature receiver circuitry. Arrangements were made for continuing exchange of information between Bendix and Sylvania.

Microwave Communications Equipment

● USASRDL personnel visited AFBMD on 7-8 March to review and discuss the AFBMD prepared development plan. Funding estimates for all phases of the program were agreed upon. Technical data covering the microwave communications, as submitted to AFBMD by USASRDL, were included in the development plan with only minor deviations which will be corrected before the plan is submitted to ARPA.

● Preliminary test results obtained on the Varian Associates 8,000 mc, high-power klystron indicate that the tube is capable of the required performance.

● Draft specifications for the ground complex and satellite equipment have been completed by USASRDL.

more advanced phases was replaced by a single integrated effort to which the code name ADVENT was applied. ADVENT calls for an R&D program for a 24-hour global communications satellite system. The feasibility of placing a satellite in a predetermined position in a 19,300 mile equatorial orbit must be demonstrated. The satellite must be capable of providing worldwide communications on a real time basis at microwave frequencies with a high channel wide bandwidth capacity. Amendment 5 also requires the design of a single final stage vehicle for microwave equipment compatible with launching by either AGENA "B" or CENTAUR second stage boosters.

The ADVENT program, as defined in amendment 5, will consist of the following flight tests:

a. Four ATLAS/AGENA "B" flights, nominal 5,600 nautical mile orbits.

b. Seven ATLAS/CENTAUR flights, launched from the Atlantic Missile Range into 19,000 mile equatorial orbits.

c. Three flight tests, using payload space on the last three NASA ATLAS/CENTAUR R&D flights.

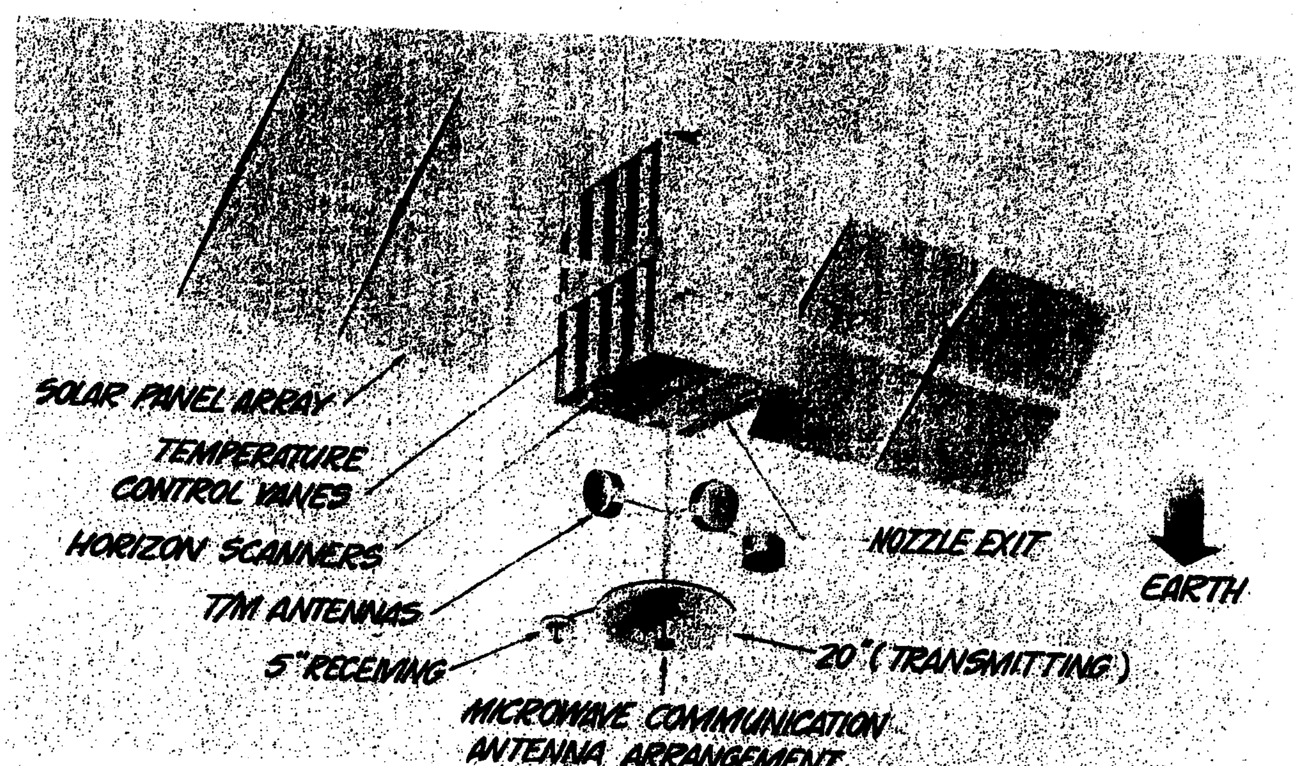
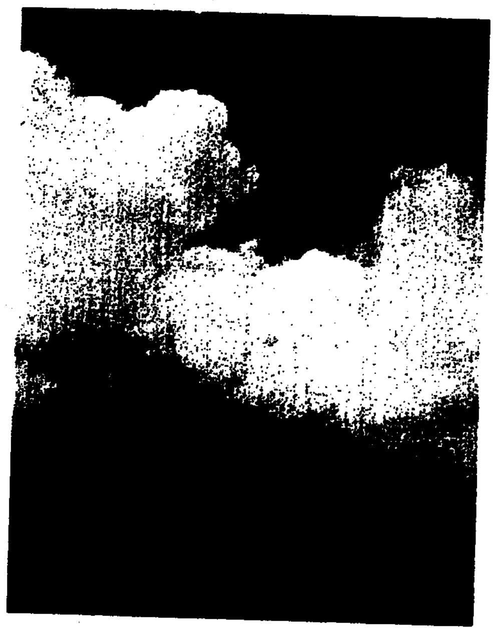


Figure 2. Artist's concept of proposed microwave communications.

SPACE



projects

ABLE
TRANSIT
COURIER
TIROS
AGENA
ABLE-STAR
MERCURY
609A

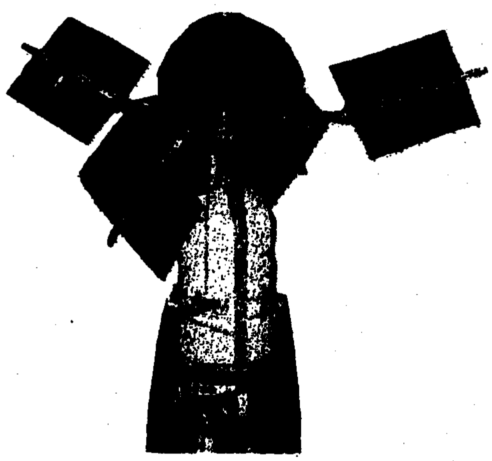


Figure 2. ABLE-3 third stage and payload with solar paddles in fully extended position.

The ABLE Projects Program consists of the development and launching of three vehicles from the Atlantic Missile Range. The program is being conducted by AFBMD under NASA direction. The equipment and objectives of the three flights are as follows:

ABLE-3—This four stage flight vehicle was launched from the Atlantic Missile Range on 7 August 1959. The vehicle consisted of a THOR booster, a second stage using the AJ10-101A rocket engine, a third stage powered by the ABL-248 A3 engine, and a fourth stage consisting of the payload and an injection rocket. In addition to carrying a highly sophisticated payload, the ABLE-3 flight was used to demonstrate the validity of the ABLE-4 vehicle and component configurations. All phases of the launching were successful and the advanced scientific observatory satellite was placed in an extremely elliptical geocentric orbit about the earth. Trajectory

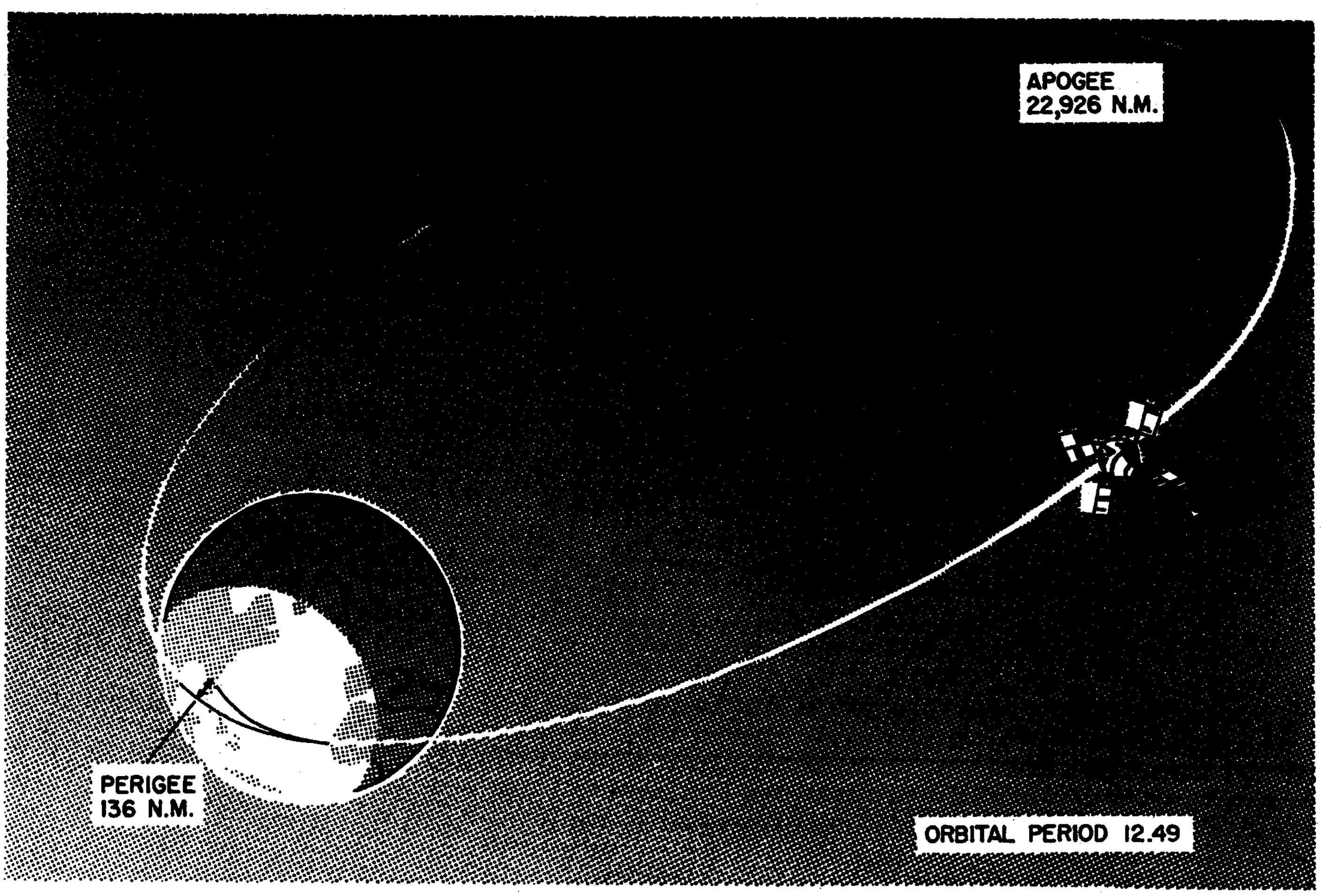


Figure 3. Drawing of extremely elliptical ABLE-3 orbit.

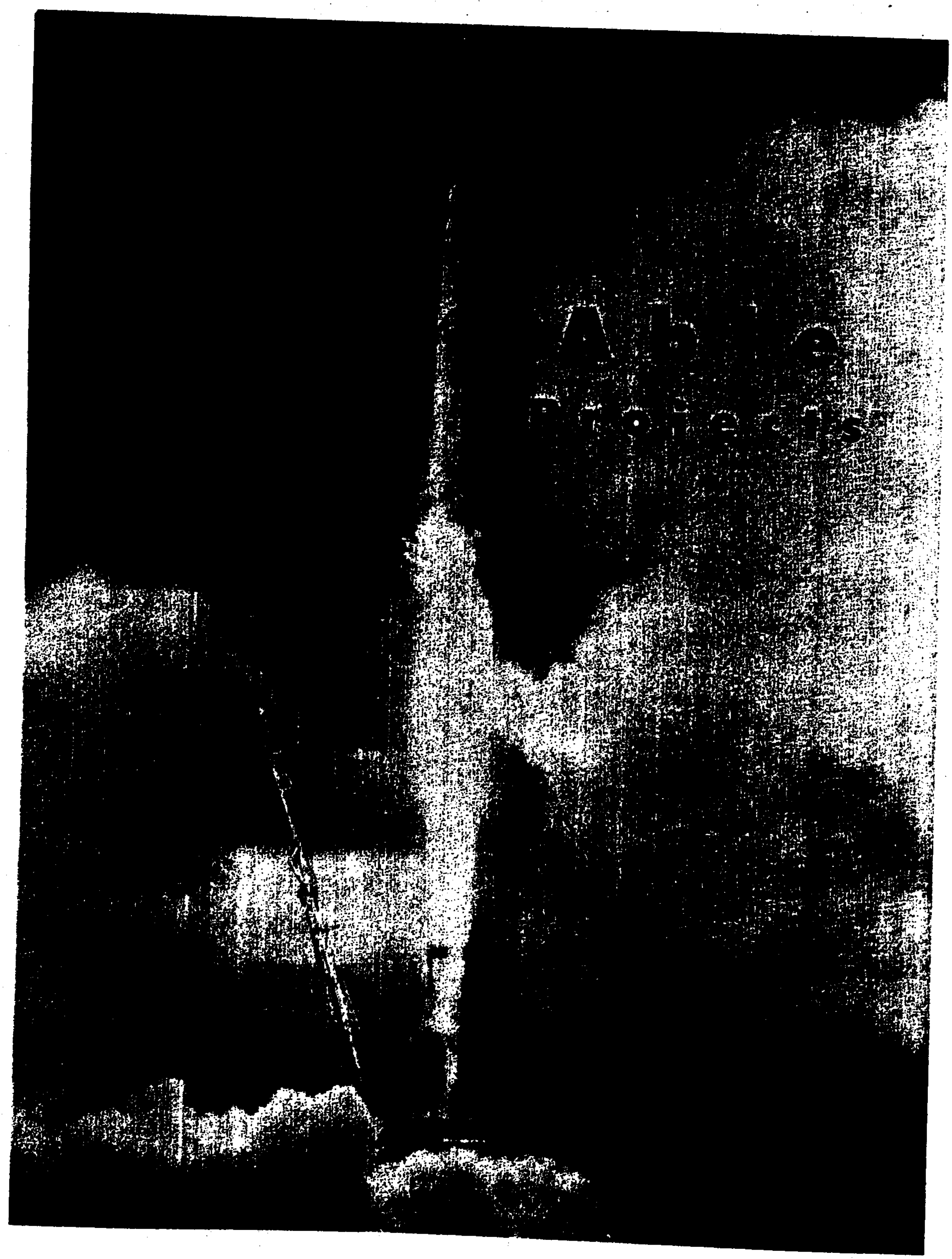
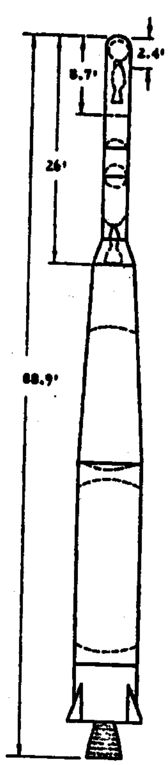



Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.

imately 48 seconds after launch. The ATLAS performed as planned over its entire powered flight trajectory. The trajectory of this flight, from the Atlantic Missile Range to the vicinity of the moon, was established to achieve the tightest possible circular lunar orbit consistent with the highest probability of success. The final burnout conditions were to have provided an inertial velocity of 34,552 feet per second. The payload was designed to investigate space environment and propagation effects and to transmit crude television images of the far side of the moon. This was the first flight in which an ATLAS ICBM was used as the booster for a multi-stage space flight.

ABLE-4 THOR is a deep space probe which was launched into a solar orbit intermediate between the orbits of earth and Venus. At its closest approach to the sun, the probe will pass near the orbit of Venus, returning to intersect the orbit of earth at its greatest distance from the sun. The vehicle consists of a THOR first stage, AGC 10-101 liquid fueled, guided second stage, and ABL248A-3 solid-fuel third stage. This vehicle will place a 90 pound payload into space flight. The payload contains no retro-rocket, and no attempt will be made to intercept Venus. The design of the payload components is the same as those which have been proven on the ABLE-3 satellite.

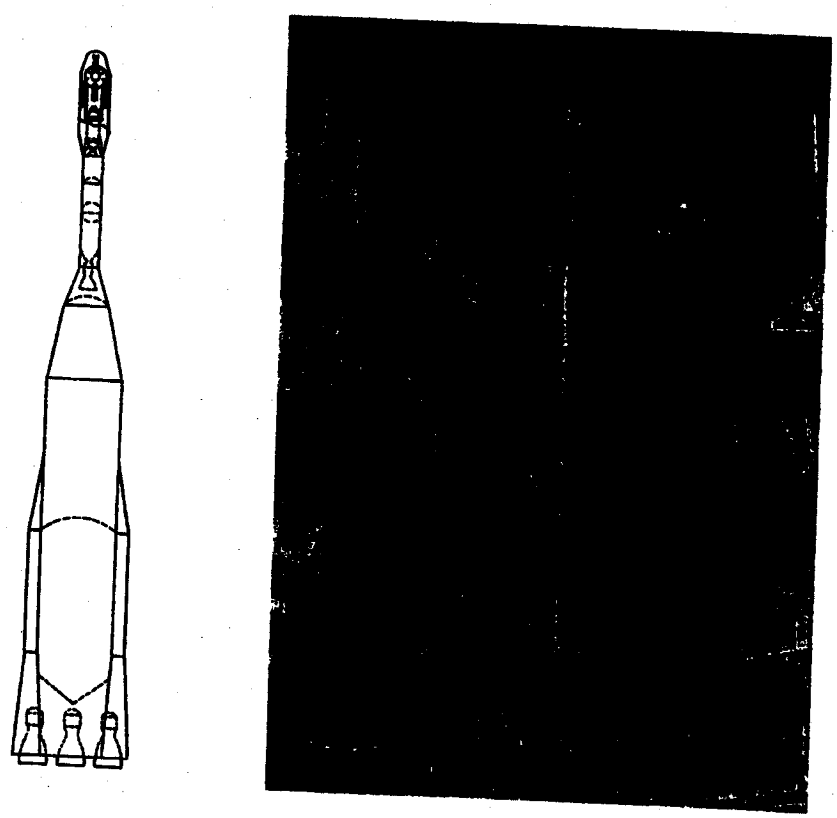
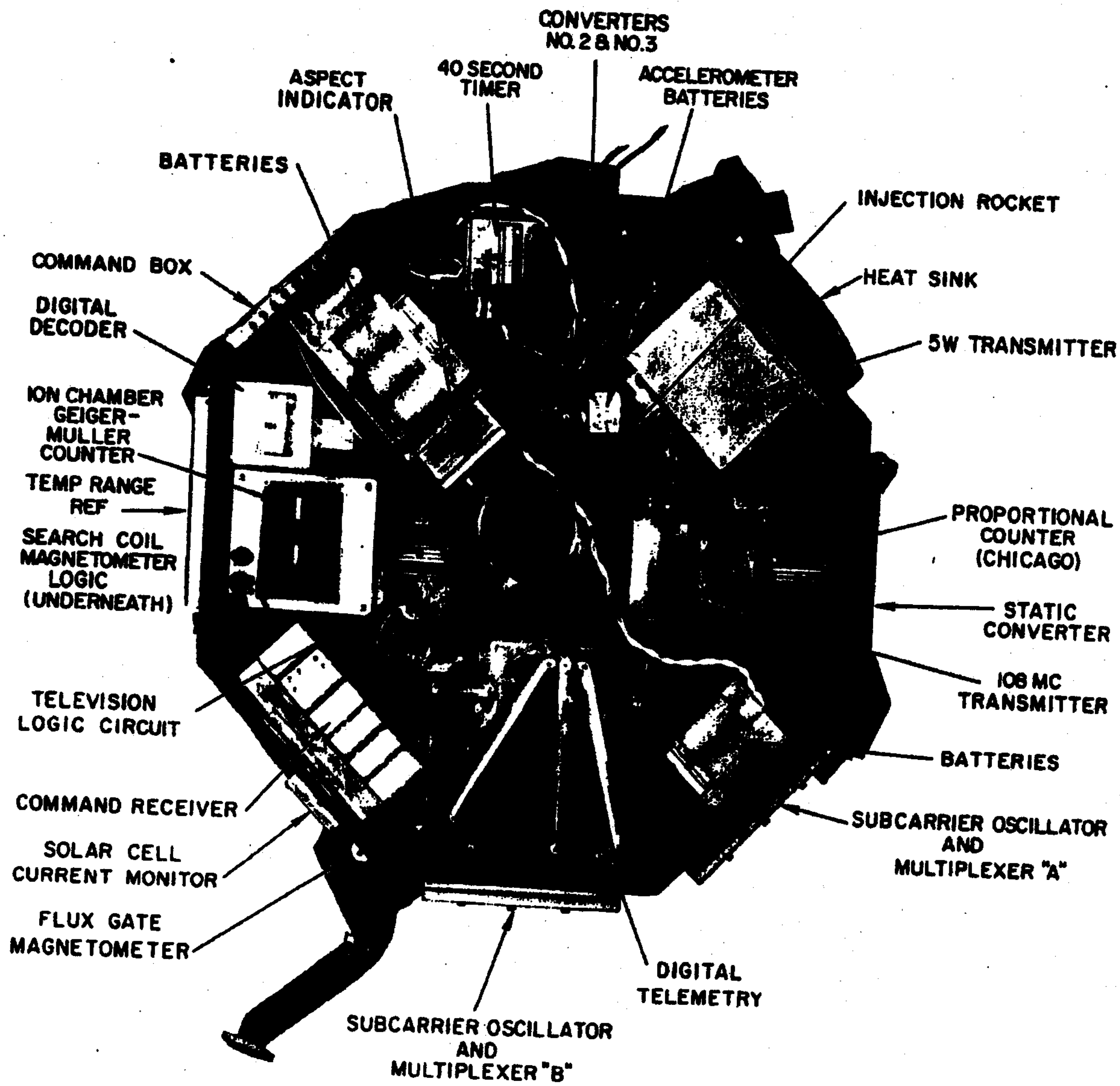


Figure 5. Line drawing of ABLE-4 ATLAS flight test vehicle. Photos show vehicle on launch pad. Vehicle booster and second-stage were subsequently destroyed during flight firing readiness.



THOR-ABLE III PAYLOAD (TOP VIEW)

Figure 4. ABLE-3 payload (top view).

and orbit were essentially as predicted with deviations in apogee and perigee occurring on the more than nominal side. The payload was the most sophisticated to have been placed in orbit by this nation at the time and contained provisions for conducting 13 experiments in space environment and propagation. A wealth of valuable data was obtained from satellite telemetry until the last transmission was received on 6 October. It is believed that the satellite, while yet in orbit, is incapable of generating sufficient power for transmitting signals due to solar paddle damage suffered during initial paddle extension and the resultant unfavorable sun "look" angle.

ABLE-4 ATLAS—This vehicle differed from the ABLE-3 only in that an ATLAS ICBM was used as the first stage instead of a THOR IRBM. The unsuccessful launch of the ABLE-4 ATLAS occurred on 26 November 1959. Structural breakup resulted in the third stage and payload parting from the vehicle approx-

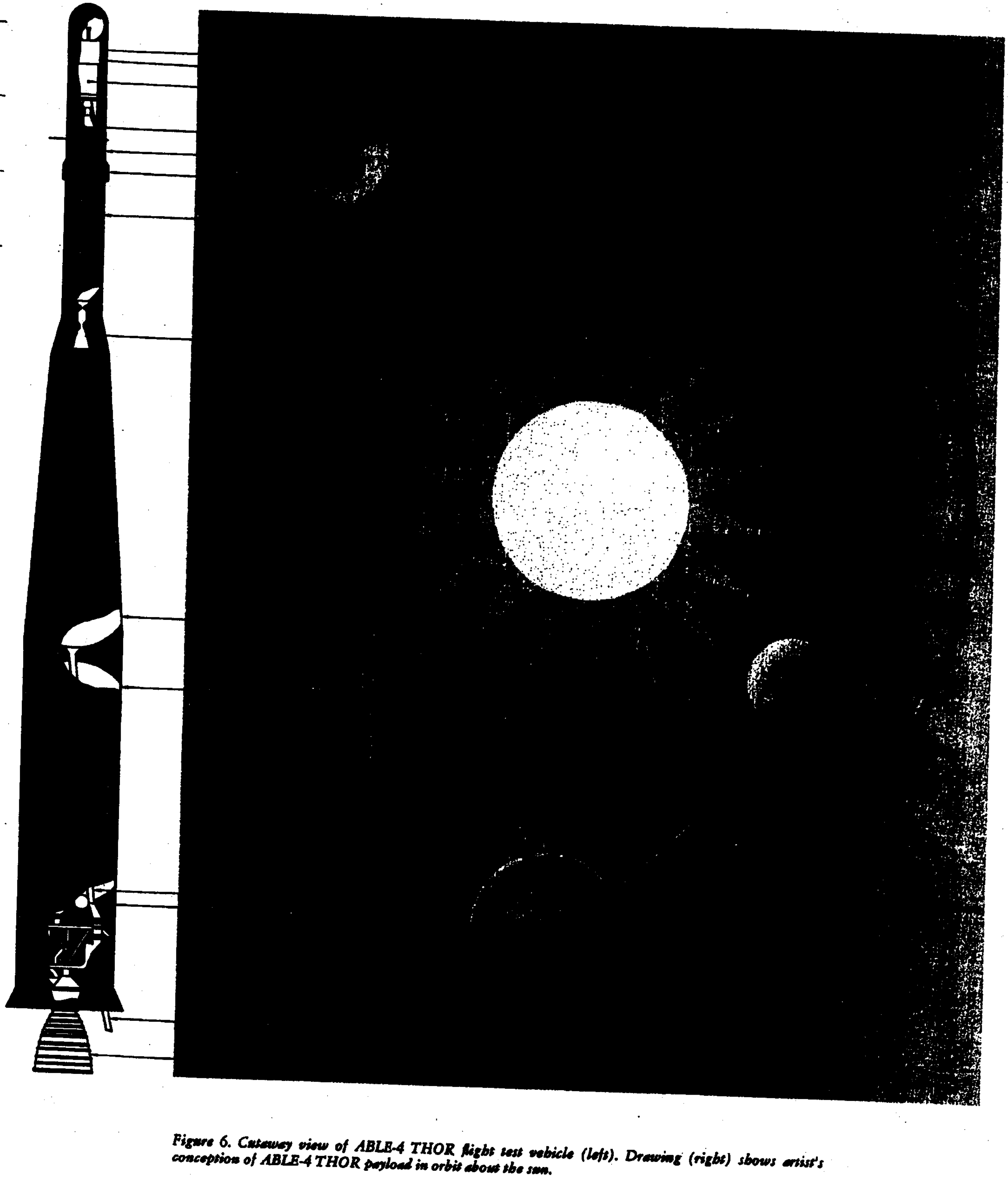
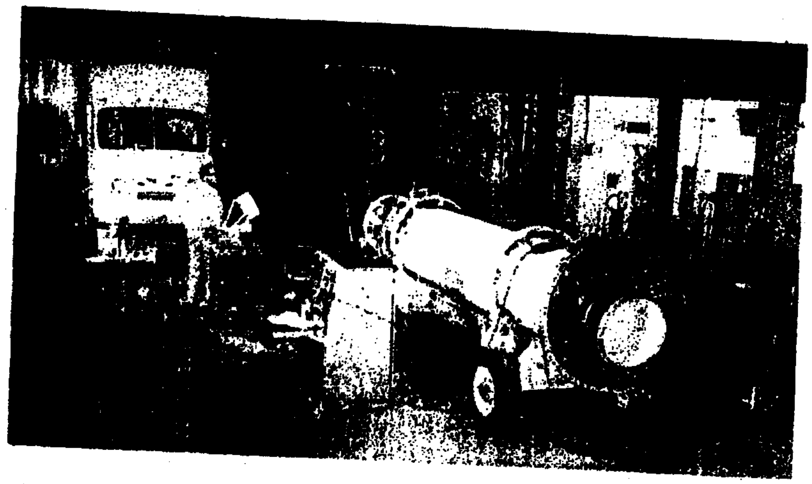


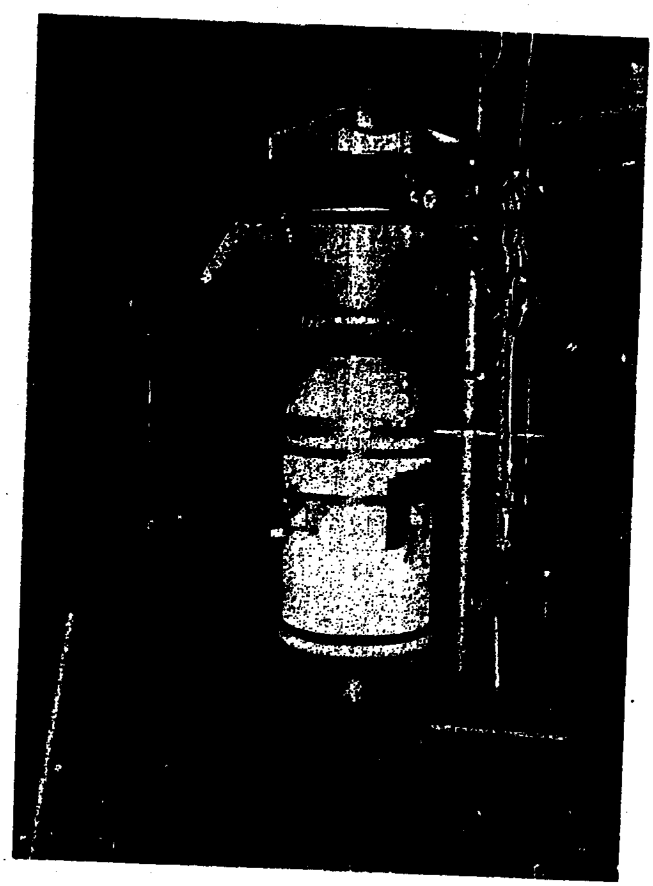
Figure 6. Cutaway view of ABLE-4 THOR flight test vehicle (left). Drawing (right) shows artist's conception of ABLE-4 THOR payload in orbit about the sun.

Preparing the Stages . . .

Second Stage Checkout . . .

Systems checkout of second stage being performed in hangar at Atlantic Missile Range. Photo below shows ABLE vehicle mounted on transporter; mobile checkout vans in background.





***Third Stage—
Payload . . .***

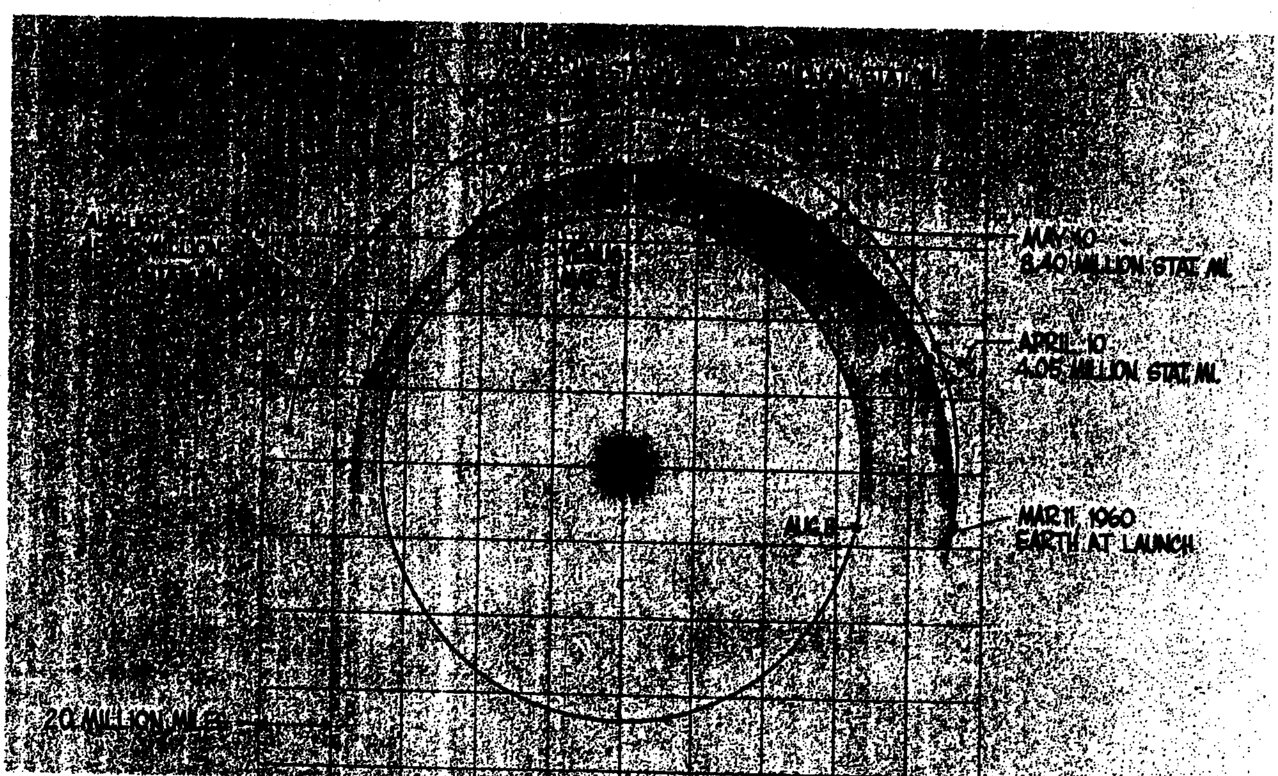
Third stage, with test payload installed, during stress testing of installation. Extensive last minute vibration tests were conducted on the third stage with highly successful results being obtained.

ABLE-4 THOR (PIONEER V)

● On 11 March 1960, at 0800 EST, the ABLE-4 THOR interplanetary probe flight test vehicle was launched from Atlantic Missile Range (AMR) Pad 17A. Twenty-five minutes later, following excellent performance by all three stages, satellite vehicle separation occurred and the PIONEER V satellite was placed in an elliptical orbit about the sun. At this time, all aspects of this flight continue to produce the desired results. Performance of the three booster stages, communications level, and information from payload experiments have far exceeded any previous achievements in space research. ABLE-4 THOR was the third flight in the ABLE Space Probes Program. The vehicle and payload were similar to those tested in the highly successful ABLE-3 earth satellite (EXPLORER VI).

● The ABLE flights began in March 1958 to provide flight test support for development of ballistic missile re-entry vehicles over intercontinental trajectories. Successful R&D flights led to the use of the THOR/ABLE vehicle, with a third stage added, for deep space and interplanetary probe missions. This has proven to be an exceptionally capable and reliable vehicle. No other comparable ballistic missile has ever attempted the payload weight handled by this vehicle.

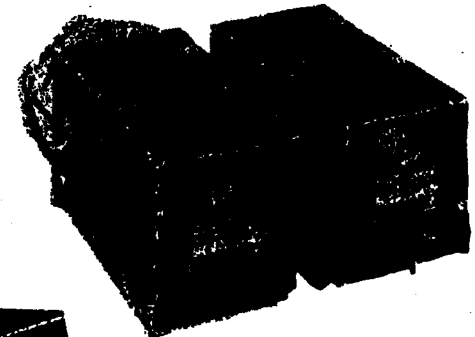
● The high degree of success achieved resulted from close and effective administrative and technical coordination among the National Aeronautics and Space Administration (NASA) and the Air Force Ballistic Missile Division/Space Technology Laboratories team.



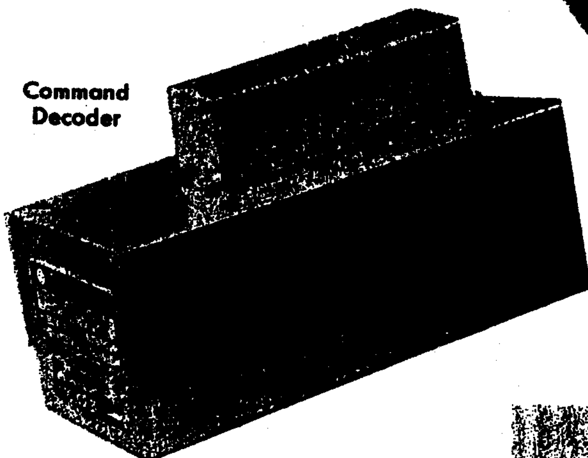
Trajectory—ABLE-4 THOR (PIONEER V)

PIONEER V PAYLOAD

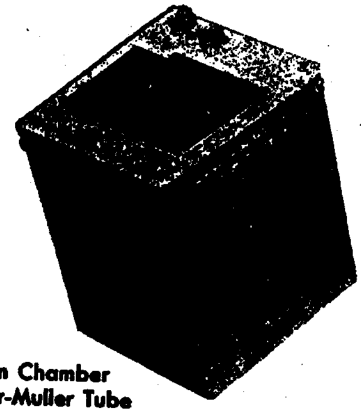
(top view)



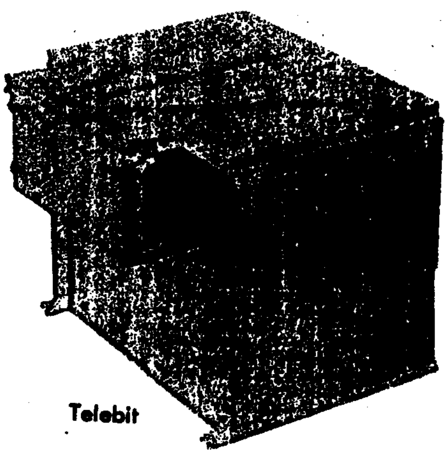
Batteries



Command Decoder

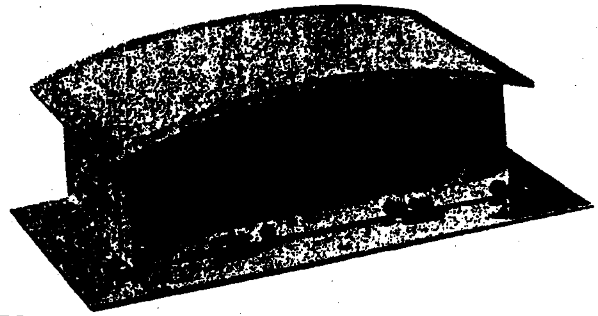


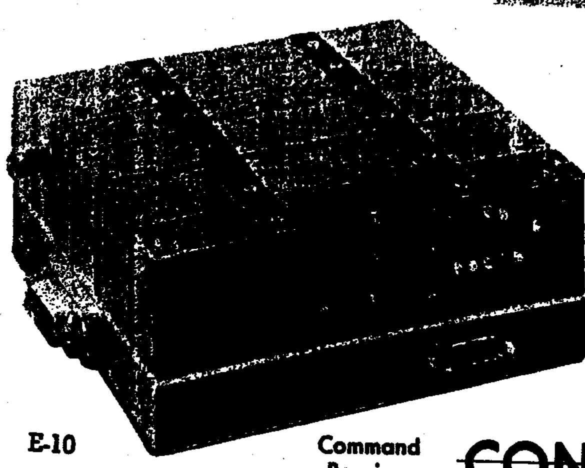
Ionization Chamber and Geiger-Muller Tube



Telebit

Heat-Sink— 150-watt Transmitter





Command Receiver

Pre-Launch

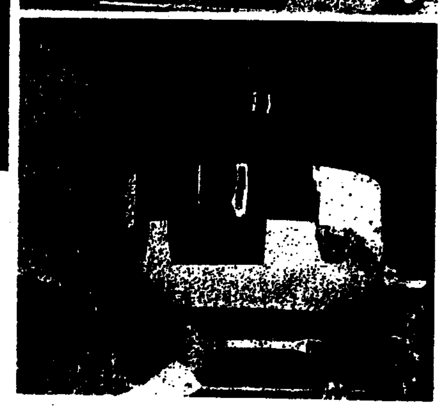
● ABLE-4 THOR pre-launch activity began in July 1959 when THOR 219 was installed on launch pad 17A. The booster remained on the pad until it lifted off under its own power eight months later. This period encompassed the most extensive testing and checkout program ever conducted on a single vehicle.

● The second stage used for ABLE-4 THOR was originally programmed for and installed on the ABLE-4 ATLAS. This stage was damaged while being removed from the ATLAS; repaired, and installed on THOR 219. When the ABLE-4 THOR flight was deferred by NASA, the second stage wal removed and stored. With the resumption of pre-launch operations in February, this stage developed a leak which was repaired after removal of the engine and six hours of intensive X-raying. On 25 February, a thrust chamber nozzle closure diaphragm was blown accidentally. The stage was again repaired and reinstalled on THOR 219 on 29 February. No further problems were encountered.

● During inspection of the third stage prior to final installation on the flight vehicle, two gouges were discovered in a critical area of the casing. The back-up third stage for ABLE-3, stored for nearly a year in the AMR Ordnance area, was substituted. Evidence of excessive third stage vibration obtained from NASA SHOTPUT flights in December necessitated a delay to permit investigation and corrective action. Extensive studies of vibration, test procedures, and test stand facilities were conducted. A revised testing program was formulated and performed with satisfactory results being obtained.

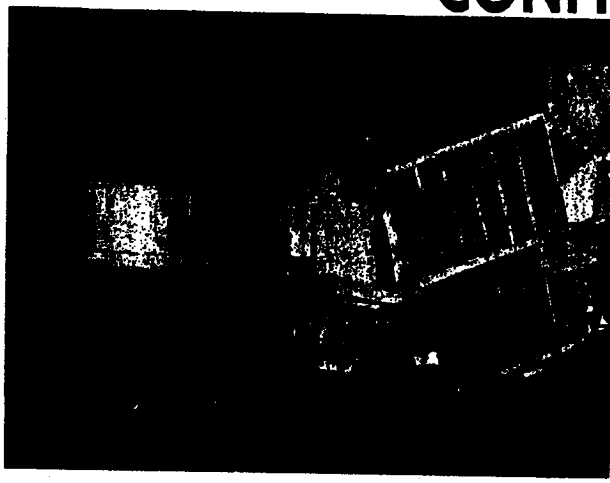
● Construction of the vehicle which eventually became the PIONEER V satellite was htarted over a year ago. The finished test unit was shipped to the AMR on 27 November 1959. As a result of component failures in the power supply subsystem, it was returned to Space Technology Laboratories (STL) on 19 December for evaluation and testing. During January and February it was subjected to exhaustive qualification testing both at STL and in an altitude simulation chamber. The requalified vehicle arrived at the AMR on 25 February.

● On March 2, a power converter failed during special calibration testing of the 5-watt transmitter causing the flight to be rescheduled from 8 March to 10 March. On 10 March, difficulties with the LOX supply topping equipment caused the countdown to be stopped at T minus 5 minutes, and subsequent rescheduling on the launch attempt for 11 March.

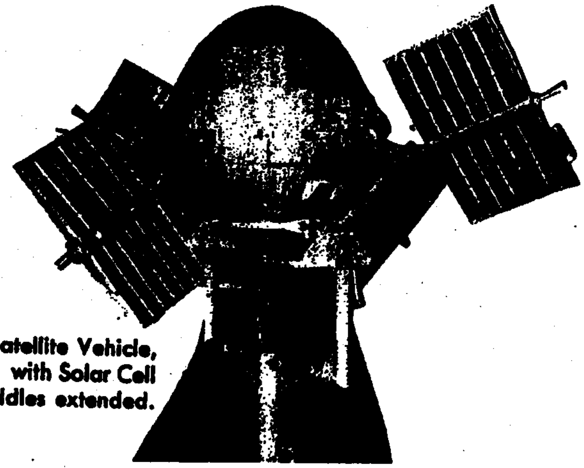


Payload and Satellite Vehicle Assembly . . .

Technicians installing components in payload platform (above) and placing top shell of satellite vehicle on payload platform (top right). Completed satellite vehicle (bottom right) showing mounting clamp and arms for solar paddle installation.

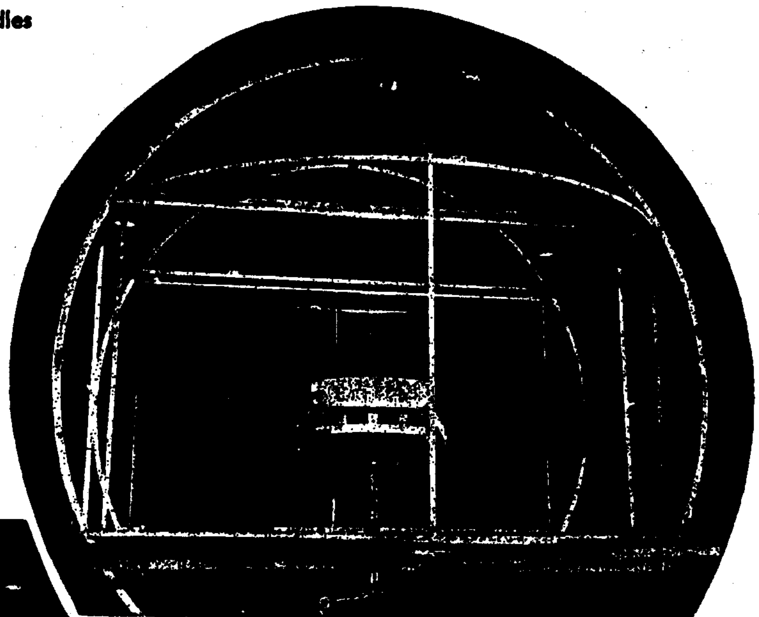


Installing Solar Cell Paddles

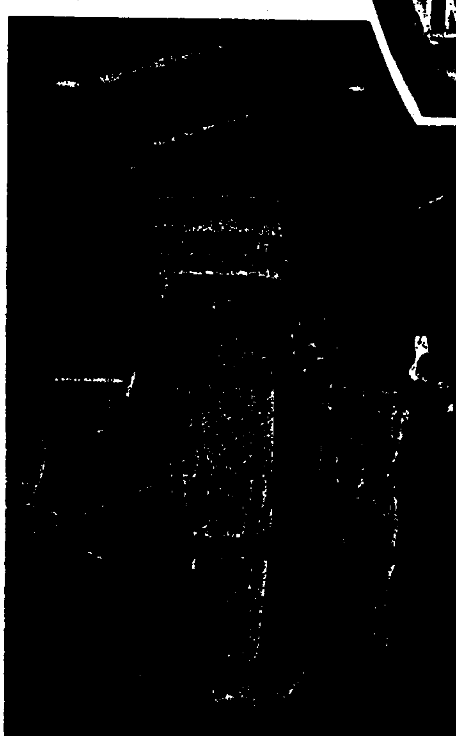


Satellite Vehicle, with Solar Cell Paddles extended.

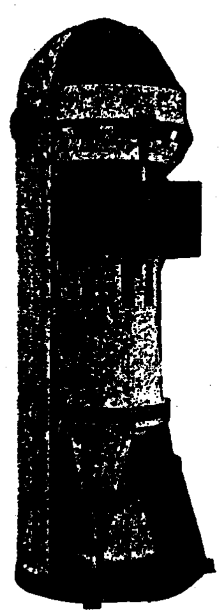
Third Stage . . . . . . Satellite Vehicle



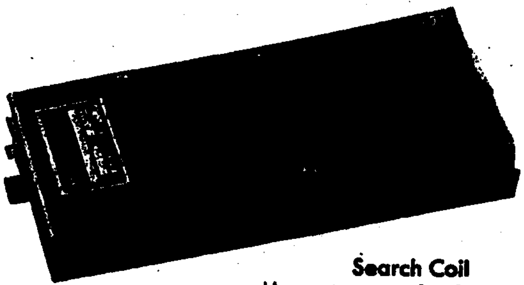
Payload installed in Helmholtz Coil Test fixture, used to check operation of magnetometer experiment



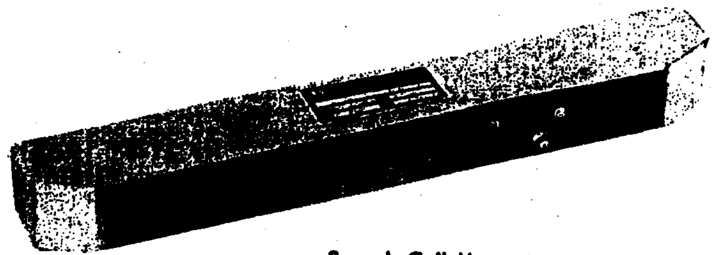
Checking Paddle Latching Mechanism



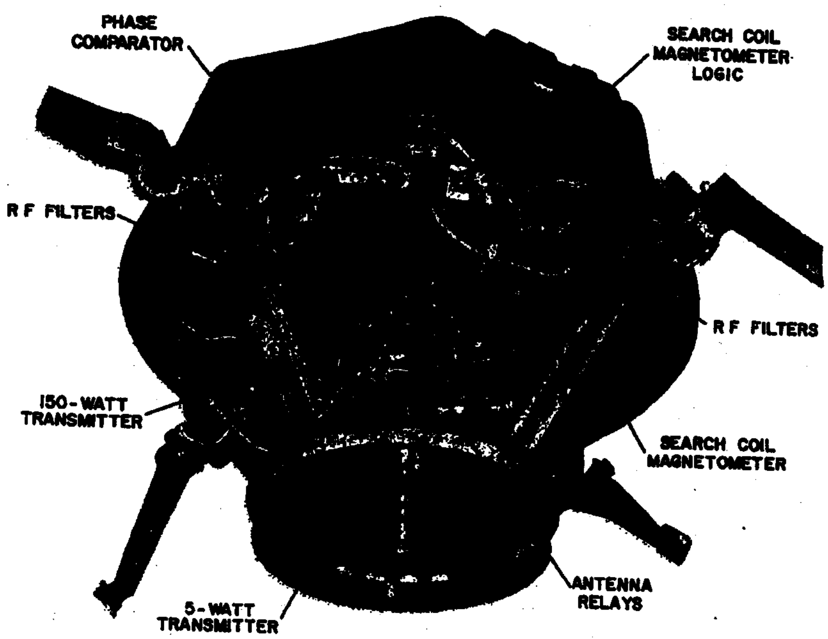
Third stage and Satellite Vehicle, Paddles folded Down. Half of Fairing Shell in Place.



Search Coil
Magnetometer Logic

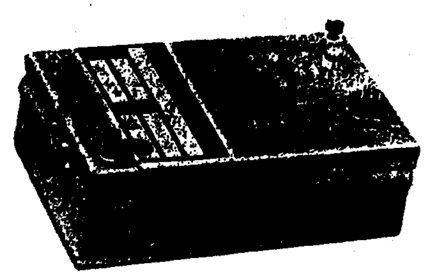


Search Coil Magnetometer

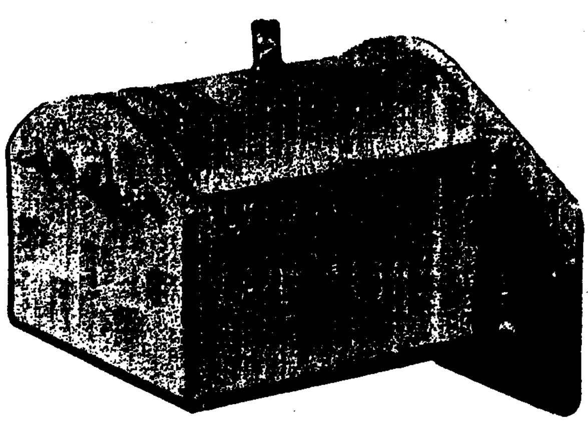


PIONEER V PAYLOAD

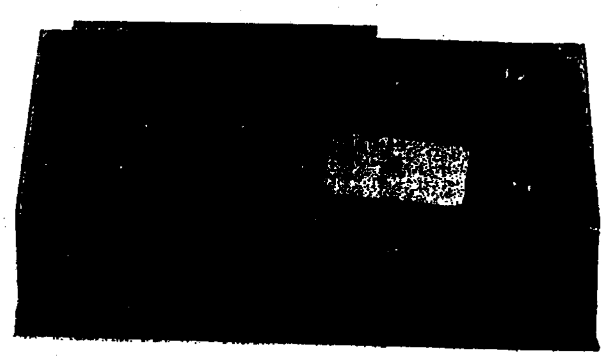
(bottom view)



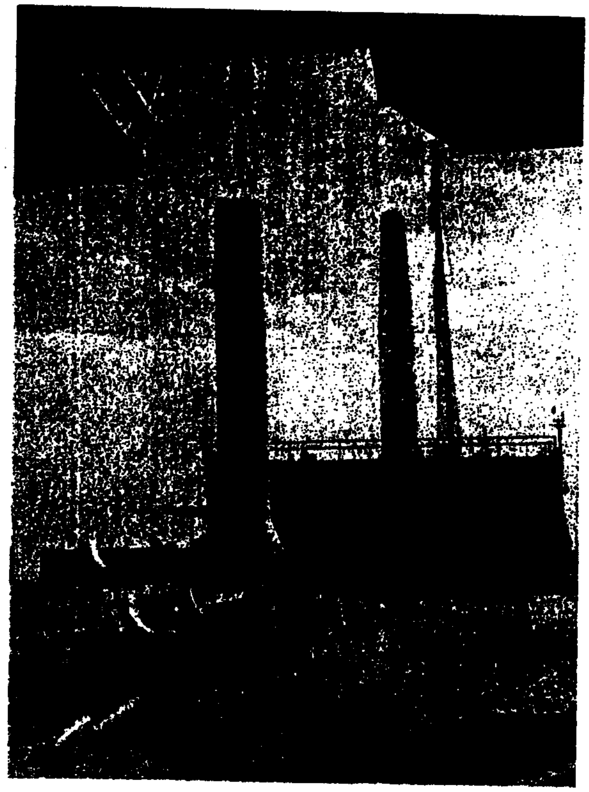
Phase Comparitor

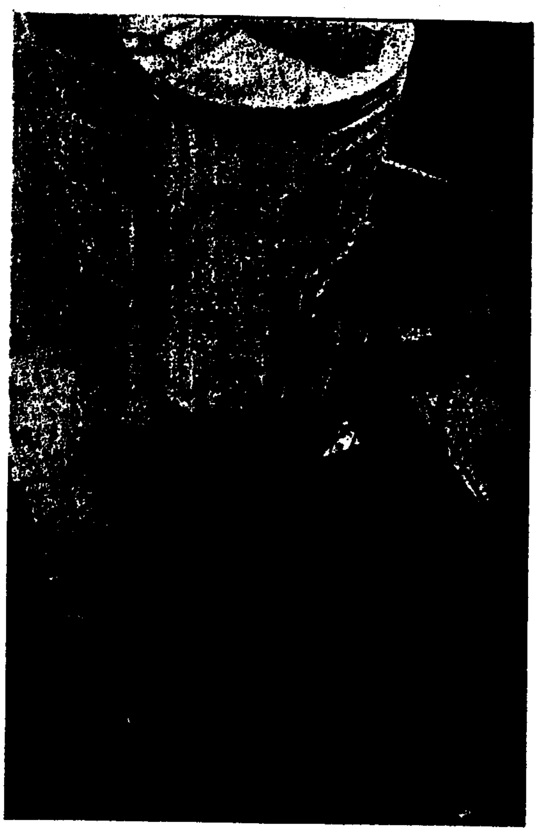


150-watt Transmitter



5-watt Transmitter

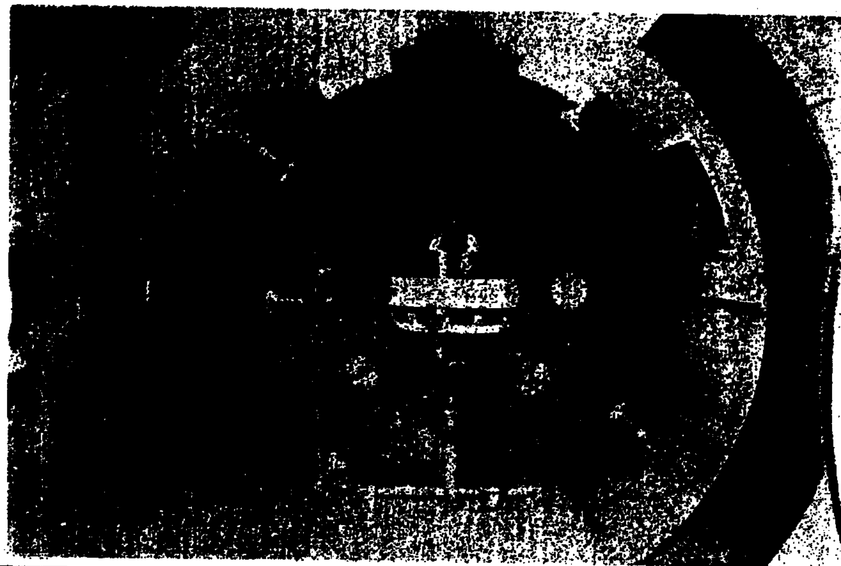


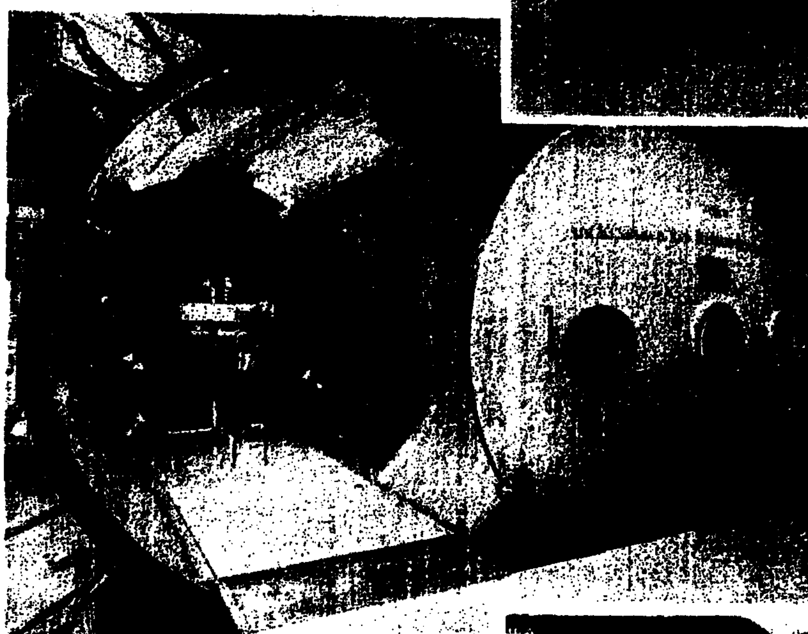


Installation on Launch Pad

Second Stage . . .

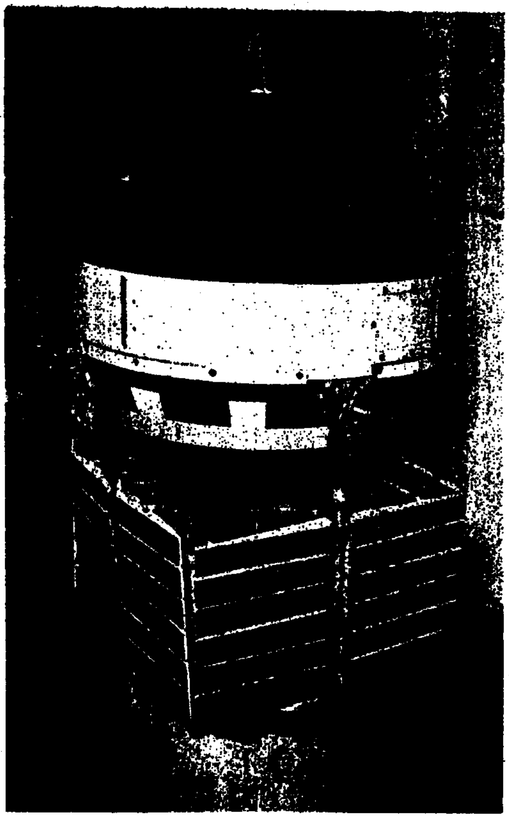
Delivered to gantry (above) . . . being raised into gantry tower (above left) . . . being lowered into mating position with THOR (bottom left) . . . and during mating with THOR.





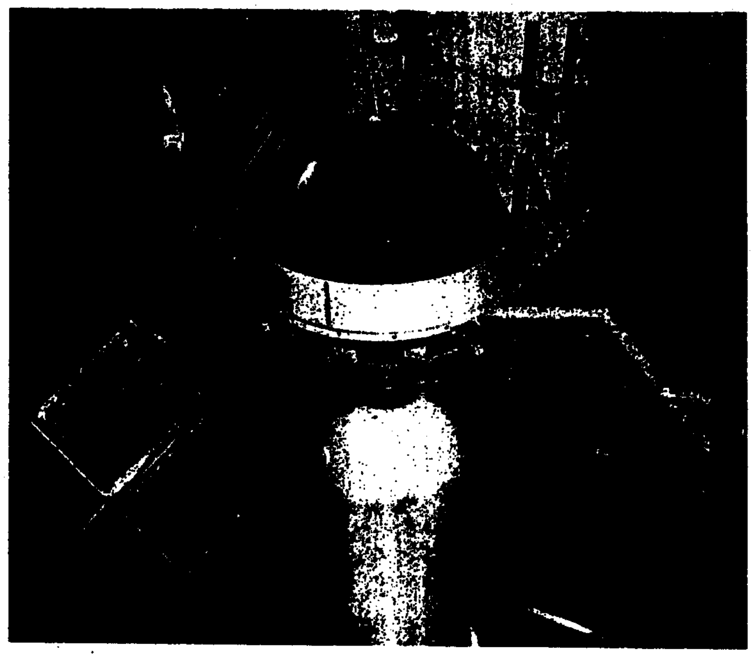
Payload in High Altitude Chamber Tests

Following extensive rework of the payload early this year it was subjected to severe operational and environmental testing in the high altitude simulation chamber shown.

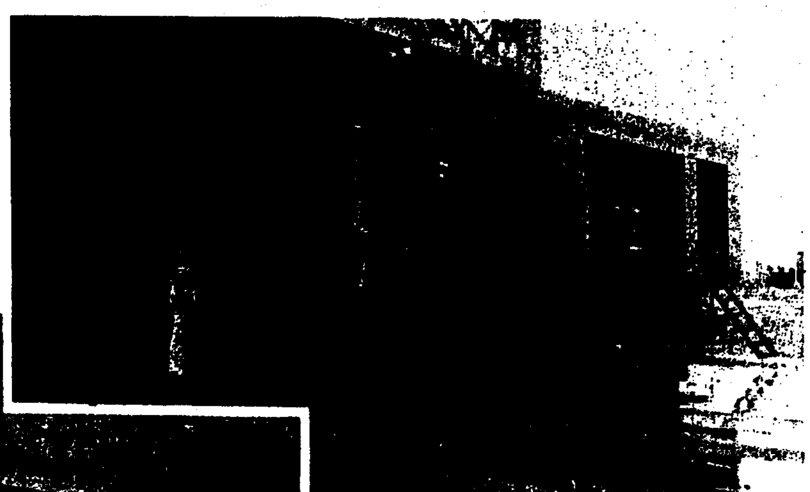


Solar Paddles . . .

In folded (launch) position (left) . . . in extended (orbital) position (below).

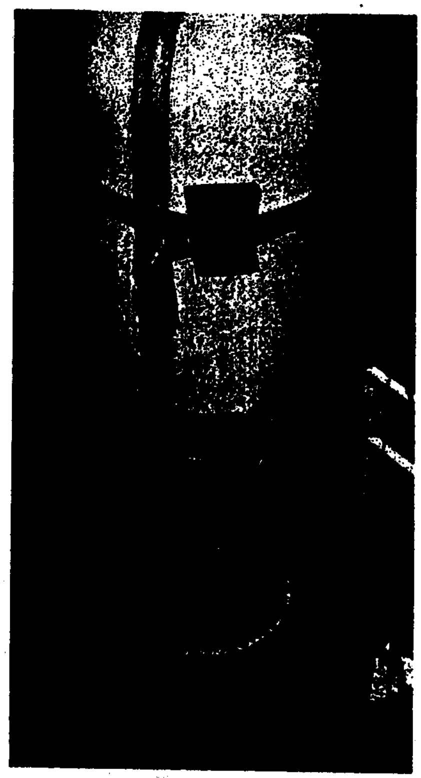


Servicing . . .



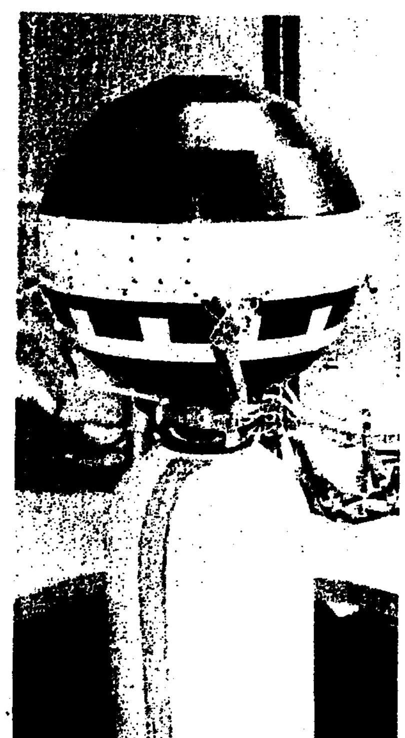
. . . Flight vehicle with fuel (left) and oxidizer (right above).

Third Stage . . .



. . . Hoisted onto tower platform (left) . . . being lowered toward second stage (center and right).

Payload . . . Hoisted onto gantry (left) . . . being mated with third stage (center) . . . installed on third stage (right).



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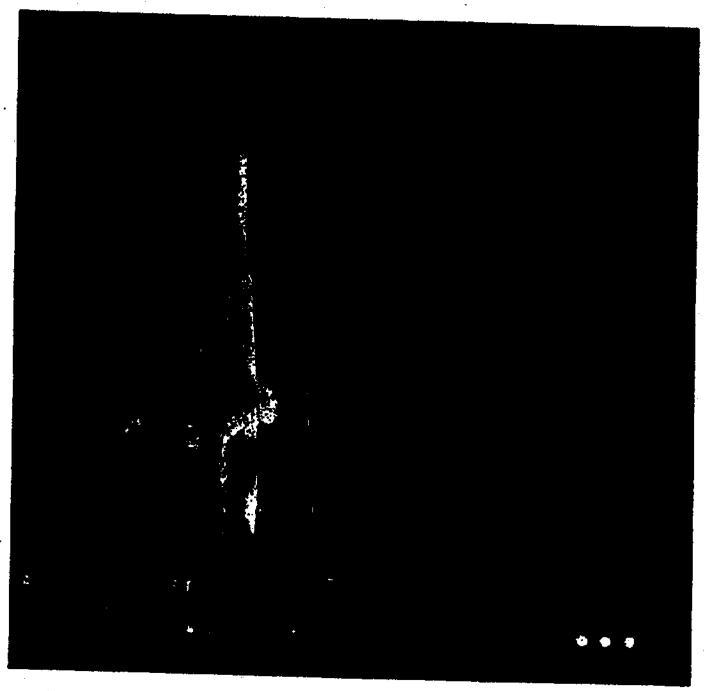
Launch . . .

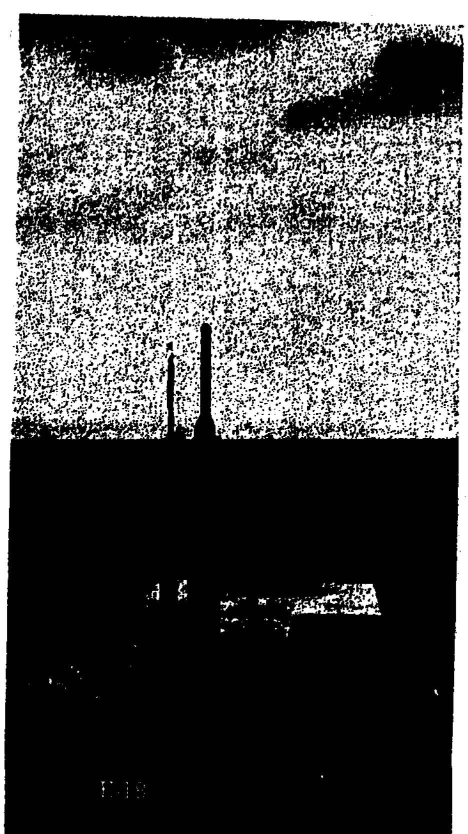


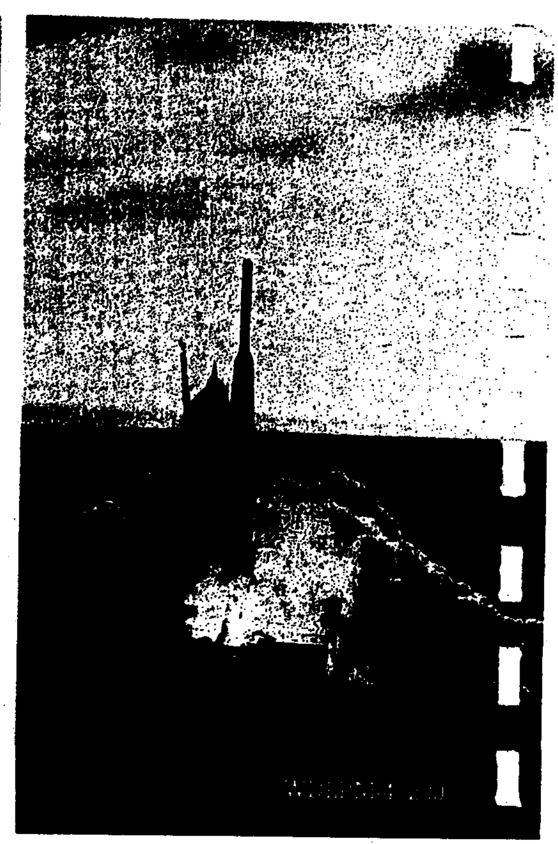
Launch

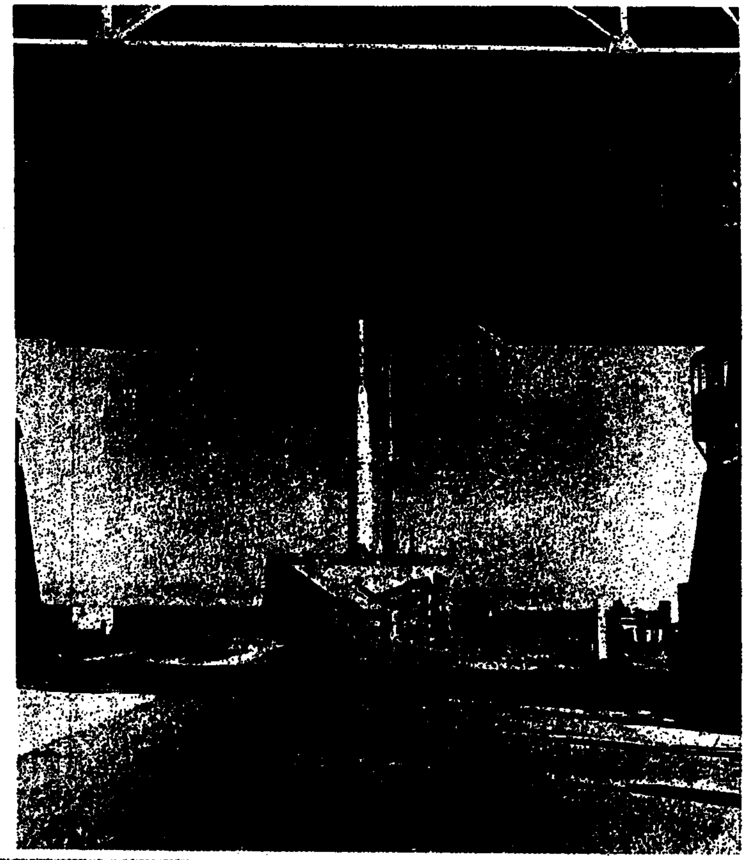
● Countdown was initiated at 0300 EST, on 11 March. Final missile preparations, including ordnance provisions, were completed by 0430. The final checkout tasks (advanced guidance system and payload) were completed at approximately 0540. The one-hour hold programmed into the countdown at T minus 35, was started at 0625. Terminal countdown was resumed at 0725:30 and a time synchronization made. The blockhouse was secured at 0736. Launch area was declared to be clear at T minus 27 seconds. Blockhouse vents were closed at T minus 6 seconds. Countdown remained on schedule until launch.

Powered Flight

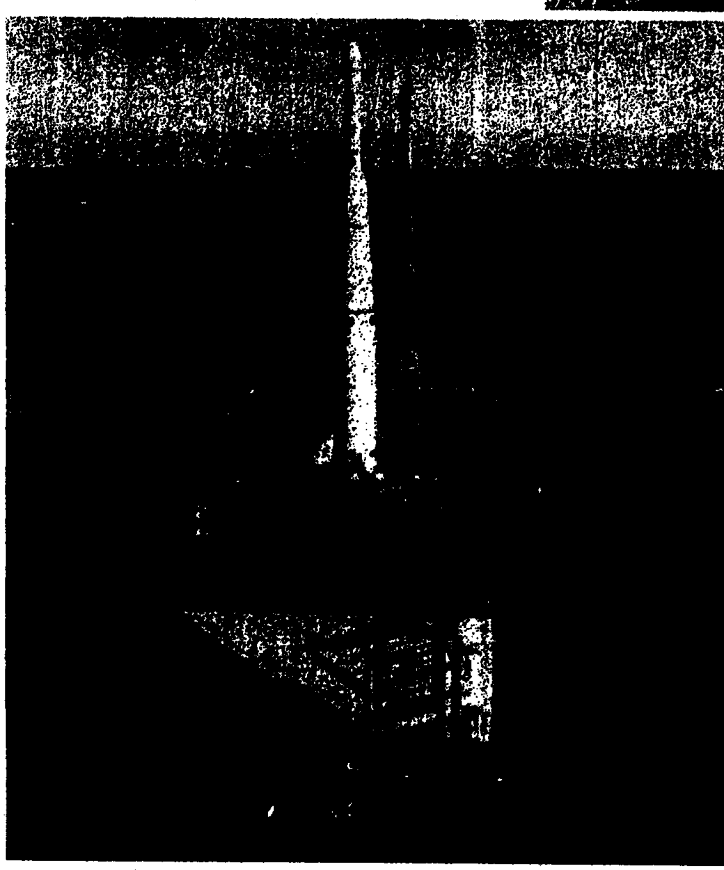
● Liftoff occurred at 0800:07:1 on a launch azimuth of 90 degrees true. Gross weight at liftoff was 113,675.01 pounds. Performance of all three stages was excellent and separation occurred as planned. Burning time for the THOR and third stage engines was within one second of nominal. The Aerojet AJ10-101A second-stage engine cut off within one tenth of one second of nominal burn time. The third stage separated from the terminal vehicle at 0825:15 EST. Velocity, at the time of third stage separation was approximately 36,480 feet per second, over 800







Ready for Launch . . .



. . . from Atlantic Missile Range launch pad 17A

will be approximately 24,869 miles per hour. PIONEER V will have an orbital "year" (time period to complete an orbit) of approximately 312 days.

Period	311.64 days
Time to perihelion	151.96 days
Eccentricity	0.104
Semimajor axis	0.889 astronomical unit
Inclination ecliptic	3.35°
Longitude to first ascending node	−10.29°
Arguement of perigee	−2.58

Table 2. ACTUAL ORBITAL PARAMETERS

- Performance figures for PIONEER V, as of 22 April, are as follows:
  - Days since launch 42
  - Miles from earth ....4,915,000 n.m.
  - Velocity (in relation to earth) 5,126 n.m./hr.
  - Telemetry reception rate, (see communications section) ....8 pps
  - Temperature (solar cell paddles) ....50 degrees Fahrenheit

Ground Station Tracking and Data Acquisition

- ***Atlantic Missile Range***—All launch and powered flight tracking operations performed by this station were completed satisfactorily. The station was able to track the satellite only for the first five days.

- ***Manchester, England*** — The 250-foot antenna at this station acquired the ABLE-4 THOR vehicle 15 minutes after launch. Reception has been excellent throughout the flight to date, in spite of several equipment failures; all of which have been repaired. Only a small amount of transmitter noise has been encountered. The parametric amplifier is performing quite satisfactorily and has been used throughout the flight. It has the usual noise figure of 2 db.

- ***South Point, Hawaii***—Telemetry reception by this station has been second only to Manchester. Because of a transmitter failure, which has been repaired, tracking was not accomplished for two days. Late in April the reception rate had dropped to 1 pulse per second (from the 5-watt transmitter) and quality had decreased to "garbled." A decrease in transmitter noise was realized by the installation of the 3⅛ inch styroflex cable and the welding of the screen of the antenna reflector. Parametric amplifier performance has been satisfactory.

- ***Singapore***—This station was able to transmit commands to the satellite for the first two days in orbit and to receive telemetry for the first five days. All equipment operated satisfactorily.

- ***Millstone Hill, New Hampshire***—Reception at this station was very excellent via the regular 400 mc radar feed attached to the 85-foot antenna. Because of its lobing capability, Millstone was able to give very accurate satellite angle information.

Satellite Vehicle

- The ABLE-4 THOR satellite is an approximate spheroid, measuring 26 inches in diameter at its equator. Four solar paddles are evenly spaced about its equator. The paddles were folded downward during first and second stage powered flight. At the time of second stage shutdown the paddles were released and erected in their permanent positions, prior to spin up and firing of the third stage engine. Each of the solar paddles is offset in angle about 30 degrees relative to the vehicle spin axis to permit a relatively constant number of solar cells to be exposed to the sun despite the changing attitude of the satellite.

- The satellite weight is 95 pounds, distributed as follows:

Structure	11.3
Platform and wiring	7.4
Instrumentation	36.5
Experiments	9.5
Batteries	17.2
Paddles and solar cells	10.2
Temperature control material	0.8
Dynamic balance weights	1.7

Satellite Instrumentation

- ***Communications*** — Communications equipment aboard the PIONEER V is by far the most powerful ever carried on a missile or space flight. Information will be sent to earth from both the 5-watt and 150-watt transmitters. A high sensitivity receiver permits satellite reception of earth transmitted commands. When interconnected coherently, both range and range rate information may be obtained to permit accurate tracking of the satellite.

- ***Transmitters*** — Satellite transmissions to date have been performed by the 5-watt transmitter. It is intended that this procedure will be followed until feet per second faster than necessary to escape the earth's gravity. First acquisition of the vehicle by a ground station in the ABLE tracking network was made at approximately 0815 EST by the Jodrell Bank Experimental Station at Manchester, England.

Parameter	*Nominal*	*Actual*
Inertial burnout velocity	36,597 ft/sec	36,404 ft/sec
Inertial velocity angle	75.80°	78.28°
Inertial velocity azimuth	93.04°	93.02°
Latitude	28.105°	28.25°
Longitude (from Vernal Equinox)	297.6°	297.9°
Radial distance from the earth's center	22,275,000 ft	22,336,000 ft

Table 1. BURNOUT PARAMETERS

Flight Test Vehicle

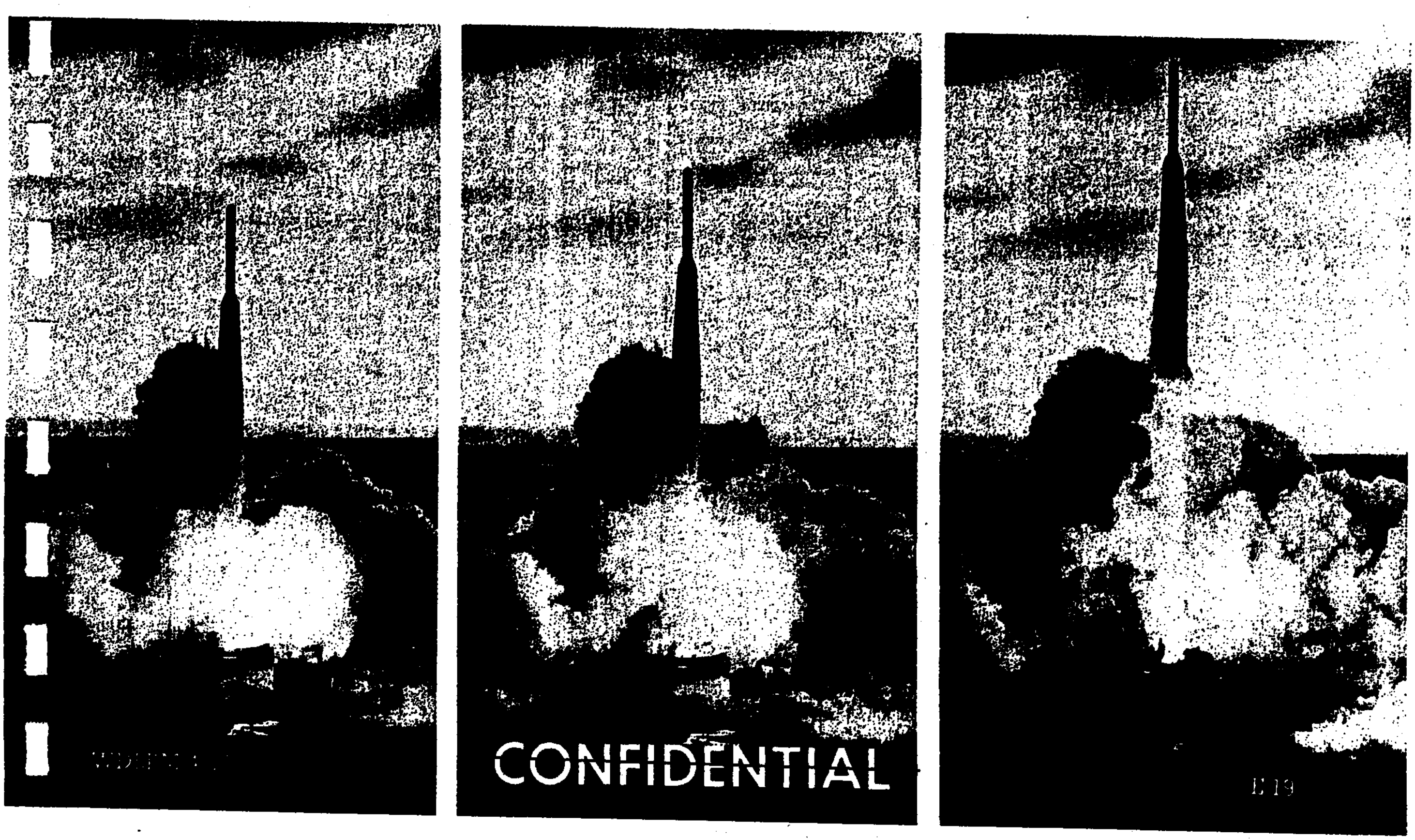
- ***First Stage***—Stand THOR intermediate range ballistic missile, with the inertial guidance system removed and a modified control system. Guidance was accomplished by roll and pitch programmers. The Rocketdyne engine used RJ-1 fuel and LOX.

- ***Second Stage***—ABLE vehicle. Aerojet-General Corporation (AJ10-101A) propulsion system using a hypergolic combination of inhibited white fuming nitric acid oxidizer and unsymmetrical dimethyl hydrazine fuel. The second stage incorporated an STL Advanced Guidance System utilizing a ground based Burroughs Corporation Mod I guidance computer.

- ***Third Stage***—Allegany Ballistics Laboratory 248-A4 solid propellant rocket, with a burning time to propellant depletion of 38 seconds. Spin stabilized by six spin rockets installed on the second stage.

Satellite Flight

- The PIONEER V satellite is presently on a 152 day journey of 46,400,000 miles to reach its closest point to the sun on its elliptical solar orbit. The closest point to the sun (perihelion) will be about 70,000,000 miles. This point is only a few million miles away from an intersection with the orbit of Venus. Distance from the earth will increase to approximately 186,000,000 miles when the satellite reaches a point on the far side of the sun (estimated date: December 1962). Its orbit will then swing the satellite back to within 50,000,000 miles of the earth sometime in 1963. Its galactic velocity in solar orbit



● *Receiver*—The payload command receiver is a transistorized double-conversion, phase-lock-loop receiver which produces a coherent output at 2/17 of the receiver frequency. It can be operated with an effective noise bandwidth of either a 25-cps or a 40-cps bandwidth. The receiver operates continuously and, since its bandwidth is less than the frequency uncertainty of the received signal, it repeatedly sweeps over a range of 30 kc searching for a carrier. The sweep period is 10 seconds for the wide band and three minutes for the narrow band. When the receiver acquires and locks on a signal from the earth, the sweeping stops and the receiver can then accept any of eight possible commands, as follows:

1. Transmitters "off."
2. Five-watt transmitter "on" at 64 pulses per second.
3. Five-watt transmitter "on" at 8 pps.
4. Five-watt transmitter "on" at 1 pps.
5. Stage three separation.
6. Receiver narrow band.
7. 150-watt transmitter plates on.
8. 150-watt transmitter filament on.

● Signals from the earth to the satellite are transmitted by using a high-power carrier, phase-modulated with a 512 cps subcarrier. Amplitude modulation of the subcarrier with a coded train of 13 pulses provides the required information to the satellite command decoder. The receiver weighs four pounds, occupies 1300 cubic inches, and draws 1.5 watts at 16 volts.

● *Range and Range Rate Information*—Satellite range is measured by frequency modulating the ground station transmitter by low-frequency sinusoids. A modulating frequency of 16 cps, when adequately smoothed, provides range accuracies of better than 100 miles. Additional modulation frequencies are used to resolve other signal ambiguities. Angle tracking is performed by nodding the ground antenna alternately in elevation and azimuth as it aims at the payload. Angular accuracies of about 0.2 degrees are possible with the four-station network. Trajectory smoothing by the ground network can provide velocity and angular measurements within 0.01 degree and 0.1 ft./sec after the first few days of tracking.

● Range rate is being measured to accuracies of 1 ft./sec by extracting the two-way doppler frequency shift between the transmitted and received signal, after correcting for the frequency offset introduced by the satellite transponder.

Telebit System

● This digital telemetry unit, developed by Space Technology Laboratories accepts both analog and digital inputs from the various payload experiments and satellite performance transducers. The converted information appears at its output as a binary coded subcarrier (1024 cps) which then phase modulates the signal of the transmitter. All satellite data is contained in seven separate "words" which are sent to the ground. Six of these are information on experiments. The seventh is subcommutator measurement information consisting of: paddle temperatures forward (1) and aft (2), transmitter heat-sink temperature (3), battery temperature (4), internal ambient temperature (5), converter heat-sink temperature (6), battery voltage (7), and receiver phase error (8).

● The binary output of the system occurs at a synchronous rate and is composed of repeating sets of frames of words. Eight words per frame are used for the PIONEER V payload. One word of each frame is used for frame synchronization and is read out as all zeros. The other seven words are coded with the digital representation of the input information. Each word contains 12 pulses. The first two pulses of information words represent zero and one to provide a word synchronization. The other ten pulses contain the experimental data or vehicle measurements in binary number form.

● The conversion of analog to digital information is accomplished with a digital ramp and a voltage comparison circuit. The counting is actually performed in a shifting accumulator, just as for digital data.

Power Supply

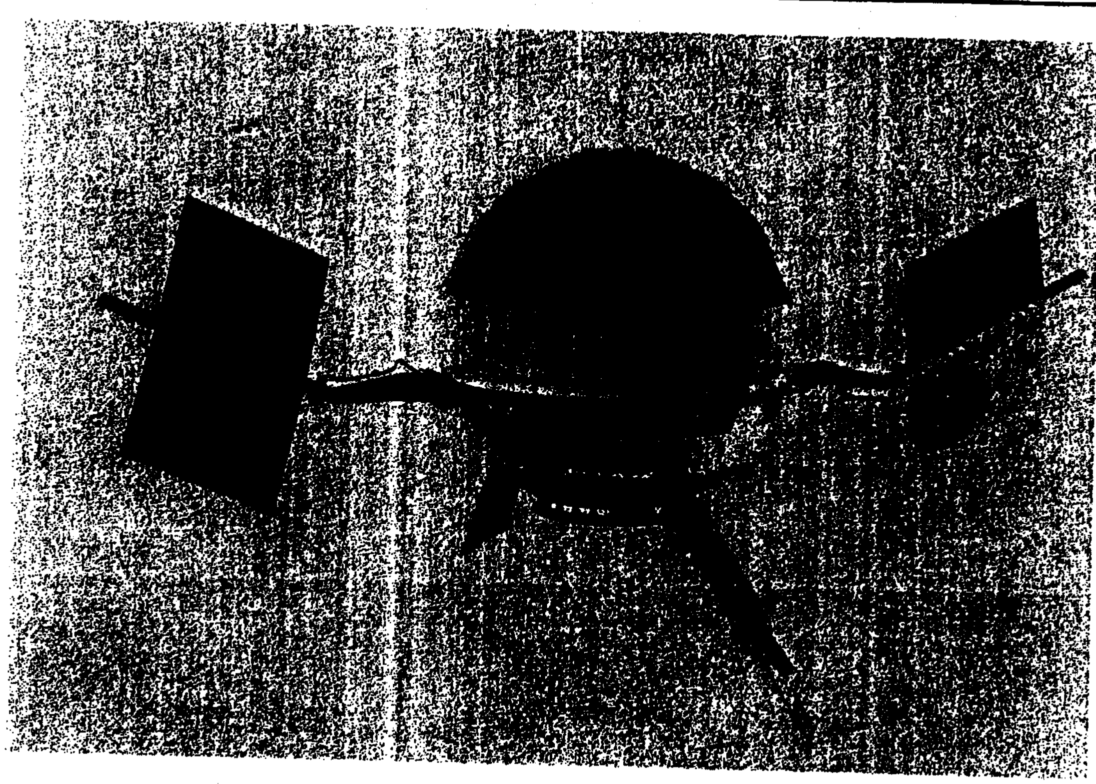
● *Solar Cells*—A total of 4,800 boron-diffused silicon solar cells are carried on the satellite's four solar paddles. Because of attitude and spin considerations, however, only about 1,000 of the cells are receiving solar energy at a given time.

● *Batteries*—The satellite storage battery consists of two packs of 14 nickel-cadmium cells each. Part of the power developed in the solar cells is consumed immediately by the experiments and the receiver, and the charging rate of the battery is lessened by this amount. The 5-watt transmitter, drawing a large portion of its power from the batteries, can be operthe reception at Manchester is reduced to one bit per second. This reception rate is expected to occur when the satellite is approximately 10,000,000 miles from earth (about 15 May). When this condition occurs, the 150-watt transmitter will be turned on and is expected to provide acceptable communications up to a range of 50,000,000 miles.

- For communications to the earth, the transmitter accepts an I-F signal from the satellite receiver, translates in frequency, and amplifies it either to a 5- or 150-watt level. When the 150-watt transmitter is operating, the 5-watt transmitter acts as a driver. In the process, the signal (378 mc frequency) is modulated with a 1024-cps subcarrier containing the time-multiplexed pulse-code-modulated output of the Telebit System. Biphase modulation is used to impress the telemetry output on the subcarrier. The 150-watt transmitter weighs about six pounds.

- Performance capabilities for the ground stations, computed prior to launch, are as follows:

Days After Launch	Range (N. Mi.) (Millions)	Vehicle Transmitter Power (watts)	Station	Information Rate (bits/sec)	Remarks
5	.7	5	Atlantic Missile Range	1	Maximum range
			Singapore	1	for Singapore
			Hawaii	8	and Atlantic
			Manchester	64	Missile Range
14	2	5	Hawaii	1	Maximum range for
			Manchester	8	5-watt transmission to Hawaii
72	15	150	Hawaii	1	Maximum range
			Manchester	8	for Hawaii
142	60	150	Manchester	1	Maximum range



PIONEER V Satellite Vehicle

permit an accurate determination of the length of the astronomical unit. This unit, the semi-major axis of the earth's orbit, is a basic astronomical constant. It is the unit for determining the absolute distances of solar system bodies from each other; it is the basis for the parsec unit of astronomical distances; its magnitude, and the derived value of the mass of the sun, are fundamental to all space trajectory calculations. Depending upon the length of time that PIONEER V will be tracked, a determination of the Astronomical Unit within an accuracy of 0.03 percent or better is anticipated, thus providing a cross-check of the AU value as determined optically and by reflecting radar signals off the planet Venus.

ated approximately 15 percent of the time; the 150-watt transmitter can be operated approximately 2 percent of the time. The nominal power available from the solar cell conversion system is about 15 watts when the payload is near the earth and will be about 24 watts at its perihelion.

- The batteries operate at 18 volts. A series of static converters provides a variety of voltage levels. An undervoltage control automatically removes the transmitter load from the batteries in case battery discharge threatens to disable the receiver and thus prevent the satellite from being commanded from the ground. In addition, the undervoltage control assures the conservation of battery lifetime by preventing deep battery discharges. Battery voltage is ranging between 16 to 19 volts and temperature is varying between 80 to 100°F.

Experiments

- The payload aboard the PIONEER V satellite consists of experiments designed to measure three types of phenomena in space: radiation, magnetic fields, and micrometeorite density.

Radiation Experiments

- Designed to determine the relative abundance of the different species of charged particles and to indicate their energy distribution. Although each of these experiments is independent, the results cannot be evaluated separately. Although all three sensors measure the total flux of particles, each has a different detection threshold. Total flux is measured by each sensor above its particular threshold. The combined results provide an intensity versus energy spectrum.

- *Ion Chamber and Geiger-Mueller Tube (University of Minnesota)*—The ionization chamber is of the integrating type used extensively in the University of Minnesota balloon flights. Together, these two instruments provide information giving the incident particle flux and mean ionization per particle. The minimum energy particles which can enter the detectors are about 1.25 mev electrons or 25 mev protons.

- *Proportional Counter Telescope (University of Chicago)*—This experiment contains a bundle of seven small proportional counters; arranged with a central counter surrounded by two sets of three counters. It is designed to provide single incidence and triple coincidence measurements to obtain a measure of both primary cosmic-rays and the low-energy background. Results, to date, correlate with count rates obtained from EXPLORER VI in its apogee areas. In addition, two occasions of sudden decrease in cosmic-ray intensity have been observed which correspond to similar decreases at ground monitoring stations and one probable decrease which does not correspond. There is evidence of an increase in "soft" radiation several hours after the decrease in cosmic-ray intensity. The experiment continued to function excellently as this report was being prepared.

Magnetic Field Experiment

- *Search-Coil Magnetometer*—This unit is mounted near the periphery of the satellite to measure the component of the magnetic field perpendicular to the spin axis. By making use of the spin of the vehicle (knowing the orientation of the axis of the spin) the magnitude of the magnetic field through which the satellite is moving can be deduced. A phase comparator which measures the phase relationship between the output of a photodiode sun scanner (aspect indicator) and the output of the magnetometer permits accurate knowledge of the direction of the field in the spin plane. Performance of this experiment continues to be excellent at the time the report is being prepared. Early results essentially confirm those obtained from PIONEER I and EXPLORER VI. This experiment has defined a point which seems to be the actual "edge" of interplanetary space. Beyond this point, approximately 64,000 miles from earth, no evidence of a magnetic field appears to exist.

Micrometeorite Experiment (Air Force Cambridge Research Center)

- The micrometeorite momentum spectrometer determines the times of micrometeorite impact and separates the momenta into two groups of different energies. Equipment consists of a diaphragm on the payload shell, a microphone mounted beneath the diaphragm, an amplifier, and a pulse height analyzer. Comparison of the total count of micrometeorites encountered with the two-value level of energy measured will permit an evaluation of the density of particles encountered and also, estimates of their energy (velocity or size). Experiment performance has been excellent but data has not been analyzed sufficiently to draw any scientific conclusions.

Astronomical Unit

- In addition to the scientific results made possible by the specific experimental equipment carried on PIONEER V, the precise long-range tracking data will

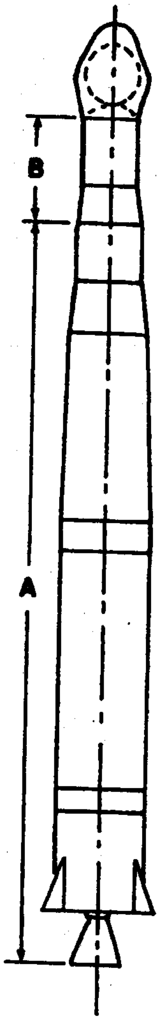
Summary of . . .

"FIRSTS in SPACE"

. . . achieved by

ABLE-4 THOR
PIONEER V

1. The greatest range over which man has maintained command of an instrumented space vehicle.
2. The greatest range over which a man-made object has been tracked.
3. The first instrumented space laboratory which has permitted measurements to be made of interplanetary space beyond 250,000* miles in the following areas:
   a. The number of meteorites.
   b. The momentum spectrum of these interplanetary dust particles.
   c. The intensity of the interplanetary magnetic field.
   d. The planar direction of this field.
   e. The total energy of radiation in interplanetary space.
   f. The two-level energy levels of this radiation.
4. The first test of an interplanetary guidance system components (with no force control of the satellite available).
5. The first interplanetary space probe to carry its own, self-sustaining auxiliary power supply.
6. The highest powered transmitter (150-watts) ever carried on a space probe mission.

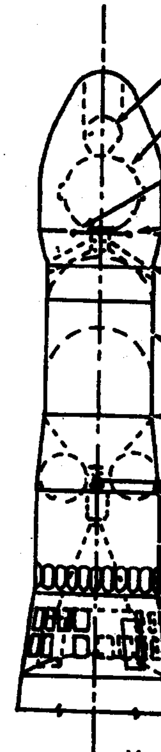


A. SECOND STAGE—ABLE-STAR (AJ10-104)

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

B. FIRST STAGE—THOR IRBM

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



—TRANSIT 1B, 2A and 2B

Program Objectives

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

Flight Vehicles TRANSIT 1A consisted of three stages as shown in Figure . TRANSIT 1B, 2A and 2B are two-stge vehicles as shown in Figure .

Launch Plans All vehicles will be launched from Atlantic Missile Range pad 17A or 17B. Launch azimuth for TRANSITS 1A and 1B is 44.5 degrees and for TRANSITS 2A and 2B, 140 degrees.

Powered Flight Trajectory The powered flight trajectory for TRANSITS 1B, 2A and 2B is shown and described in Figure . The sequence of events from launch through payload separation for TRANSIT 1B is given in Table 1.

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

Transit

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

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

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

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

C. FIRST STAGE—THOR IRBM

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

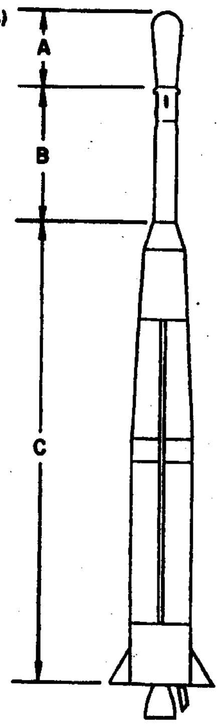
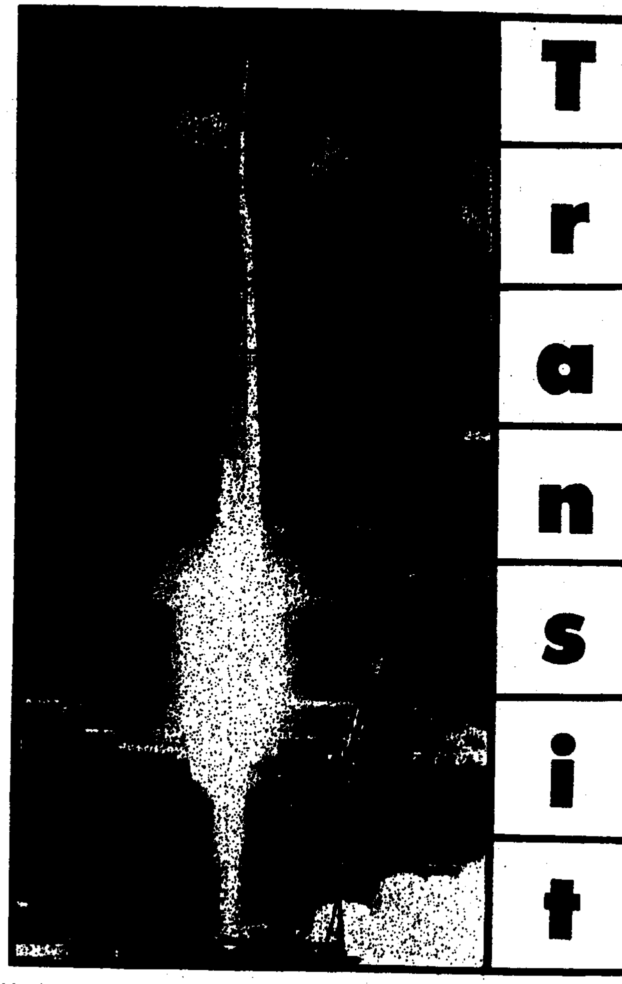


Figure 1. TRANSIT 1A three stage flight vehicle.



TRANSIT 1A launched from Atlantic Missile Range

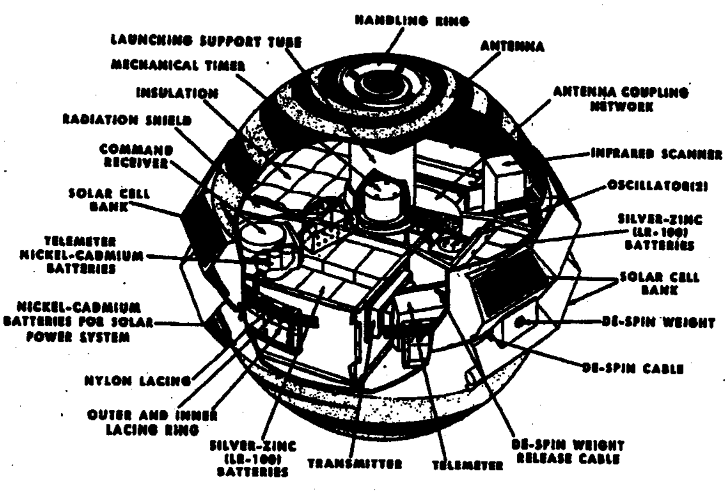


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV 1).

The TRANSIT Program consists of the flight testing of four vehicles to place 200-270-pound satellite payloads into circular orbits of 400 to 500 nautical miles. The program is designed to provide extremely accurate, world-wide, all-weather navigational information for use by aircraft, surface and subsurface vessels, particularly in relation to POLARIS missile firings. The ARPA Order for TRANSIT 1A was initiated in September 1958 and amended in April 1959 to add TRANSIT 1B, 2A and 2B flights. The program is currently authorized by ARPA Order No. 97, which assigns AFBMD responsibility for providing the booster vehicles, integrating payloads to the vehicles, and flight operations from launch through attainment of orbit, including communications to the tracking and data handling facilities. Payload and tracking responsibility has been assigned to the USN Bureau of Ordnance. Applied Physics Laboratory is the payload contractor.

Time (sec)	Stage	Event	
X + 0.1	I	Liftoff switch activates	
		Programmer starts	
		Gyros uncaged	
	II	Umbilicals eject	
		Arm destruct initiator	
X + 2	I	Roll program initiated	
X + 9	I	Roll program complete	
X + 10	I	Pitch program initiated	
		Ist step pitch rate	As required
X + 25	I	2nd step pitch rate	for trajectory
X + 70	I	3rd step pitch rate	and detailed in
X + 90	I	4th step pitch rate	DTO
		Autopilot gain change	
	II	Programmer armed	
X + 130	I	Pitch program complete	
X + 152	I	Main engine cut-off (MECO)	
		Circuitry armed	
X + 163.5	I	MECO back-up armed	
X + 167.0	I	MECO	
X + 167.0	II	Start programmer	
X + 170.0	II	Engine fire signal	
		Uncage thrust chamber in pitch and yaw	
		Uncage high thrust roll jets	
		Uncage gyros	
X + 170.85	II	Blow separation bolts	
X + 176.0	II	Start pitch program	

Time (sec)	Stage	Event
X + 230.0	II	Jettison nose fairing
Times vary in	II	Stop pitch program
accord. with		Pitch command
trajectory.		Yaw command
X — 429.0	II	Stop pitch program
X — 441.5	II	Engine cut-off signal
		Switch pneumatic coast control system on pitch, yaw and roll
X — 471.0	II	Turn off hydraulic power
X — 480.0	II	Initiate coast phase pitch program
X — 1036.8	II	Stop coast phase pitch program
X — 1458.6	II	Start hydraulic power
X — 1488.6	II	Engine restart fire signal
		Uncage accelerometer
X — 1491.6	II	Cage coast pneumatic control system
X — 1500	II	Arm TPS cut-off probe (back-up)
		Arm oxidizer probe (back-up)
		Arm spin and separation mechanism
X — 1504.0	II	Engine cut-off signal
		Uncage coast pneumatic control system
		Start spin table
		Start timer on spin table
X — 1506.0	II	Engine cut-off (back-up)
		Start spin table (back-up)
X — 1507.0	II	Remove spin table bolt power
X — 1526.0	II	Blow separation bolts
		Activate separation actuators
		Payload separation occurs

Sequence of Events—TRANSIT 1B, 2A and 2B

[redacted]

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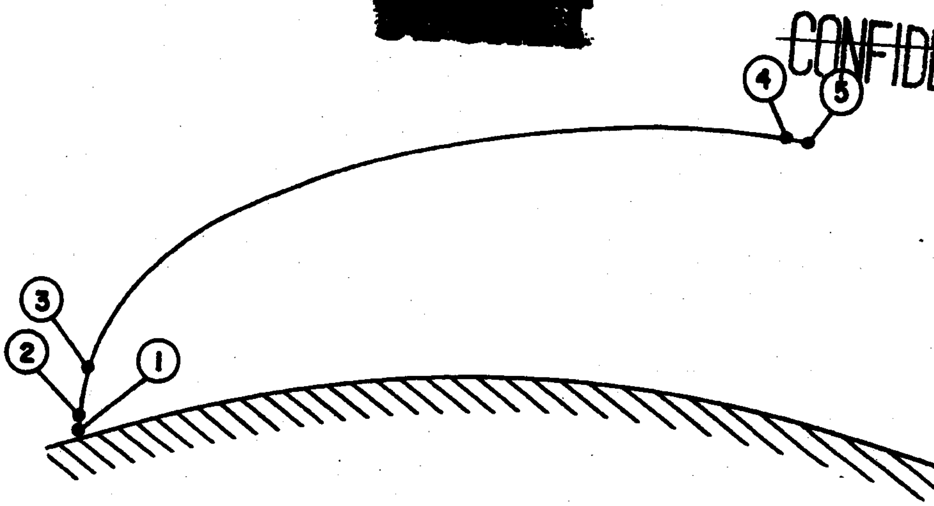


Point	Flight Time (seconds)		Comments	Inertial Speed (ft/sec)		Downrange Distance (n.m.)		Altitude (n.m.)	
	1-B	2-A 2-B	Transit vehicles	1-B	2-A 2-B	1-B	2-A 2-B	1-A	2-A 2-B
1	10	10	End of vertical rise	1,346	1,346	0	0	0.077	0.077
2	167	167	First stage burnout	13,611	12,929	75.2	79.7	41.2	48.3
3	442	448	End of second stage first burning period	24,539	24,376	785.6	778.0	200.1	203.0
4	1,489	1,447	Restart second stage engine	22,486	22,339	4,233.2	4,080.0	500.0	500.0
5	1,504	1,462	Injection into orbit	24,258	24,259	4,416.3	4,130.0	500.0	500.0

FLIGHT TRAJECTORY—TRANSIT 1B, 2A and 2B

Orbital Performance Achievement of program objectives is based primarily on measuring the doppler shift of satellite transmitted radio signals. During the first three months of flight, the four transmitters will be operated to obtain experimental confirmation of the theoretical mathematical relationship between the frequency and the refractive index of the ionosphere. Studies have shown that refraction effects on the doppler shift can be eliminated by using the transmission from two satellites. After four months of tracking the satellite by measuring the doppler shift of the satellite radio signal, the exact position of the satellite at any point in the orbit should be known. Using known orbital positions, ships and aircraft can then use satellite signals to make analogous computations to establish accurate position. Navigational fixes of 0.1 mile accuracy are expected to be obtained.

Ground Support Stations Tracking stations will be operated in Maryland, Texas, New Mexico, Washington and Newfoundland. First and second stage tracking and telemetry and second stage guidance will be provided by the Atlantic Missile Range. A mobile tracking and telemetry van will be located in Germany for TRANSIT 1B and South America for TRANSITS 2A and 2B. These locations were selected as the closest sites possible to the orbit injection point.

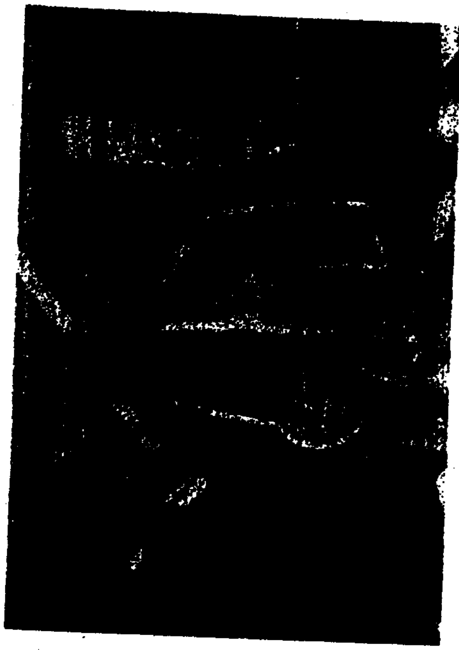
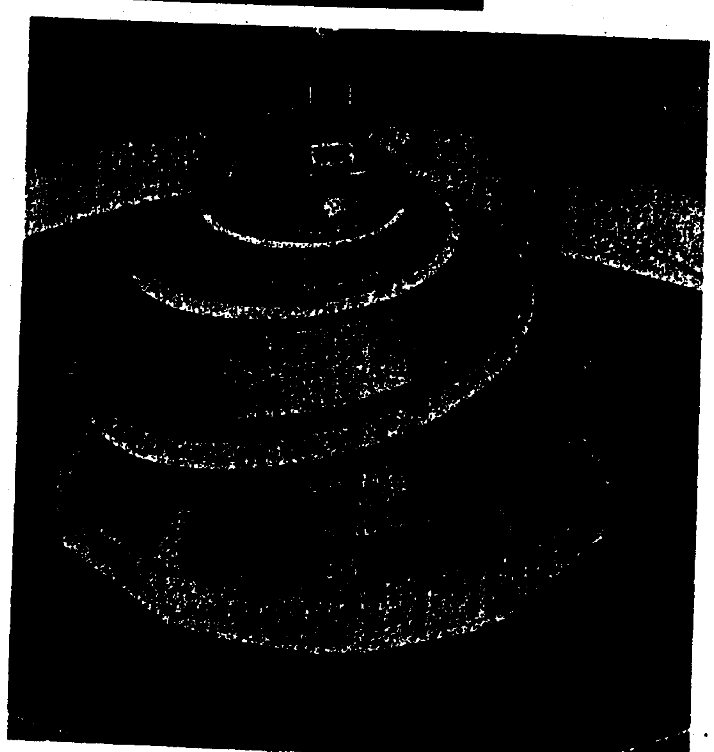


Figure 4. Preparing the payload for installation . . . guiding the payload into position above the second stage. Note the spiral stripe on the payload (actually a broad band antenna capable of handling the four different frequencies on which the two satellite transmitters broadcast) and the solar cells around the equator of the 36 inch sphere.



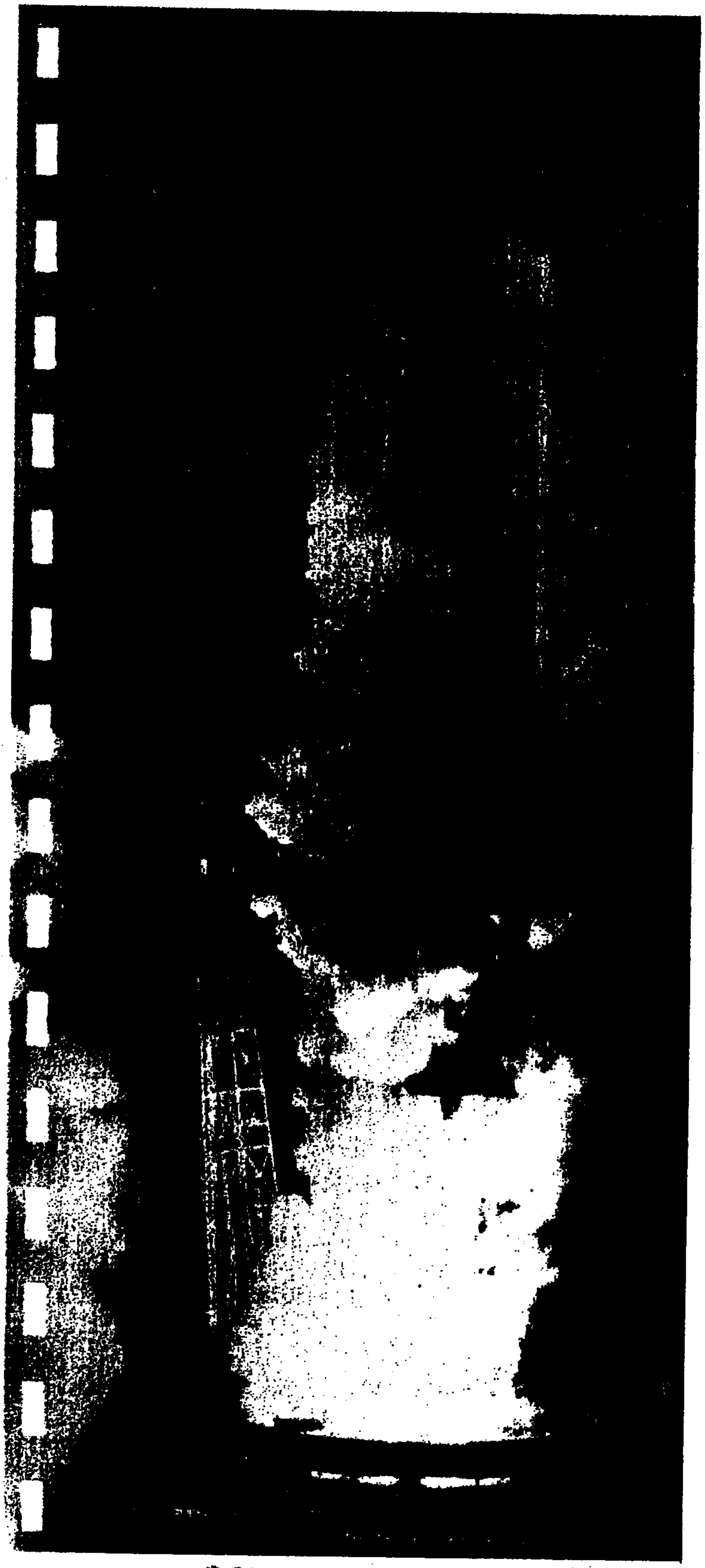


Figure 3. TRANSIT 1B just after liftoff from stand 17B, Atlantic Missile Range.

MONTHLY PROGRESS—TRANSIT Program

Flight Test Program

- A very successful TRANSIT 1B launch was accomplished from Stand 17B, Atlantic Missile Range, at 0702 EST on 13 April. The THOR ABLE-STAR boosted satellite was the seventeenth United States satellite to be placed into orbit.

- The countdown proceeded smoothly except for one two-hour hold caused by some minor vehicle problems and satellite radio interference. The vehicle problems were corrected and the cause of interference was found to be the NOTS infrared experiment transmitter. The experiment would be terminated after seven days in orbit and this would alleviate the problem.

- Both stages of the TRANSIT vehicle performed within the programmed limits. The ABLE-STAR second stage (on its first flight test) fired, then shut off and coasted, then on command fired again. This was the first time in the free world a rocket engine had been restarted in space. See Table 1 for nominal and actual orbital parameters.

Parameter	*Nominal*	*Actual*
Apogee	500 N. Mi.	409 N. Mi.
Perigee	500 N. Mi.	175 N. Mi.
Period	103 Min.	95 Min.
Inclination Angle	49.95°	51.3°

Table 1. ORBITAL PARAMETERS

- Tracking stations in the United States, Newfoundland, and Germany are tracking and receiving data from TRANSIT 1B.

- Experiments contained in TRANSIT 1B will help to determine the feasibility of using a satellite as a navigational aid and to obtain very accurate geodetic measurements. The success of TRANSIT 1B paves the way for future navigation satellites which may very well obsolete century-old, weather-dependent, celestial navigation, and the more recently developed LORAN (long range aid to navigation).

TRANSIT 1B

Program Administration

● The Data Acquisition and Support Plan for TRANSIT 1B, a major revision of the Program Requirements document for Projects TRANSIT and COURIER, and the revised Detailed Test Objectives document for TRANSIT IB, has been published.

Technical Progress

● The helium bottle and engine anti-rotation bolt retrofit was accomplished prior to shipment in addition to the correction of the items listed in the February report.

● It was determined that adequate aerodynamic heating protection for the guidance antennas had not been provided. Treating the antennas with an ablating coating eliminated this problem.

Ground Support Equipment

● The downrange telemetery and tracking station underwent final system tests, including checkout of the tracking function in conjunction with a manned aircraft. The downrange station arrived at Erding, Germany, on 21 March and has been erected. Calibration using a helicopter is scheduled for 1 April.

TRANSIT 2A

Program Administration

● The Detailed Test Objectives document for TRANSIT 2A and the Program Requirements document for Projects TRANSIT and COURIER has been published.

Launch Schedule

● The assembly and checkout of the second stage is proceeding on schedule based on a hardware availability for launch of 18 May.

Technical Progress

● The rework of the helium bottles and the engine anti-rotation bolts was accomplished.

● The aerodynamic heating problem reported for TRANSIT 1B was also encountered on the TRANSIT 2A. These units will have an ablating coating applied.

● The thrust chamber assembly which was delivered with the AJ10-104 propulsion system was of minimum performance. As a result or trajectory studies using this performance the success of the mission was in doubt. To correct this problem the original thrust chamber assembly was replaced with one of higher than nominal performance.

● The second stage range safety, guidance and control system checks have been completed. The accelerometer and programmer have been checked out on the vehicle. The propulsion control system compatibility sequence test has also been completed.

Ground Support Facilities

● During March a site selection team completed arrangements for locating a mobile downrange telemetry and tracking van at Punta Arenas, Chile. Arrangements have been completed for the local telephone company to supply a teletype circuit to the station.

TRANSIT 2B

Launch Schedule

● Because of interference problems on use of ground facilities the launching of TRANSIT 2B was rescheduled to early November.

Technical Progress

● Space Technology Laboratories is continuing to release drawing changes to Aerojet-General Corporation and Space Electronics Corporation as changes occur on the TRANSIT 2A configuration. No schedule changes due to vehicle design are anticipated at this time.

COURIER

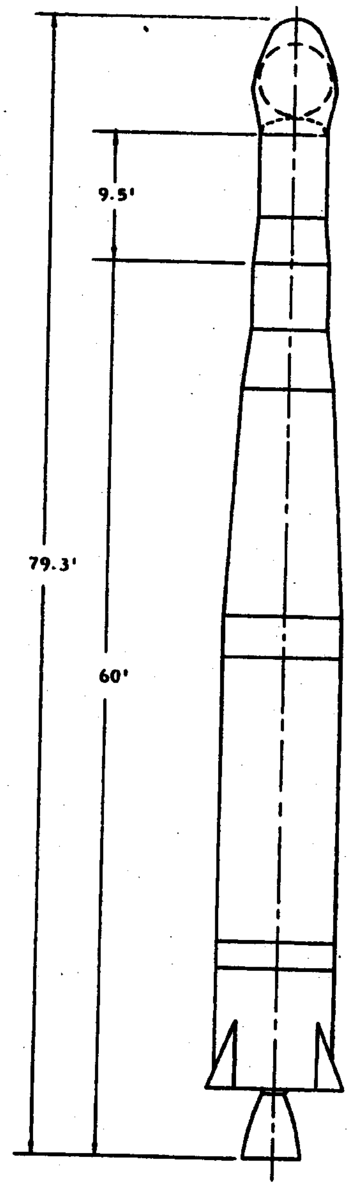
The ARPA COURIER Program consists of two flight vehicles to be launched from the Atlantic Missile Range. The program objective is to test delayed repeater communications between a satellite and ground stations. The program also will be used to determine the operating characteristics and capabilities of the ABLE-STAR (AJ10-104) second stage vehicle. The program is being conducted under ARPA Order No. 98, dated 1 July 1959 (Project Code No. 2200). AFBMD responsibility includes development of the launch vehicle, payload integration, launch, injection of payload into orbit, and verification of orbital parameters at injection. The Army Signal Research and Development Laboratory will design, develop and fabricate the payload, and will be responsible for world-wide ground station requirements. Primary payload contractor is Philco Corporation.

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

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

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

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



SECOND STAGE—ABLE-STAR (AJ10-104)

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

FIRST STAGE—THOR IRBM

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

MONTHLY PROGRESS—COURIER Program

Program Administration

- A major revision of the Program Requirements document for projects TRANSIT and COURIER has been published.

Technical Progress

COURIER 1A

- The AJ10-104 propulsion system which was to be delivered on 15 March will not be delivered until 8 April. This late delivery will not change the hardware availability for launch.
- The late propulsion system delivery created a problem in the availability of checkout vans. Van 2 which is used in Los Angeles will be in use by Aerojet-General Corporation on COURIER 1B. This will necessitate van 3 being shipped from AMR to Los Angeles to permit checkout and assembly of the second stage vehicle. Van 3 would then be shipped back to AMR with the vehicle.
- Some delay in the calculation of the final flight trajectory was caused by the late propulsion system delivery. This trajectory is needed for establishing the proper rates for the control system and times for the programmer.
- It was determined that inadequate aerodynamic heating protection for the guidance antennas had been provided. The application of an ablating coating will solve this problem.
- Aerodynamic heating studies indicate that some protection will have to be afforded the payload because of nose fairing radiation. The COURIER payload contractor has agreed that aluminum foil can be used to eliminate the additional heating caused by the nose fairing radiation. The foil must not cover the inner surface of the nose fairing lower than the payload equator.

COURIER 1B

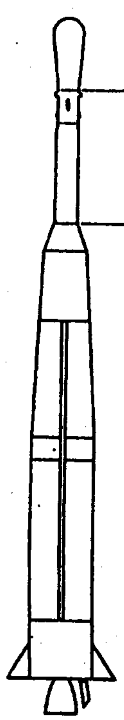
- Space Technology Laboratories is continuing to release drawing changes to Aerojet-General Corporation and Space Electronics Corporation as changes occur on the COURIER 1A configuration. No schedule changes due to vehicle design are anticipated at this time.
- Aerojet-General Corporation and Space Electronics Corporation are continuing fabrication of components and subsystems based on a scheduled launch date of 1 September.

TIROS

The TIROS Program consists of one flight from the Atlantic Missile Range early in 1960. Primary objectives include: (a) To determine the feasibility of using an earth satellite to measure, record, and transmit synoptic weather conditions; (b) To establish system parameters for weather satellites; (c) To acquire information on electromagnetic propagation through the atmosphere and acquisition of additional geodetic and geophysical data by tracking a satellite in a precise orbit. The National Aeronautic and Space Administration is the primary program agency. AFBMD is responsible for supplying the launch vehicle, integrating the payload to the launch vehicle, and providing communications to the tracking and data-handling agencies from launch through attainment of orbit. Payload design, fabrication and testing will be accomplished by the Radio Corporation of America for NASA. NASA retains cognizance for operating, tracking, and recording and processing of satellite data.

VEHICLE DESCRIPTION

The three-stage TIROS vehicle (Figure 1) consists of a THOR Booster, Aerojet-General (AJ10-42) liquid propellant second stage with Bell Telephone Laboratories radio-inertial guidance system, and the Allegany Ballistics Laboratory solid propellant third stage (248). Design specifications for each of the three stages are shown on Figure 1.



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

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

SECOND STAGE—AJ10-42 (Aerojet-General)

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

FIRST STAGE—THOR IRBM

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

FLIGHT DESCRIPTION

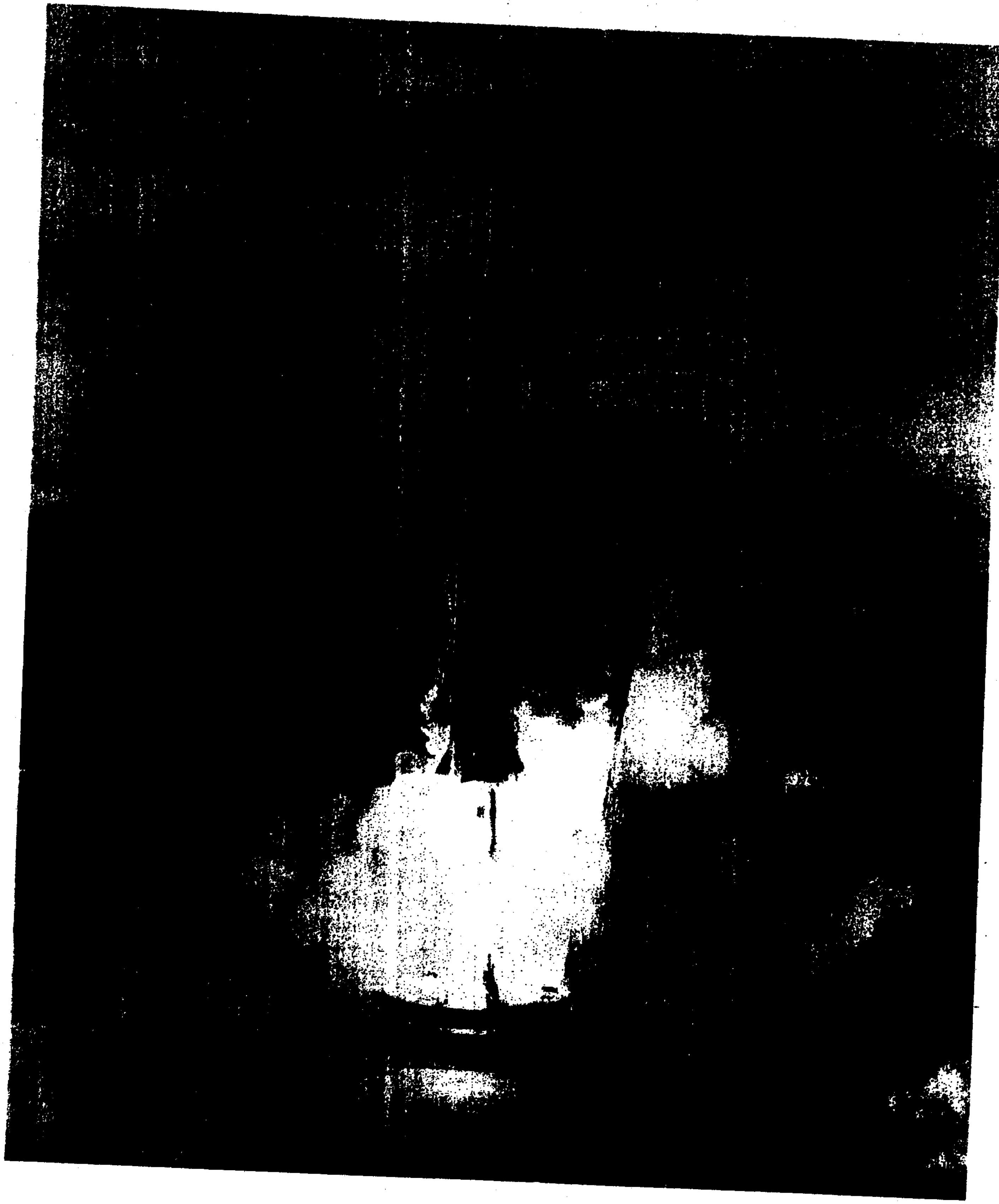
The sequence of events for the powered flight from launch at AMR to injection into orbit is given in Table 1. The payload will be placed in a 380 nautical mile circular orbit having an inclination angle of 48.67 degrees. Orbital life is expected to be five months.

PAYLOAD OBJECTIVES

The 270 pound, cylindrical payload will be 42 inches in diameter and 17 inches in height. Payload equipment includes 2 television cameras designed to observe, record and transmit weather data. Power sources include sixty 20-volt nickel-cadmium chemical batteries and 9260 solar cells to recharge the batteries. The solar cells, installed in the top and cylindrical side walls of the satellite will furnish an average output of 13 watts for the first 140 days of vehicle life. Once during each orbit the satellite will be interrogated and reprogrammed from a ground station. The two television cameras have different resolution capabilities and coverage patterns to permit observation of a wide variety of cloud patterns. Two modes of TV system operation are possible. When the satellite is within radio communications range of a ground station, pictures may be taken on command and transmitted directly to earth. When the satellite is beyond radio communication range, camera operation is controlled by a clock and programming circuits and the images recorded on magnetic tape for readout during the next pass over a ground station. Two beacon transmitters are installed on the bottom side of the satellite to facilitate tracking.

GROUND SUPPORT STATIONS

The Air Force ground station at Kaena Point will be used to support this program. Tracking and data acquisition will be conducted on 108 mcs and command transmission on 140 mcs. Required modifications to the TLM and VERLORT radars are in progress. Use of this support station will result in: (a) minimum cost by maximum use of existing facilities, (b) minimum equipment modification and operation effort, and (c) a satisfactory system configuration with minimum complexity. Use of this facility also will benefit the SAMOS and MIDAS programs by attaining an early buildup of experienced personnel.

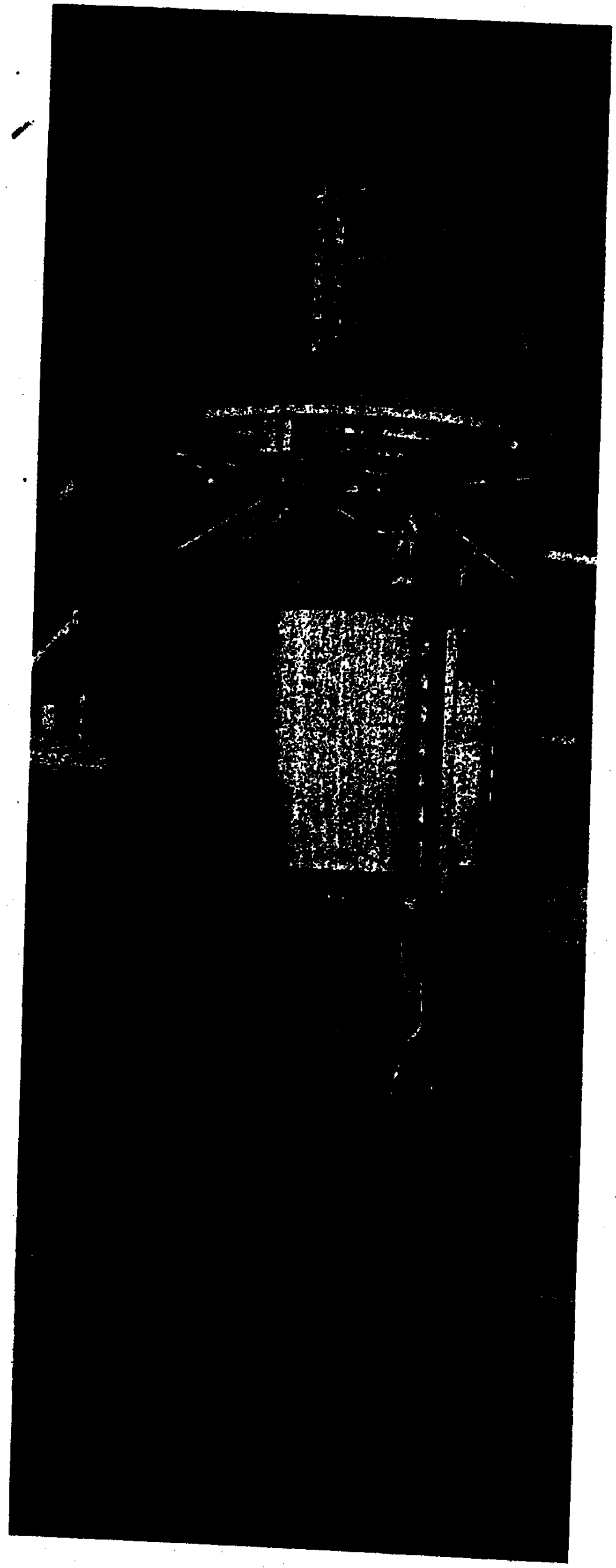


MONTHLY PROGRESS—TIROS Program

Flight Test Progress

● The TIROS satellite was launched from stand 17A, Atlantic Missile Range, at 0640 EST on 1 April. This launch again proved the reliability of the THOR-ABLE combination. Because of the payload restraint of obtaining a specific angular relationship with the sun at injection the launch had to be made within a one hour time span or be postponed to the following day. The TIROS satellite was launched approximately three minutes before the end of that period.

● All prelaunch checks progressed smoothly until T minus 5 days. On 26 March, during checkout the payload de-spin squibs were fired. A faulty squib tester was believed to have been the cause, but further investigations showed it to be caused by



TIROS LAUNCH

TIROS leaving stand 17A, Atlantic Missile Range, on 1 April for its successful orbit. This list of orbital parameters shows the nominal and actual values achieved.

Apogee	381.5 N.M.	498.8 N.M.
Perigee	379.8 N.M.	378.3 N.M.
Period	98.67 min.	99.17 min.
Latitude at injection	42.336° N	42.277° N
Longitude at injection	56.90° W	57.045° W
Inclination angle	48.330°	48.359°
Payload spin rate (in orbit)	12 rpm	10 rpm

THIRD STAGE—PAYLOAD

This picture shows the payload mounted on the third stage vehicle. The solar cells are arranged around the periphery of the payload. Three of the four antennas can be seen projecting down from the payload.

trouble within the satellite vehicle. At T-2 days the satellite was removed from the stand and the launch was rescheduled to 1 April. The repairs were made, the satellite was reinstalled, and the checkout proceeded with no further trouble. The launch countdown was conducted without a hold until the start of the terminal count (T-35 minutes). At T minus 2 minutes a hold was initiated because of diffculties encountered with the "C" band beacon. The count was recycled first to T-8 minutes and then to T-15 minutes when the launch stand fill and drain valves froze. These problems were corrected and the launch was accomplished on schedule.

● All three stages of the TIROS vehicle operated within the programmed limits, with the exception of the "C" band beacon. However, the operation of this beacon did not affect the orbit obtained. For the nominal and actual Powered Trajectory Flight Plan refer to Table 1.

● The Fort Monmouth, New Jersey, and Kaena Point, Hawaii stations are tracking, commanding and receiving data from the TIROS satellite as planned.

● This flight has proved the feasibility of using an earth satellite to provide information for more accurate long-range weather forecasting. The SAMOS and MIDAS programs will benefit because of this successful flight. Unofficial information received indicates the successes accomplished by this satellite.

a. High quality pictures taken by the wide angle camera are being received on both the direct and delayed read-out modes.

b. High quality pictures taken by the narrow angle camera are being received on the direct read-out mode only. The delayed read-out mode is not operating properly.

c. The solar cell recharging rate is higher than anticipated.

d. All tracking, command, and data read-out transmitters and receivers are operating satisfactorily.

e. Some malfunction in the system is preventing proper sun scanner (attitude indicator) operation.

● Data received indicates that the payload will be operational throughout its programmed useful life of five months. The satellite will remain in orbit for several years.

EVENT	NOMINAL (Time in seconds)	ACTUAL (Time in seconds)
Vertical lift-off	0	0
BTL guidance begins Stage I closed-loop steering	90	90
End Stage I pitch program	130	129.55
MECO—Stage I main engine cutoff	158.5	160.80
Stage II separation and ignition; begin Stage II pitch program	162.3	164.70
BTL guidance begins Stage II closed-loop steering	172.3	175.80
BTL guidance ends Stage II closed-loop steering	253.9	250.90
BTL discrete ends Stage II pitch program	255.5	252.80
BTL discrete spins up third stage and payload—120 rpm	268.6	265.70
Stage II cutoff—SECO; begin coast period	270.6	267.70
Stage II—III separation; start Stage III coast timer	272.1	269.20
Fire Stage III rocket	662.89	664.0
Injection into orbit	700.31	699.0

Table 1. Powered Trajectory Flight Plan

AGENA

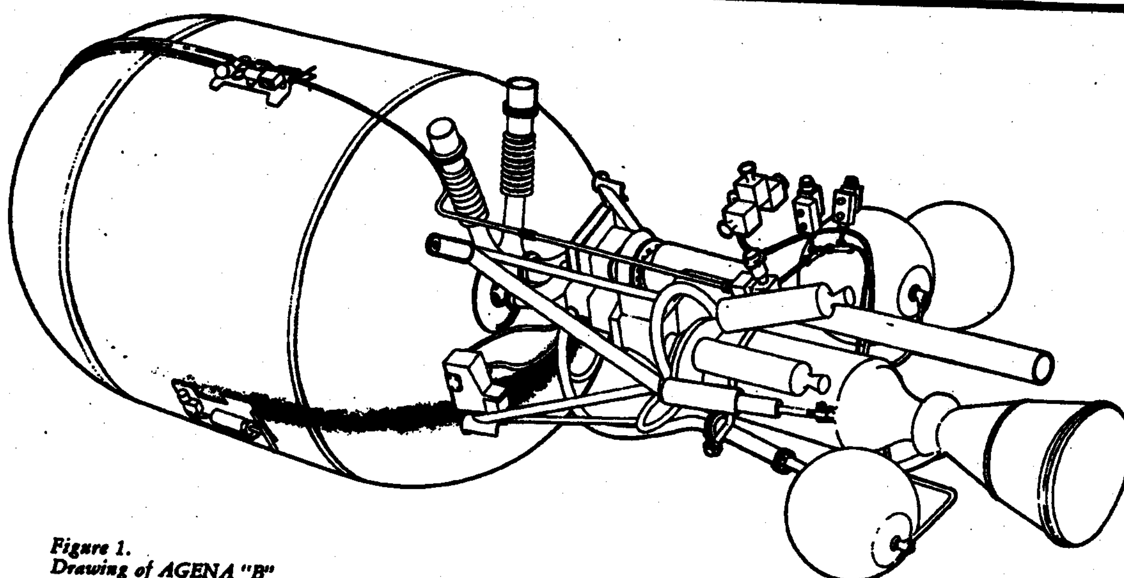
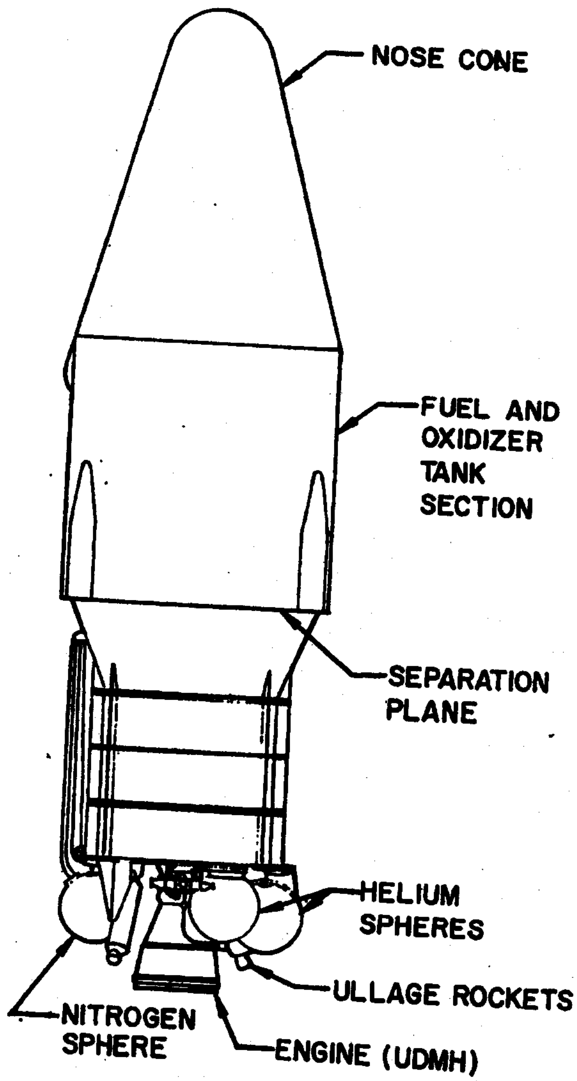


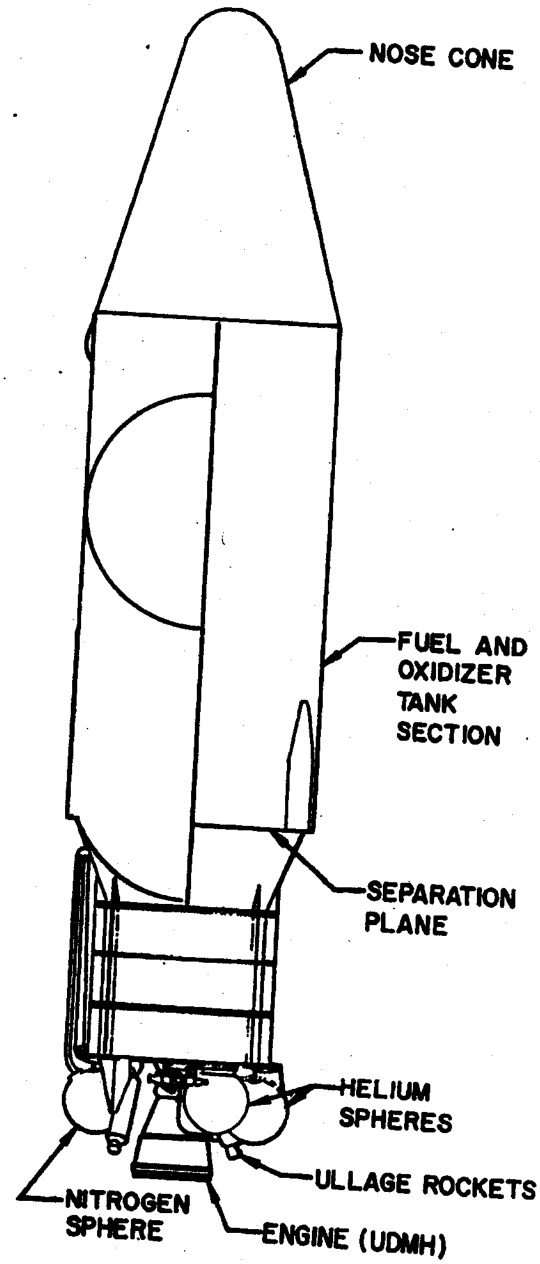
Figure 1.
Drawing of AGENA "B" propulsion system.

The AGENA vehicle was originally designed by the Air Force for use as the basic satellite vehicle for the Advanced Military Reconnaissance Satellite Program (Weapon System 117L). The vehicle was designed to be boosted by an ATLAS ICBM and basic dimensions were derived from this booster selection. The type of trajectory possible using the ATLAS booster, coupled with the stringent eccentricity requirements of these programs, led to selection of a satellite guidance system suited to accomplishing orbital injection in a horizontal attitude. This led to the development for the AGENA of an optical inertial system for vehicle guidance and gas jets for orbital attitude control. The Bell Aircraft LR81-Ba-3 engine (Bell Hustler engine developed for B-58 aircraft) was chosen for AGENA propulsion due to its advanced state of development. The YLR81-Ba-5 version of this engine was developed to provide increased performance through the use of unsymmetrical di-methyl hydrazine (UDMH) fuel instead of JP-4. Accelerated flight testing of the AGENA vehicle and its subsystems became possible when the DISCOVERER program was created, based on the low cost and early availability of the THOR IRBM, and a study which indicated that the AGENA could be flight tested successfully in low altitude orbits.

Progress in the design of payloads for the MIDAS program created an urgent need for the attainment of higher altitude orbits. As a result a modification program was initiated to develop the AGENA "B" configuration. This work was authorized by ARPA Order No. 48 and continued under ARPA Order No. 96. On 17 November 1959 program responsibility was assigned to the Air Force by the Secretary of Defense. The AGENA "B" configuration includes the addition of a single restart and extended burn capability to the engine and propellant tankage of twice the AGENA "A" capacity. The engine (Bell Aircraft Model 8081), for use on this vehicle, is officially designated USAF Model XLR81-Ba-7. A subsequent version, XLR81-Ba-9 (Bell Aircraft Model 8096), with a nozzle expansion ratio of approximately 45:1 will further increase performance capability. The AGENA "B" configuration has increased the effectiveness of the payload weight/orbital altitude relationship for this vehicle. This reduction of payload restrictions has increased greatly the potentialities of using the extremely reliable THOR as an AGENA booster. In order to obtain maximum efficiency from the use of ATLAS as an AGENA booster, modifications to the ATLAS are being made to reduce limitations imposed by trajectory requirements and static load capabilities.

Payloads may be installed on the AGENA forward equipment rack, or distributed throughout the vehicle. An ejectable recovery capsule has been developed for the nose section of the AGENA vehicle and flight tested in the DISCOVERER program.





AGENA "A"		AGENA "B"
1,370	Weight—Inert	1,600
6,550	Impulse Propellants	13,100
	Fuel (UDMH)	
	Oxidizer (IRFNA)	
67	Pyrotechnics	100
7,987	GROSS [redacted]	14,800

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MONTHLY PROGRESS—AGENA Program

AGENA "B"

XLR81-Ba-7 Engine

● The formal review on 15 - 17 March of the Preliminary Flight Rating tests resulted in a requirement for additional firings to test effects of propellant water content on engine performance and to demonstrate satisfactory engine operation following the malfunction condition of simultaneous firing of both starting charges. These additional firings were successfully completed during March. Formal inspection of the disassembled engines in April will conclude the Preliminary Flight Rating tests of this engine.

XLR81-Ba-9 Engine

● Testing of the XLR81-Ba-9 engine installed in the propulsion vehicle test assembly was completed at Santa Cruz Test Base. The total testing program consisted of nine firings, two of which were completed in February. All firings included gimballing tests and propellant utilization evaluation. A weld crack had developed in the thrust chamber during the second gimballing test on 25 February. New welding techniques and more stringent quality control procedures will eliminate this problem. Five subsequent firings were made during 2 - 10 March using a replacement thrust chamber. Each firing consisted of approximately 210 seconds of firing, a five minute shutdown, and 30 seconds of firing after restart. The final two tests of 247 and 243 seconds duration used the repaired original thrust chamber and were completed 14 March. Problems with thrust chamber erosion were encountered in the tests on the replacement thrust chamber. Bell Aircraft Corporation is conducting an intensive experimental program to determine the effectiveness of new thrust chamber coatings and to determine possible injector modifications to relieve the thrust chamber cooling problems. In the interim, however, adequate thrust chamber cooling can be assured by closely controlling the solids content and the ambient temperature of the oxidizer used.

● Testing of the engine uncooled nozzle extension (to achieve a 45:1 area ratio) was continued at Bell and at AEDC. After minor repairs and recoating of the interior the titanium extension that had been fired last month at Bell was sent to AEDC and successfully tested in three separate firings of 85 seconds duration each during 21 - 25 March.

● A titanium extension constructed with a tapered skin and weighing approximately ten pounds less than the previous design was successfully fired for 240 seconds at Bell on 25 March.

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Able-Star

This program will develop a versatile and efficient upper stage for use with varied booster/vehicle combinations. This stage will have basic design features proven in the dependable AJ10-101 stage used on the THOR/ABLE vehicles. Improvements being made include: (a) increased propellant capacity; (b) a multiple restart capability; and (c) a full-time attitude control system to operate during coast periods as well as powered flight. These improvements will permit a two-stage THOR/ABLE-STAR vehicle to attain weight/altitude performance equal to that of the three-stage THOR/ABLE vehicles. This will provide increased reliability and accuracy.

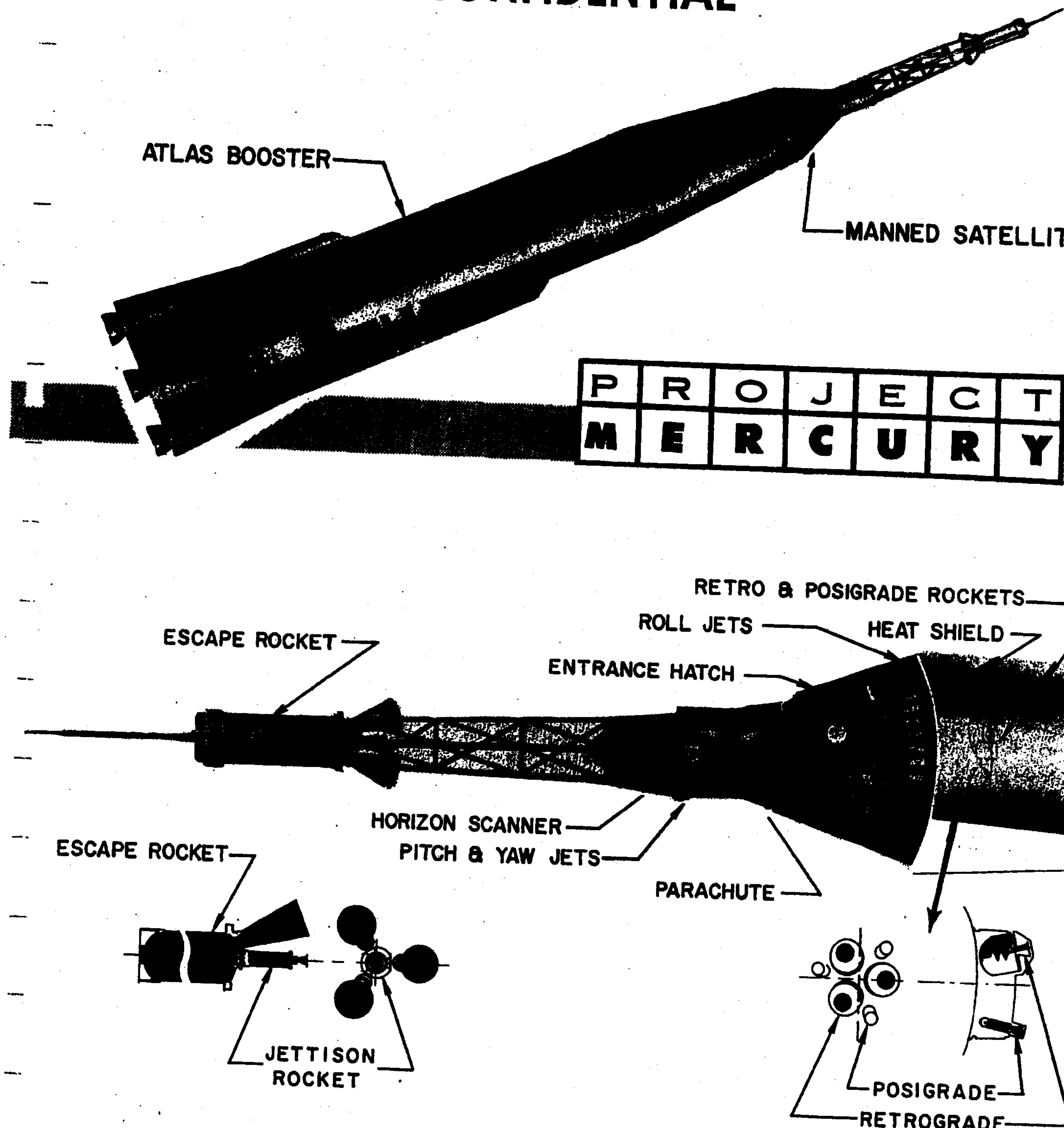
This stage will be suitable for mating to THOR, ATLAS or TITAN space boosters and can be modified to accept a solid propellant third stage, if needed.

Figure 1. Side view of ABLE-STAR vehicle mounted in handling dolly.

MONTHLY PROGRESS—ABLE-STAR Program

- All work related to the development of the ABLE-STAR (AJ10-104) propulsion system as directed by ARPA Order No. 95-60 was completed during the month. A final report to ARPA will be submitted by AFBMD in April.

- Initial flight test of the ABLE-STAR vehicle is scheduled for 13 April, as the second stage for the TRANSIT 1B. Additional ABLE-STAR flight tests are programmed at present for TRANSIT 2A and 2B, and COURIER 1A and 1B.



WEIGHT AT SEPARATION	APPROX 25 LBS	ORBIT INCLINATION	33 DEGREES
ORBITAL ALTITUDE	105-115 MILES (n)	HEAT SHIELD	ABLATIVE
ORBITAL CYCLES	3-18	RECOVERY	WATER OR LAND

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

Project MERCURY represents the transitional threshold between this nation's cumulative achievements in space research and the beginning of actual space travel by man. The primary program objective is to place a manned satellite into orbit about the earth, and to effect a controlled re-entry and successful recovery of the man and capsule (Figure 1). Unmanned ICBM trajectory and near-orbital flights, and unmanned orbiting flights will be used to verify the effectiveness and reliability of an extensive research program prior to manned orbital flights (Figure 2). The program will be conducted over a period of nearly two years. The initial R&D flight test was accomplished successfully in September 1959. The total program accomplishment is under the direction of NASA. The primary responsibility of AFBMD to date consists of: (a) providing 14 ATLAS boosters modified in accordance with program objectives and pilot safety factors, and (b) determination of trajectories and the launching and control of vehicles through injection into orbit. The division of responsibilities for this program is given in Table 1. Specific details of AFBMD support are given in Table 2.

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

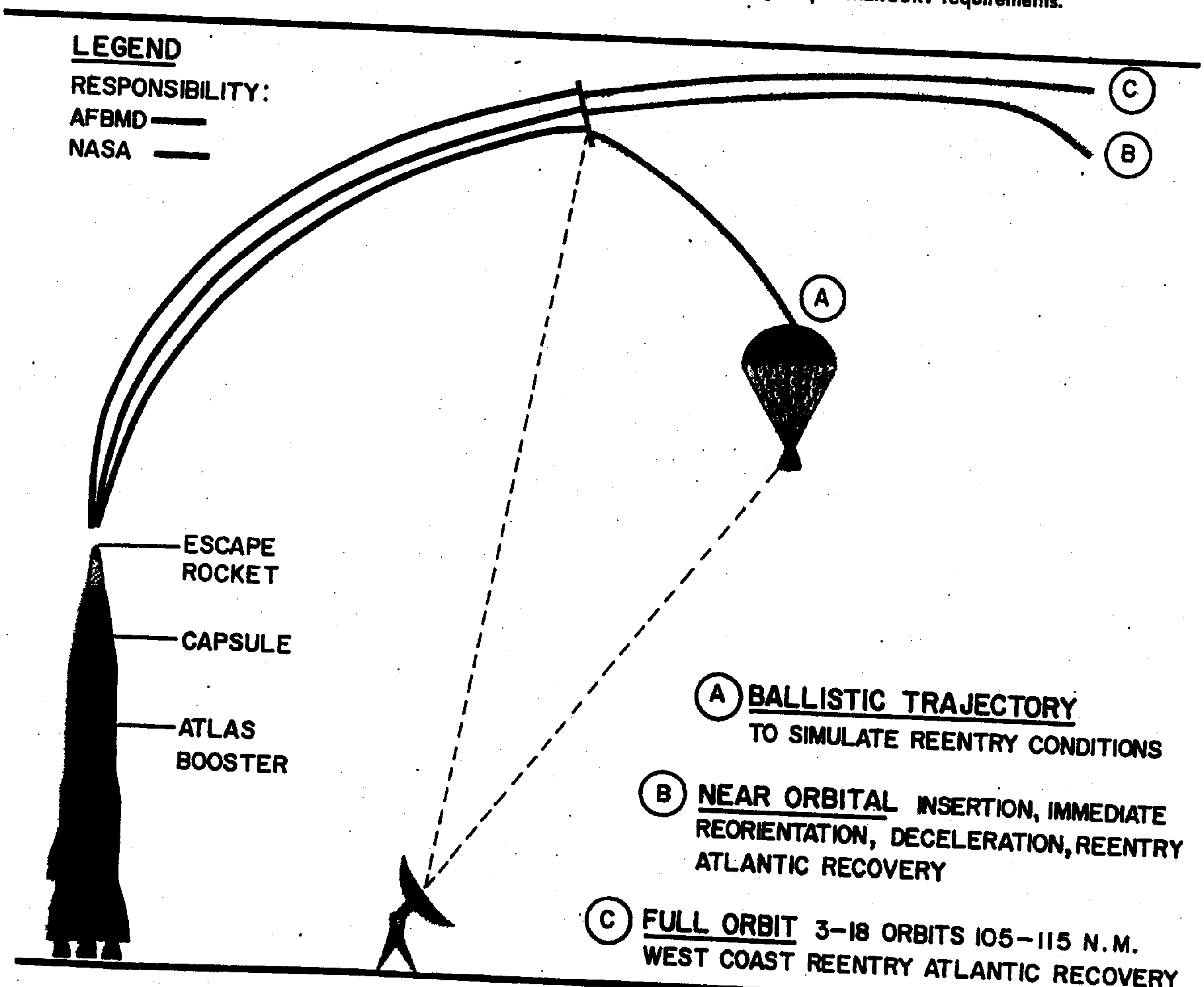


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.

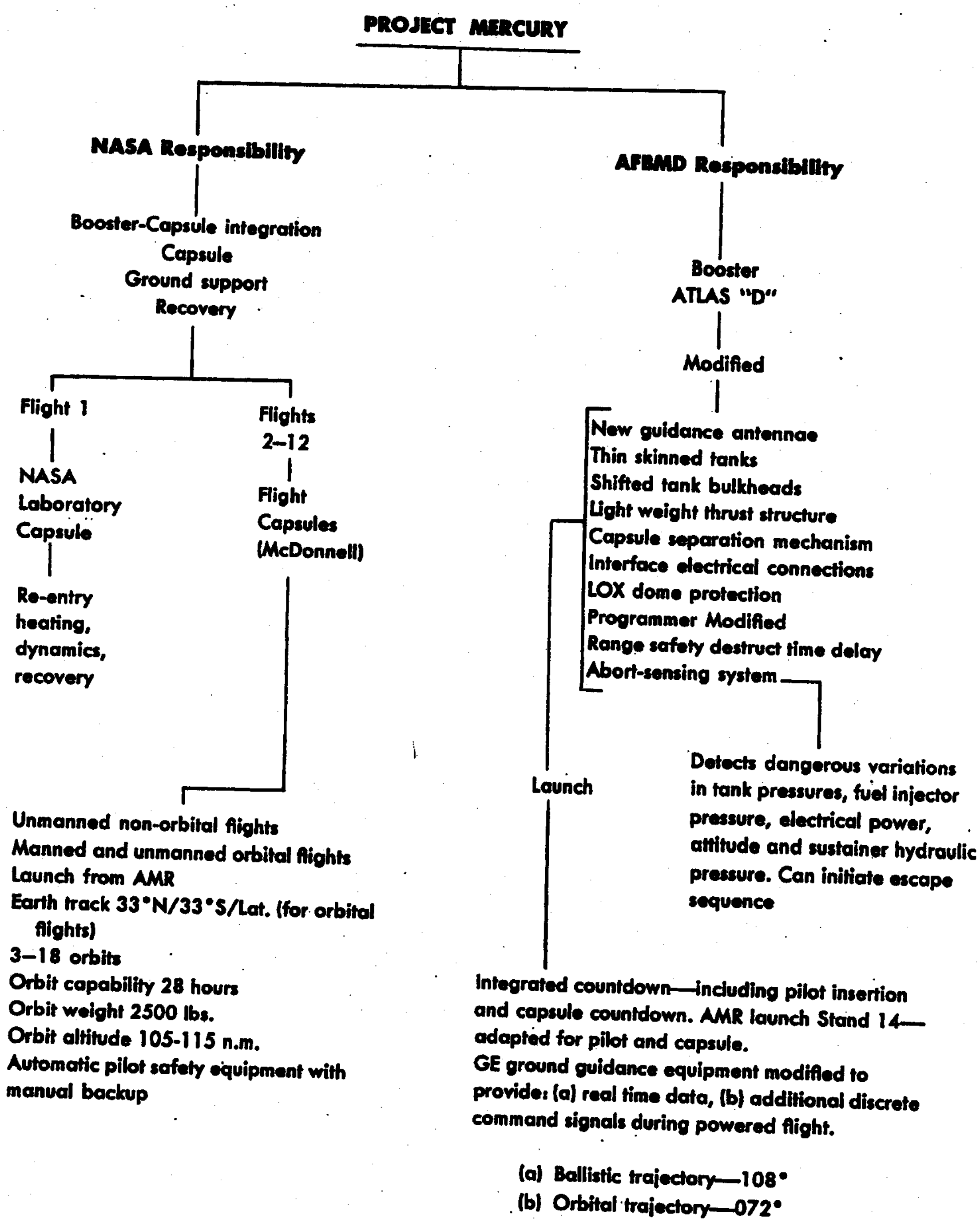


Table 1. Outline of NASA and AFBMD responsibilities in PROJECT MERCURY.

PROJECT MERCURY

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

Design, engineering studies
Equipment modification
Hardware fabrication
Flight scheduling
Launch support
Trajectory data
Missile allocation

Provide fourteen (14) ATLAS boosters.	Modify boosters for NASA preliminary research and manned orbital flight and safety objectives.	Launch, control and define trajectories of booster-capsule vehicle up to, and including, injection into orbit.

Table 2. AFBMD responsibilities in support of PROJECT MERCURY.

MONTHLY PROGRESS—Project MERCURY

Program Administration

● A revised HS-36 Development Plan for a 14 missile/13 launch, 51.5 million dollar ATLAS/MERCURY program has been approved by AFBMD and forwarded to NASA. The funding breakdown is as follows:

FISCAL YEAR	DOLLARS (In Millions)
1959	8.761
1960	14.910
1961	19.979
1962	7.854
TOTAL	51.504

Flight Test Progress

● Test preparation for the second launch in the ATLAS/MERCURY flight test program is proceeding on schedule. This launch is scheduled for late May or early June from Atlantic Missile Range complex 14 which will be made available to MERCURY on approximately 21 April.

Technical Progress

● As a result of NASA revising their test plans and elimating the C-band radar beacon from on-board capsule equipment the 50D ATLAS booster will carry a General Electric impact predictor. The C-band beacon would have been sufficient to satisfy range safety requirements as a back-up to the Azusa impact predictor carried aboard the booster.

● A concerted effort has been made to save weight in both booster and capsule design. One result of this effort is a lightweight telemetry system, identified as CENTAUR Telemetry Subsystem No. 2, for installation in the booster. It is anticipated that this change will be incorporated on the ATLAS booster.

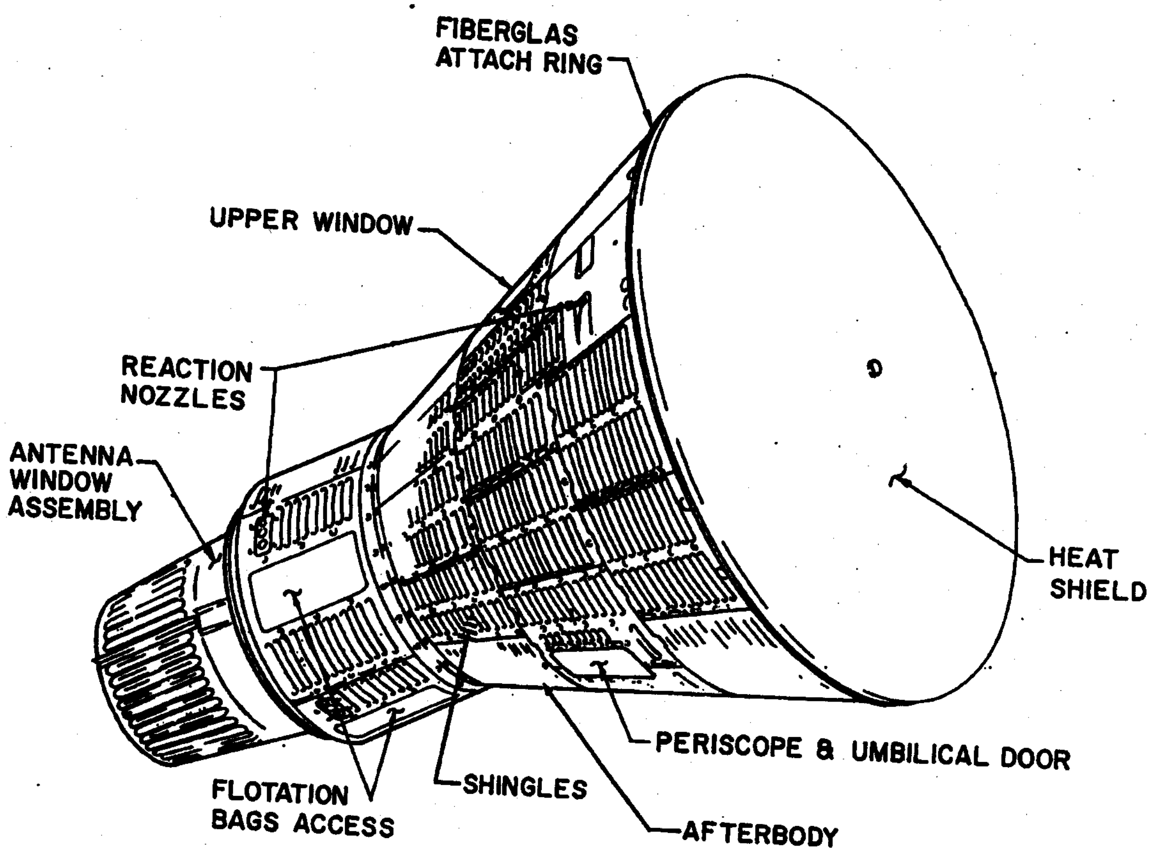


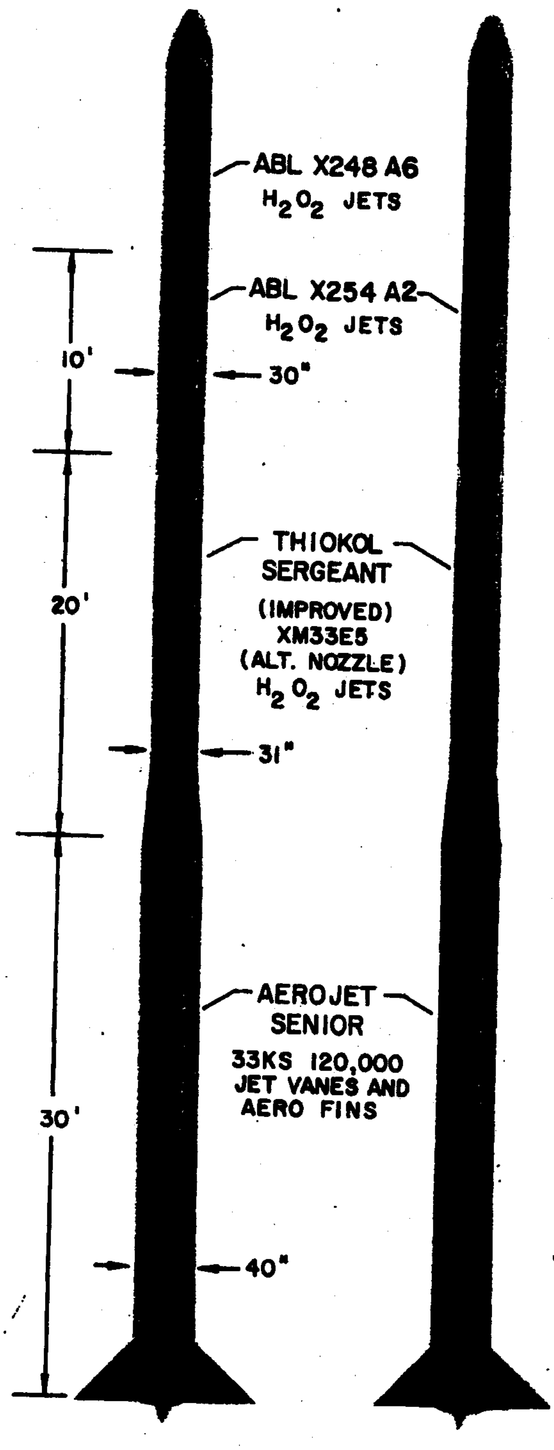
Figure 3. McDonnell shell to be carried on second ATLAS/MERCURY flight test.

PROJECT 609A

Hyper-Environment Test System

PROGRAM DESCRIPTION—The Hyper-Environment Test Program (609A) is divided into R&D and Operational Phases. The R&D phase will be used to develop and flight test vehicles capable of carrying 50 to 1,000 pound payloads to altitudes of 200 to 7,000 miles. The Operational phase will use this standardized vehicle to permit the economical performance of flight test experiments in support of scientific research and advanced military space system programs.

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



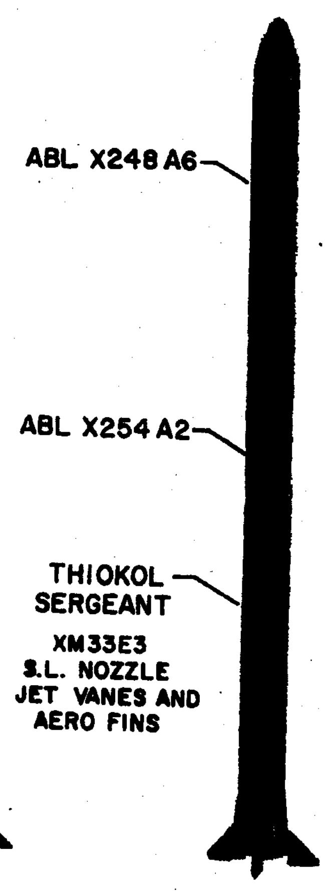


Figure 1. Three variations of Project 609A vehicle demonstrate the mission-versatility of the program.

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

Program Management—An abbreviated development plan, covering the R&D phase only, was approved on 9 January 1959. Funds in the amount of $9,077,000 were made available for this abbreviated portion of the program only. A letter was issued assigning management responsibility to AFMBD, with emphasis on integrating the program with the scientific and military research experiments conducted on regularly scheduled ballistic missile flight tests (Piggyback Program). In June 1959, Aeronutronic Division of the Ford Motor Company was chosen through normal competitive bidding as the Payload, Test, and Systems Integration Contractor. Arrangements have been made for the procurement of vehicle components and associated support equipment, modified to meet Program 609A requirements, through NASA, rather than through the SCOUT Program contractors. Atlantic Missile Range facilities consisting of launch complex 18 will be made available to the Air Force for this program. A Project 609A division has been established within the 6555th Test Wing (Development) at AMR to supply Air Force technicians to participate in the assembly, checkout and launch operations of the R&D phase under the direction of the Payload and Test Contractor. An all-military operational capability will be developed from within this group.

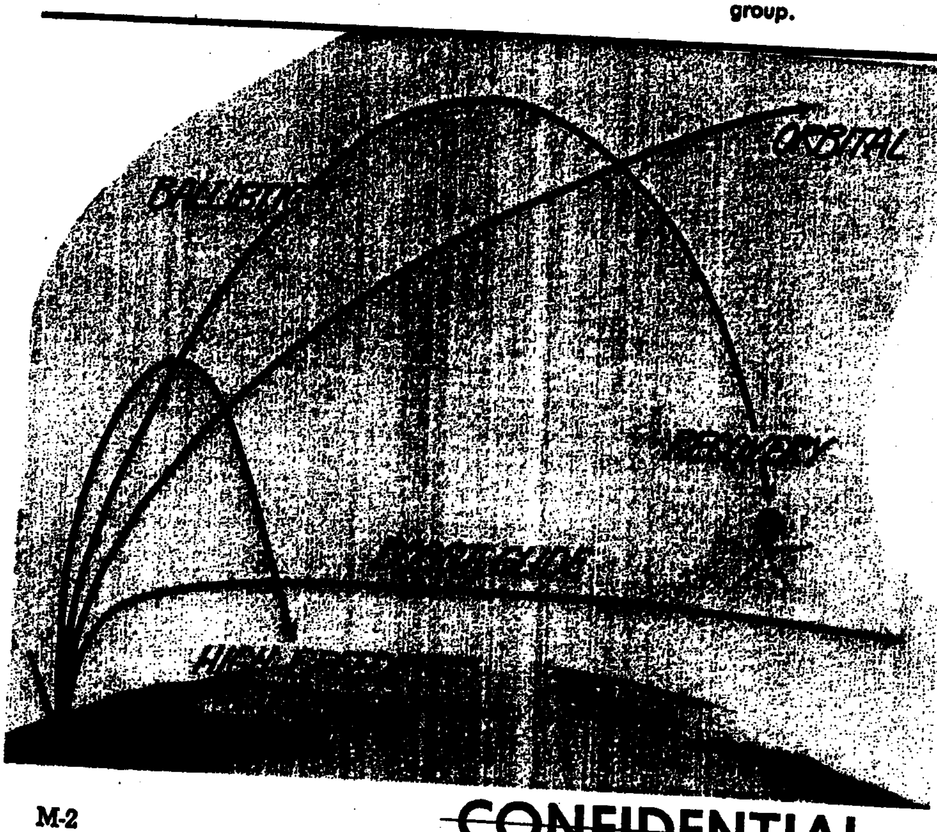
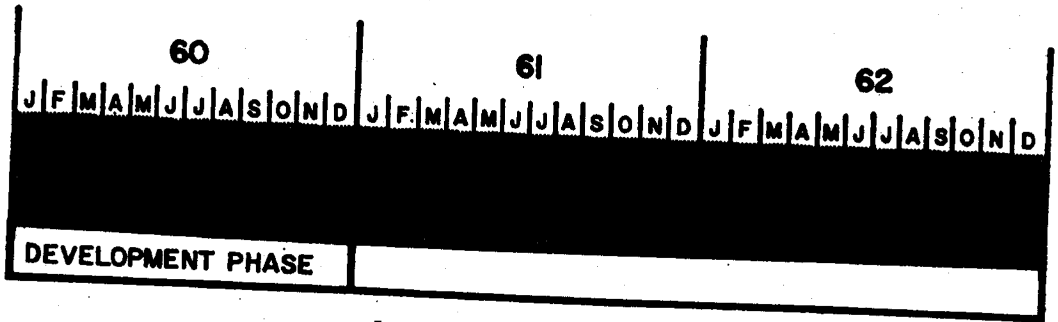


Figure 2. Four different trajectories possible using different arrangements of Project 609A stages.



Launch Schedule

MONTHLY PROGRESS—Project 609A

Program Administration

- NASA has decided that an early launching of a modified, unguided SCOUT is desirable. This test vehicle will be launched in late April and will consist of the first stage, a dummy second stage, a live third stage, and a nose cap of weight equal to the fourth stage. The purpose of this launch is to obtain flight experience with critical hardware items at the earliest possible date.

- On 3 March, representatives of NASA, Chance-Vought, Minneapolis-Honeywell, Aeronutronic and BMD met to establish a firm 609A schedule which could be met regardless of further NASA development slippages. A definite schedule outlining dates on which each agency must complete their part of the program and its relationship to the launch date of each flight was agreed on. This is the first time in the 609A program that a complete and detailed schedule has been agreed to by all agencies concerned.

- The FY 61 Financial Plan for Project 609A, consisting of data and documentation required to define and justify the effort programmed for 61, was submitted to WDLPM on 21 March.

- A revised 609A Development Plan is being prepared by AFBMD for submission to Hq ARDC in April. This plan will cover both the development and operational phases and will present some program reorientation based on commitments to support the Navy TRANSIT Program.

- A transfer of obligation authority for $777,000 was received from AFSWC for four 609A (2-3-5-6 configuration) vehicles. AFBMD was requested to procure four additional 609A unguided vehicles with AFSWC funds and launch them with AFSWC payloads during CY 1960. AFSWC has Hq ARDC approval of this program, necessary funding, and a high priority requirement to make these tests this year. AFBMD is taking steps to integrate the additional 2-3-5-6 vehicles into the Development Test launch schedule.

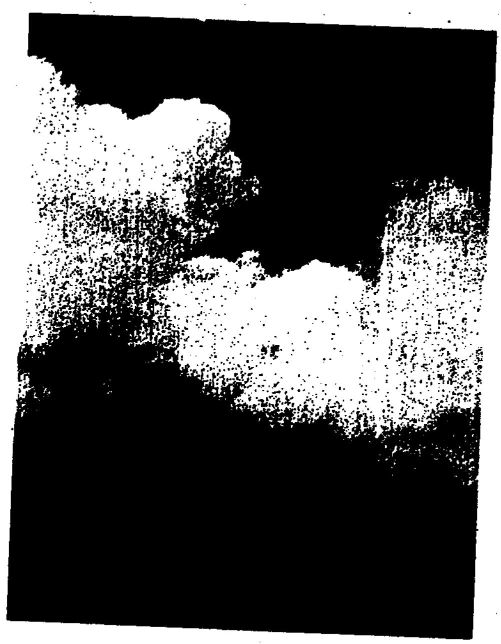
Test Requirements Conference

- This conference, attended by a total of 57 representatives from AFCRC, AFSWC, APGC, AFMDC, Aeronutronic, BMC and AFBMD, was held 1 - 2 March at AFBMD to collect, review, and discuss payloads planned for the 609A operational program. The experimental requirements for CY 1961, which will be used to formulate the vehicle budget to be presented to BMC, were of particular importance. Approximately 108 experiments (AFCRC 62, WADD 25 and AFSWC 21) were scheduled. AFMDC has requirements for testing guidance systems, but it appeared that the present 609A recovery system is inadequate for payloads as large as those required by AFMDC. The AFBMD Payload Review Committee met to plan the approach for evaluating, validating, assigning priorities, and deciding whether or not some experiments shall be referred to other programs, such as ATLAS Piggyback. Following this review, Aeronutronic will combine the validated compatible experiments into payloads and the required vehicle configurations and quanties will be determined.

Technical Progress

- The ABL X254A6 (third stage) engine has successfully completed two test firings under simulated altitude conditions at Arnold Engineering Development Center. These tests completed the prequalification test program. The first flight engine will be delivered in April.

SPACE



studies

ADVANCED SYSTEMS STUDIES

1. The Advanced Systems Studies Division has several space studies in progress. The purpose of these studies is to determine the military missions and mode of operation in space. For the purpose of study, space has been divided into three broad areas; earth orbital, lunar, interplanetary. Studies in the lunar and interplanetary area are being managed and directed at AFBMD. There are two studies in the Lunar area: SR 192 (U) Strategic Lunar System, and SR 183 (U) Lunar Observatory. There is one study in the interplanetary area: SR 182 (U) Strategic Interplanetary System.

2. The objective of SR 192 is to determine a military posture in the lunar area which is defined as the surface of the moon and the area in its surrounding gravitational field. This is a broad conceptual type study which will examine all facets of military operations such as offensive, defensive, and supporting systems. This study was funded with $600,000 in Fiscal Year 1959 and final reports from the contractors are due at AFBMD by February 1960. In addition to the three funded contractors working on this study, there are three voluntary contractors. Consequently, the total effort being applied is estimated as equivalent to one million dollars.

3. An obvious military requirement in the lunar area will be a surveillance and intelligence collection system. Therefore, SR 183 (U) Lunar Observatory was initiated to examine this problem. The objective of this study requirement is to determine a sound and logical approach for establishing a manned intelligence observatory on the moon from which the entire earth and its surrounding area can be kept under continuous surveillance. All earth orbital systems can be monitored and enemy activities in space and on the lunar surface can also be watched. All possible types of sensors and their probable ranges will be examined. This study will also include the means of logistically supporting and establishing the lunar base. This study was funded with $420,000 in Fiscal Year 1959. Three contractors were funded and three additional contractors are performing the study on a voluntary basis. Consequently, it is estimated that this study has the equivalent of $1.5 millions being applied to it.

4. The interplanetary area is being studied under SR 182 (U) Strategic Interplanetary System. The objective of this study is to determine the possible military missions and the type of equipment necessary for operations in the interplanetary area. This area is being studied separately from the lunar area because the operational problems involved appear to be somewhat different, the distances are much greater; our present knowledge of the area is limited, therefore, special types of navigational and propulsion systems will be required. This study was funded with $285,000 in Fiscal Year 1959 which has been distributed among three contractors. Contractors' final reports are due at AFBMD in February 1960.

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