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WDLPM-4

30 May 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 introduced by a concise history of the administration, concept and objectives, making possible a more meaningful evaluation of the monthly progress information. The program description information is revised monthly as necessary to reflect major technical and administrative changes. These programs must be sufficiently flexible to permit continuous and effective integration of rapidly occurring advances in the state-of-the-art.

This month's report includes information on the highly successful MIDAS II launch on 24 May. Performance with regard to planned orbital parameters was outstanding. This flight is a significant milestone in the MIDAS program.

The successful TIROS launch on 1 April marked the end of AFBMD's participation in this program. This report reviews the program and the launch and concludes the reporting on this program.

O. J. RITLAND
Major General, USAF
Commander

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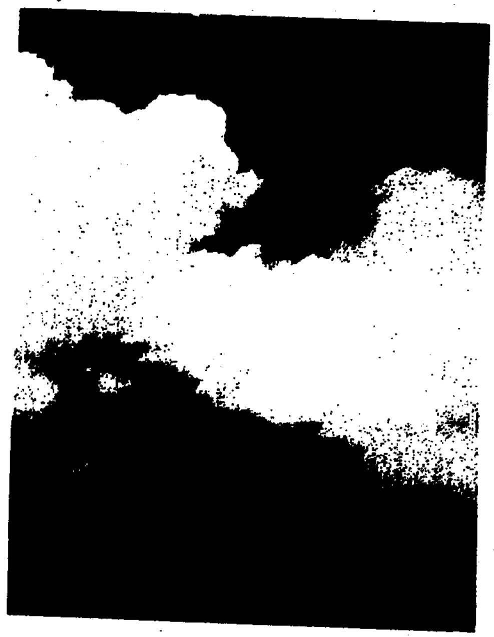
WDAT 60-2711

a foreword to...



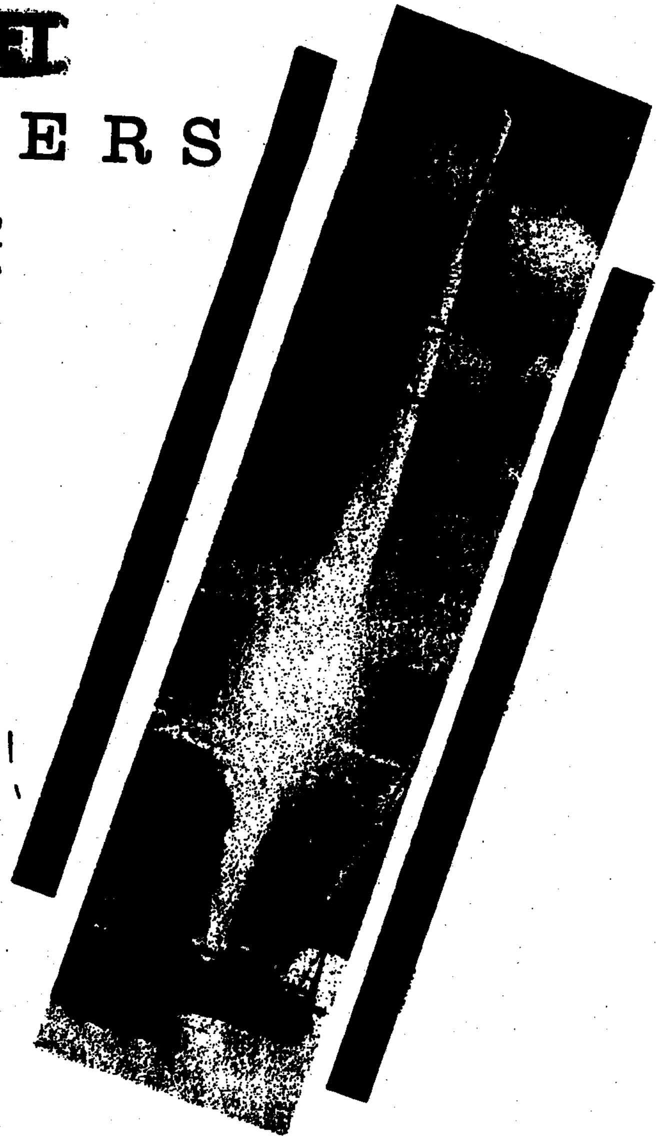
SPACE

Space Program BOOSTERS

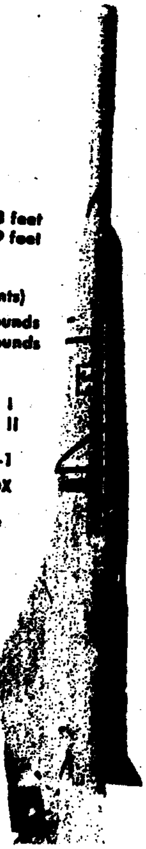
Planning time schedules for the accomplishment of Space Program missions is based largely, at present, on the availability of booster vehicles. IRBM, ICBM, and upper stage development programs must be closely monitored. As modifications are incorporated into these programs: reducing weight, increasing 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 NASA and Department of Defense 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.



THOR



Prime contractor:
Douglas Aircraft Co.

Engine manufacturer:
Rocketdyne Div., North American Aviation

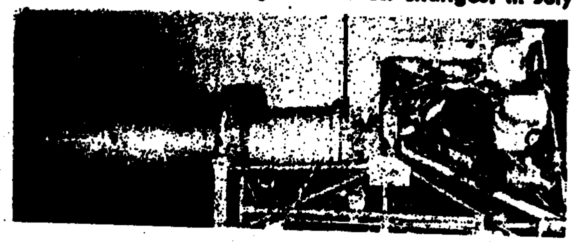
Height	
SM-75	61.3 feet
DM-21 (without re-entry vehicle)	56.9 feet
Weight (no residual propellants)	
SM-75	106,546 pounds
DM-21	108,395 pounds
Engine	
SM-75	MB-3 Block I
DM-21	MB-3 Block II
Fuel	RJ-1
Oxidizer	LOX

Guidance—removed on space booster flights

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

SECRET

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

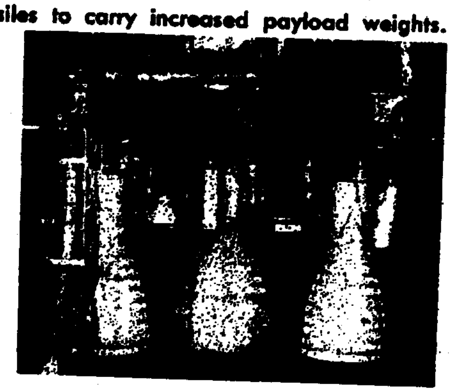
Engine manufacturer:
Rocketdyne Div., North American Aviation

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 ATLAS-boosted flight test vehicle in Project Mercury was launched on 7 September with all objectives essentially achieved. ATLAS performance on both the 26 February and 24 May MIDAS launches was exceptional. Future flights will use modified ATLAS series "D" missiles to carry increased payload weights. 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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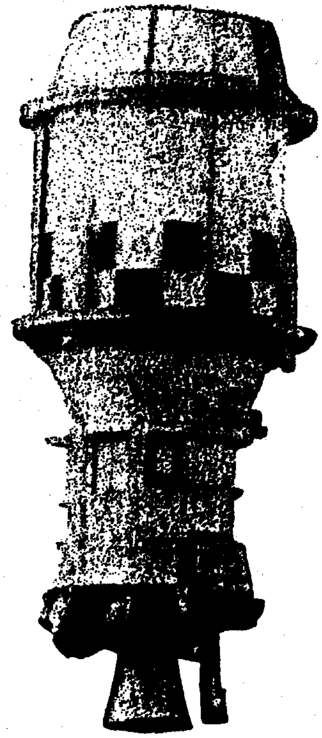
AGENA

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

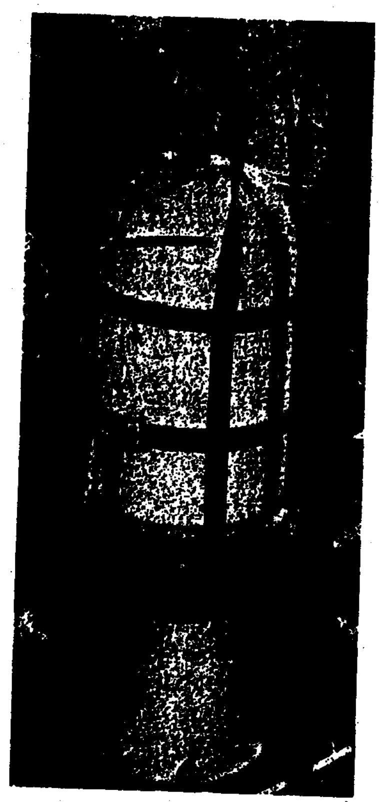
Oxidizer
Inhibited White Fuming Nitric Acid

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

Specifications....

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	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

SECOND STAGE

AGENA	D "A"	E "B"	F "B"
Engine Model	YLR81-Ba-5	XLR81-Ba-7(3)	XLR81-Ba-9(4)
(1)Weight—inert	1,155	1,370	1,400
Impulse propellants	6,550	13,100	13,100
Pyrotechnics	67	108	108
(2)TOTAL WEIGHT	7,772	14,578	14,608
Separation Weight	7,746	14,552	14,582
Thrust-lbs., vac.	15,500	15,500	16,000
Spec. Imp.-sec., vac.	277	277	290
Burn Time—sec.	120	240(4)	240(4)

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.*

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

THIRD STAGE

(5)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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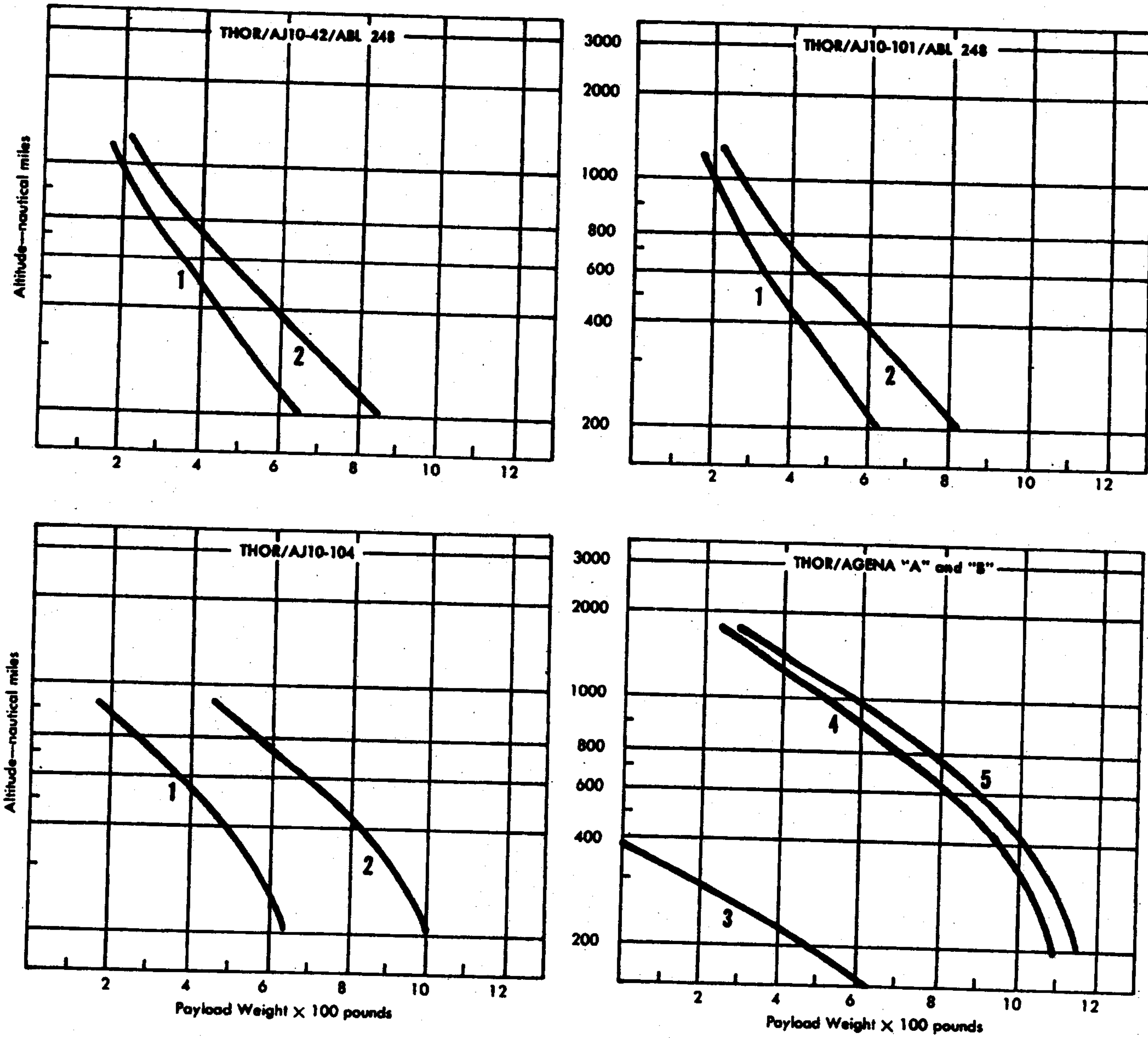
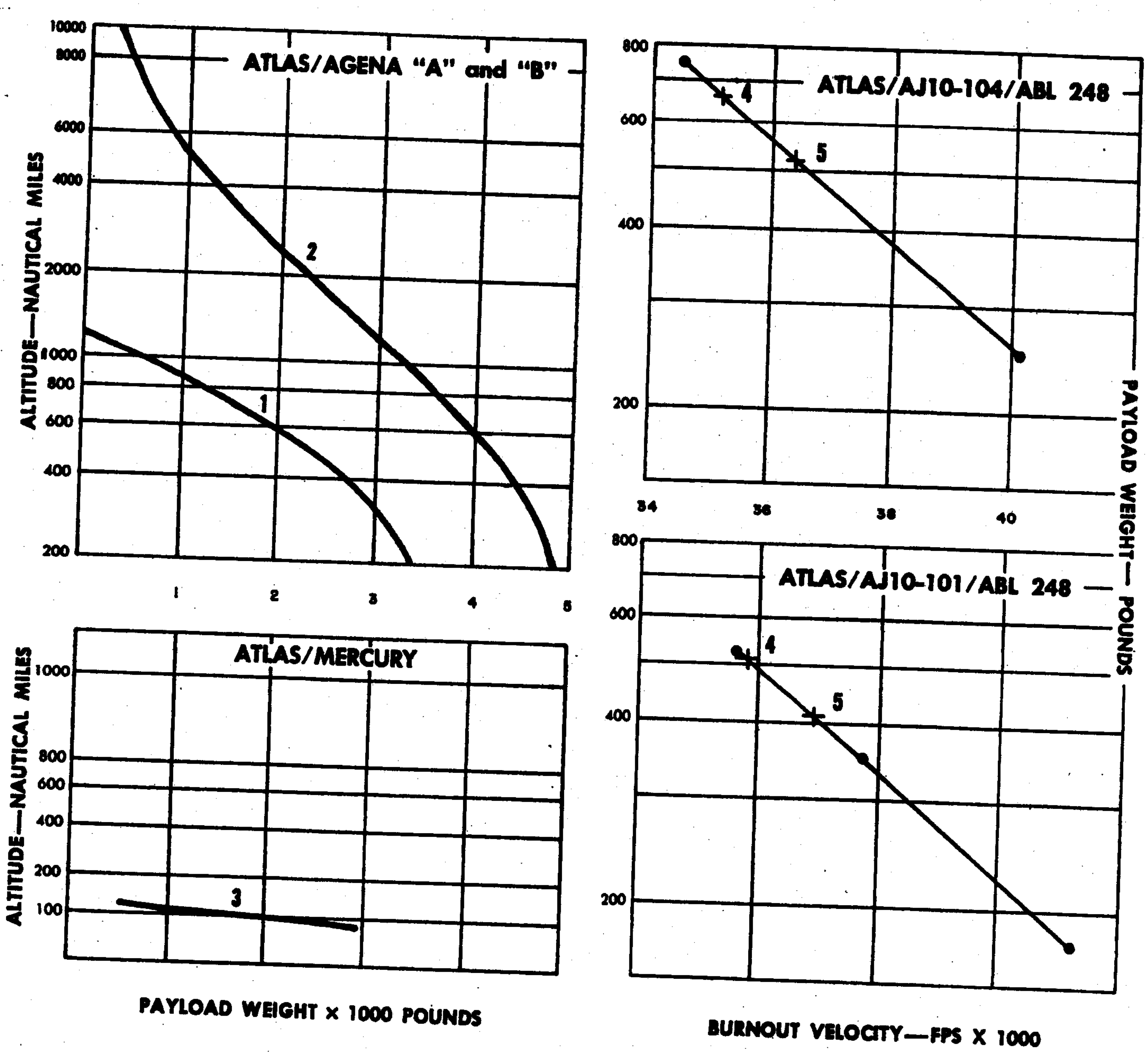
Performance Graphs — THOR BOOSTED



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)

Performance Graphs — ATLAS BOOSTED



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

4. Lunar Probe
5. Venus Probe

SPACE

systems

DISCOVERER

SAMOS

MIDAS

COMMUNICATIONS SATELLITE

SPACE SYSTEMS

The DISCOVERER Program consists of the design, development and flight testing of 33 two-stage vehicles, using the THOR IRBM as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Project's Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

PROGRAM OBJECTIVES

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

(b) Attaining satellite stabilization in orbit.

(c) Obtaining satellite internal thermal environment data.

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

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

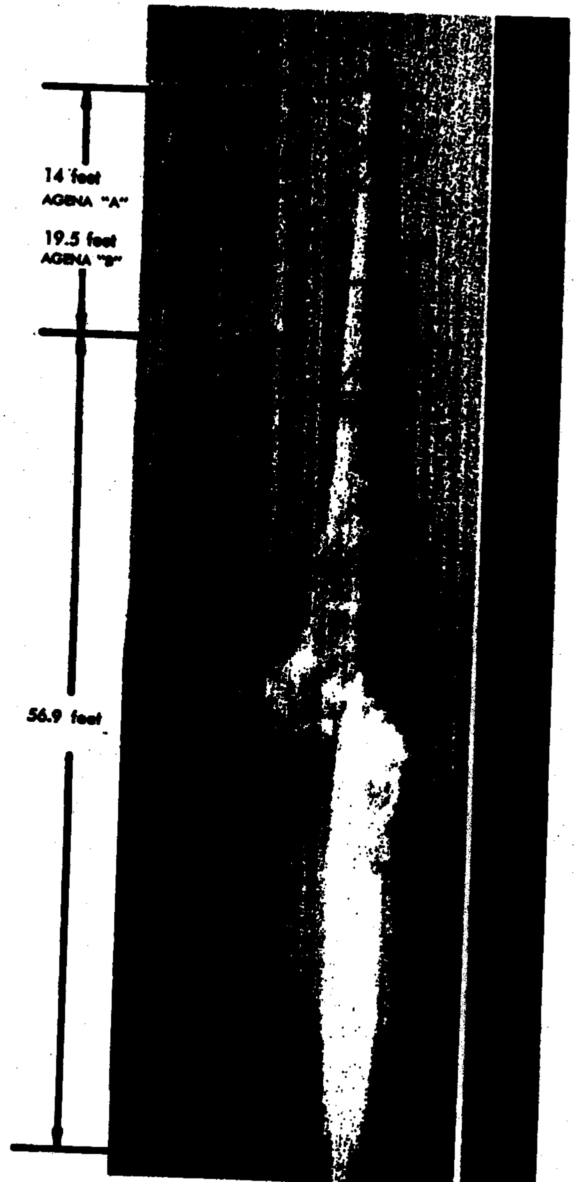
(f) Conducting bio-medical experiments with mice and small primates, including injection into orbit, re-entry and recovery.

PROGRAM SUMMARY

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

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

D i s c o v e r e r



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

THOR BOOSTER	DM-18	DM-21
Weight—Dry	6,950	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

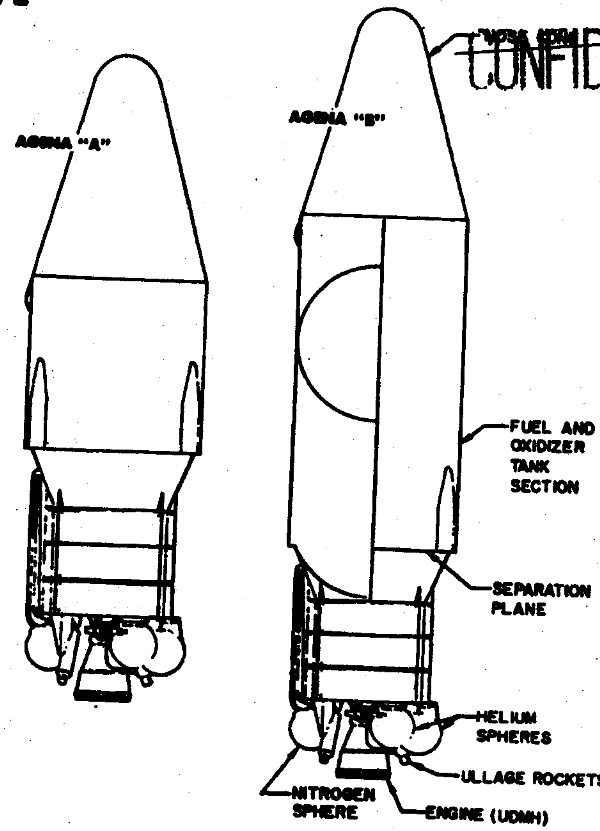
Telemetry-ships are positioned as required by the specific mission of each flight. Figures 2 and 3 show a typical launch trajectory from Vandenberg Air Force Base, and figure 3 shows schematically a typical orbit. An additional objective of this program is the development of a controlled re-entry and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

FLIGHT VEHICLE

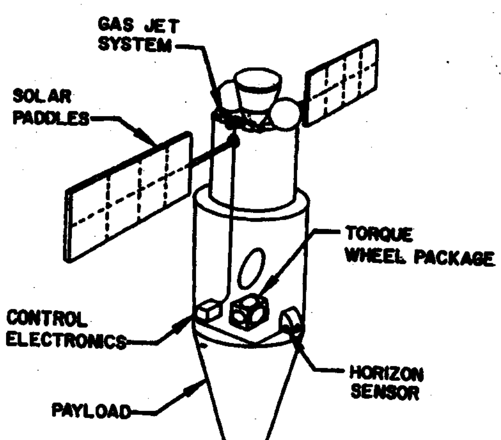
The three versions of flight test vehicles used in the DISCOVERER Program are defined in the launch schedule shown on page A-5. Specifications for the two THOR configurations and three AGENA configurations used are given on page A-1.

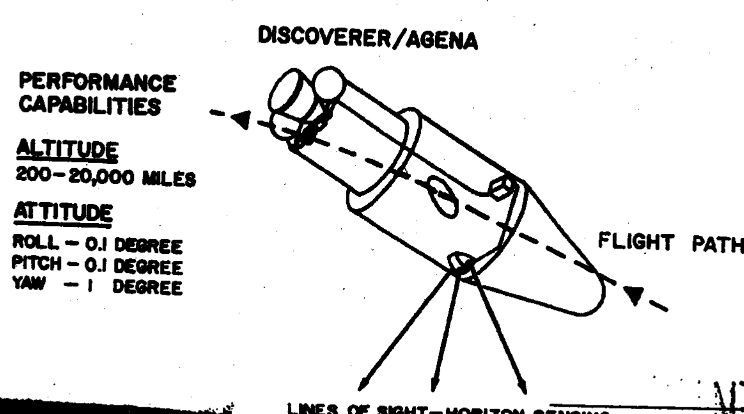
AGENA VEHICLE DEVELOPMENT

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



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





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Powered Flight Trajectory

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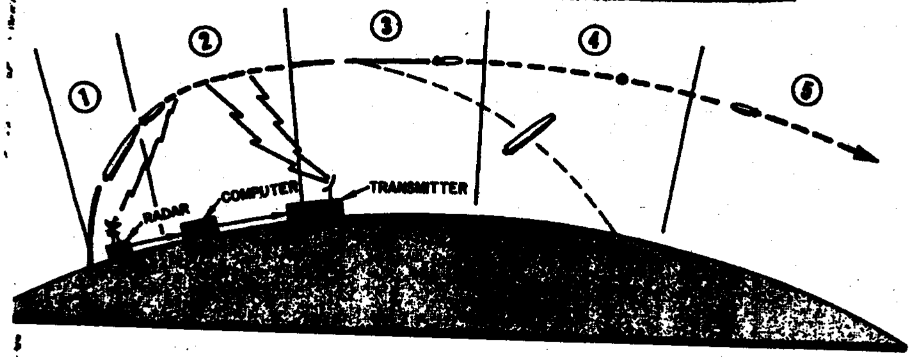
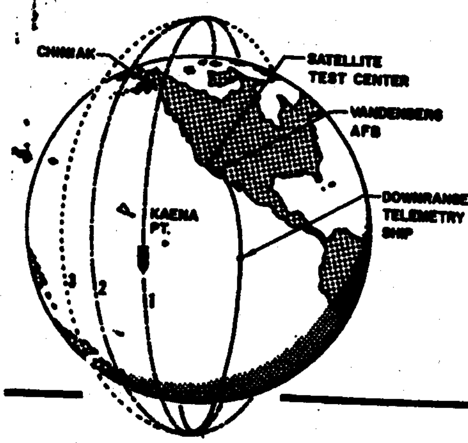
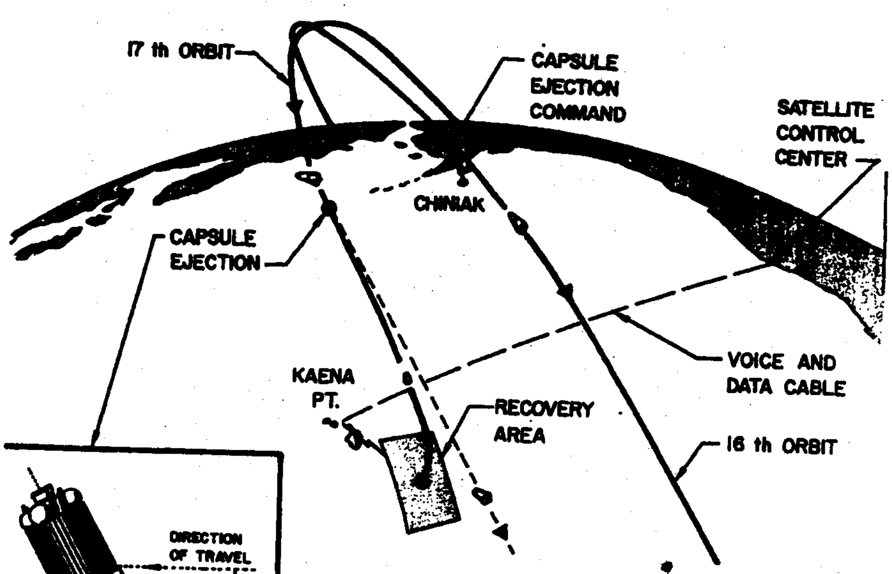


1. **First Stage Powered Flight**—2.5 minutes duration, 78 n.m. downrange, guided by programmed auto pilot.
2. **Coast Period**—2.4 minutes duration, to 380 n.m. downrange; altitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity to be gained commands.
3. **Second Stage Powered Flight**—2 minutes duration, to 770 n.m. downrange. Guided and controlled by inertial reference package, horizon scanner, gas reaction jets (roll) gimballing engine, yaw and pitch accelerometer—integrated.
4. **Vehicle Reorients to Nose Aft**—2 minutes duration, to 2,000 n.m. downrange. Guided and attitude controlled by inertial reference package, horizon scanner and gas reaction jets.
5. **In-Orbit**—Controlled (same as 4).



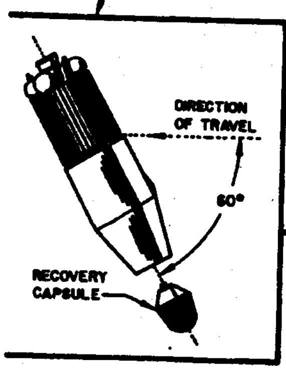
Orbital Trajectory

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



RECOVERY CAPABILITY

This objective was added to the program after the first launch achieved vehicle flight and orbit objectives successfully. It includes the orientation of the satellite vehicle to permit a recoverable capsule to be ejected from the nose section of the AGENA vehicle. Ejection is programmed to occur on command on the 17th orbit, for capsule impact within the predetermined recovery area south of Hawaii. Aircraft and surface vessels are deployed within the area as a recovery force.



CAPSULE RECOVERY SEQUENCE

Capsule ejection command is sent to the satellite by the Chiniak, Alaska station on the 16th orbit. The vehicle reorients its position (see inset) to permit ejection to occur on a re-entry trajectory on the 17th orbit. The recovery capsule parachute is activated at about 50,000 feet, and the capsule beacon transmits a radio signal for tracking purposes. The recovery force is deployed in the recovery (impact) area.

SECRET

Facility	*Equipment*	*Flight Function*
Satellite Test Center	A	Over-all control, convert tracking stations data to obtain a predicted orbit and generate subsequent ephemerides issue acquisition data to tracking stations for subsequent passes, predict recovery area.
Vandenberg AFB	BCDEFGHIJK	Launch, ascent and orbital tracking, telemetry reception, trajectory measurements including time to ignite second stage.
Point Mugu	BCDEFGHIJKL	Ascent tracking and telemetry data reception, transmits command to ignite and shut down AGENA (via guidance computer).
Telemetry Ship (Pvt. Joe E. Mann)	DF	Final stage ascent tracking and telemetry data reception.
Annette Island, Alaska (tracking station)		Activity at this station terminated 1 December 1959 due to fund limitations.
Cape Chiniak, Alaska (tracking station)	BDEFGHIJK	Orbital tracking and telemetry data reception, including first pass acquisition, recovery capsule ejection and impact prediction.
Kaena Point, Oahu, Hawaii (tracking station)	BCDEFGHIJK	Orbital tracking and telemetry data reception.
Hickam AFB Oahu, Hawaii		Over-all direction of capsule recovery operations.

*** *Equipment***

a. 2 UNIVAC 1103-A digital computers
b. VERLORT (Modified Mod II) radar
c. TLM-18 self-tracking telemetering antenna
d. Tri-helix antenna
e. Doppler range detection equipment
f. Telemetry tape recording equipment
g. Telemetry decommutators for real time data presentation
h. Plot boards for radar and TLM-18 tracking data
i. Conversion equipment for teletype transmission of radar, TLM-18 and doppler tracking data in binary format
j. Acquisition programmer for pre-acquisition direction of antennas
k. Ground command to satellite transmission equipment
l. Guidance computer

GROUND SUPPORT FACILITIES

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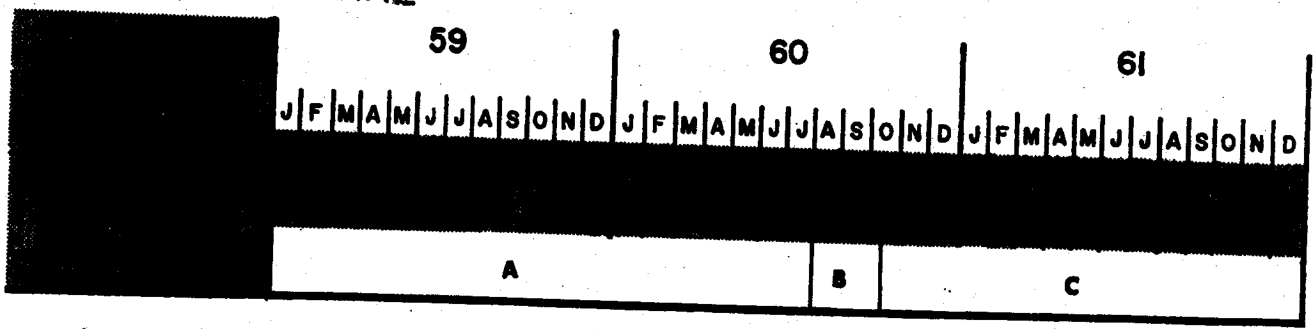

A. THOR—DM-18 / AGENA "A"

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.*
XI	1055	234	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*

Monthly Progress—DISCOVERER Program

Flight Test Progress

DISCOVERER XI

- The high re-entry trajectory of the recovery capsule following the very successful launch and orbiting of DISCOVERER XI on 15 April has resulted in an intensive recovery system component test program. This program is designed to gather information from which correctives will be made to assure maximum probability of recovery on subsequent DISCOVERER flights.

- Telemetry data on the DISCOVERER XI flight indicate that the recovery capsule was ejected on the 17th orbit as planned. A good track of the capsule telemetry transmitter was obtained by the Kaena Point station which showed that the predicted re-entry trajectory did not occur. Capsule separation and retro-rocket firing were verified. However, spin rocket firing was not verified. Data evaluation indicated that resultant velocity magnitude and direction were incorrect and, as a result, recovery was not effected.

- As part of the diagnostic program a more complete "blossom" telemetry package is being installed to monitor the DISCOVERER XII payload recovery sequence. This package will provide information on all phases of capsule ejection including retro, spin, and de-spin rocket separation and parachute deployment.

- An intensive recovery system test program is being conducted at two sites:

  1. Santa Cruz Test Base—Spin rocket firings have been checked in a series of capsule drop tests. While the test capsule was in free fall from a tower, various firing combinations of spin rockets were attempted and the effects on the capsule recorded.
  2. Holloman Air Force Base—Functional phases of the recovery system (including rocket firings and parachute deployment) are being tested in a series of balloon drop tests.

- DISCOVERER XI was the first orbiting AGENA to carry the dual-frequency doppler beacon (APL) and four optical tracking lights. Satisfactory tracking of both systems was achieved at stations in the United States and abroad. Sufficient data were received to

Figure 1. Spin rocket firings at Santa Cruz Test Base. Capsule is dropped from tower (upper photo), various combinations of spin rockets are fired, and the results are recorded. Capsule is caught in the net on the lower left. Spin rockets being replaced (lower) after capsule drop test.

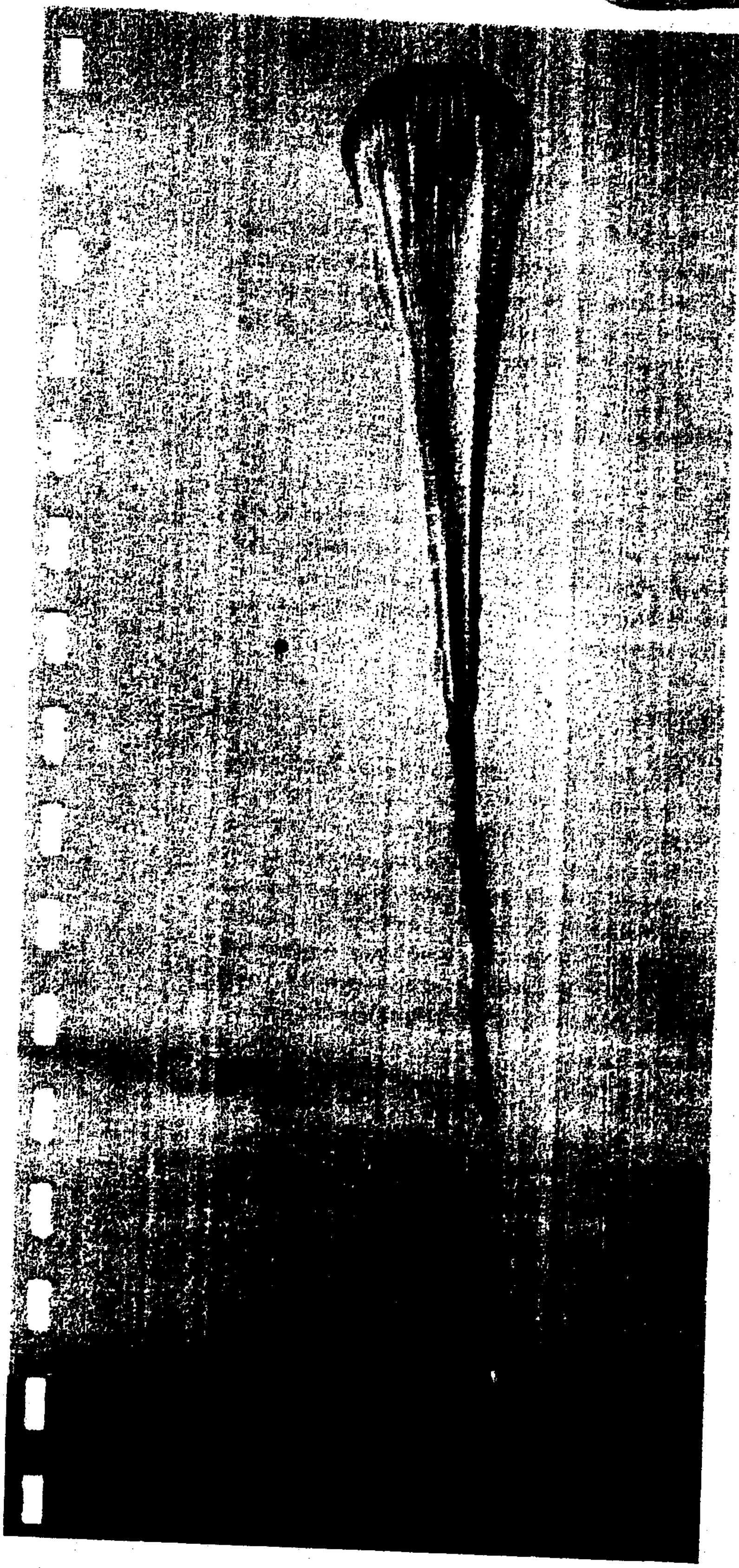

Figure 2. Capsule recovery system drop tests at Holloman Air Force Base. Filling the balloon (above) prior to liftoff. Recovery capsule is suspended from crane at right. The capsule is lifted to altitude by the balloon and released. Operation of the retro, spin and de-spin rockets, and parachute deployment are being checked by this test series.

indicate successful performance of the system. Although the APL beacon is being displayed by a portion of the diagnostic payload for the next DISCOVERER flight, the optical tracking lights will be operational. Subsequent AGENA "A" DISCOVERER vehicles will carry the complete system.

DISCOVERER XII

● A flight readiness date for the launch of DISCOVERER XII depends upon the installation of the diagnostic payload and completion of the recovery system test program. A re-disposition of the recovery forces is being effected for this flight. Telemetry receiving equipment is being installed on Christmas Island in the South Pacific to provide telemetry reception in the event the actual re-entry trajectory carries the capsule beyond the planned recovery range . Ground tracking stations having telemetry receiving equipment are located at Kodiak, Alaska, Kaena Point, South Point, and Barking Sands, Hawaii. Five C-54 aircraft will provide telemetry reception in addition to telemetry on three surface vessels, the Pvt Joe E. Mann, the Dalton Victory, and the Haiti Victory. Additional instrumentation and telemetry will transmit all phases of the DISCOVERER XII payload recovery sequence from ejection through parachute deployment.

Technical Progress

Second Stage Vehicles

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

- The third AGENA "B" vehicle (XLR-81Ba-7 engine) underwent hot firing tests on 3 May at the Santa Cruz Test Base. The first and third vehicles have been returned to the Systems Test Area for rework and a second systems check prior to Air Force acceptance. The second vehicle is in storage following Air Force acceptance on 3 May.

- The Preliminary Flight Rating Tests (PFRT) for the XLR-81Ba-7 engine were rerun because of the gas generator propellant valve malfunction during last month's tests. Safe functioning of the engine after simultaneous firing of both starter propellant charges was demonstrated. The modifications made to the gas generator propellant valve have solved the valve binding problem.

- Evaluation of Zirconia thrust chamber coating was continued during the month. Tests of modified injectors for the XLR-81Ba-9 engine indicate a successful remedy for thrust chamber erosion problems may be found in this change. Informal component level PFRT type tests of the XLR-81Ba-9 engine began during May. Engine level tests are scheduled to begin in June using existing thrust chambers. An extension of the PFRT program will be conducted to prove the reliability of the thrust chamber modification prior to the first launch.

- Testing of the XLR-81Ba-9 engine with 45:1 area ratio nozzles continued at Arnold Engineering Development Center. A test series was initiated on 6 May including starts and restarts at temperatures of plus 20 and minus 10 degrees F.

Biomedical Capsule

- Delivery of the test capsule (USE-77) to be used in the specialized biomedical environmental testing of Mark II flight components has been delayed until August. Upon arrival a series of vibration, centrifuge, and impact tests will be conducted to assure reliable flight operation.

Facilities

- The conversion of launch pad 5 at Vandenberg Air Force Base to AGENA "B" capability has been started. All ground handling and service equipment necessary to make the change has been shipped to the site. Included is the new mast extension required to accommodate the greater length of the AGENA "B" vehicle. Changes are also being incorporated into the propellant loading system which will permit two acid trucks to load propellant into the vehicle.

Figure 3. Model XLR-81Ba-9 engine with titanium 45:1 area ratio nozzle extension at the right. The dual starter cans are mounted on the upper left.

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Samos

BOOSTER—ATLAS ICBM

Weight—Wet	
Fuel, RP-1	15,100
Oxidizer (LOX)	74,900
	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	1,508	1,695
Payload equipment	2,605	3,058
Orbital	4,113	4,753
Impulse Propellants	6,492	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	718
GROSS WEIGHT (lbs.)	11,211	18,421
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
Burn Time, sec.	120	240

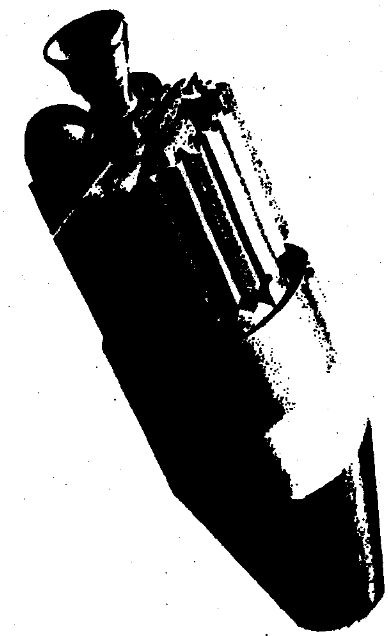
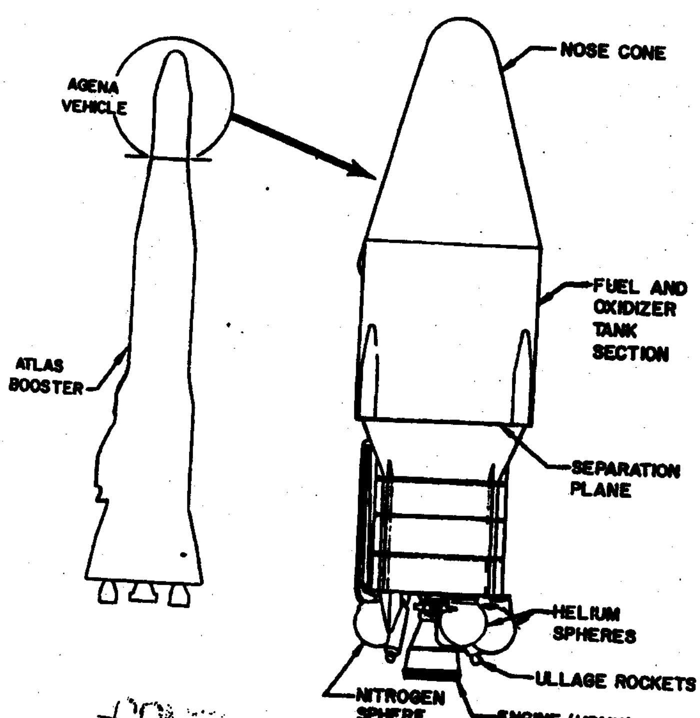


Figure 1.

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 visual and electronic coverage 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.

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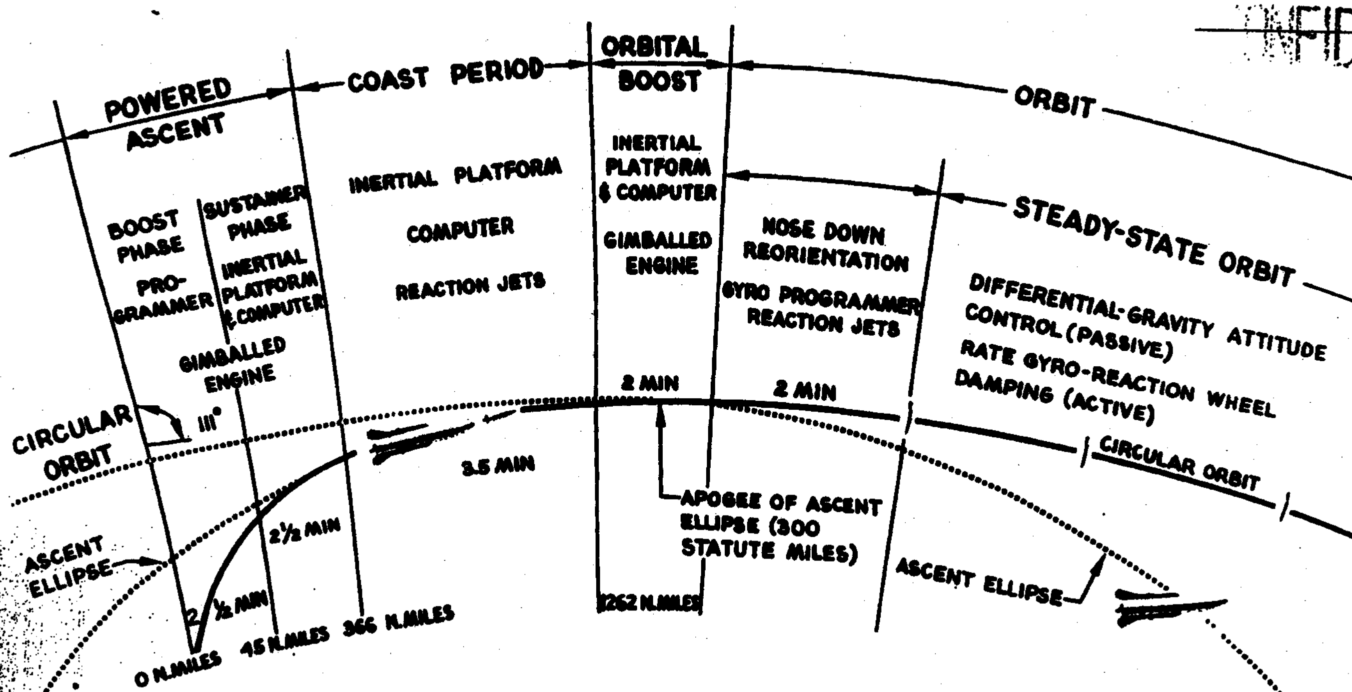

Figure 2. Typical SAMOS trajectory, launch- to-orbit.

Ferret Reconnaissance...

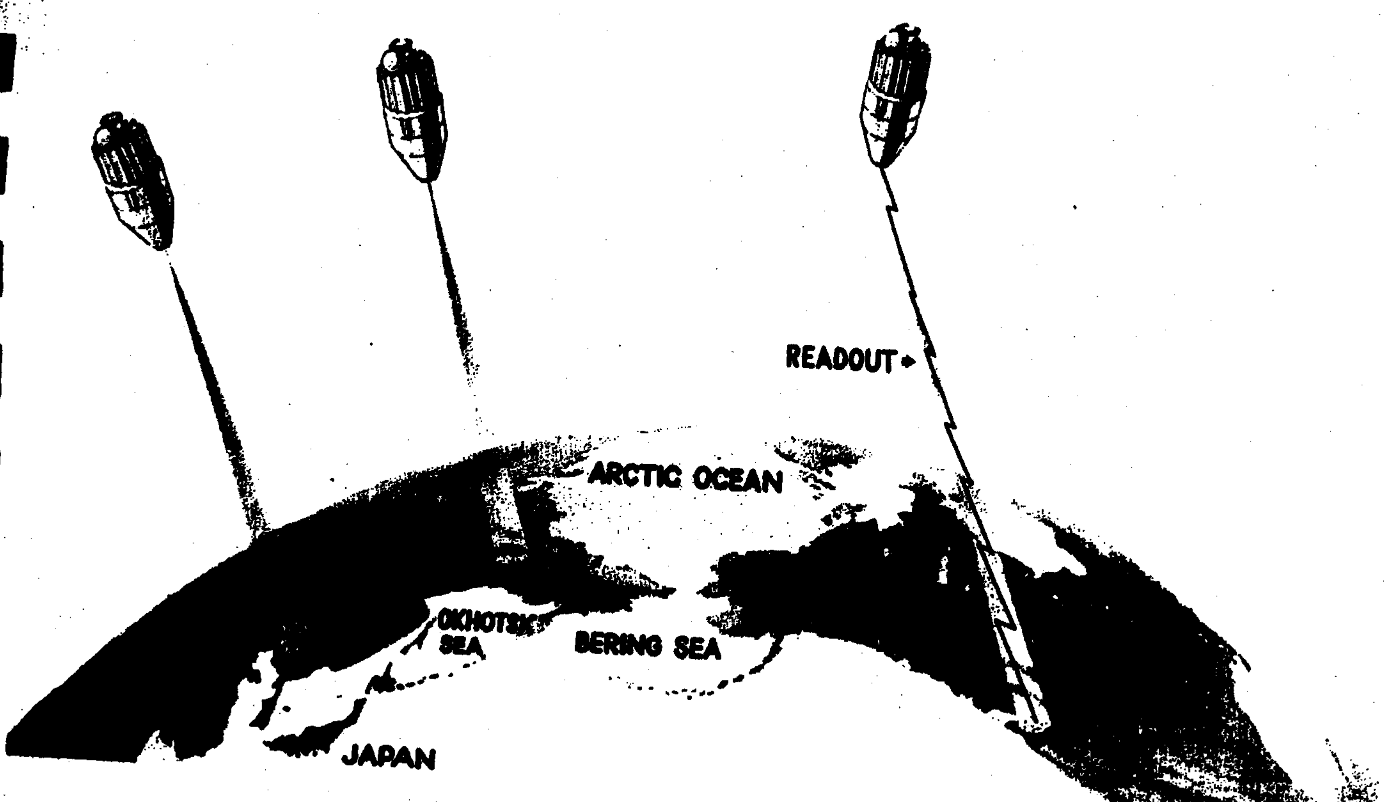

Figure 4. The Ferret reconnaissance system will gather data from electronic emissions over areas of interest.

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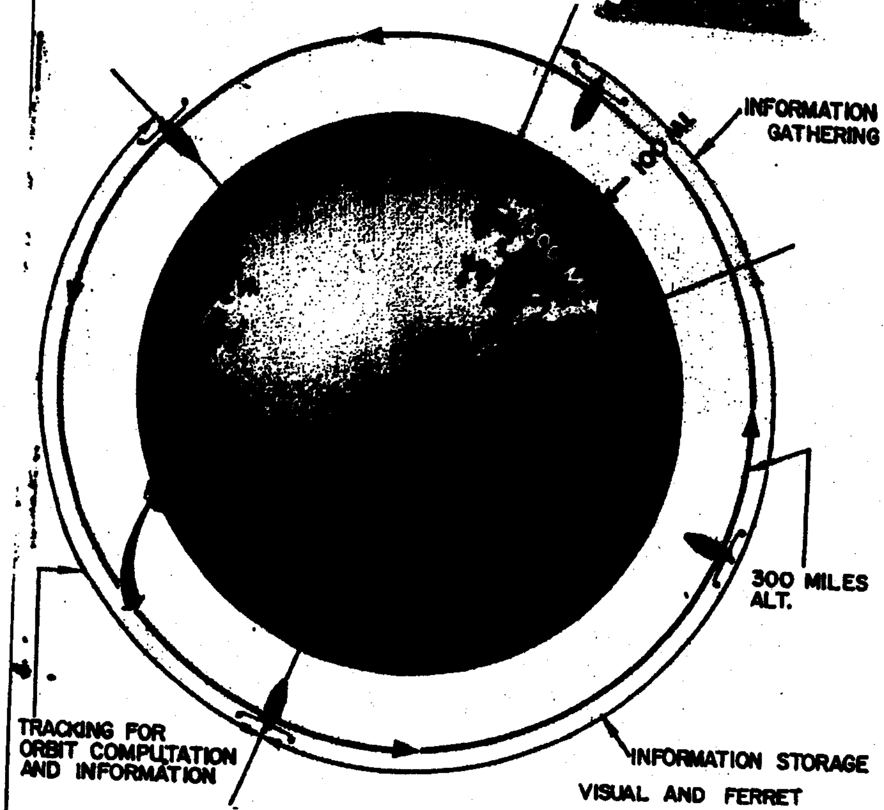


Figure 3.
Schematic of SAMOS system in operational orbit. When the satellite is over the area of interest the sensing equipment is turned on (Information gathering). When it leaves the area of interest the sensing equipment is turned off and the sensing data is processed (Information storage). When the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

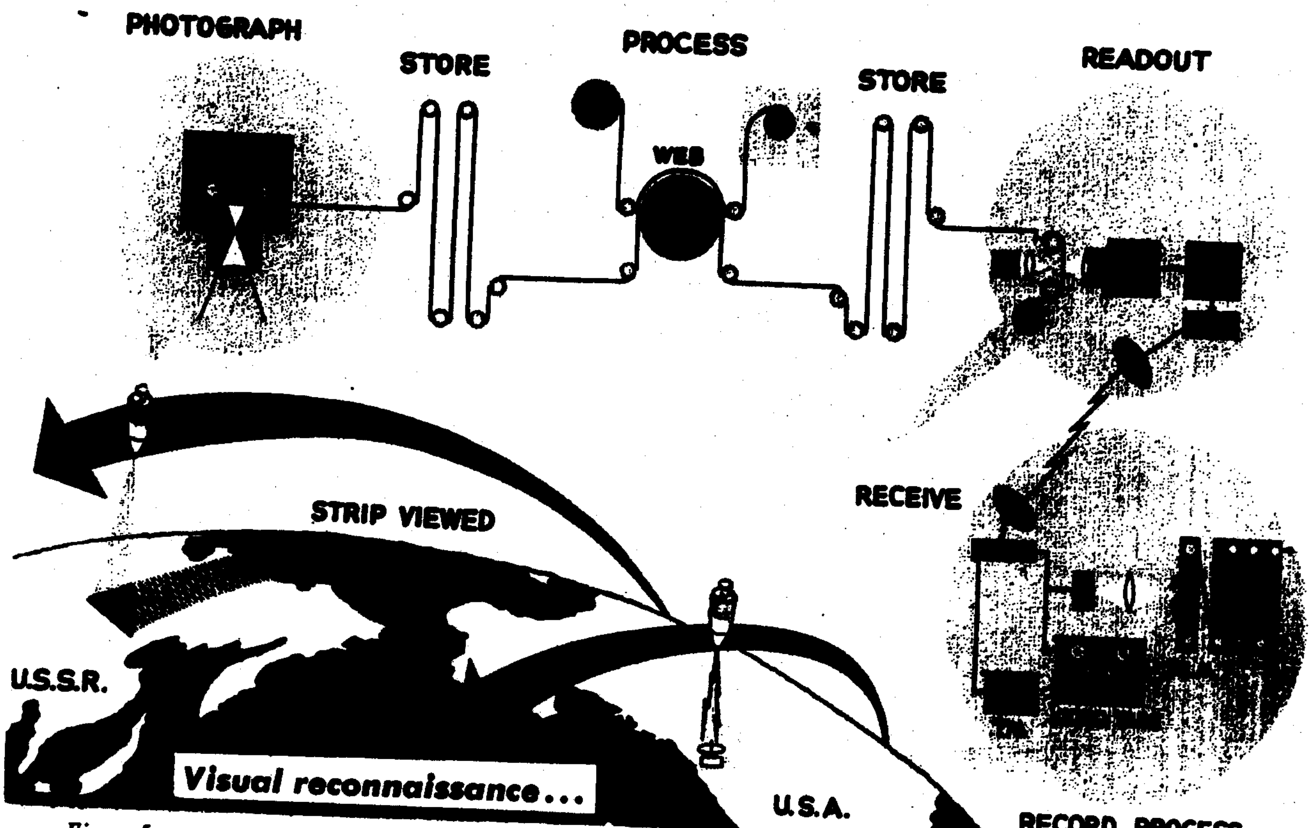


Figure 5.
The initial visual reconnaissance program will use conventional photo techniques with automatic film processing and TV-type electronic image readout to ground stations thru a data link. Ground electronics will reconvert the signal into photo image form, with a capability of resolving objects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

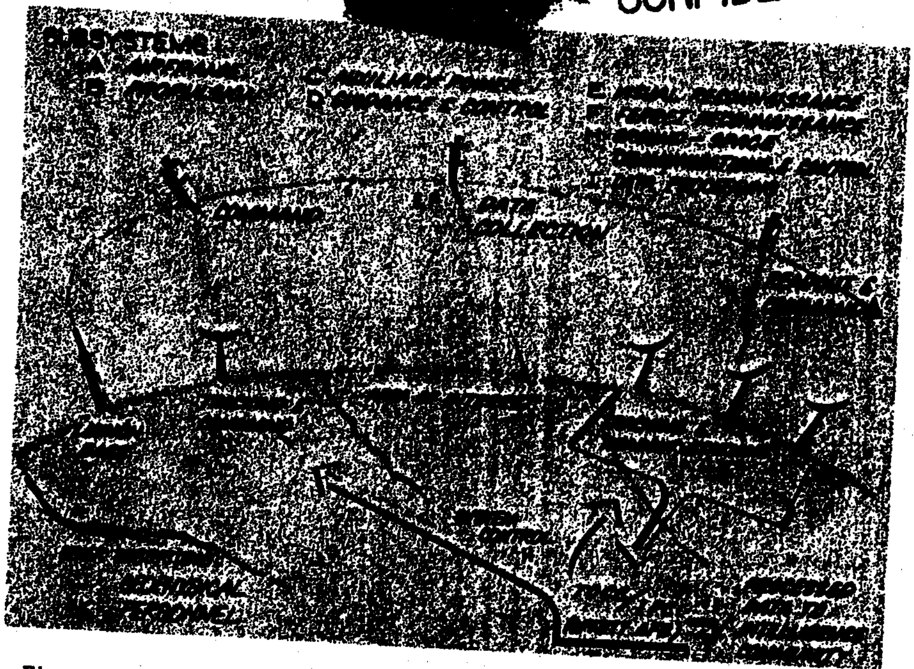


Figure 6. SAMOS concept, showing reception of commands and transmission of data between satellite and ground station; and subsystem functions (schematic).

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.

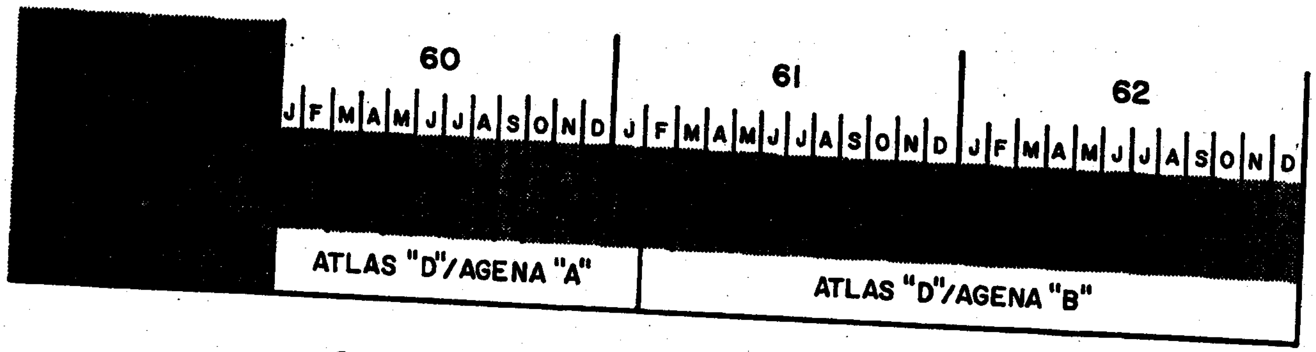
CONCEPT

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—Three versions (E-1, E-2, and E-5) of visual payloads are being developed. The E-1 payload is a photo component test payload which is combined with the F-1 ferret payload. The E-2 photographic payload, under development by Eastman Kodak Company, includes a camera, film processor, and electronic readout equipment. The E-5 recoverable system designed by Lockheed will retain the exposed film and the 66-inch focal length camera developed by Itek Corporation.

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 superheterodyne 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.



SAMOS Launch Schedule

Monthly Progress—SAMOS Program

Second Stage Vehicles

- System checks of the AGENA vehicle for the first SAMOS flight are nearing completion with delivery to Santa Cruz Test Base scheduled for 2 June.
- Final assembly of the third AGENA "A" vehicle for the last of the SAMOS dual-payload flights was completed and delivery to the Systems Test Area was accomplished on 2 May.
- Subassembly of the first AGENA "B" vehicle continues on schedule. This vehicle is scheduled for launch in April 1961 carrying an E-2 payload. This is the first of the single-payload SAMOS vehicles which will carry either an E-2 photo readout or an F-2 ferret reconnaissance payload.

Visual Reconnaissance Systems

- *Visual Reconnaissance Systems payloads are being developed in a minimum number of configurations to attain readout and recovery mission objectives. The design 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**—The third E-1 payload was received from the contractor in mid-May.
- **E-2 Payloads**—Testing and assembly of E-2 payload components is continuing at the contractor's facility. Functional evaluation of service test models is in progress. Tests of the E-2 thermal model in the high altitude temperature simulator indicated that a change was required in the upper pressure shell conductance level. The lower pressure shell test results were satisfactory.
- **E-5 Payloads**—Design is continuing on the high acuity panoramic camera to combine all camera components as an integrated unit. The optical glass for two of the 66-inch, f/5 lenses has been delivered from West Germany. The release of engineering drawings for the payload thermal model and fabrication of the first Recovery Equipment Test Unit have been accomplished. Ballistic range test of the recovery capsule configuration indicate satisfactory capsule stability. Wind tunnel tests of the recovery capsule configuration are being continued.

Ground Support Equipment

- Installation of the vacuum test chamber (for leak testing E-1 and E-2 payloads prior to launch) in the missile assembly building at Vandenberg Air Force Base is complete except for the electronics portion of the chamber. Delivery of the electronic portion is scheduled for June. Delivery of the E-1/E-2 ground reconstruction electronics equipment, primary record cameras, and operating consoles for the Vandenberg Air Force Base tracking and acquisition station has been delayed until June. Compatibility test and incorporation of design changes at Eastman Kodak caused this one month delivery slippage.

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**—The third F-1 payload was received from Airborne Instruments Laboratory on 27 May.

● **F-2 Payloads**—Testing and assembly of F-2 payload components is continuing at the contractor's facility. Results of the F-2 thermal control for all orbital conditions are satisfactory. Functional evaluation of service test models is in progress.

Ground Support Equipment

● Installation and preliminary functional testing of the F-1 data conversion equipment in the interim area of the Satellite Test Center were completed during the report period.

Facilities

● **Point Arguello**—Equipment installation for Pad 1 is essentially complete, and systems tests of these equipments in the launch and operations building and service building were underway at the close of the report period. Final inspection of launch stand 2 was held on 12 May. All deficiencies are in the process of correction and will be completed early in

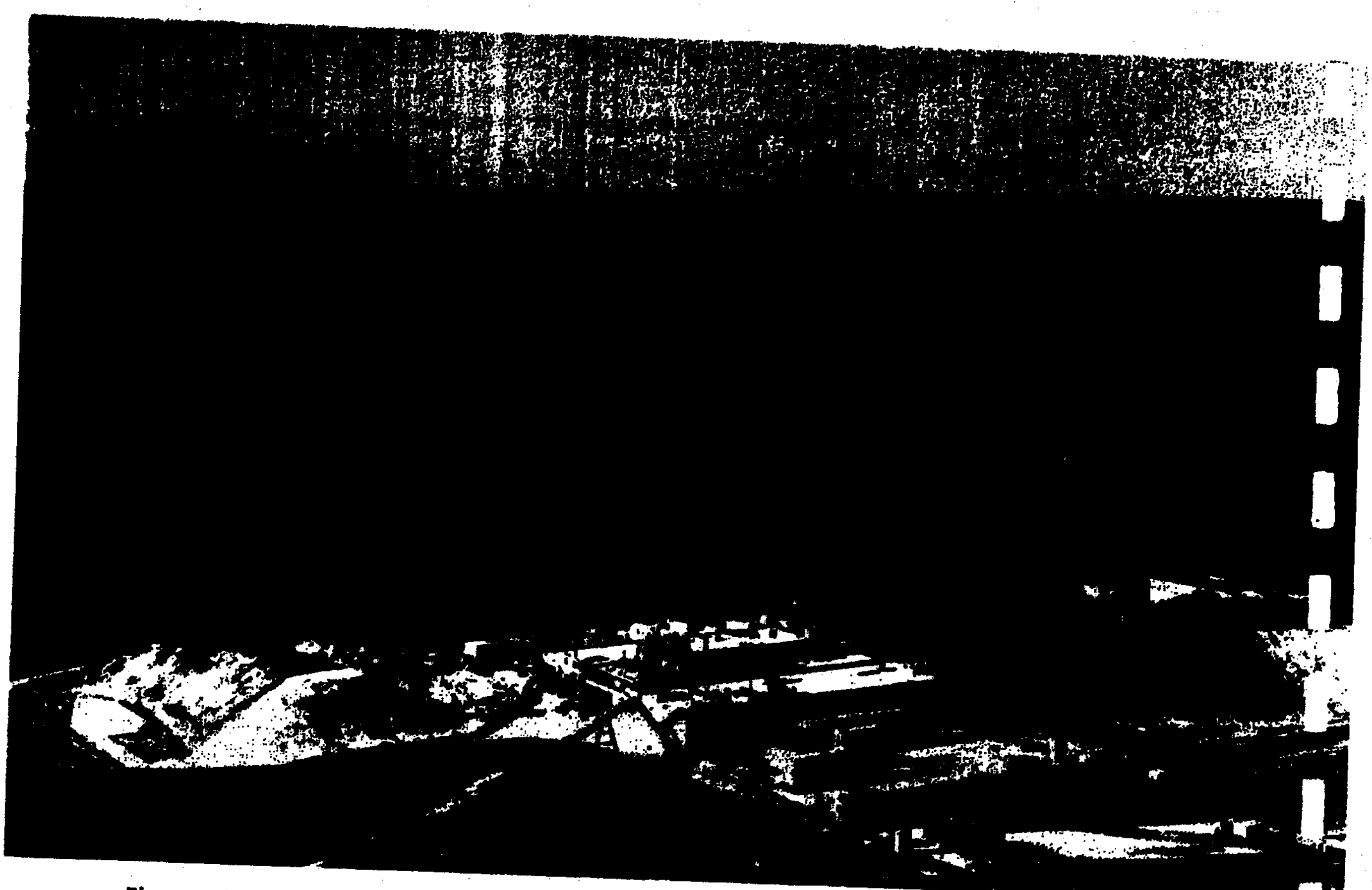


Figure 7. Over-all view of Pad 1 at Point Arguello. Installation of launch monitoring control, and ground handling and service equipment has been completed.

June. Installation of the Pad 2 launch monitoring control system and ground handling and service equipment is in progress.

• **New Boston, New Hampshire,** Tracking and Data Acquisition Station—Design of support facilities for the station has been completed and the project is being advertised for bid. Completion of the support facilities is scheduled for December, with the exception of the radome structure for the UHF antenna receiver No. 2, which is scheduled for completion in August 1961.

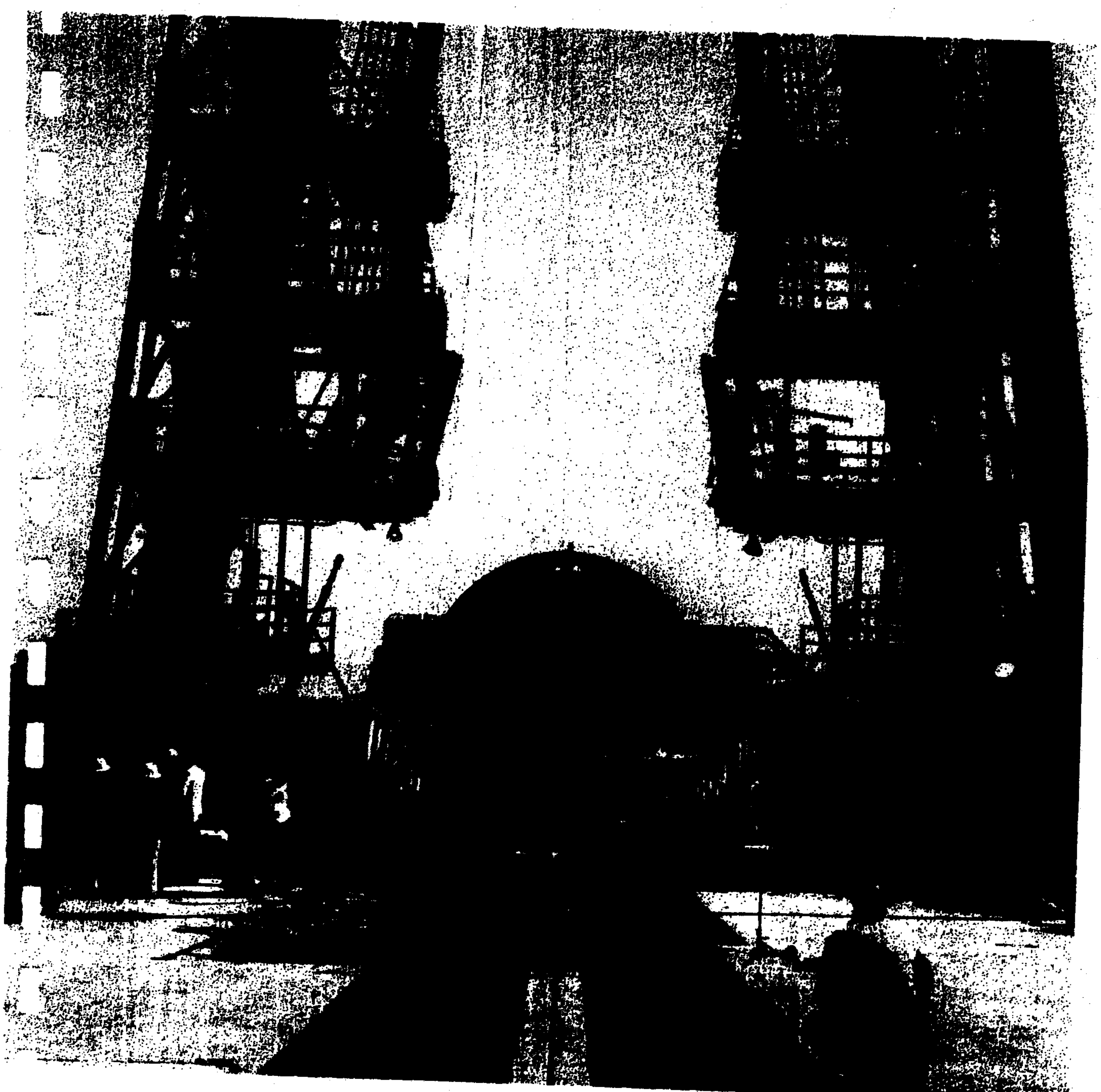
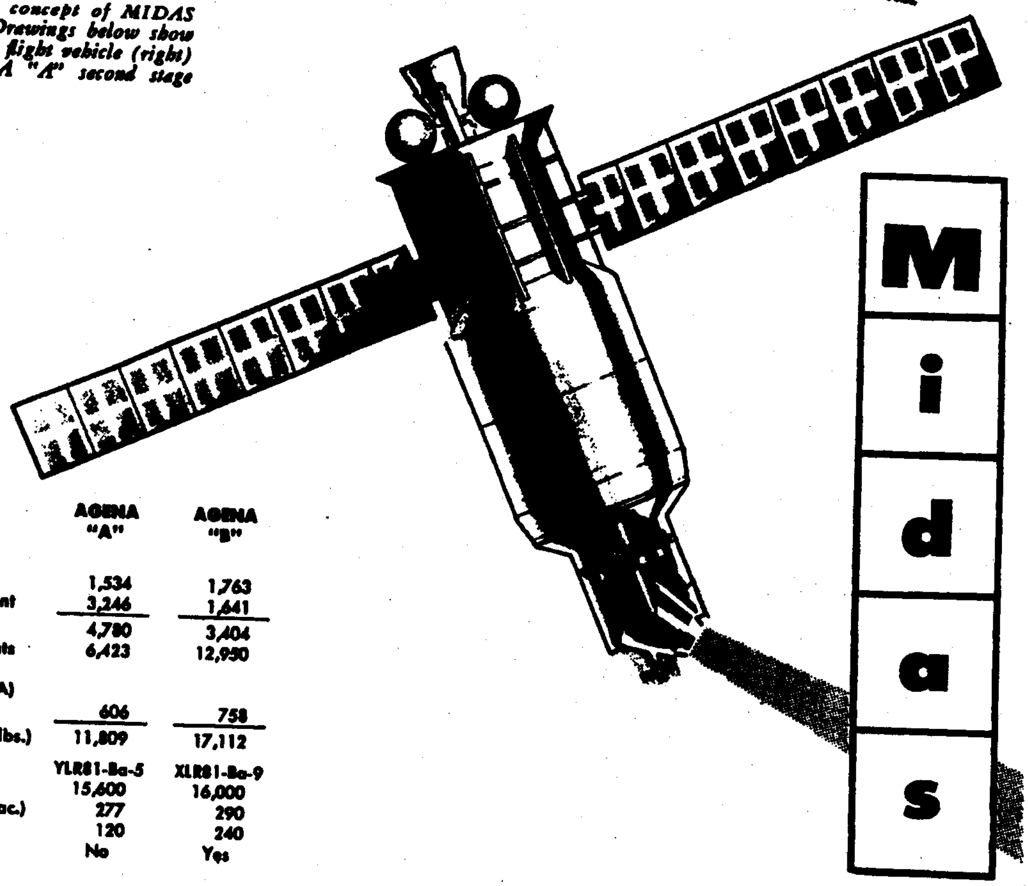
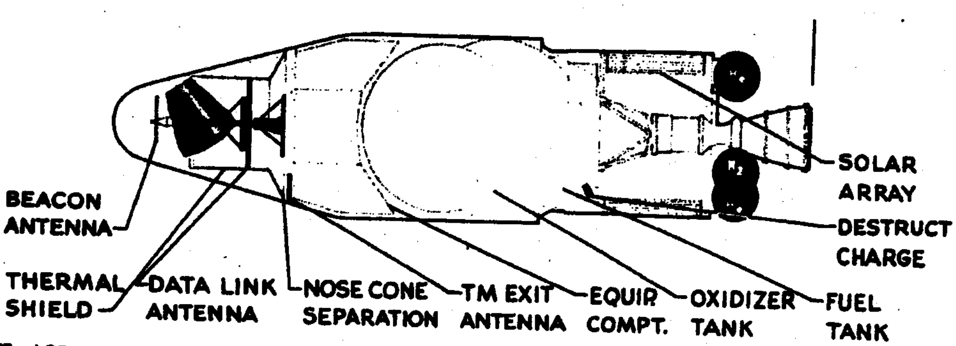


Figure 8. Mockup of the ATLAS booster being mated to the launcher at Pad 1.

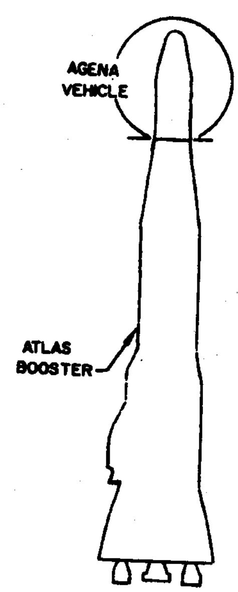
Figure 1. Artist's concept of MIDAS satellite (right). Drawings below show complete two-stage flight vehicle (right) and basic AGENA "A" second stage vehicle (left).



SECOND STAGE	AGENA "A"	AGENA "B"
Weight—		
Inert	1,534	1,763
Payload equipment	3,246	1,641
Orbital	4,780	3,404
Impulse Propellants	6,423	12,950
Fuel (UDMH)		
Oxidizer (IRFNA)		
Other	606	758
GROSS WEIGHT (lbs.)	11,809	17,112
Engine	YLR81-Ba-5	XLR81-Ba-9
Thrust, lbs. (vac.)	15,600	16,000
Spec. Imp., sec. (vac.)	277	290
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

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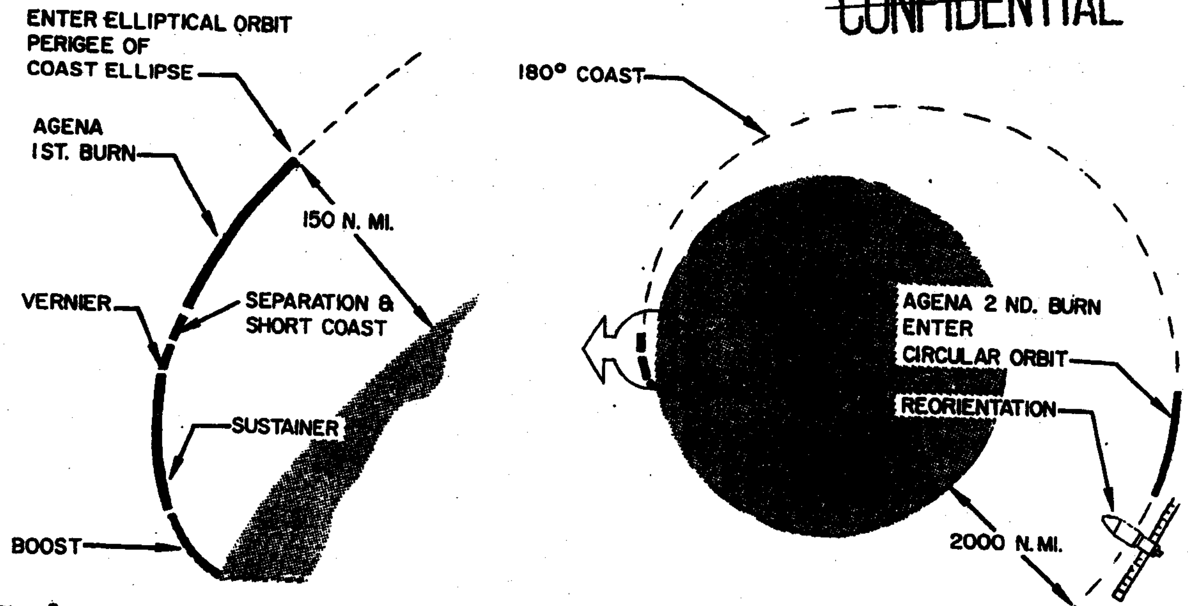


Figure 2.
Launch-to-orbit trajectory for flights 3 and subsequent. Optimum ATLAS boost, guided by radio-inertial system. AGENA ascent (coast, burn, coast, second burn) provides attitude reference. Also governs velocity magnitude and direction by inertial guidance system monitored by horizon scanner.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

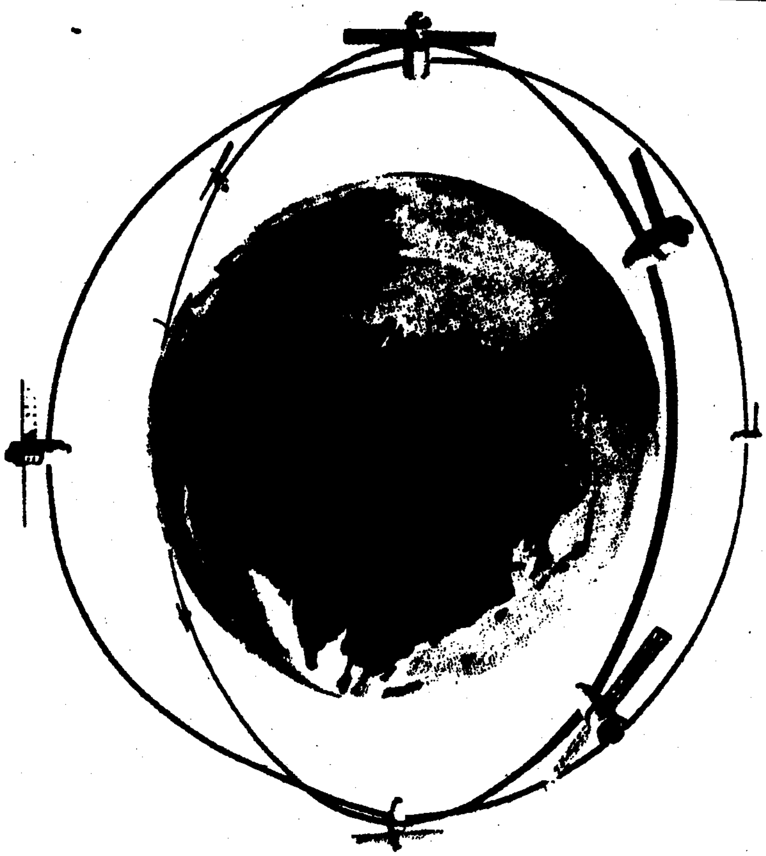
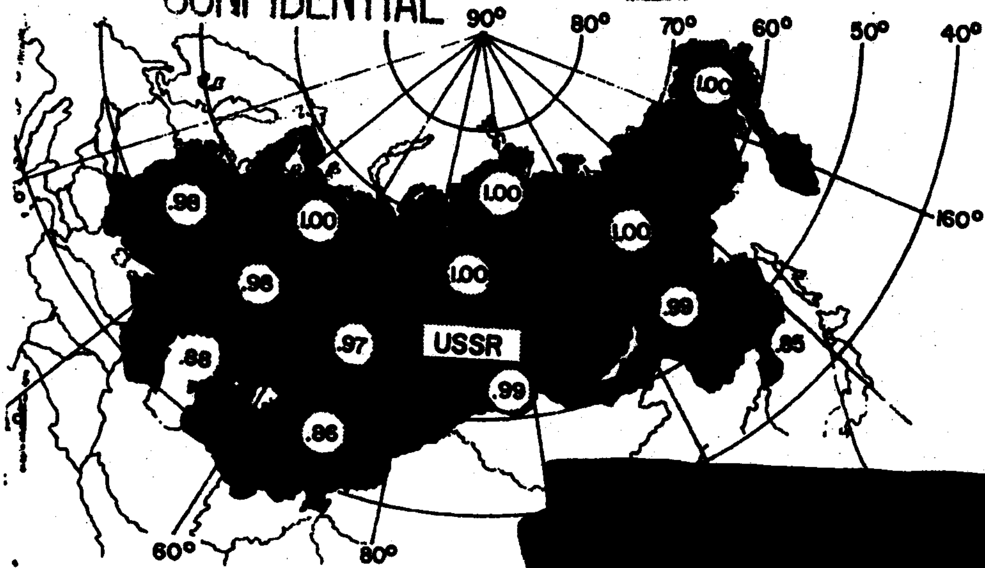


Figure 3.
Proposed MIDAS system. Four satellites spaced equidistant in each of two orthogonal planes at 2,000 n.m. altitude. Provides maximum coverage of USSR with minimum number of satellites.

PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared 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 should make possible the achievement of an operational system by 1963.



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

[redacted]

gure 4.
biting satellites detect infrared radiations itted by Soviet ICBM's in powered flight. ta telemetered instantaneously to MIDAS ntrol Center via far north readout stations. coded data reveals approximately the num- r of missiles launched and launch location, ection of travel and burning characteris- s. Map above shows probability of at least e MIDAS satellite detecting an ICBM nch in each of the illustrated segments of USSR. These probabilities are based on ometric considerations.

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 used the AGENA "A" vehicle 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 polar orbit.

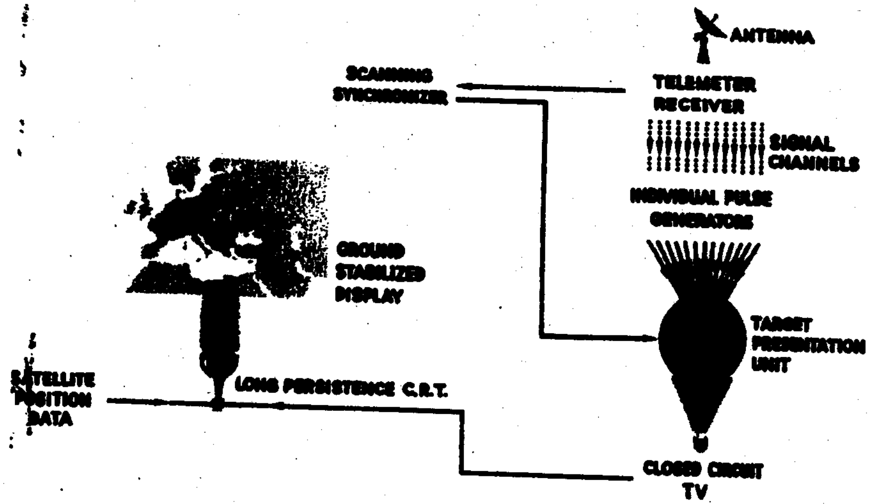
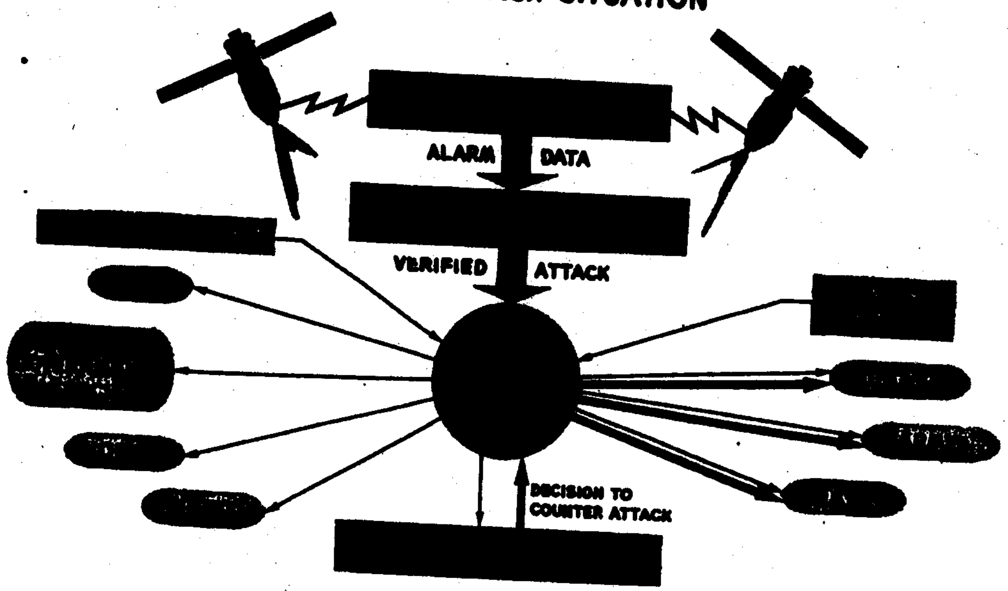


Figure 5.
Simplified version of ground presentation system (left) for display of infrared reconnaissance data. The data is displayed on a TV monitor with a map overlay. The chart below shows data flow from the readout stations to decision-making agencies. The MIDAS Control Center, or other using agencies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

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.

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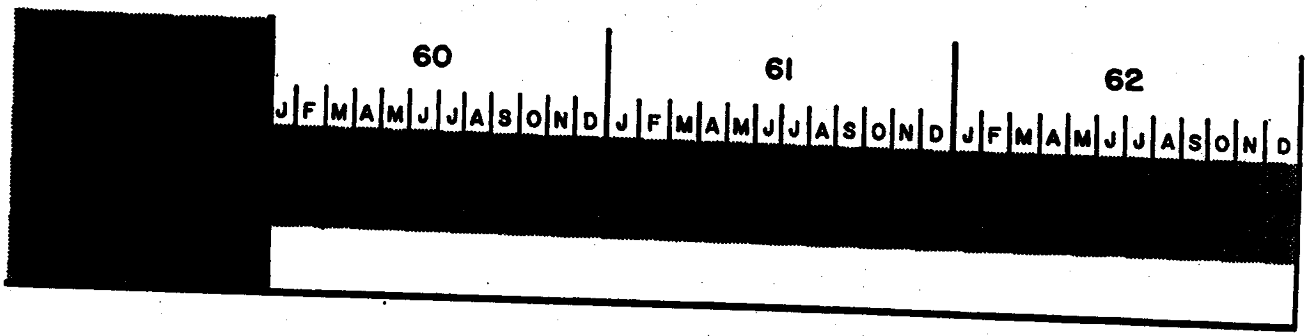


MIDAS Launch Schedule

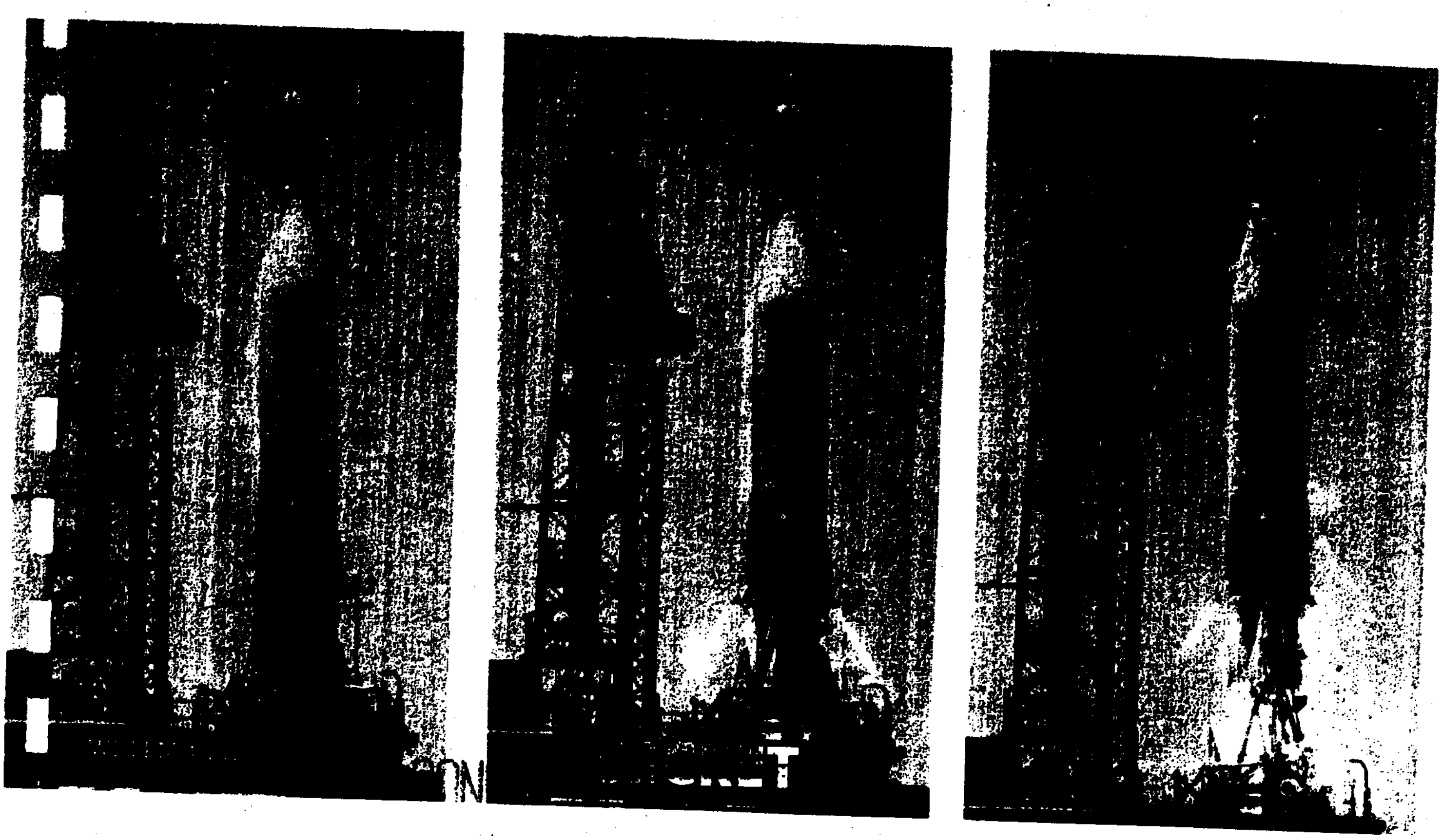
Monthly Progress—MIDAS Program

Flight Test Progress

- The second MIDAS flight test vehicle was launched from Pad 14, Atlantic Missile Range, at 1036 hours, PST, on 24 May. The countdown proceeded smoothly except for minor holds. Performance with respect to programmed orbital parameters was outstanding. Acquisition was accomplished by every station.
- The high degree of success achieved in the launch phase is demonstrated by the comparison of programmed actual figures for ascent and orbital parameters given in Tables 1 and 2.

PARAMETER	PROGRAMMED	ACTUAL
Booster Cutoff	148.8	146.8
Sustainer Cutoff	238.9	238.5
Vernier Cutoff	256.7	257.6
AGENA Ignition	551.6	551.1
AGENA Cutoff	661.1	660.0

TABLE 1. ASCENT PARAMETERS
(Times shown are in seconds)



PARAMETER	PROGRAMMED	ACTUAL
Apogee	262 N. Mi.	280 N. Mi.
Perigee	262 N. Mi.	254 N. Mi.
Period	94.1 Min.	94.44 Min.
Inclination Angle	32.64°	33.04°
Eccentricity	0.0003	0.0025
Injection Velocity	25,023 fps	25,052 fps
Satellite Life	40 months	
Active (battery) Life	28 days	

TABLE 2. ORBITAL PARAMETERS

● Real-time display at Vandenberg Air Force Base during the first pass indicated satisfactory operation of the Aerojet-General payload. The data recordings of the first two passes, which total approximately thirty minutes of readout time, indicate a considerable amount of infrared background data. This data, unavailable until this flight, on the various levels of natural infrared radiation background will be most beneficial to the design of later vehicles which must identify rocket exhaust temperatures. Payload data recordings have been received from subsequent vehicle passes, are being reduced, and will be analyzed. These results will be reported in next month's report.

Technical Progress

Second Stage Vehicle

● Fabrication of the AGENA "B" vehicle for the third MIDAS flight is behind schedule for a December 1960 launch date. Present work schedules indicate a February 1961 launch for MIDAS III. A review is being conducted to determine if an earlier launch date is possible.

Infrared Scanner Units

Infrared scanner units for flights 3, 4, and 5 are being manufactured by Baird-Atomic, Inc.

● The prototype Baird-Atomic infrared scanner (a flight retrofitable unit) is undergoing the shock and vibration tests portion of the acceptance test cycle at Avco. Delivery of this unit to LMSD is expected to be delayed until mid-July.

● Aircraft radiometer design modifications to provide more general information on background radiation continued at Baird-Atomic.

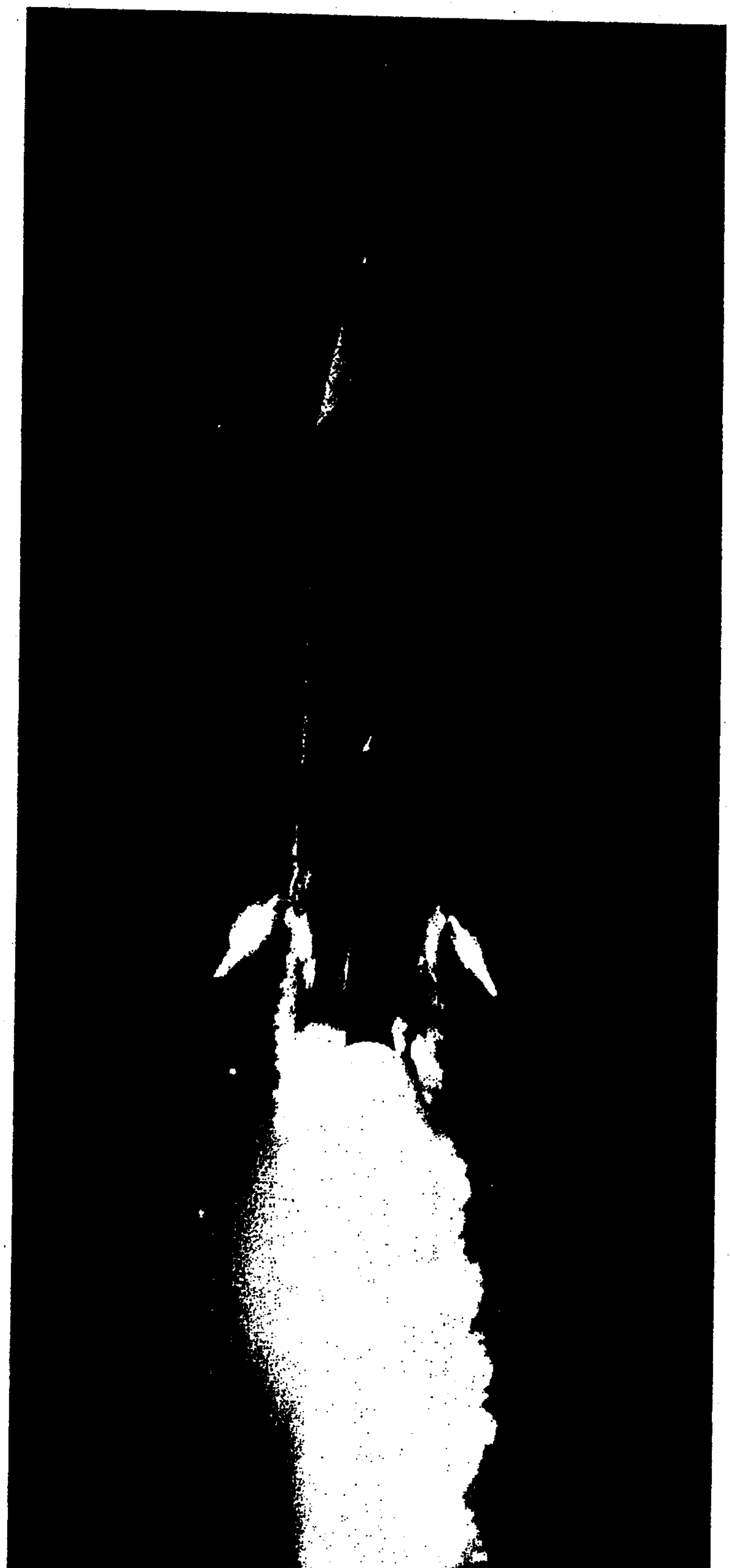


Figure 6. Second MIDAS flight test vehicle following a successful launch from Atlantic Missile Range Stand 14.

- Initial design of the advanced presentation unit for infrared payload ground display continued at General Electric. The first unit is scheduled for delivery in May 1961.

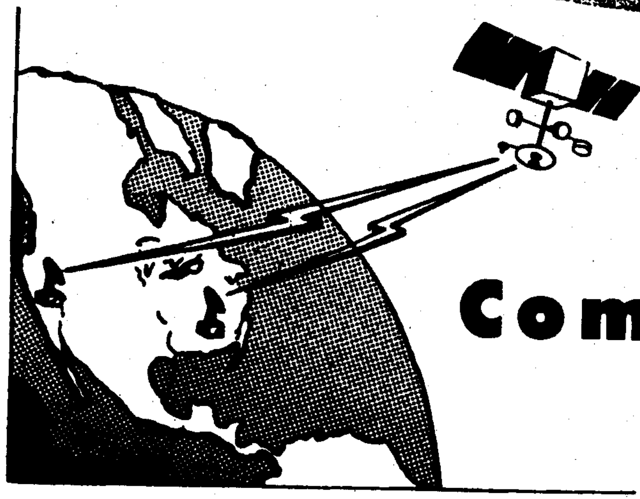
Communications and Control

- Procurement has been authorized for a third Programmable Integrated Control Equipment (PICE) unit for installation in December as part of the interim MIDAS equipment at the New Boston, New Hampshire tracking station. This unit will be identical to the units at the Satellite Test Center (STC) and Vandenberg Air Force Base except for a smaller memory unit and fewer access registers. Commands from the STC to the satellite, orbital predictions and other data are transmitted through the STC PICE to the tracking station PICE for distribution in the station or transmission to the satellite. Tracking, payload data and other data are returned through PICE to the STC for computation, display, or storage.

Facilities

[redacted]

- **North Atlantic Station**—Studies are being continued to locate a suitable site for this station.
- **Vandenberg Air Force Base**—Work on the modification to the data acquisition and processing building to accommodate a revised computer configuration started on 9 May. Completion is scheduled for 16 July.



Communications Satellite

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

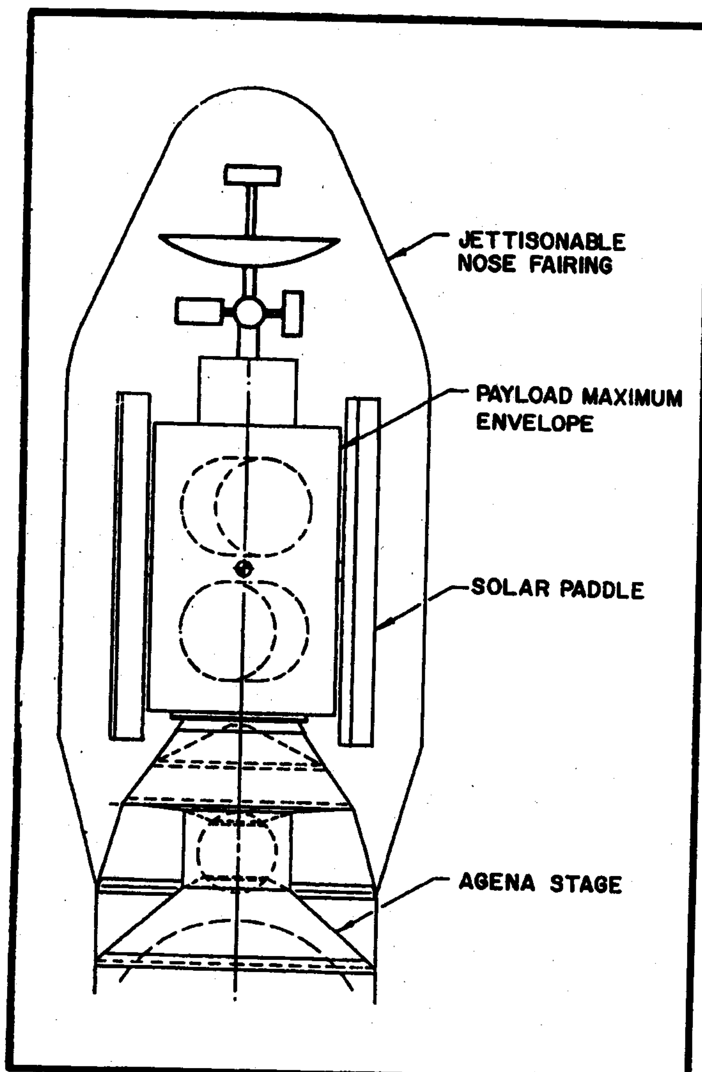


Figure 1. Proposed satellite with jettisonable fairing mounted on AGENA second stage.

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 NASA ATLAS/CENTAUR R&D flights Number 4, 5, and 6.

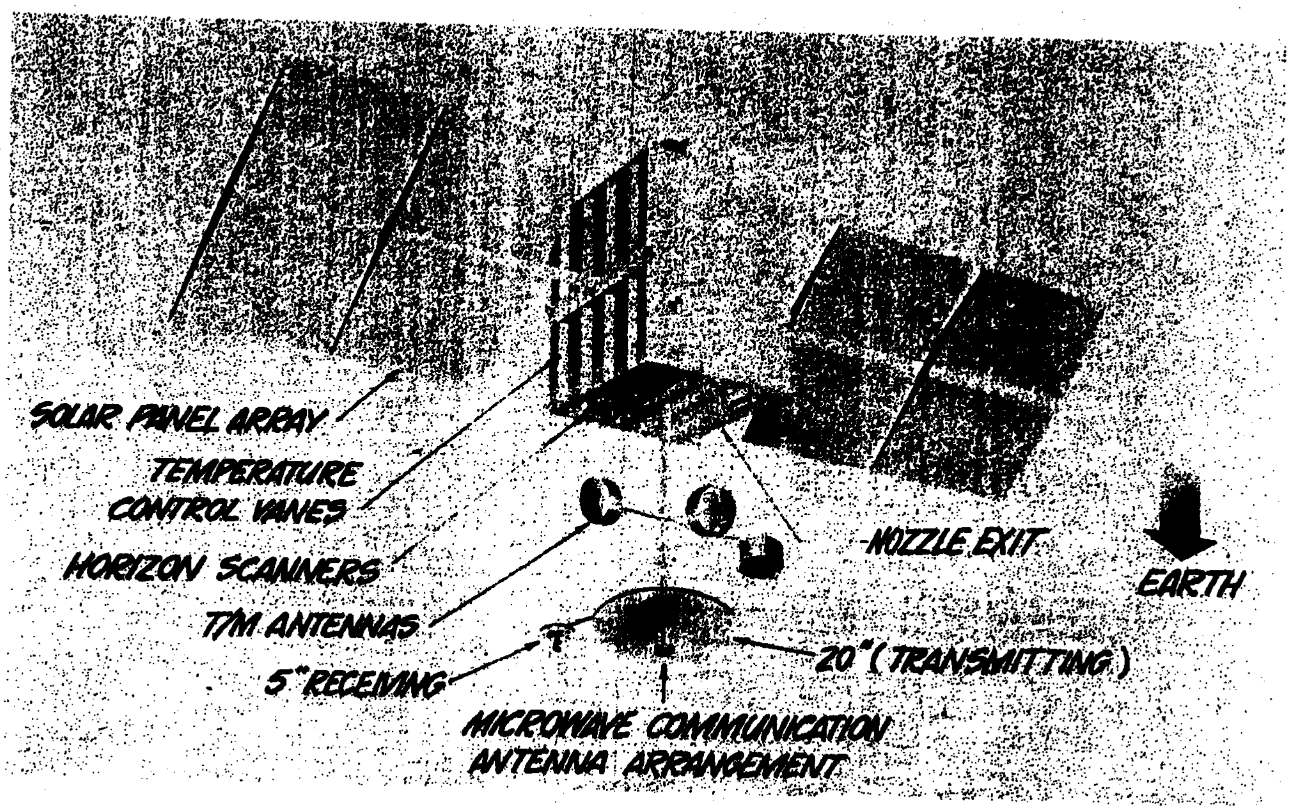


Figure 2. Initial design of final stage vehicle.

Monthly Progress—COMMUNICATIONS SATELLITE Program

Technical Progress

Microwave Communications Equipment

● Representatives of AFBMD, Space Technology Laboratories (STL), and Army Signal Research and Development Laboratory (USASRDL) attended a coordination meeting on 10-12 May. Drafts of work statements were reviewed, satellite interface areas involving the communication equipment were discussed, and consideration was given to contractor relationships.

● A microwave communication subsystem integration meeting was held on 25 May at USASRDL, attended by General Electric, STL and AFBMD personnel. Present scheduling concepts were discussed for compatibility with the program. Critical interface relationships requiring immediate resolution were defined. Plans were formulated for a USASRDL antenna engineer to work directly with G.E. vehicle structure engineers in arriving at a firm configuration.

● Final specifications for ground antenna, ground terminal and satellite terminal have been completed. One contract will be placed for development, fabrication and installation of the 60-foot automatic tracking antenna system for the ground terminal equipment. A second contract will be awarded for the development, fabrication, testing and installation of the microwave communications equipment for the satellite and ground terminals. Work statements and specifications for the antenna were completed and requests for proposals mailed on 24 May. It is expected that requests for proposals on the communications equiment will be mailed to bidders on 3 June.

● Procurement data is being processed for award of a contract to Varian Associates for the development of a prototype high power X-band tube for the ground terminal equipment.

Launch Vehicles

● A summary was prepared for ARPA on the ATLAS/CENTAUR capability to place a final stage vehicle into a 24-hour circular equatorial orbit at 105 15 degrees west longitude assuming various final stage vehicle propulsion capabilities. Results with propulsion capability of zero and 1000 feet per second are given in paragraphs 1 and 2, respectively, as follows:

1. Assuming a launch trajectory in which CENTAUR second burn period occurs at the first northerly crossing of the equator; and with zero velocity deficiency, the ATLAS/CENTAUR combination can place 818 pounds into orbit with a 3-sigma certainty of success. The estimated weight of an R&D final stage vehicle with zero propellant for velocity deficiency, and with no capability for lunar perturbation compensation is 806 pounds. This system does not provide an operational indexing capability.

2. Assuming a launch trajectory in which CENTAUR second burn period occurs at the first southerly crossing of the equator, and with 1000 feet per second velocity deficiency at separation, this vehicle combination can place 1170 pounds into orbit with a 3-sigma certainty of success. The estimated weight of an R&D final stage vehicle with propellant to make up a velocity deficiency of 1000 feet per second, and with no propellant for lunar or solar perturbation compensation is 988 pounds. This system does provide an operational indexing capability.

Final Stage Vehicle

● A work statement has been completed in rough draft form to reorient the General Electric Company final stage vehicle contract in accordance with the 24-hour mission defined in Amendment No. 5. The draft has been coordinated informally with ARPA, General Electric, USASRDL, and AFBMD. Although final coordination has not been accomplished, this work statement and its annexes will require very little revision when a development plan has been approved, assuming no major reorientation of the program.

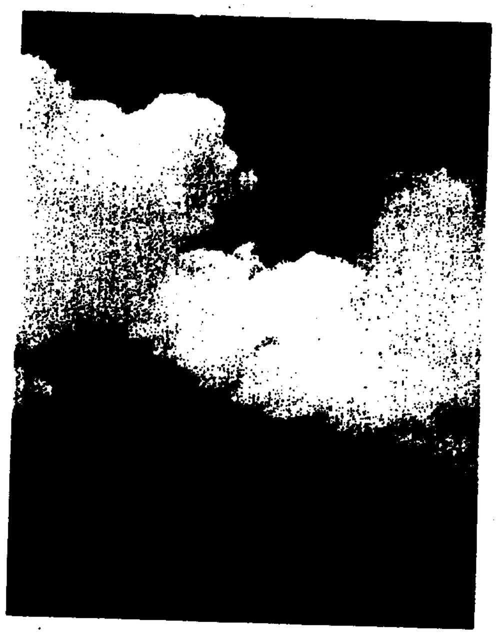
● A report has been completed on a feasible technique for attitude stabilization and earth reference acquisition of the final stage vehicle following second stage separation. The acquisition technique developed in the report is being simulated on an analog computer to analyze quantitatively the over-all system behavior for variations in the filter characteristics and in internal disturbances.

● A study has been completed and a report is being prepared of the cumulative effects (stored momentum per orbit) of solar radiation pressure on the final stage vehicle. Equations were derived both in terms of body coordinates and internal coordinates. The second approach yields a simpler expression, but still requires numerical integration for quantitative results.

Ground Stations

● Site surveys have been initiated on the East and West coasts of the United States to determine suitable locations for ADVENT ground stations. Topographical studies of the middle Atlantic area are being made by air to insure meeting the line-of-sight requirements.

SPACE



projects

- ABLE
- TRANSIT
- COURIER
- TIROS
- MERCURY
- 609A
- DYNA SOAR

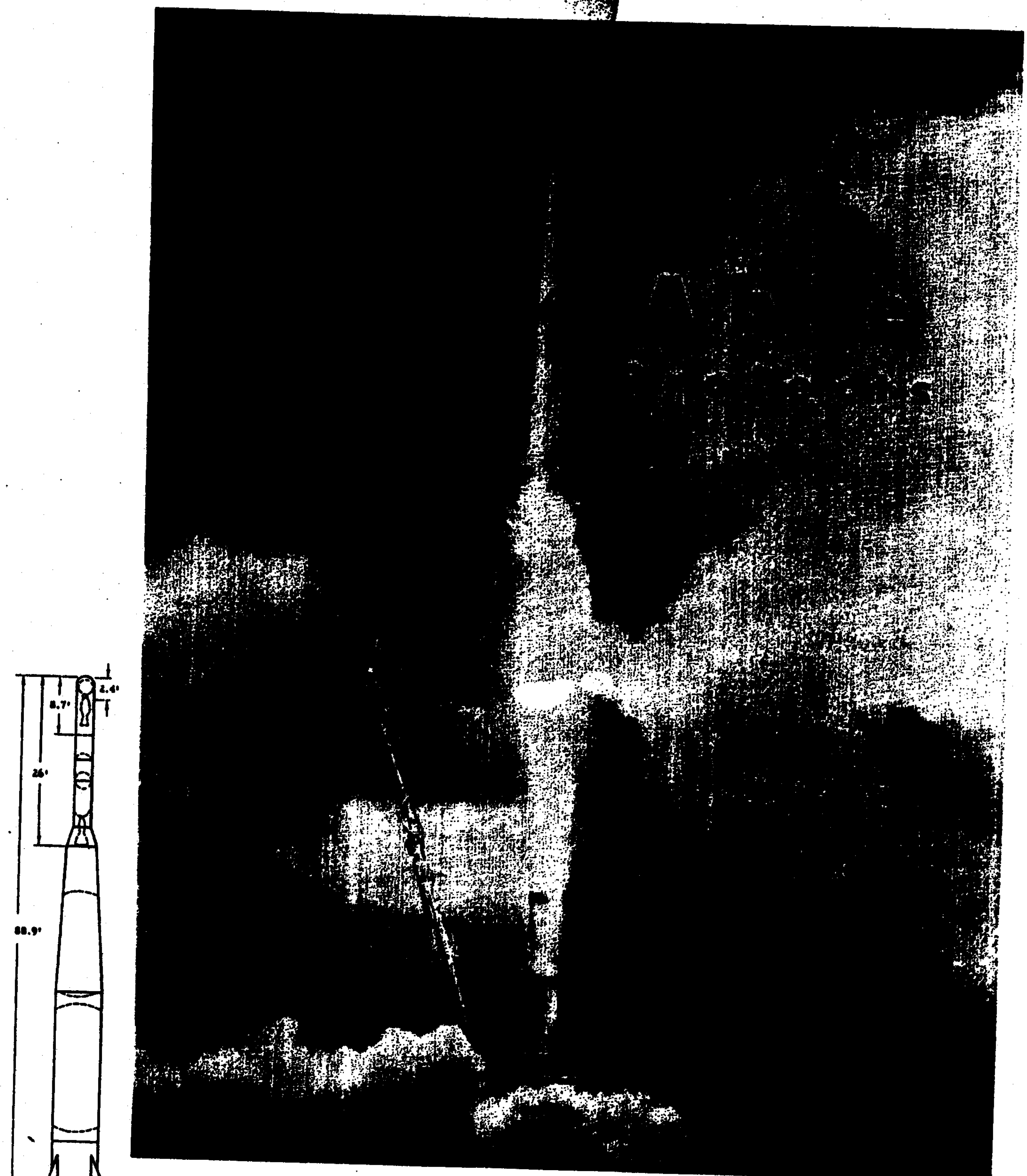


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.

Flight tests of the three ABLE-1 vehicles in 1958 confirmed the feasibility of using this three stage vehicle to launch satellite payloads on interplaneary space probe missions. Objectives of the ABLE program were further defined in AFBMD proposals submitted to NASA and ARPA late in 1958. In October 1958 NASA, given cognizance over the effort, requested AFBMD to proceed with the ABLE-3 and two ABLE-4 projects. In February 1960 NASA authorized the two-flight ABLE-5 (ATLAS boosted) program. The lunar satellites will be launched late in 1960. General objectives included demonstration of vehicle and communications capability and performance of scientific research experiments over interplanetary distances. A four stage vehicle was selected consisting of a THOR or ATLAS first stage, an ABLE second stage, ABL 248 solid propellant third stage and the satellite vehicle fourth stage. A hydrazine engine with multi-start capability was developed for the ATLAS boosted vehicles to permit midcourse vernier control and to provide controlled thrust to inject the vehicle into orbit about another planet. Solar cell auxiliary power equipment was developed with a useful life period in excess of one year. An extensive network of ground support stations was established, the most powerful of which is the 250-foot antenna at the Jodrell Bank Experimental Station, University of Manchester, England. Central control and data computation is accomplished at the Space Navigation Center, Los Angeles, California, with other military and NASA centers assisting in tracking and telemetry according to the specific requirements of each mission. The flight histories of ABLE-1, ABLE-3, ABLE-4 ATLAS and ABLE-4 THOR are summarized in the following paragraphs, followed by a description of the ABLE-5 projects.

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 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 propagaton. A wealth of valuable data was obtained from

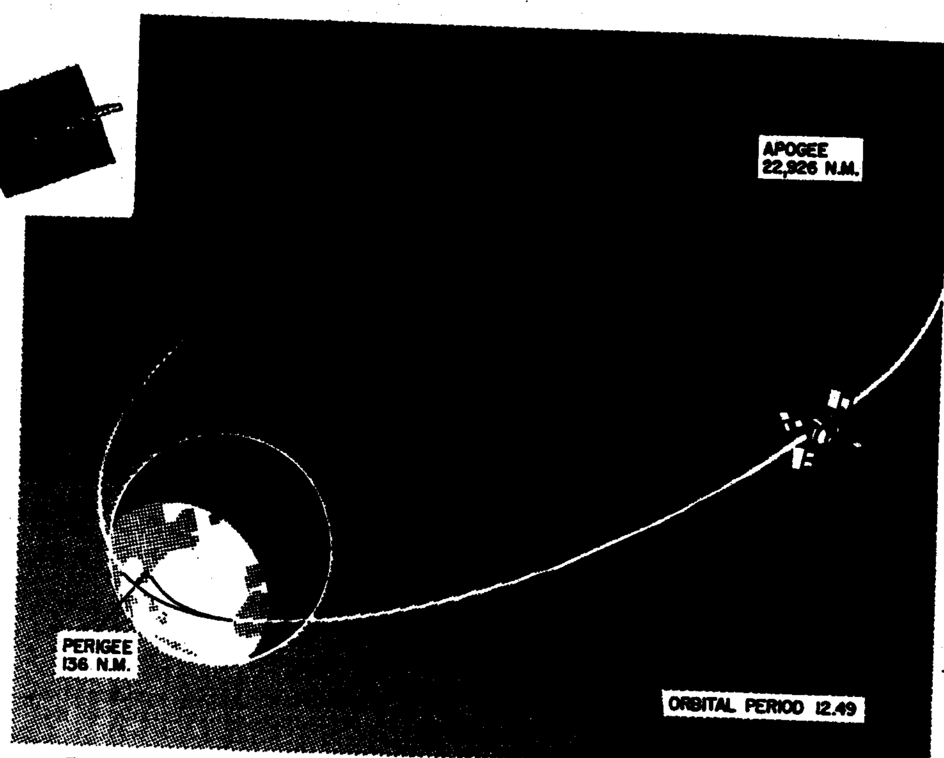


Figure 2. ABLE-3 third stage and payload (above) with solar paddles fully extended. Drawing of extremely elliptical orbit achieved by ABLE-3 (EXPLORER VI).

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 vehicle was launched on 11 March from the Atlantic Missile Range and succeeded in placing the PIONEER V satellite into a solar orbit. At its closest approach to the sun, the satellite will pass near the orbit of Venus, and return to intersect the orbit of earth at its greatest distance from the sun. The vehicle consisted of a THOR first stage, ABLE second stage with AJ10-101 liquid fueled propulsion system and an STL guidance system, and an ABL248A-3, solid fuel third stage. The 95 pound payload contains instrumentation for conducting

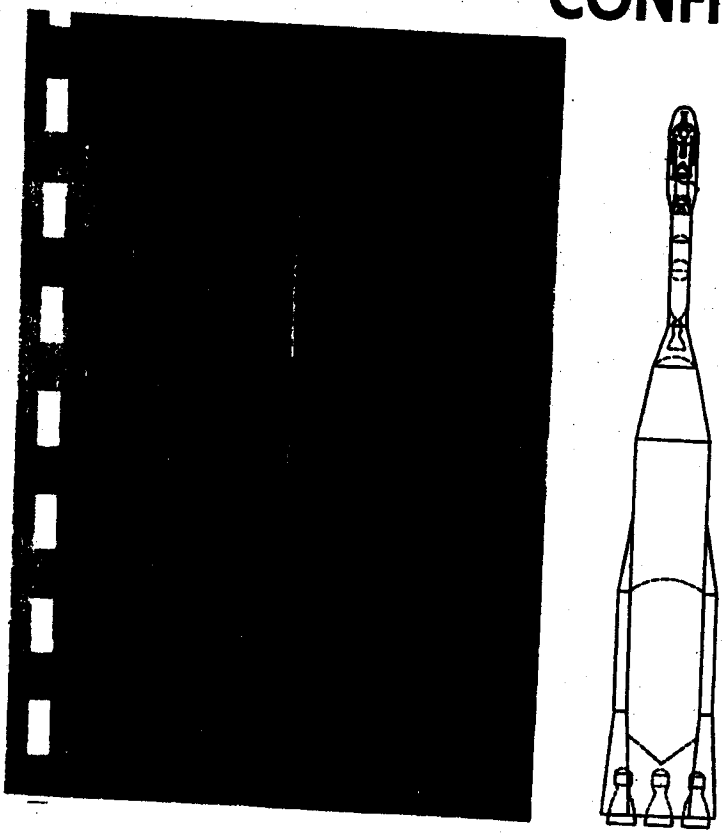


Figure 3. ABLE-4 ATLAS vehicle configuration drawing and photo of vehicle installed on AMR launch pad.

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 sufficint 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 approximately 48 seconds after launch. The ATLAS performed as planned over its entire powered flight trajectory. The trajectory of this flight, from the Atlantic Missile Range to the vicinity of the moon, was established to achieve the tightest possible circular lunar orbit consistent with the highest probability of success. The final burnout conditions were to have provided an inertial velocity of 34,552 feet per second. The payload was designed to investigate space environment and propagation effects and to

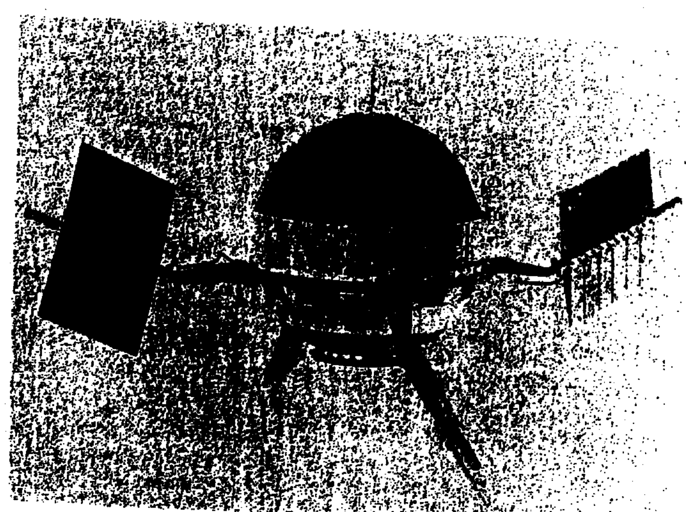
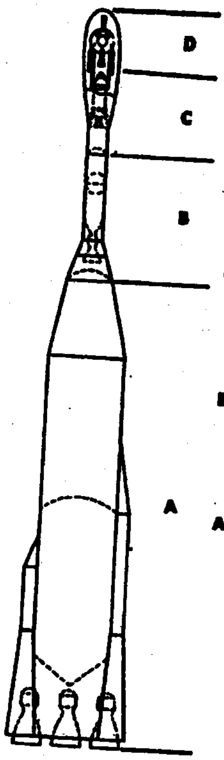


Figure 4. PIONEER V satellite vehicle shown in orbital flight position. This solar satellite was launched from AMR on 11 March 1960.



D. Satellite Vehicle	
Gross Weight	371.6 lb
Gross Weight (Burnout)	233.6 lb
Specific Impulse (vac)	230 sec
Thrust (vac)	18.3 lb
C. THIRD STAGE ABL 248-A9	
Gross Weight	897.4 lb
Gross Weight (Burnout)	432.7 lb
Specific Impulse (vac)	250.5 sec
Thrust (vac)	3100 lb
B. SECOND STAGE AJ 10-101	
Gross Weight	5107.3 lb
Gross Weight (Burnout)	1816.1 lb
Specific Impulse (vac)	268 sec
Thrust (vac)	7575 lb
A. FIRST STAGE ATLAS "D"	
Gross Weight	266,390 lb.
Gross Weight (Burnout)	11,790 lb
Thrust (S. L.)	316.5 sec
Specific Impulse (vac) Sustainer	81,863 lb
Thrust (vac) Sustainer	290.6 sec
Specific Impulse (vac) Booster	251 sec
Specific Impulse (S. L.) Booster	367,787 lb

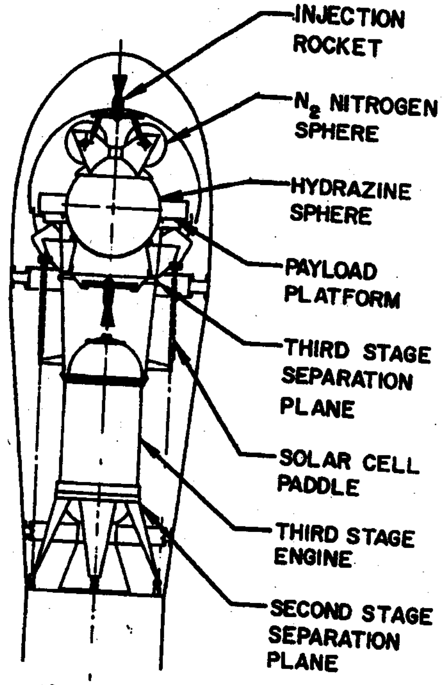


Figure 5. ABLE-5 vehicle configuration drawing and specification list. Third stage and payload configuration (right). Trajectory of ABLE-5 into lunar orbit is shown in drawing (below).

scientific experiments related to magnetic field and radiation phenomenon in deep outer space. Also included in the satellite is a 150-watt transmitter which is expected to permit communications between the satellite and earth over an approximately 90 million mile range.

ABLE-5

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

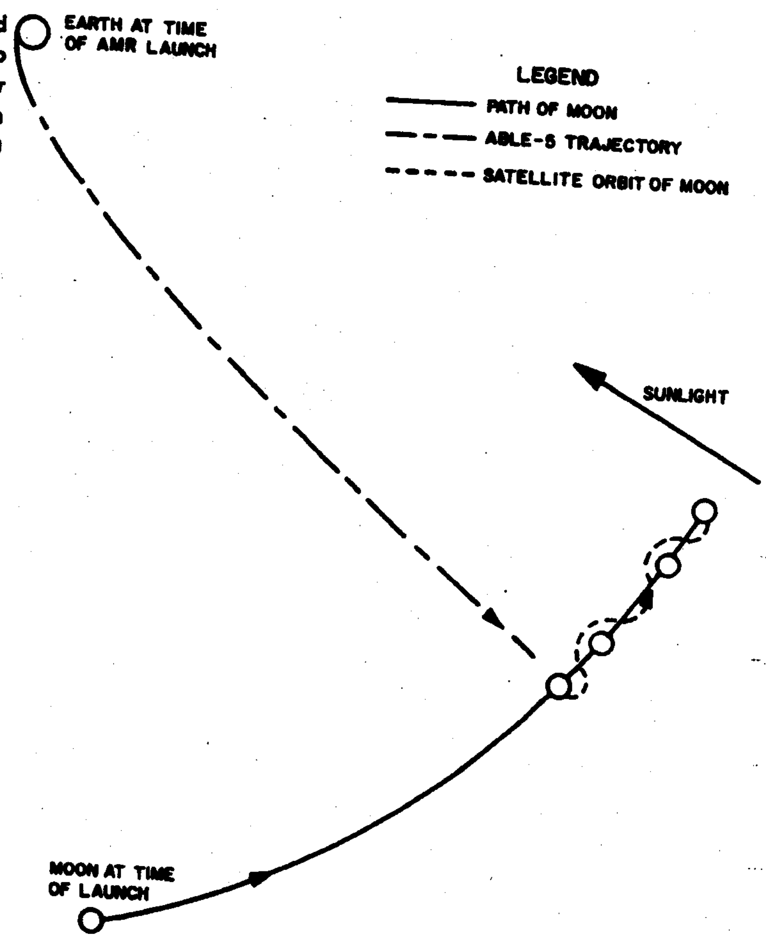
Program Objectives

1. Place a satellite into lunar orbit with an apogee of 3,000 nautical miles and a perigee of 2,000 nautical miles.

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

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

4. Successful conduct of payload experiments.



Program Vehicle **(see figure 5)**

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

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

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

Fourth Stage (Satellite Vehicle)—Space Technology Laboratories designed, incorporating an injection rocket capable of being restarted four times to increase payload velocity and two times to decrease payload velocity. The satellite also contains a telemetry system (capable of continuous operation), four solar cell paddles, and scientific equipment for conducting the experiments. Satellite vehicle weight is 371.6 pounds.

Launch and Powered Flight

These vehicles will be launched from the Atlantic Missile Range on a true azimuth of 92.5 degrees. ATLAS performance parameters have been based on results obtained from series D R&D flight tests. Parameters for all four stages are shown on figure 5. Final burnout is programmed to occur 23,290,000 feet from the center of the earth at an inertial velocity of 34,552 ft./sec.

Orbital Characteristics

Major Axis	0.209848 x 10⁹ feet
Eccentricity	0.245859 degree
Orbital period	765.4 minutes
Apolune	4,303 nautical miles
Perilune	2,605 nautical miles
Duration of eclipses	less than 90 minutes

Payload Experiments **(See table 3)**

Scintillation Counter and Pulse Height Analyzer—measure electron energy (greater than 50Kev per particle) and proton energy (greater than 1.0Mev per particle).

Ion Chamber and Geiger-Muller Tube—flux and rate data for electron particles (greater than 1.25 Mev per particle) and proton particles (greater than 25 Mev per particle).

Proportional Counter Experiment—measure integrated intensity of cosmic ray particles: electrons (greater than 12 Mev per particle) and portons (greater than 70 Mev per particle).

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

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

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

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

Ground Support Program

Atlantic Missile Range—track vehicle for first 14 hours after launch (except for a three hour period starting a few minutes after liftoff), provide ATLAS guidance, provide first vernier correction for payload stage.

Manchester, England—track vehicle for 7 hours, starting 13 minutes after launch, provide second vernier correction for payload stage (and additional corrections as required).

South Point, Hawaii—Transmission of commands, including vernier corrections as necessary.

Millstone Hill, Massachusetts—track vehicle for 7 hours, starting 13 minutes after liftoff.

Other support stations include, Singapore, Goldstone, JPL and NASA stations, and the SPAN center at Los Angeles.

Monthly Progress—ABLE Projects

ABLE-4 THOR (PIONEER V SATELLITE)

The PIONEER V satellite was placed into an elliptical solar orbit on 11 March as soon as it escaped from the earth's gravitational pull. On 25 May, the satellite was 11,919,700 miles from earth and was traveling at a velocity (relative to the earth) of 11,380 miles per hour.

Telemetry

- On 16 May, a definite decrease in the amount of transmission prior to undervoltage cutoff was noted. All evidence indicates a failure of one of the two battery packs supplying power to the transponder. With this reduced power the satellite is capable of a total of approximately 50 minutes of 5-watt transmission each day. Two of the five transmission periods each day are "blind" since the Hawaiian station is unable to receive satellite telemetry via its 60-foot antenna. Manchester reception is averaging 10 to 15 minutes per period, at a rate of 1 pulse per second.

- As of 25 May, PIONEER V has been in space for 1810 hours. The 5-watt transmitter had been operated for a total of 123 hours and the 150-watt transmitter for approximately 15 minutes. The 150-watt transmitter will be commanded "ON" when reception at Manchester from the 5-watt transmitter is no longer usable.

- The automatic undervoltage control in PIONEER V was activated twice on 3 May when Manchester was tracking. Abrupt termination of the signal at a time when battery voltage was calculated to be low was a strong indication of undervoltage cutoff. In both cases, however, Manchester waited a few minutes for the battery voltage to regain some strength and then commanded the payload transmitter "ON" for one minute in order to be certain that it was the undervoltage relay operation and not a component failure that stopped transmission. This brief tracking exercise presages tracking conditions of the future since the "OFF" command was sent before the response to the "ON" command was heard.

Solar Flare Activity

- On 28 April, the Enrico Fermi Institute of the University of Chicago alerted the SpaN Network to the existence of extraordinary solar flare activity in outer space. The transmission schedule for PIONEER V was altered to permit this solar phenomena to be examined in maximum detail. Since the satellite was 4 million miles closer to the sun than was the earth at that time, it is anticipated that much valuable information will be obtained from telemetry during this period.

ABLE-5

First Stage

- The tentative acceptance date for ATLAS 80D is 6 July. Although this date represents a three week slippage in schedule, it is compatible with program requirements. ATLAS 91D is in the initial stages of fabrication.

Second Stage

- Fabrication of the relay junction box type-test unit and first flight unit is 75 and 50 percent complete, respectively. The first flight harness is 60 percent complete. All electrical system drawings have been released.

Third Stage

- At a meeting of representatives from AFBMD/NASA and Space Technology Laboratories the over-all performance of the ABL X248 was reviewed. As a result of this meeting the specification for the X248A-9 engine was revised to require that the propellant charges be manufactured from a single lot of casting powder and that tighter controls be maintained on the casting powder temperature during the engine manufacturing process. To further assure reproducibility of the flight engine, AFBMD was requested to procure two additional engines for quality assurance and performance evaluation tests at Arnold Engineering Development Center (AEDC).

- A list of procedures required for the ABLE-5 field operation has been prepared and published. Work is progressing on the over-all systems test procedure for ABLE-5. Included are the flight systems test and the guidance-link loop test.

- The first control compartment has been delivered and is being assembled as a structural test unit. Delivery is expected in one week.

Payload

- The first production solar cell modules were exposed to a severe type-test environment, including a −200°F temperature shock test followed by sustained exposure in the low-temperature environment. On completion of the test, it was noted that some cracking of the filter glass occurred because of the low temperature. Although these cracks have little effect on the conversion efficiency, improvement of the adhesive which will eliminate this problem is underway. In addition, internal failure of the solar cells as a result of the sustained exposure to low temperature has been observed. This known characteristic of the solar cells has resulted in selection of a lunar orbit which will minimize the duration of eclipses.

● Sonotone has delivered one hundred cells for the payload batteries. These cells have been graded on the basis of results obtained in two charge-discharge tests. The batteries for the type-test payload have been fabricated and were delivered for installation in the payload. A general evaluation test plan, modified as a result of the PIONEER V battery performance data, has been prepared to determine the degradation effect on nickel-cadmium batteries of vacuum, temperature, cycling and overcharging. A battery is being prepared for use in a thermally controlled vacuum test duplicating the actual PIONEER V duty cycles. The balance of the cells for the ABLE-5 batteries has been ordered.

● A test program for the temperature control units has been established and is reflected in the specification for these units. Rework of rejected temperature control units can be accomplished without significantly affecting the fabrication of complete temperature control systems.

● The problem of payload antennas heating during operation of the vernier or injection motors has made a redesign of the payload antenna system necessary. The antennas will now consist of nickel-plated stainless steel. Delivery of this new antenna will not delay payload assembly and test.

● ABLE-4 command receivers were converted to the ABLE-5 configuration and have completed environmental qualification tests. Work has continued on the 2-watt transmitter for ABLE-5 and six units are now ready for environmental tests. Modulation and frequency stability problems discovered during early testing have been remedied.

● The specification for converter No. 1 has been revised to reflect the latest changes imposed on this converter as a result of PIONEER V experience. Three No. 1 converters have been delivered. One has successfully completed environmental type testing; the two flight units are undergoing acceptance testing at this time. Three No. 2 converters have been delivered to the transmitter group for detailed electrical tests.

● The type-test digital decoder, which was constructed from spare ABLE-3/-4 components, has been completed and is available for installation in the type-test payload. The fabrication of new units is on schedule.

● It has been decided to incorporate a 2,000 psi nitrogen bottle into the payload propulsion system. Lead time on procurement of this bottle requires that a dummy be utilized in the type-test payload. No schedule slippage for delivery of the propulsion system to the payload resulted from this design change. A surge chamber has been incorporated into the Conax valve clusters. Five complete tests of the four start engine system and six tests of the two start system have been completed without failure. Additional tests are planned.

● Vibration tests of the ABLE-4 spare payload structure, reworked to an approximate ABLE-5 configuration, were conducted to confirm the suitability of the ABLE-5 payload structural modifications under vibratory loads. A test was made to determine effectiveness of Aqua Plaz (a paint-like coating) in reducing high frequency vibration levels at the equipment shelf. Some reduction was experienced and use with type-test and flight payloads will be considered. A soft interstage joint which performed satisfactorily in earlier tests also is under consideration.

● Errors arising during the uncontrolled portion of the trajectory have been reevaluated for the ABLE-5 configuration. To reduce this source of error to a practical minimum, if any changes are made to the payload following the preacceptance test balance operation, it is planned to rebalance the payload prior to launch.

● The sequence of payload release from the third stage was reevaluated resulting in the recommendation that payload separation be accomplished as close to third stage burnout as possible. The present flight sequence has been modified and payload separation is programmed to occur fifteen seconds after third stage burnout. A zero "g" experiment to observe the motion of the third stage and connected payload after third stage burnout is being considered. This test, if conducted would provide additional confidence that the selected payload separation time is suitable.

Ground Support Equipment

- The ground station equipment for ABLE-5 remains essentially the same as ABLE-4 except for replacement of digital telemetry punches with more reliable punches and improvement of threshold sensitivity for digital telemetry.

- The design of Test Van No. 4 is approximately 90-percent complete. The chassis and body of the van have been delivered. The electrical equipment racks are currently being installed. The design of ABLE-5 power control and monitor equipment for the van subsystem panels is approximately 90-percent complete. Modifications to existing ABLE-4 equipment is in progress. Checkout has started on primary units consisting of launch control panel, relay drawer and van distribution rack.

Guidance Equations

- Two sets of guidance equations were completed during the month, except for constants. The first set covering the ATLAS sustainer phase will have all constants selected by the end of June. The second set of guidance equations covering the ABLE stage will have all constants selected by the end of July.

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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

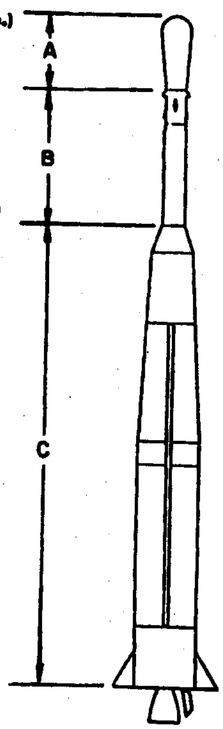
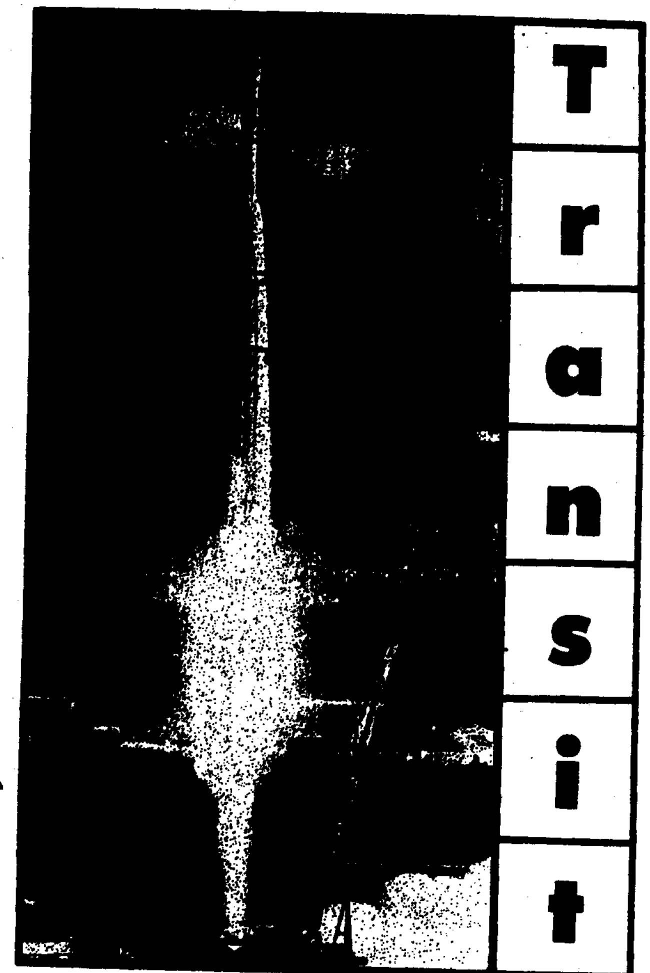


Figure 1. TRANSIT IA three stage flight vehicle.



TRANSIT IA launched from Atlantic Missile Range

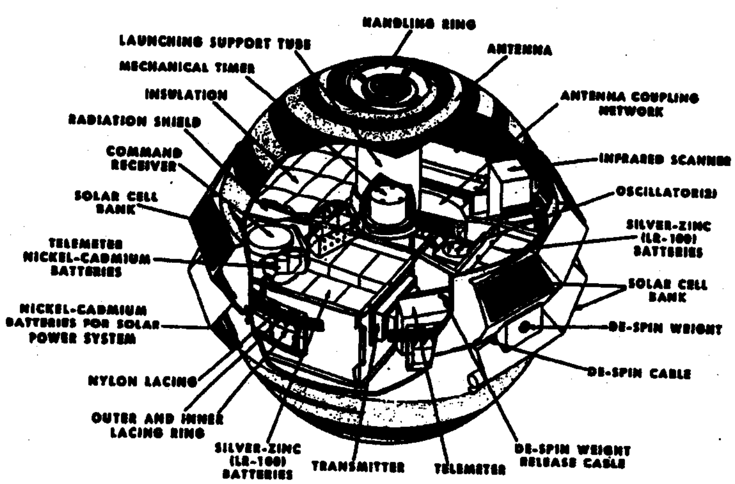
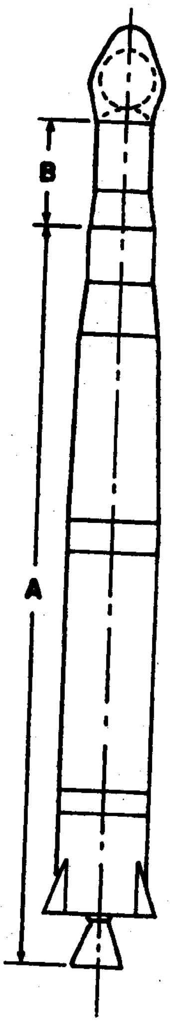


Figure 2. Cut-away drawing of TRANSIT IA payload (NAV 1).

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.

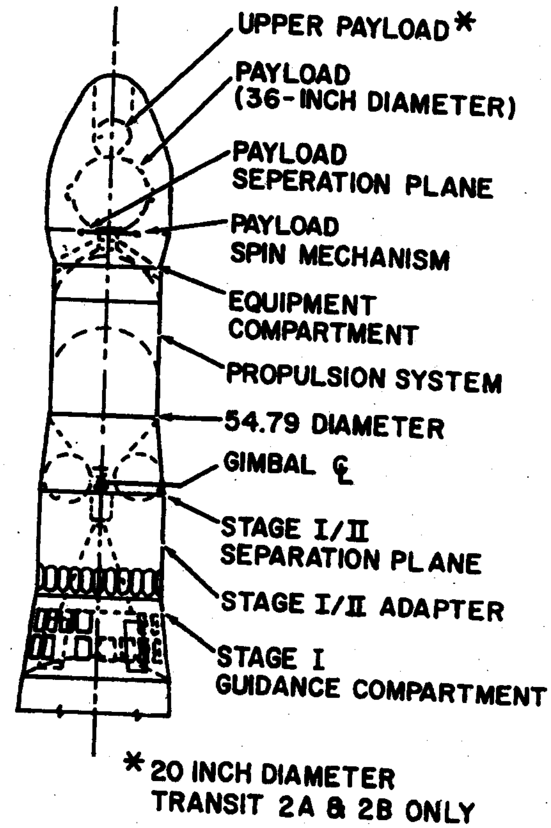


A. SECOND STAGE—ABLE-STAR (AJ10-104)

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

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.

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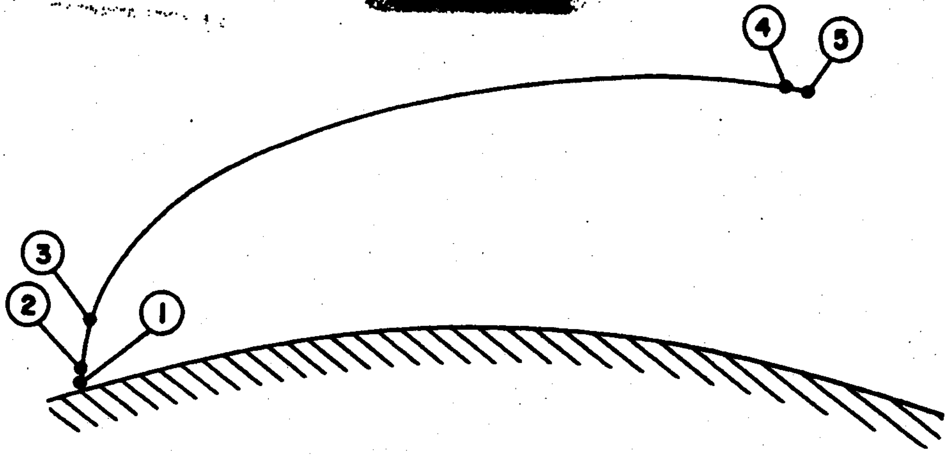

Point	Flight Time (seconds)		Comments	Inertial Speed (ft/sec)		Downrange Distance (n.m.)		Altitude (n.m.)	
	1-B	2-A 2-B	Transit vehicles	1-B	2-A 2-B	1-B	2-A 2-B	1-A	2-A 2-B
1	10	10	End of vertical rise	1,346	1,346	0	0	0.077	0.077
2	167	167	First stage burnout	13,611	12,929	75.2	79.7	41.2	48.3
3	442	448	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.

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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

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Monthly Progress—TRANSIT Program

Flight Test Progress

TRANSIT 1B

● Data reduction of a TRANSIT 1B experiment is being accomplished and the results will be reported in next month's report.

Technical Progress

TRANSIT 2A

● The Flight System Test (FST) was successfully completed at the Atlantic Missile Range during the report period. The vehicle is currently sealed in a nitrogen gas atmosphere for protection. On 6 June the vehicle will be removed from storage and the guidance and control subsystem tests and the FST will be repeated. The following additional checks and modifications will be accomplished in time to insure meeting the 21 June launch date:

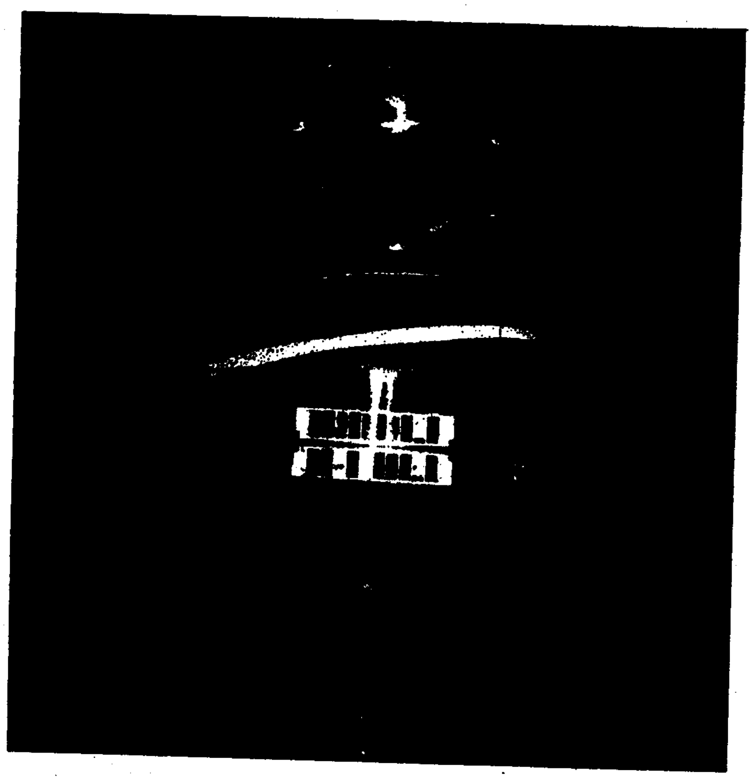
1. Leak checks
2. Weight and center of gravity determination checks
3. Equipment compartment vent modifications
4. C-Band beacon battery modifications will permit FPS-16 radar tracking from Vandenberg Air Force Base and Holloman Air Development Center.
5. Re-allocation of telemetry channels to provide additional staging information.

● The ground guidance modification is proceeding on schedule. The first interconnection test between the ground guidance system and the FPS-16 radar is scheduled for 10 June. Missile-ground guidance compatibility checks are scheduled for 13 June.

TRANSIT 2B

● The project schedule has been revised to reflect a hardware availability for launch date on 1 November. Aerojet-General Corporation and Space Electronics Corporation are working to meet this revised schedule.

● The AJ10-104 propulsion and force control system was acceptance fired at Sacramento during the month. This unit is scheduled for delivery to the Air Force early in June.



TRANSIT 2A PAYLOAD . . .

The 20-inch upper sphere contains instrumentation for studying solar emissions. The solar cells and broad band antennas (spiral stripes) can be seen on the 36-inch sphere.

COURIER

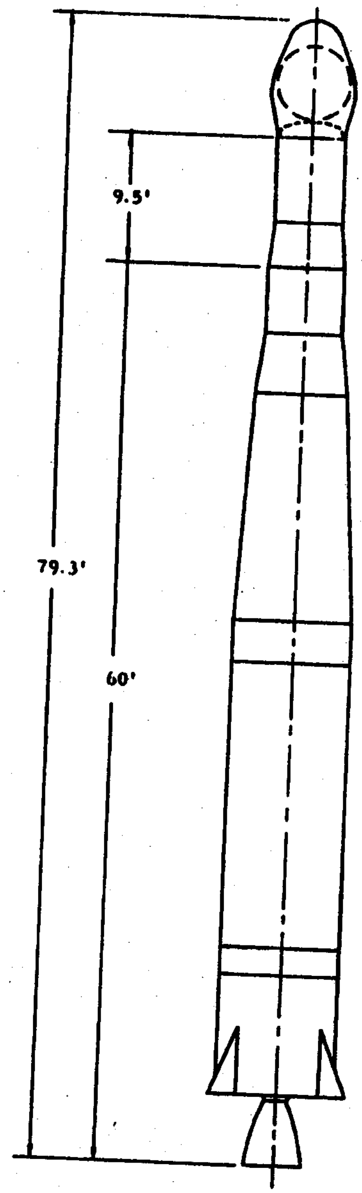
The ARPA COURIER Program consists of two flight vehicles to be launched from the Atlantic Missile Range. The program objective is to test delayed repeater communications between a satellite and ground stations. The program also will be used to determine the operating characteristics and capabilities 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 × 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

Technical Progress

COURIER 1A

- The following modification and checks will be accomplished prior to the 22 June shipping date:
  1. Telemetry channel modification
  2. Weight and center of gravity determination checks
  3. Leak checks
  4. Post injection yaw program insertion
- The Flight Test Working Group at AMR has recommended that the launch date be rescheduled from 15 July to 19 July.
- Checkout of the ABLE-STAR (AJ10-104) vehicle through flight system test has been completed. Re-allocation of telemetry channels has been made. Transducers are being added to provide nose fairing pressure and additional staging information. A C-Band battery modification to increase the battery capacity has been completed. This will permit FPS-16 radar tracking from Vandenberg Air Force Base and Holloman Air Development Center.
- Aerojet-General Corporation and Space Electronics Corporation are continuing component and subsystem fabrication based on a scheduled launch date of 1 September.
- The checkout van and associated test equipment has been delivered to Aerojet-General Corporation for checkout of the ABLE-STAR vehicle for CONVAIR 1B.

Tiros

Program Administration.

● With the successful launch and orbit of the TIROS payload on 1 April, AFBMD's responsibility in the program ended. The National Aeronautic and Space Administration was the primary program agency. AFBMD was responsible for the launch vehicle, integrating the payload to the launch vehicle, and providing communications to the tracking and data-handling agencies from launch through attainment of orbit. Payload design, fabrication and testing were accomplished by the Radio Corporation of America for NASA. NASA retained cognizance for operating, tracking, and recording and processing of satellite data.

Flight Test Progress

● The TIROS satellite was launched from stand 17A, Atlantic Missile Range, at 0640:09 EST, on 1 April. The three stage THOR-boosted flight vehicle placed the TIROS payload into the most perfect cricular orbit achieved by this nation up to that time (the recent MIDAS orbit is only .00278 off a perfect circle). For the nominal and actual Powered Trajectory Flight Plan refer to Table 1. Table 2 presents a comparison of nominal predicted orbital parameters with those actually achieved by the satellite.

PARAMETER	NOMINAL	ACTUAL
Apogee	381.5 N.M.	408.8 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

Table 2. Orbital Parameters

EVENT	NOMINAL (Time in Seconds)	ACTUAL (Time in Seconds)
Vertical lift-off	0	0
Bell Telephone Laboratories (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	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

Pre-launch Tests

● The pre-launch testing of the second and third stages of the TIROS vehicle consisted of a series of subsystem tests to determine proper operation and detailed performance parameters. Following these tests system tests were conducted for complete check-out of the stages before shipment to the Atlantic Missile Range (AMR). To provide maximum assurance that the flight test objectives would be met, the system tests were repeated at AMR to determine that damage to the equipment had not occurred during transfer.

● A flight acceptance test and composite system test to insure proper first stage operation, were performed on the THOR after its erection on the test stand. Following assembly of the complete vehicle, subsystem and integrated system tests were performed on the second stage autopilot and guidance system. Ground electrical power was provided for these tests. The umbilical was connected to permit monitoring of system functions. After the radiation and interference tests were completed an integrated acceptance test of the entire vehicle was conducted. During this test, the vehicle is powered by flight-type batteries and the umbilical is removed so that data is obtained only by telemetry and visual inspection.

● A final check of the vehicle was performed during the mock countdown one day prior to launch. This countdown is also used to familiarize launch personnel with the countdown procedures. The TIROS mock countdown proceeded smoothly. All engine checks and electrical checks were completed satisfactorily with the exception of the C-band beacon check. The beacon check proved unsatisfactory and when attempts to correct the situation failed the beacon was removed and reworked. The replacement of two tubes improved the beacon sensitivity approximately four decibels. No other vehicle problems developed and the mock countdown was completed after having continued 1 ½ hours longer than scheduled.

Launch

● The launch countdown started on 31 March and proceeded with only minor vehicle problems until 0410 EST, 1 April when a programmed one hour hold began. Terminal count (T-35 minutes) began at 0510 and proceeded without a hold until T-2 minutes. At T-2 minutes a hold was initiated because of

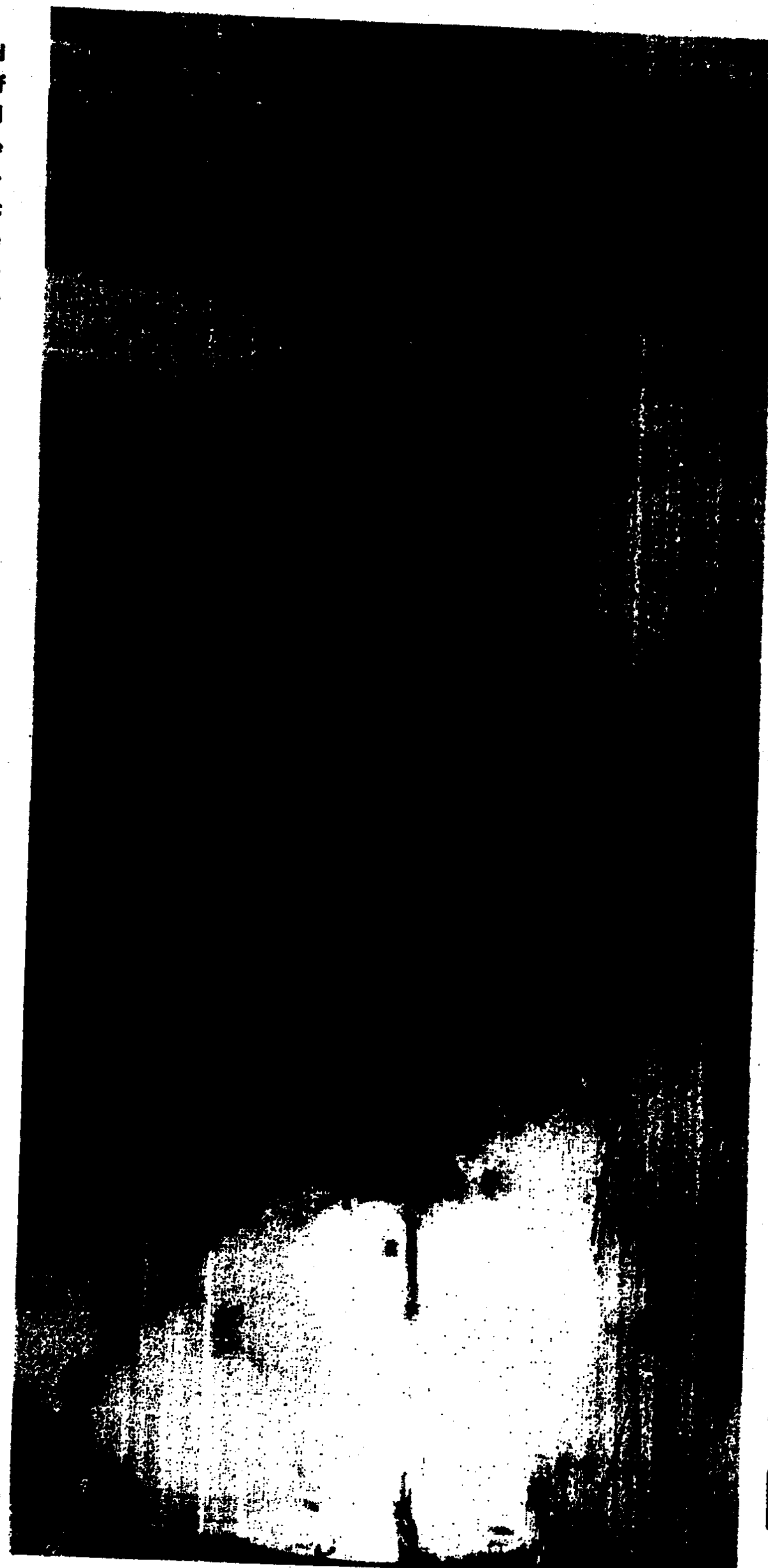
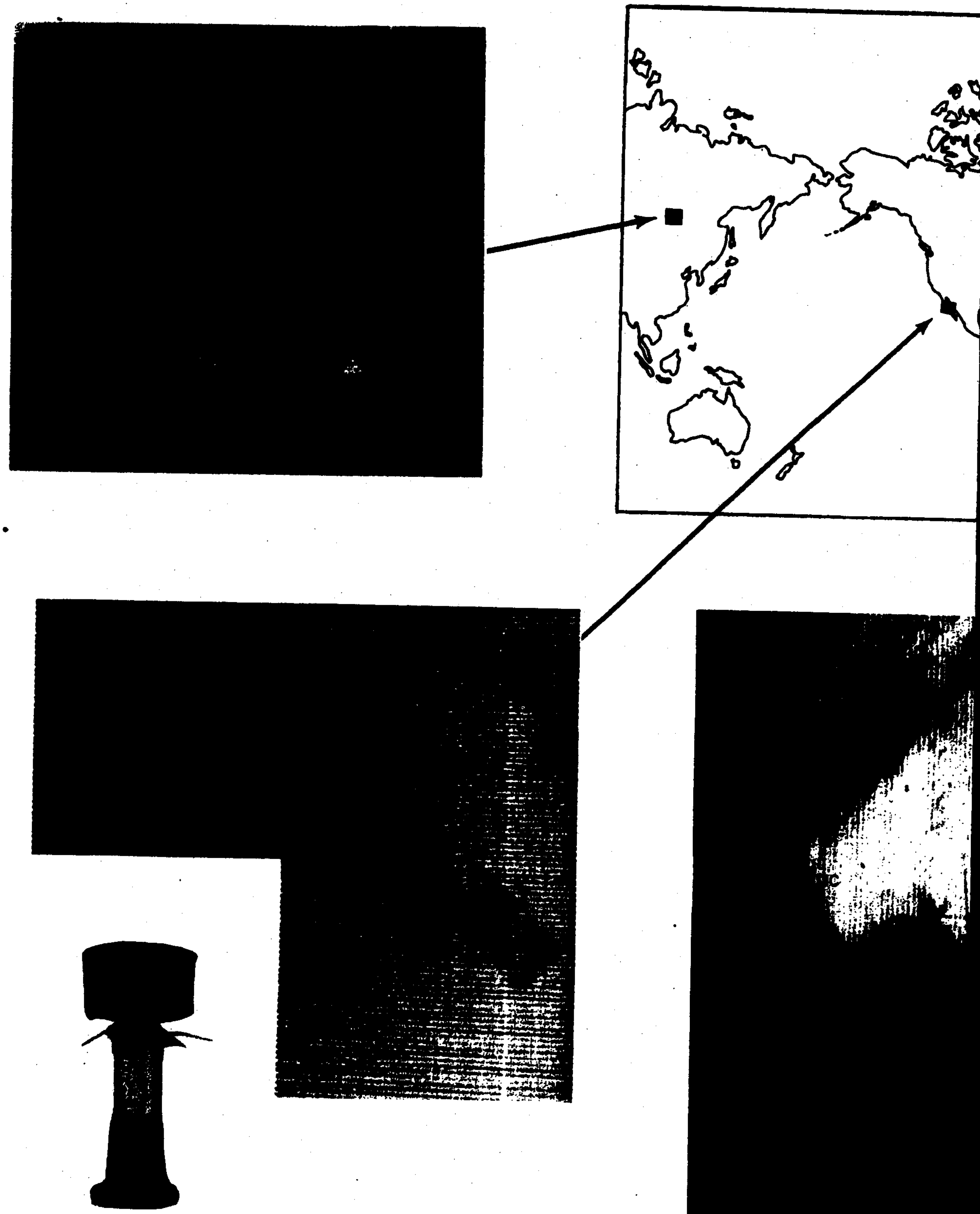


Figure 1. TIROS vehicle during liftoff from Atlantic Missile Range Stand 17A on 1 April



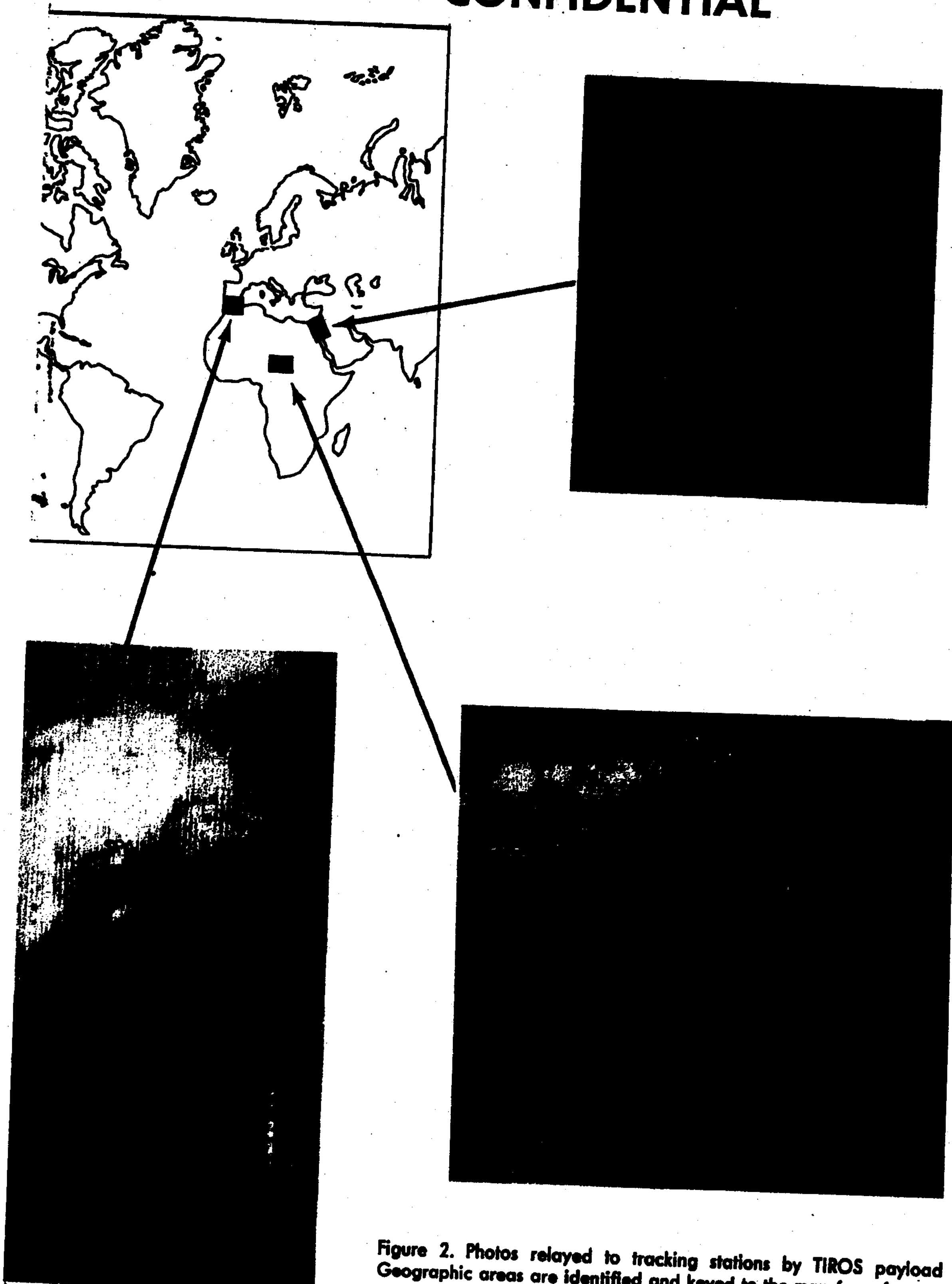
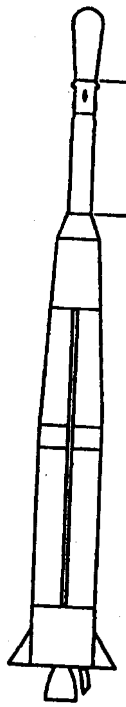


Figure 2. Photos relayed to tracking stations by TIROS payload equipment. Geographic areas are identified and keyed to the map for reference. The photos were taken from approximately 400 miles altitude. The TIROS payload (left) is shown mounted on the third stage.



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

difficulties encountered with the C-band beacon. During the hold, three LOX topping valves became inoperative. These problems were resolved and the countdown was recycled to T-15 minutes. The launch proceeded smoothly to liftoff which occurred at 0640:09.021.

Flight Vehicle

● The first stage was a modified THOR intermediate range ballistic missile with the inertial guidance system removed. The second stage utilized an Aerojet-General (AJ10-42) propulsion system and a Bell Telephone Laboratories guidance system which was also used for guidance during first stage flight. An Allegany Ballistics Laboratory X-248 solid propellant engine was used for the third stage.

Payload

● The 270 pound, cylindrical payload is 42 inches in diameter and 17 inches high. Payload equipment includes two television cameras designed to observe, record and transmit weather data. Power sources include sixty 20-volt nickel-cadmium chemical batteries and 9,260 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 satellite life. Two beacon transmitters are installed in the satellite to facilitate tracking.

Operation

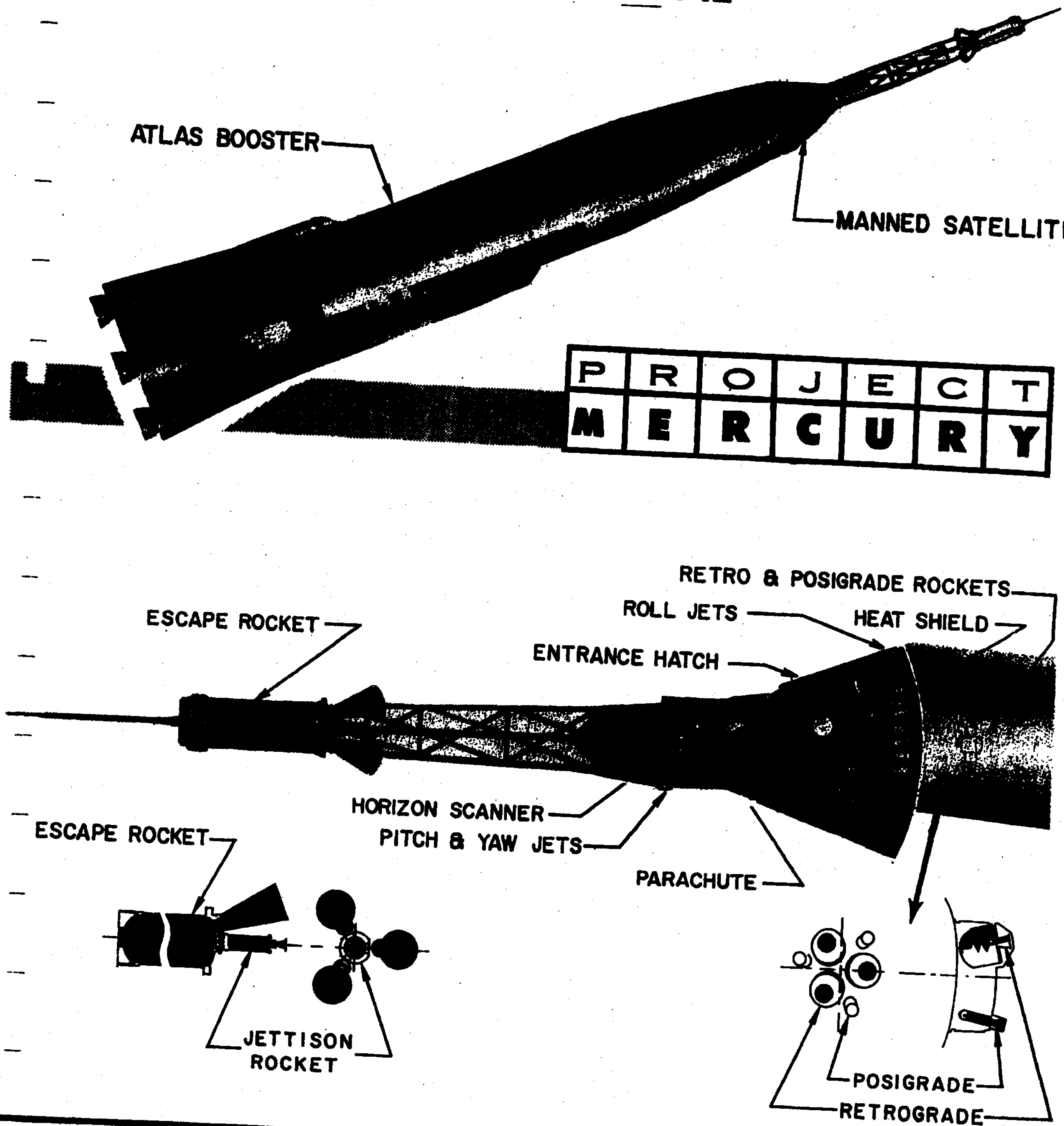
● Once during each orbit the satellite is interrogated and re-programmed from a ground station. The Fort Monmouth, New Jersey, and Kaena Point, Hawaii stations are tracking, commanding and receiving data from the TIROS satellite. Use of the Air Force facility will benefit the SAMOS and MIDAS programs by attaining an early buildup of experienced personnel.

● 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 the 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.

Accomplishments

● This flight has proved the feasibility of using an earth satellite to provide information for more accurate long-range weather forecasting. Information received indicates the following successes have been accomplished by this satellite.

1. High quality pictures taken by the wide angle camera are being received on both the direct and delayed readout modes.
2. High quality pictures taken by the narrow angle camera have been received on the direct and delayed readout modes. The delayed readout mode resumed operation on 2 May after failing to respond since 2 April, the day after launch. It is believed that a soldered joint in the timing mechanism opened at low temperatures. "Soaking" in sunlight may have closed the joint and reestablished contact.
3. All tracking command, and data readout transmitters are operating satisfactorily.
4. The solar cell recharging rate is higher than anticipated indicating that the payload will be operational throughout its programmed useful life of five months.



WEIGHT AT SEPARATION	APPROX. 2500 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.

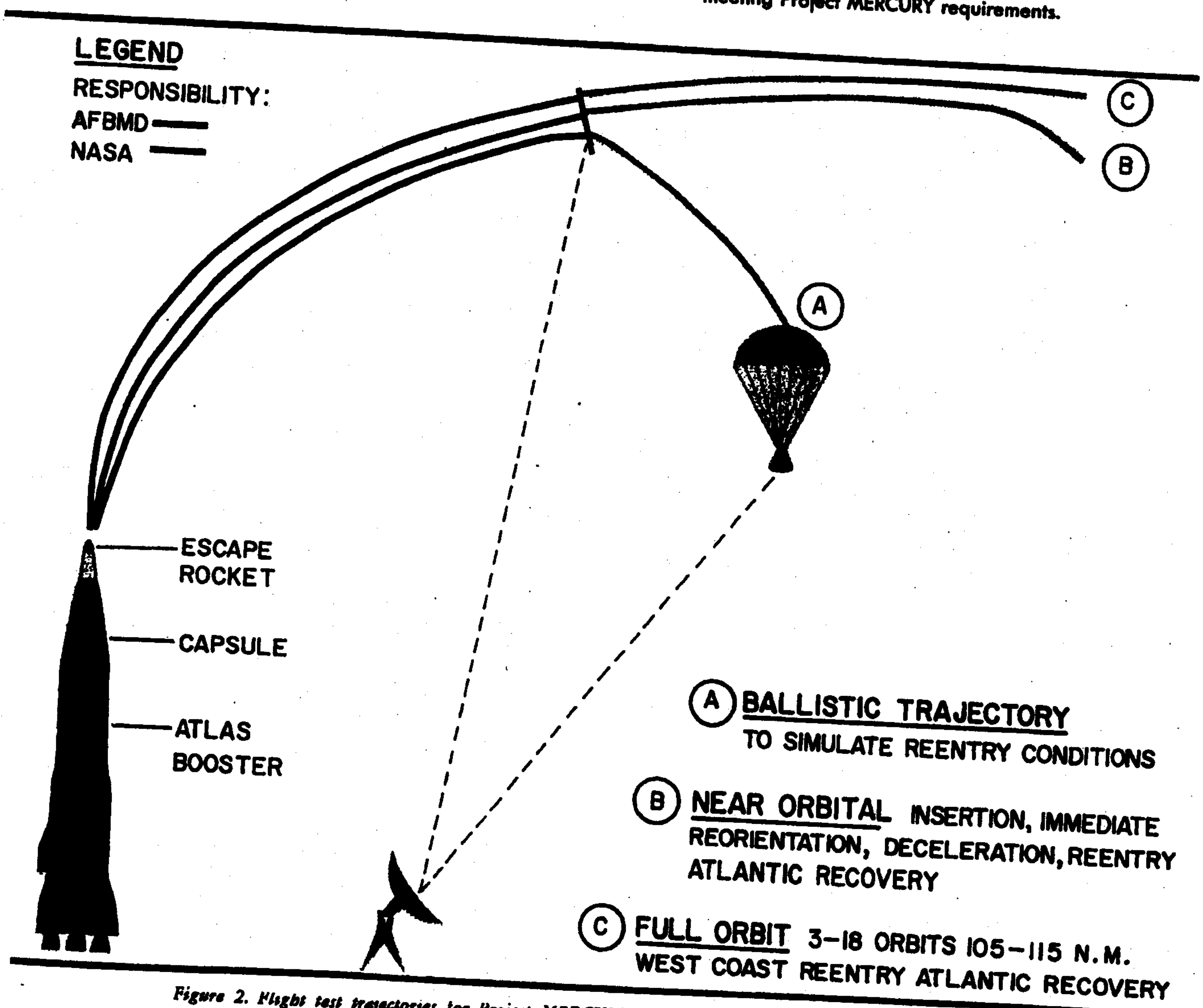


Figure 2. Flight test trajectories for Project MERCURY, defining specific objectives. Trajectory C represents the path of the final (manned) flight. The point at which AFBMD and NASA responsibility is divided represents injection into orbit.

PROJECT MERCURY

- **NASA Responsibility**
  - Booster-Capsule integration
    Capsule
    Ground support
    Recovery
    - Flight 1
      - NASA Laboratory Capsule
        - Re-entry heating, dynamics, recovery
    - Flights 2–12
      - Flight Capsules (McDonnell)
        - Unmanned non-orbital flights
        - Manned and unmanned orbital flights
        - Launch from AMR
        - Earth track 33°N/33°S/Lat. (for orbital flights)
        - 3–18 orbits
        - Orbit capability 28 hours
        - Orbit weight 2500 lbs.
        - Orbit altitude 105-115 n.m.
        - Automatic pilot safety equipment with manual backup
- **AFBMD Responsibility**
  - Booster
    ATLAS "D"
    - Modified
      - New guidance antennae
      - Thin skinned tanks
      - Shifted tank bulkheads
      - Light weight thrust structure
      - Capsule separation mechanism
      - Interface electrical connections
      - LOX dome protection
      - Programmer Modified
      - Range safety destruct time delay
      - Abort-sensing system
        - Detects dangerous variations in tank pressures, fuel injector pressure, electrical power, attitude and sustainer hydraulic pressure. Can initiate escape sequence
      - Launch
        - Integrated countdown—including pilot insertion and capsule countdown. AMR launch Stand 14—adapted for pilot and capsule.
          GE ground guidance equipment modified to provide: (a) real time data, (b) additional discrete command signals during powered flight.
          (a) Ballistic trajectory—108°
          (b) Orbital trajectory—072°

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

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.

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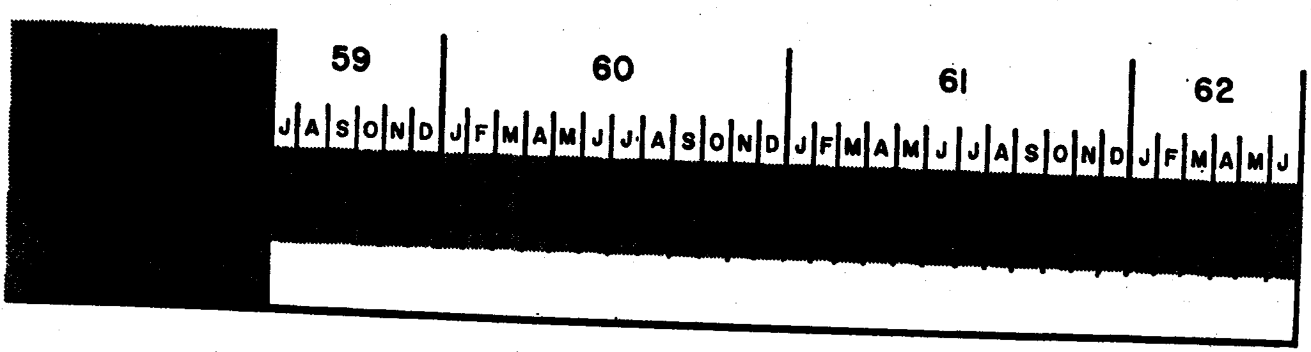


Project MERCURY Launch Schedule

Monthly Progress—Project MERCURY

Flight Test Progress

● During May the ATLAS booster and the MERCURY capsule for the second flight test (MA-1) were delivered to AMR and are undergoing pre-launch hangar checks. The ATLAS 50D booster and the capsule will be mated in mid-June for the scheduled mid-July launch. Launch will be made from Atlantic Missile Range Complex 14 with trajectory parameters and test objectives as outlined in the April report. An ATLAS R&D missile is presently erected on stand 14 and will be launched prior to MA-1. Present stand loading has another ATLAS R&D missile scheduled for launch from stand 14 between the second and third MERCURY flights.

● The capsule for the third MERCURY flight (MA-2) will be a McDonnell full scale production model with live escape system, live posigrade rockets and dummy retrorockets. The capsule will incorporate all six primary capsule systems:

1. Communications system
2. Automatic stabilization and control system
3. Automatic reaction control system
4. Environmental control system
5. Electrical power supply system
6. Landing and recovery system

● The primary capsule test objectives for the MA-2 flight are:

1. Recover capsule
2. Determine the integrity of the MERCURY capsule structure, ablation shield, and afterbody shingles during a simulated normal re-entry from orbit.
3. Determine the capsule full-scale motions and afterbody heating rates during a simulated normal re-entry from orbit.
4. Evaluate the performance of the operating capsule systems during the entire flight.
5. Evaluate the compatibility of the capsule escape system with the ATLAS/MERCURY system.

● The secondary capsule test objectives for the MA-2 flight are:

1. Establish the adequacy of the location and recovery procedures.
2. Establish prelaunch, launch, monitoring, and recovery procedures for operation personnel.

● The primary booster test objectives for the MA-2 flight are:

1. Determine the ability of the ATLAS booster to release the MERCURY capsule at the position, altitude, and velocity defined by the guidance equations.
2. Determine the closed-loop performance of the Abort Sensing and Implementation System.

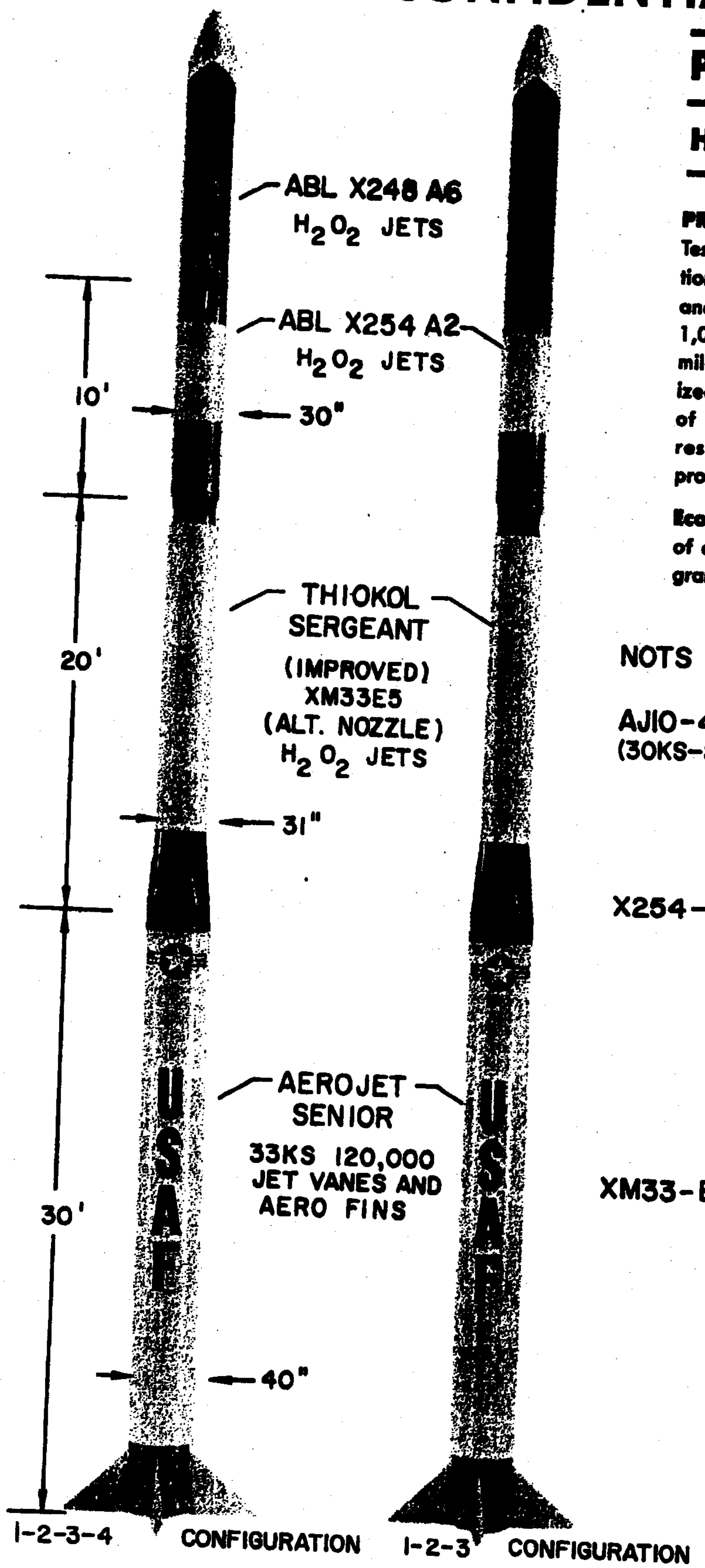
● A secondary booster test objective for the MA-2 flight is to obtain data on the repeatibility of the performance of all ATLAS missile and ground systems.

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



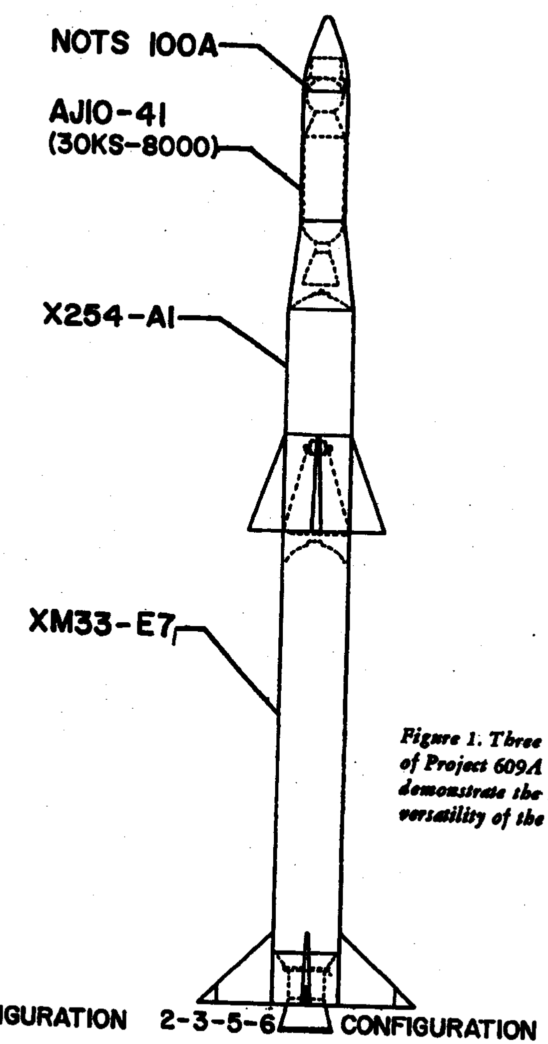


Figure 1. Three variations of Project 609A vehicle demonstrate the mission-versatility of the program.

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/attitude combinations; (b) boost-glide trajectories; (c) ballistic missile trajectories; (d) downward boosted, high-speed re-entry profiles, and (e) full orbit to approximate maximum of 400 miles with 150 pound payloads.

Program Management—An abbreviated development plan, covering the R&D phase only, was approved on 9 January 1959. Funds in the amount of $9,077,000 have been made available for this R&D phase of the program only. A letter was issued assigning management responsibility to AFMBD, with emphasis on integrating the program with the scientific and military research experiments conducted on regularly scheduled ballistic missile flight tests (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.

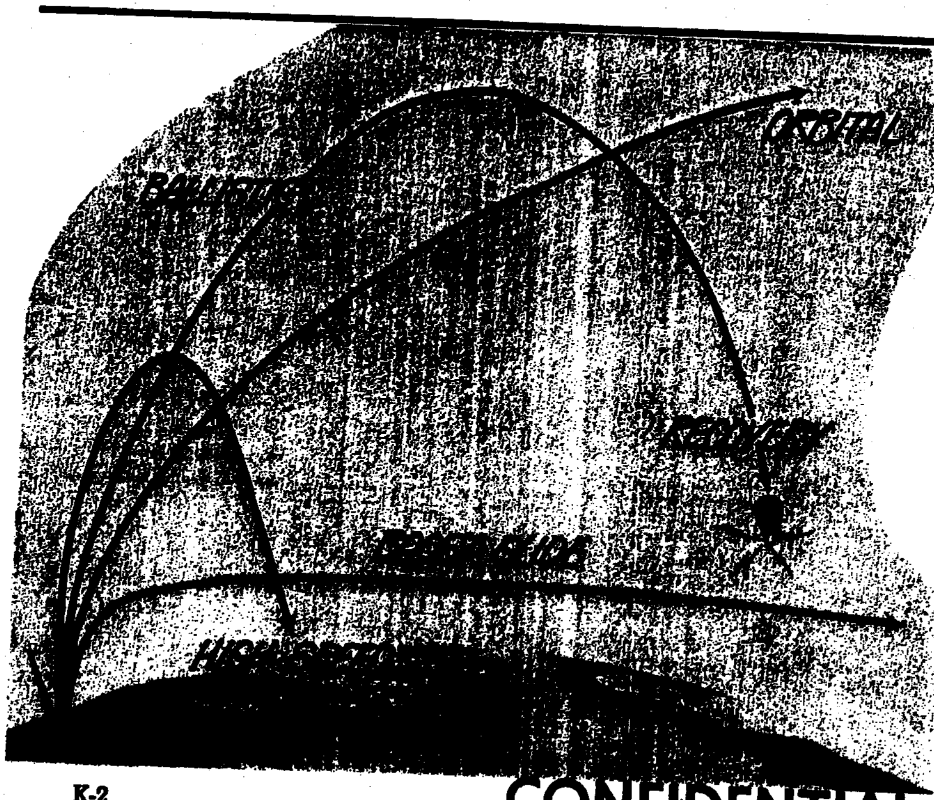
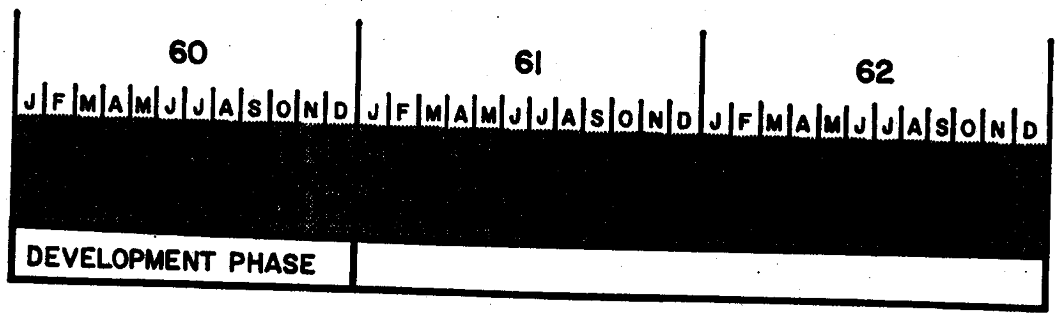


Figure 2. Four different trajectories possible using different arrangements of Project 609A stages.



Project 609A Launch Schedule

Monthly Progress—Project 609A

Program Administration

- The new 609A Development Plan was submitted to Headquarters ARDC. Included is a revised development and test program reoriented to adjust for delays in NASA SCOUT development and permit the Air Force to provide reliable vehicles in support of the Navy TRANSIT Program on a timely basis. Also included is a proposed follow-on program providing 609A support of the ARDC applied research program. Approximately thirty launches are programmed for CY 61 at a cost of $19 million.
- A new program plan, outlining a reoriented development and test program, in support of the new Development Plan has been submitted by Aeronautics. The new plan proposes two orbital launches during December.
- Complete responsibility for the TRANSIT Program has been transferred to the Navy by ARPA. AFBMD is now providing THOR/ABLE-STAR vehicles to support the TRANSIT Program. Later, the size of the satellite will be reduced and 609A/SCOUT vehicles will be provided for launch support.
- A request for $1,060,000 was submitted to Headquarters ARDC for design and construction of additional facilities at the Atlantic Missile Range to support the follow-on ARDC operational program. Approval was received for expenditure of $60,000 for design of facilities with indications that the one million dollars for construction would be made available later.
- Because of increased hardware and systems management costs, a request for additional FY 60 funds of $1,043,000 was made to Headquarters ARDC. AFBMD was requested to determine the absolute minimum amount required to support the development and test program up to 1 July without serious detriment to the program. Following NASA's agreement to defer its requirement until July, $223,000 was still required to fund the Aeronutronic Contract through June. This minimum funding for the 609A Project has been promised; however, a program funding deficiency of $1,043,000 still exists.
- Purchase requests totaling $587,000 for rocket motors, transtainers, and airframes to be procured through the NASA has been initiated. Purchase requests for $728,000 were initiated for procurement of payload carrier and systems integration from Aeronutronics.

Technical Progress

- The first full-scale guided SCOUT launch by NASA is scheduled for 18 June. An apparent solution of the hydrogen-peroxide second stage control system problems permitted the launch date to be moved up one week.
- Successful rocket motor destruct tests have been conducted using XM-33 and ABL-X254 motors for the 2-3-5-6 configuration vehicle. These tests were performed to meet Range Safety requirements at the Atlantic Missile Range. A linear charge destruct test

of the Aerojet-General SENIOR motor for the 1-2-3-4 configuration has been scheduled at Edwards Air Force Base in early June.

● The first launch of an unguided, 2-3-5-6 configuration 609A vehicle is scheduled for late in June. A decision by AMR Range Safety for a vehicle destruct system waiver will not be made until complete dispersion data and corrected trajectory data are provided. Aeronutronic will furnish the dispersion data by 10 June and trajectory data by 17 June. Vehicle components and ground support equipment for this flight are arriving at AMR on schedule.

● Additional development testing of 609A rocket motors has been conducted. A successful test was completed at Arnold Engineering Development Center (AEDC) on an ABL-X254 to verify corrective action taken to solve nozzle blistering problems. A test is scheduled for 10 June at AEDC on a unit composed of an ABL-X254 motor, section "C" airframe, and peroxide control system. This test will provide information on peroxide control system operation in a low density atmosphere and vibration information about the motor.

● An Aerojet-General SENIOR motor was successfully fired after completing an aging and cycling test at Sacramento.

Facilities

● The Architect-Engineer Evaluation Board has selected a contractor to design additional facilities at AMR for the 609A operational program. The design is scheduled for 31 August completion, with the construction contract to be issued on 1 October. Beneficial occupancy date for the first assembly building is 1 February 1961.

SECRET

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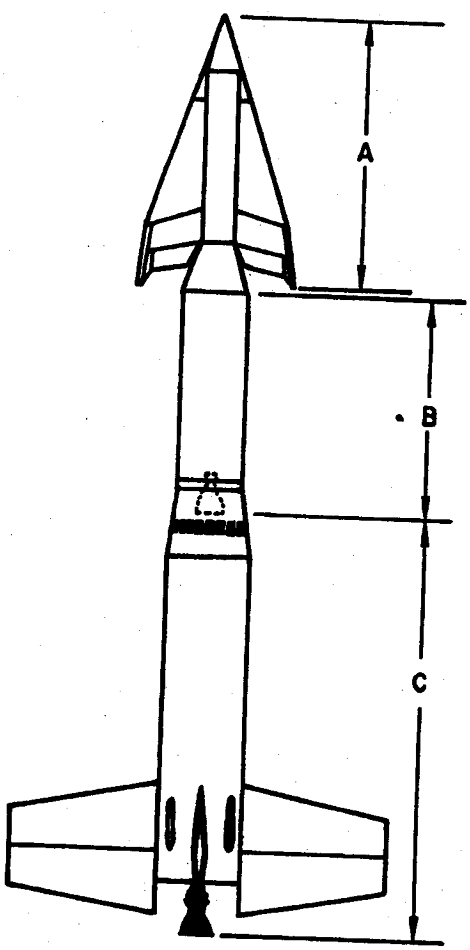
DYNA SOAR

The DYNA SOAR program will explore the possibilities of manned flight in the hypersonic and orbital realms. The program will proceed in three major steps from a research and test phase to an operational military system. In step one, a full scale, minimum sized manned glider will be developed. A modified version of the TITAN ICBM will boost the glider into hypersonic flight at velocities up to 22,000 ft/sec. In step two the glider will be tested, using a more powerful booster to achieve orbital velocities. This phase may be expanded into an interim operational weapon system providing all-weather reconnaissance and satellite interceptor capabilities. The objectives of step two are to test vehicle performance between 22,000 ft/sec and orbital velocities; and to gather re-entry data from various orbits. Step three will provide an operational weapon system with a vehicle that will operate primarily in a hypersonic glide, be able to maneuver within the atmosphere, and be able to make a conventional landing at a predetermined site. The capability of DYNA SOAR type systems to perform these programmed missions appears attractive as a result of studies made to date.



A. GLIDER	
Weight	9,500 lbs.
Wing Area	330 sq. ft.
B. TITAN SECOND STAGE	
Thrust (lbs. vac.)	80,000
Initial Weight	45,700
Burnout Weight	4,431
C. TITAN FIRST STAGE	
Thrust (lbs. sea level)	300,000
Initial Weight	117,800
Burnout Weight	9,251

FIRST STAGE MODIFICATIONS

- Stabilizing Fins Added
- Skirt Section and Intertank Section Modified and Strengthened

SECOND STAGE MODIFICATIONS

- Ignition Prior to Separation
- Propellant Tanks Capacity Increased
- Intertank Section Strengthened

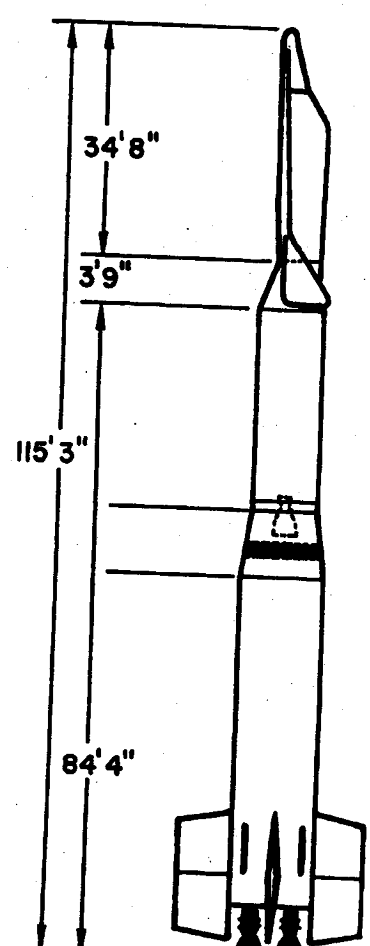


Figure 1. DYNA SOAR vehicle configuration drawing and specification list.

Step one includes twenty manned flights with the glider being dropped from a B-52, five unmanned launches, and eleven manned launches from the Atlantic Missile Range (AMR). The first unmanned launch is scheduled for September 1963 with one and one-half month span between launches. The manned flights are programmed to start in mid-1964 with a two-month span between launches.

The range from Wendover AFB, Utah, to Edwards AFB is adequate instrumented for the tracking and telemetry required during the air launched tests of the DYNA SOAR glider. Instrumentation sites for the AMR launches will be located at Cape Canaveral, San Salvador, Mayaguana, Antigua, Santa Lucia, and Fortaleza. Instrumentation, tracking, and recovery ships will be provided to supply additional support for the AMR launches. Landing facilities will be provided at Fortaleza, Brazil; Santa Lucia, Windward Islands; and Mayaguana, Bahama Islands.

Steps one and two of the DYNA SOAR program are to be conducted by the USAF and NASA participation. USAF will provide the over-all program management and technical direction, with WADD having responsibility for over-all system management. AFBMD is responsible for the booster, booster subsystems, ground support equipment and booster requirements of the launch complex. WADD will have responsibility for glider and subsystem development. NASA will provide technical support in the design and operation of the glider in obtaining basic aeronautical and space design information.

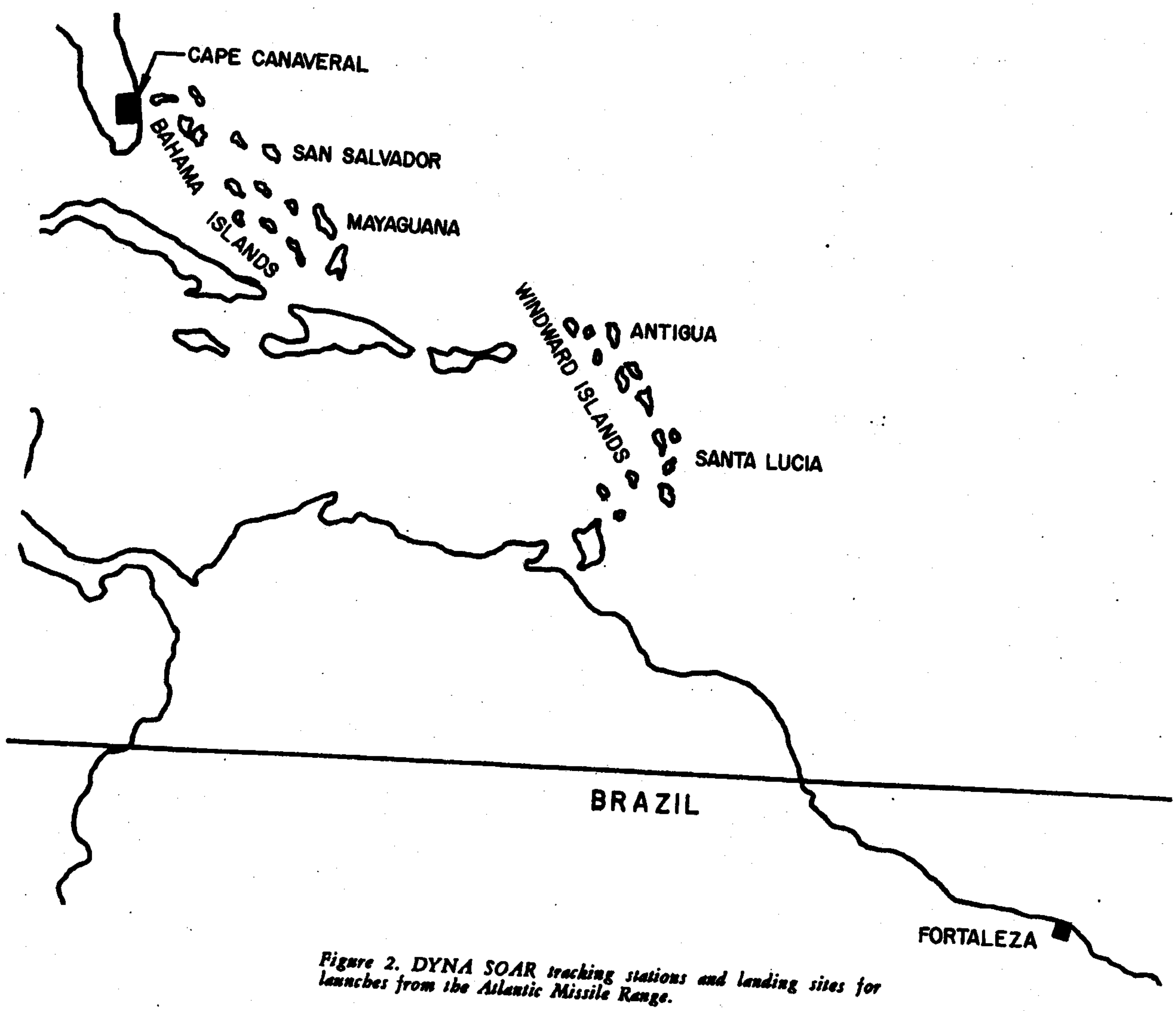


Figure 2. DYNA SOAR tracking stations and landing sites for launches from the Atlantic Missile Range.

Monthly Progress—DYNA SOAR Program

Program Administration

● The DYNA SOAR Program is still in the preliminary planning stage and it will be some time before the assembly of hardware begins and component or subsystem tests are started. On 13 May, Martin Company was notified to proceed with their portion of the Step I contract including design trade studies and booster hardware program planning. On 20 May, Aerojet-General Corporation was notified to start on design trade studies in support of the Martin Company and booster engine program planning. A systems engineering and technical direction contractor for the booster system is presently being selected. Specific areas of progress include:

1. Statements-of-work for the associate contractors (Martin Company and Aerojet-General Corporation) have been prepared and approved.

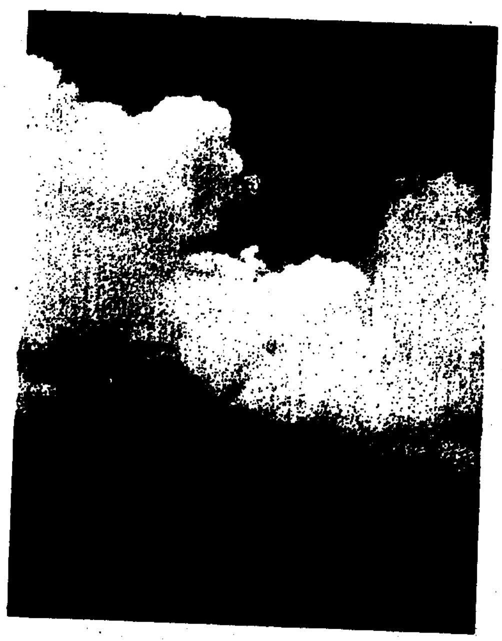
2. The booster performance specification has been prepared and approval is expected in July.

3. The detailed programs for carrying out the design trade studies have been established.

4. The contractors have organized the administrative and engineering staffs required to support the DYNA SOAR Program.

● During the design competition the contractors completed many preliminary design studies to support their proposals. With the selection of contractors essentially completed, design data is being exchanged and a high degree of cooperation in solving interface problems has been exhibited. Design trade studies are being conducted in many areas, among them are studies to determine optimum booster fin configuration, booster structural reinforcement, staging methods, and booster-glider interface. Many of the studies will be completed within 90 days and summary reports, including recommendations, will be submitted to BMD/WADD at that time. These reports will become part of the preliminary design data for the selected design.

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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