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DISCOVERER XIV

(AGENA 1056 / THOR 237)

SYSTEM TEST EVALUATION AND PERFORMANCE ANALYSIS REPORT

(35 - DAY REPORT)

CONTRACT [redacted]

[redacted]

Lockheed

MISSILES and SPACE DIVISION

LOCKHEED AIRCRAFT CORPORATION · SUNNYVALE, CALIF.

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DISCOVERER XIV
(Agena 1056/Thor 237)
SYSTEM TEST EVALUATION
AND
PERFORMANCE ANALYSIS REPORT
(35-Day Report)

Contract [redacted]

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Notice of Missing Page(s)

Pages vi, x, and xvi of the original document were blank and unnumbered.

Liftoff of Discoverer XIV (Agena 1056/Thor 237) from Pad 4, VAFB

Parachute and Capsule are Hooked by C-119J Boom on Third Attempt

[redacted]

FOREWORD

Administered by the Air Force Ballistic Missile Division (AFBMD), the Discoverer Program has as its principal objectives the development of Thor-boosted Agena satellites capable of functioning as carriers for scientific materials and the recovery of capsules ejected from orbiting Agenas.

As prime contractor, Lockheed Missiles and Space Division, Satellite Systems has overall responsibility for developing the program. Development of the Thor as a booster rocket for the Agena satellite has been carried out by the Douglas Aircraft Company.

This document is the final system test evaluation and performance analysis report for the launch of Discoverer XIV from Vandenberg AFB on 18 August 1960. It is prepared to meet a requirement of Contract [redacted] in accordance with Paragraph 1.4.1 of [redacted] Discoverer Program.

[redacted]

SUMMARY

Discoverer XIV (1960 Kappa), consisting of a Thor booster (237) and an Agena satellite (1056), was launched into orbit from Vandenberg AFB Complex 75-3-4 at 12:57:07.85 PDT on 18 August 1960 on the first attempt.

Liftoff, Thor boost, Agena second-stage burning and injection into orbit were accomplished without incident. Injection conditions produced a 94.54-minute orbital period, with a 441 nautical mile apogee, a 103.5 nautical mile perigee, and an eccentricity of .046.

On the initial acquisition by the [redacted] Tracking Station [redacted] attempts were made to transmit an orbital-timer increase command, but Command Tone A was not verified. However, after adjustment of the ground radar equipment, [redacted] was able to reset the orbital timer to the desired period on Pass 2. Later, Pass 10 difficulty was experienced in commanding the satellite from the [redacted] Tracking Station [redacted] but again, by readjusting the Tone A deviation of the ground radar, the commands were transmitted properly.

During Passes 1 and 2, the satellite indicated attitude instability which caused excessive use of control gas, and it appeared doubtful if sufficient gas would remain for recovery operations on Pass 17. However, when reacquired on Pass 8, the satellite had stabilized, gas-consumption rate had been sharply reduced, and nominal consumption with good stability continued until recovery. The cause of the original instability is being investigated.

On Pass 15, the orbital timer was successfully reset to permit recovery in the planned area. Therefore, on Pass 17 recovery was initiated and successfully carried out. Stations were unable to receive the capsule telemetering

[redacted]

because of telemeter circuitry failure. Several stations and recovery-force units acquired and tracked the capsule VHF beacon.

A recovery aircraft was directed to the impact area which was approximately 430 nautical miles downrange from the originally predicted area. On the third recovery pass, the capsule was hooked and successfully brought on board. The cause for the large deviation in the impact area from that predicted is now believed to be due to improper recovery orientation of the satellite. This problem is being investigated.

With the exception of the satellite instability on Passes 1 and 2 and the incorrect recovery attitude, the flight was a complete success, resulting in the first aerial space capsule recovery and the second Discoverer capsule recovery.

[redacted]

CONCLUSIONS

1. Discoverer XIV, carrying an AET payload, achieved approximately 92 percent of its flight objectives, including that of recovering an instrumented capsule from an orbiting satellite.
2. Performance of the Thor booster was within tolerance, and the orbit achieved was near preflight nominal.
3. The objectives not met included the attitude stability of the satellite for orbit and recovery. However, the malfunction was such that, while the recovery impact area was 430-nautical miles downrange, the capsule was recovered in the air by a recovery-force plane. Capsule-telemetry command difficulties proved to be primarily in the ground control equipment.
4. Communications and control by the Sunnyvale Satellite Test Center were satisfactory. Launch tracking, orbital tracking and control were properly carried out.

CONTENTS

CONTENTS (Continued)

[redacted]

ILLUSTRATIONS

[redacted]

ILLUSTRATIONS (Continued)

TABLES

[redacted]

NOMENCLATURE

ADS	Attitude-Damping System
AGC	Automatic Gain Control
Countdown	Step-by-step process leading to a missile launching
Countdown	Reduction of radar-beacon response to interrogations due to unsynchronized multiple-active tracking by two or more ground radars, or by improper spacing between the command and interrogation pulses
CWAT	Continuous-Wave Acquisition Transmitter
DAC	Douglas Aircraft Company
DF	Direction Finding
ETA	Estimated Time of Acquisition
ETPD	Estimated Time of Parachute Deployment
FM/FM	Frequency-Modulated subcarriers, Frequency-Modulating carrier
FPS-16	A C-band skin-track radar
GE	General Electric Company
GFE	Government-Furnished Equipment
HCC	Hawaiian Control Center
[redacted]	[redacted]
IRP	Inertial Reference Package
JHU/APL	Johns Hopkins University/Applied Physics Laboratory
KIAS	Knots, Indicated Airspeed
[redacted]	[redacted]
MAB	Missile Assembly Building, VAFB
MPR	Main Power Relay
[redacted]	[redacted]
PACC	Palo Alto Computer Center

[redacted]

NOMENCLATURE (Continued)

PRF	Pulse-Recurrence Frequency
PMR	Pacific Missile Range
RF	Radio Frequency
SAO	Smithsonian Astronomical-Observatory
SAPUT	Solar Auxiliary Power Unit Telemeter
SCTB	Santa Cruz Test Base
SOA	System Operation Analysis
STC	Satellite Test Center, Sunnyvale, California
System Time	Time in seconds measured from 2400 Greenwich Mean Time (GMT): recycles every 24 hours
TLM-18	A high-gain, narrow-beam, VHF, automatic-tracking, 60-foot-diameter antenna
VAFB	Vandenberg Air Force Base
VCC	Vandenberg Control Center
VERLORT	Very Long-Range Tracking Radar
VSWR	Voltage Standing-Wave Ratio
[redacted]	[redacted]

SECTION 1
INTRODUCTION

[redacted]

SECTION 1
INTRODUCTION

In Discoverer Program operations to date, 14 Agena satellites have been launched from Vandenberg AFB, 9 of which have been successfully injected into orbit. Present plans call for the launching of 16 additional satellites before the program is concluded.

PROGRAM OBJECTIVES

The principal program objectives are the development of Thor-boosted Agena satellites, capable of functioning as carriers for scientific material and the recovery of capsules ejected from the satellites. Additional objectives are the perfecting of equipment, techniques, and procedures for launching Thor-boosted Agena satellites; attaining orbit; acquiring, tracking, and commanding the Agena during launch, ascent, and orbit; recording, transmitting, receiving, and processing satellite functional and environmental data, as well as geophysical data. It is also expected that system operational techniques and procedures, including tracking-station, control-center, and launch-base training, will be refined as the program progresses. Specialized tests, including aeromedical research, will be executed during the series. A propulsion-system capability for single restart and extended-duration operation will also be tested.

Finally, an important long-range objective of the Discoverer Program is the refinement of equipment and procedures which will be used in the more advanced MIDAS and Samos programs, as well as in future deep-space probes.

[redacted]

SCOPE OF THIS REPORT

Under Test Evaluation, this report covers the Test Objectives and Results (Section 4). Test Description is concerned with all elements of the Test Configuration (Section 2) and a Chronological Description of the Test (Section 3). Additional sections under Test Evaluation provide the detailed performance of the flight, capsule, recovery operations, instrumentation, ground systems, and operations support.

[redacted]

SUMMARY OF DISCOVERER FLIGHT TESTS

[redacted]

SUMMARY OF DISCOVERER FLIGHT TESTS

DISCOVERER VEHICLES AGENA/THOR	LAUNCH COMPLEX, TIME, AND DATE	COUNTDOWNS REQUIRED	PAYLOAD DESCRIPTION	RESULTS
1019/160	Complex 4 Attempted on 21 Jan 59	1	Non-recoverable, consisting of communications equipment	Malfunction during countdown caused ullage rockets, retrorockets, separation bolts, and horizon scanner fairing to fire when hydraulic motor was turned on. Design problem. Discoverer extensively damaged.
Discoverer I 1022/163 (1959 Beta)	Complex 4 1349:16 PST 28 Feb 59	2	Non-recoverable, consisting of communications equipment	Injection angle -2.4° caused 13 day lifetime. No telemetry or radar orbit contact made. Sporadic CWAT contact reported. Satellite believed damaged structurally and/or thermally at injection or during first pass.
Discoverer II 1018/170 (1959 Gamma)	Complex 4 1318:39 PST 13 Apr 59	1	Biomedical research capsule containing four mechanical mice	Orbit achieved. Engine shutdown by command (source unknown, but believed due to relay malfunction). Capsule ejected but not recovered. 13 day lifetime recorded.
Discoverer III 1020/174	Complex 4 1309:20 PDT 3 Jun 59	4	Biomedical research capsule containing four live mice	Premature engine burnout due to fuel exhaustion. Insufficient velocity gained for orbit attainment. Below nominal performance (but within specification) achieved by Agena engine.
Discoverer IV 1023/179	Complex 5 1547:45 PDT 25 Jun 59	2	Recoverable AET research capsule	Premature engine burnout occurred, resulting in insufficient velocity for orbit attainment. Sub-nominal performance (but within specification) achieved by Agena engine.
Discoverer V 1029/192 (1959 Epsilon)	Complex 4 1200:08 PDT 13 Aug 59	6	Recoverable AET research capsule	Burnout due to propellant exhaustion. Orbit achieved. Capsule separated but not recovered. Recovery sequence believed not accomplished due to extreme cold effects on mercury battery. 46-day lifetime recorded.
Discoverer VI 1028/200 (1959 Zeta)	Complex 5 1224:44 PDT 19 Aug 59	2	Recoverable AET research capsule	Burnout due to propellant exhaustion Orbit achieved. Capsule separated but not recovered. Recovery sequence believed not accomplished. 63 day lifetime recorded.
Discoverer VII 1051 206 (1959 Kappa)	Complex 4 1228:41 PST 7 Nov 59	2	Recoverable AET research capsule	Successful launch and orbit. Slow separation experienced. Agena engine shut-down accomplished by integrator command. 400-cycle power failed after downrange telemetry last signal and satellite tumbling ensued. Nitrogen gas exhausted prior to Pass 2 contact by [redacted]. Capsule could not be ejected. 19 day lifetime recorded.
Discoverer VIII 1050 212 (1959 Lambda)	Complex 5 1125:24 PST 20 Nov 59	1	Recoverable AET research capsule	Burnout due to propellant exhaustion following accelerometer-integrator malfunction. Excessive injection velocity resulted in eccentric orbit with perigee of 115 sm and apogee of 1047 sm. 103.7-minute period with satisfactory programming of capsule separation on Pass 2. Re-entry sequence normal. No recovery although recovery force reported beacon reception for a short period. Over 90-day lifetime

DISCOVERER VEHICLES AGENA/THOR	LAUNCH COMPLEX, TIME, AND DATE	COUNTDOWNS REQUIRED	PAYLOAD DESCRIPTION	RESULTS
Discoverer IX 1052/218	Complex 4 1051:45 PST 4 Feb 60	4	Recoverable AET research capsule	Two major malfunctions at liftoff: Umbilical mast retraction delayed, failure of Agena's helium supply quick disconnect. Agena tumbled (no attitude control). Premature Thor main engine shutdown.
Discoverer X 1054/223	Complex 5 1215:14 PST 19 Feb 60	1	Recoverable AET research capsule	At liftoff, Thor booster pitch oscillations began to diverge, causing main-engine gimballing from stop to stop. Discoverer deviated excessively from programmed flight path angle and destruct signal was transmitted at T + 56.36 seconds.
Discoverer XI 1055/234 (1960 Delta)	Complex 5 1230:37 PST 15 Apr 60	1	Recoverable AET research capsule	Near polar orbit attained. Agena nose-down re-orientation for capsule separation accomplished. Retro and despin rocket firing confirmed as was thrust cone separation. Capsule beacon and telemetry recorded. Spin deficiency led to insufficient retro velocity. Capsule re-entry trajectory high and beyond predicted recovery area.
Discoverer XII 1053/160	Complex 4 1500:44 PDT 24 Jun 60	1	Recoverable diagnostic capsule	Liftoff and ascent trajectories and injection velocity met requirements. However, Agena's velocity gain not horizontally directed. A nose-down attitude (caused by incorrect horizon scanner signals) resulted in a -8.3 degree injection plane.
Discoverer XIII 1057/231 (1960 Theta)	Complex 5 1337:54 PDT 10 Aug 60	1	Recoverable diagnostic capsule	Liftoff and ascent trajectories and injection velocity met requirements. All commands transmitted to orbiting Agena were received, executed, and verified. All primary, secondary, and tertiary objectives met, including first recovery of a capsule ejected from an orbiting satellite.
Discoverer XIV 1056/237 (1960 Kappa)	Complex 4 1257:08 PDT 18 Aug 60	1	Recoverable AET capsule	Liftoff and ascent trajectories and injection velocity met requirements. Other than difficulties with Tone A, commands were transmitted properly. After excessive use of control gas to correct for initial instability, the capsule was ejected at an incorrect recovery attitude. Despite descent 430 nm south of the predicted area, the first aerial recovery of a capsule from an orbiting satellite was accomplished.

TEST DESCRIPTION

SECTION 2 TEST CONFIGURATION

SECTION 3 TEST OPERATIONS

SECTION 2
TEST CONFIGURATION

SECTION 2
TEST CONFIGURATION

As with previous flight tests in the series, the Discoverer XIV system configuration consisted of a second-stage LMSD orbital Agena satellite (Model 2205, Serial Number 1056) (Fig. 2-1) mated by an adapter section to a DAC Thor (Serial Number 237) (Fig. 2-2), with the necessary first- and second-stages support equipment, a ground station launch complex, command and communication system, and a capsule-recovery force.

The Agena 1056 weight statement and Discoverer XIV centers-of-gravity and moments-of-inertia appear in Tables 2-1 and 2-2.

TRACKING AIDS

Among the special features of the satellite were a Johns Hopkins University/ Applied Physics Laboratory (JHU/APL) tracking beacon, transmitting on 162 and 216 mc (for determining orbital parameters by the Doppler technique) and four 12-volt, 100-candlepower light bulbs (for high-accuracy optical tracking), both operated off the hydraulic battery. The beacon was programmed to operate continuously until battery exhaustion. The lamps were controlled by the orbital timer to turn on while the satellite was within reception range of the Smithsonian Tracking Stations, which were equipped with Baker-Nunn cameras.

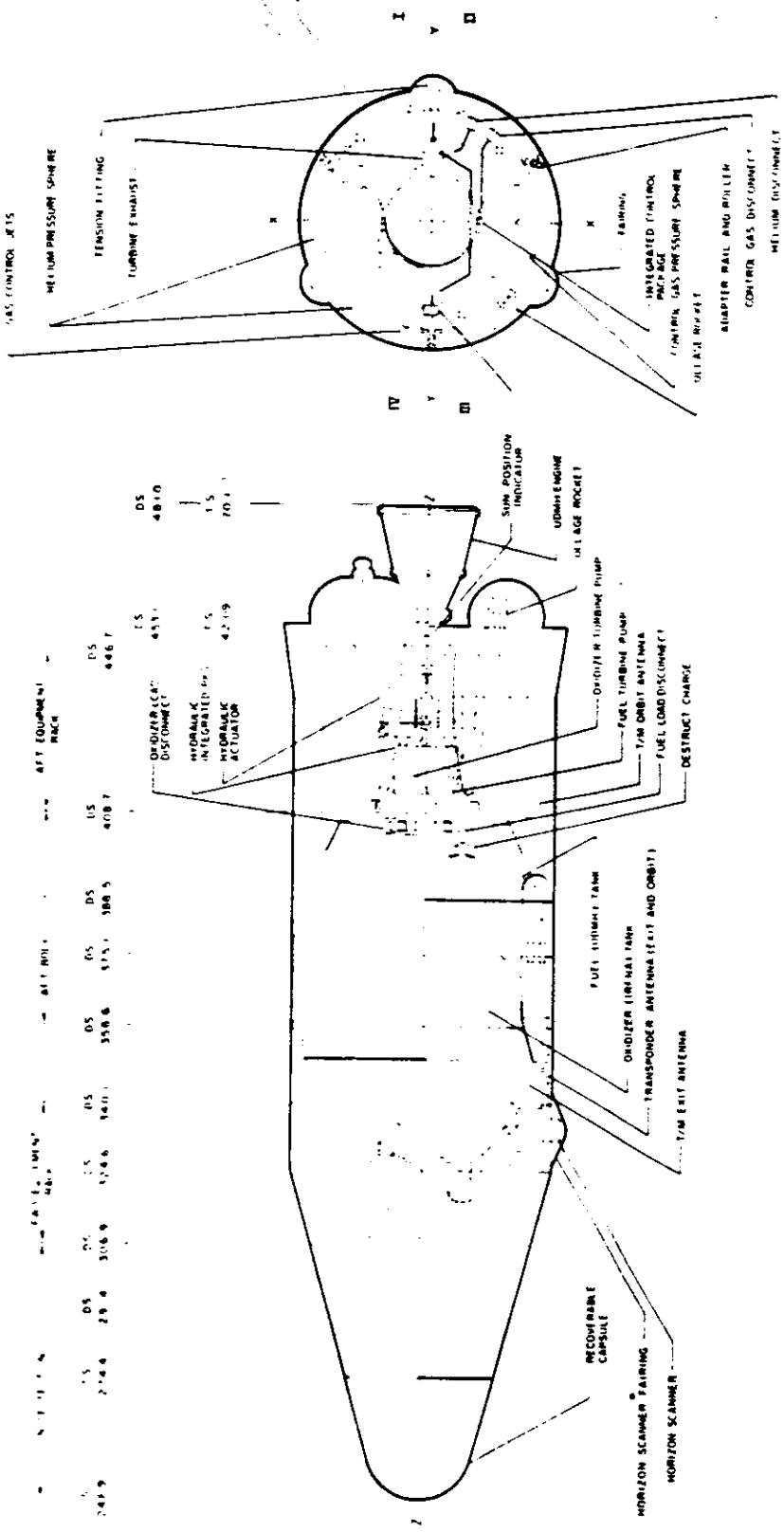

Figure 2-1 Agena Inboard Profile

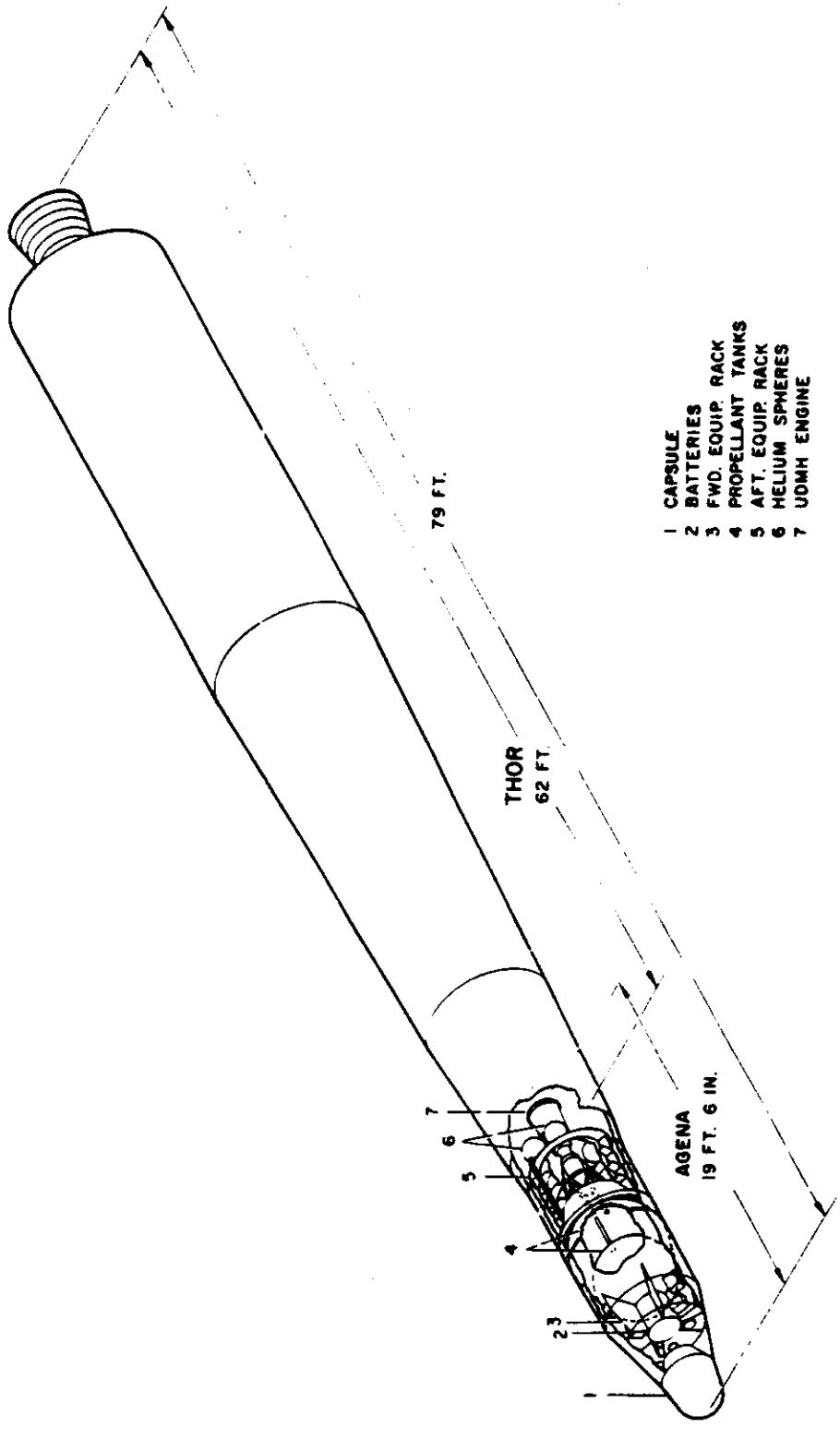

Figure 2-2 Agena 1056-Thor 237 Configuration

Table 2-1

AGENA 1056 WEIGHT STATEMENT

Weight	Predicted		Actual	
	Subtotals (lb)	Totals (lb)	Subtotals (lb)	Totals (lb)
Agena Weight Empty		2015		2011
Add:				
Oxidizer	4762		4762	
Fuel	1866		1868	
Gross Weight - Thor Payload		8643		8645
Less:				
Adapter and Attachments	149		149	
Retrorockets	16		16	
Destruct System	7		7	
Separation Weight		8471		8473
Less:				
Horizon-Scanner Fairing	2		2	
Control Gas Expended During Coast	3		2	
Ullage Rockets and Attachments	38		38	
Engine Ignition Weight		8428		8427
Less:				
Starting Charge	1		1	
Nozzle Closure	3		3	
Oxidizer Preflow	5		5	
Impulse Oxidizer	2		2	
Impulse Fuel	1		1	
Thrust Attainment Weight (90% P_c)		8416		8415
Less:				
Impulse Oxidizer	4681		4700	
Impulse Fuel	1812		1817	
Control Gas Expended During Boost	3		2	
Shutdown Weight		1920		1896
Less:				
Vented Residual Propellants	127		105	
Vented Helium	5		5	
Weight Empty on Orbit (With Control Gas)		1788		1786
Less:				
Attitude Control Gas	35		37	
Weight Empty on Orbit (Gas Expended)		1753		1749

Table 2-2

DISCOVERER XIV CENTERS-OF-GRAVITY AND MOMENTS-OF-INERTIA

CONDITION	CENTERS OF MASS (IN)			MOMENTS OF INERTIA (SLUG FT^2)		
	Z	X	Y	I_x	I_y	I_z
Booster Burnout	645.1	+0.08	+0.14	381,100	381,100	2,076
Thor Payload	362.3	-0.04	+0.07	2,421	2,422	152
Separation	361.1	-0.06	+0.08	2,251	2,266	123
Engine Ignition	360.6	-0.04	+0.08	2,162	2,177	123
Burnout	353.9	-0.12	+0.38	1,749	1,764	122
In Orbit, No Gases	349.1	+0.13	+0.43	1,613	1,625	121

RECOVERABLE CAPSULE

The Agena's recoverable capsule was similar to those on previous Discoverer flights, except that the spinup and despin rockets were replaced with the cold-gas-jet system (Freon-nitrogen) as in the previous Discoverer XIII (Agena 1057). The recoverable payload was an AET test package.

RECOVERY FORCE

The capsule-recovery force consisted of nine C-119J aircraft (for acquisition and aerial capsule pickup), four RC-121D aircraft (for capsule location), one C-130A aircraft (for acquisition and aerial capsule pickup), five JC-54 aircraft (for recording capsule telemetry signals), one WV-2 aircraft (for frequency-interference control and capsule location), and two victory ships, USS Haiti Victory and USS Dalton Victory (for surface recovery).

The nominal capsule impact point was 28-degrees north latitude and 158-degrees 48.7 minutes west longitude.

TRACKING COMPLEX

The tracking station complex was similar to that of the previous Discoverer flight, with the exception of the USS Pvt. Joe E. Mann which was replaced by a WV-2 aircraft (for telemetry reception). The Pacific Missile Range (PMR) facility at Barking Sands, Kauai, recorded capsule signals and transmitted bearing information to the [redacted] where, together with the [redacted] and South Point bearing information, the approximate capsule trajectory was determined. The temporary telemetry-receiving station on Christmas Island was also utilized to extend the capsule-detecting and telemetry-receiving range.

SECTION 3
TEST OPERATIONS

[redacted]

SECTION 3
TEST OPERATIONS

PRELAUNCH OPERATIONS

A summary of Agena 1056 progress from the time of its manufacture to the time of launch is presented in Table 3-1.

Table 3-1
AGENA 1056 HISTORY

Date	Event
5-26-59	Completed (manufacturing) final assembly LMSD, Sunnyvale
5-26-59	Sent to modification and checkout at LMSD, Sunnyvale
8-6-59	Sent to and received at SCTB
9-16-59	Completed successful "hot" firing
9-24-59	Returned to LMSD, Sunnyvale, for modifications and checkout
11-24-59	Sent to and received at VAFB
4-4-60	Completed MAB systems checkout run
4-7-60	Sent to Pad 4
4-11-60	Completed countdown and Flight Systems Check
4-26-60	Returned to MAB following planning-scheduling changes
7-21-60	Completed final MAB systems checkout
7-23-60	Transferred to launch complex
7-30-60	Completed final systems check at pad
8-16-60	Completed mating to first-stage booster
8-18-60	Launched vehicle

The one countdown required to launch Discoverer XIV began at 0430 PDT on 18 August 1960 and proceeded smoothly to a successful liftoff 8 hours and 27 minutes later. Two technical holds were necessary. These holds totaled 72 minutes and were caused by ground support equipment (GSE) delays detailed in the Countdown Chronology, Table 3-2.

The Sunnyvale Satellite Test Center (STC) and the Palo Alto Computer Center (PACC) were manned and ready for countdown and launch by 0530 PDT. Checkout of the tracking system and data-transmission link was initiated on schedule. Practice system runs were received and evaluated, and all stations were ready for launch operations at 0845 PDT.

Table 3-2
COUNTDOWN CHRONOLOGY

Task No.	Task	Time Scheduled		Actual Countdown Time		
		Start Time (min)	Duration (min)	Start Time (PST)	Start Time (min)	Duration (min)
1.	Precountdown Operations and Countdown Initiation	T - 435	10	0430	T - 435	14
2.	GFE Mating	T - 425	45	0444	T - 421	31
3.	Shelter Removal Vehicle Erection	T - 395	30	0507	T - 398	52
4.	RF Checkout	T - 380	50	0601	T - 334	94
5.	Lanyard Connection and Fuel-Truck Activation	T - 345	30	0601	T - 344	40
6.	Destruct Test	T - 315	30	0734	T - 251	23
7.	Orbital Stage Arm	T - 285	40	0757	T - 228	36
8.	Connect First-Stage Destruct System	T - 285	40	0757	T - 228	38

Table 3-2 (Continued)

Task No.	Task	Time Scheduled		Actual Countdown Time		
		Start Time (min)	Duration (min)	Start Time (PST)	Start Time (min)	Duration (min)
9.	Propellant-Line Fill	T - 245	60	0835	T - 190	75
	Hold No. 1 Imposed (a)			0910	T - 155	40
10.	Countdown Evaluation	T - 185	30	0935	T - 115	15
11.	Electronics Warmup	T - 115	90	0950	T - 155	32
12.	GFE Checkout	T - 150	40	0952	T - 153	28
13.	Range RF Checks	T - 145	30	0955	T - 150	5
14.	Propellant Tanking	T - 110	30	1022	T - 123	76
15.	Secure Propellant Trucks	T - 80	25	1138	T - 47	22
16.	Guidance and Flight-Control Checkout	T - 55	25	1200	T - 25	33
17.	Pressurization	T - 55	25	1200	T - 25	44
	Hold No. 2 Imposed (b)			1210	T - 15	32
18.	Countdown Evaluation	T - 30	17m 50s	1235	T - 15	7
19.	Terminal Countdown	T - 12m 10s	12m 10s	1245	T - 12	12
	Liftoff at	T - 0		1257:07:85		

SUMMARY OF HOLDS

(a) Hold No. 1 was called at T - 155 for work to catch up with the count after earlier delays. Causes for these delays included:

1. A hydraulic power unit malfunction during Task 3 (DAC GSE)
2. Task 4 (RF Checkout) delay to avoid RF interference with a systems run at the MAB (LMSD)
3. Short fuel-fill umbilical lanyard replacement during Task 5 (LMSD GSE)
4. Inadvertent operation of the water-deluge system at the pad during Task 9 (DAC GSE)
5. Inspection of an apparent hardline damage in the umbilical mast.

(b) Hold No. 2 was called at T - 15 to allow work to catch up again with the count, after a delay in Task 14, propellant tanking (LMSD GSE).

[redacted]

LAUNCH AND ASCENT

Discoverer XIV was successfully launched into a near-nominal orbit from Pad 4, VAFB, at 1257:08 PDT on the first launch attempt. Liftoff was normal and only minor pad damage resulted. The vehicle was launched vertically and then was properly rolled to a departure azimuth of 172.4 degrees (172 degrees predicted). All programmed events occurred in the proper sequence. The first-stage boost trajectory was nominal. Thor main-engine operation was normal with an operating time of 164.89 seconds (approximately 0.35 second longer than predicted). Separation was initiated properly and completed within 0.74 second of the predicted time.

Data received and utilized by the Reeves computer at the [redacted] during ascent and coast resulted in the transmission of 24.29 seconds of Command 5 (which extended the D-timer hold to 26.70 seconds), and 13.2 seconds of Command 6 (controls velocity-integrator setting). Both commands were received by the vehicle and properly executed.

Agena engine start (90 percent thrust) occurred at T + 277.8 seconds and nominal thrust was obtained. Duration of engine operation was 115.78 seconds, compared to a predicted time of 112.7 seconds. Engine shutdown was by integrator command. Telemetry coverage was maintained until T + 690 seconds by the downrange telemetry ship.

Table 3-3 lists the predicted launch sequence of events and the actual times when these events occurred.

ORBITAL OPERATIONS

Checkout of the tracking systems complex was conducted on the morning prior to launch, using nominal acquisition messages that had been sent to all stations. On the basis of launch tracking data received by the PACC from [redacted] and [redacted] initial orbital elements were calculated and a new

Table 3-3

LAUNCH SEQUENCE OF EVENTS

Event	Predicted Time (sec)	Actual Time (sec)
Liftoff (a)	0	0
Main-engine Cutoff	164.54	164.89
Vernier-engine Cutoff	173.84	174.48
Start Fairchild Timer	179	179.68
Explosive Bolts FIRE	181	181.75
Pneumatics ON	181	181.75
Retrorockets FIRE	181.5	182.24
Command -45 deg/min Pitch Rate	192	192.75
Command -2 deg/min Pitch Rate	221	221.65
Start D-timer Hold	221	221.65
(D-timer Hold Duration)	23.42	26.70
Command 5 ON	223	224.07
Command 5 OFF	244.42	248.35
(Duration Command 5)	21.42	25.28
Command 6 ON	244.42	248.35
Command 6 OFF	264.15	261.55
(Duration Command 6)	19.73	13.20
Ullage Rockets FIRE	263.7 (b)	264.35
Preactivate Hydraulics	263.7 (b)	264.35
Helium Bypass Valve Open	275.7 (b)	276.33
Thrust Attainment (90% P_c)	277.2 (b)	277.78
Engine Shutdown (70% P_c)	389.9 (b)	393.56
(Duration Engine Operation)	112.7	115.78
Command -40 deg/min Yaw Rate	400.7 (b)	401.35
Hydraulics Shutdown	400.7 (b)	401.35
Vent Valves FIRE	400.7 (b)	401.35

(a) 1257:07.85 PDT; system time: 71827.85 seconds; 1957:07.85 GMT

(b) Based on actual D-timer hold of 26.7 seconds

[redacted]

Table 3-3 (Continued)

Event	Predicted Time (sec)	Actual Timer (sec)
[redacted] Telemetry Fade	670.7 (b)	454
[redacted] Telemetry Fade		460
Remove -40 deg/min Yaw Rate		671.5
Downrange Ship Telemetry Fade		714

(b) Based on actual D-timer hold of 26.7 seconds

acquisition message was generated and sent to the [redacted] Tracking Station [redacted] for Pass 1. Acquisition messages were also sent to the other tracking stations [redacted] and [redacted] for use during Pass 1. Orbital tracking of the Agena is summarized in Table 3-4 for all types of signal.

Pass 1

Orbital status was verified by [redacted] when the Agena's telemetry and continuous-wave acquisition transmitter (CWAT) was acquired at 77103 system time, 27 seconds later than predicted by PACC. [redacted] tracked the satellite on radar and recorded Agena telemetry. The acquisition message for Pass 1 required [redacted] to increase the timer period by two steps. Difficulty was experienced in verifying Command Tone A, thus affecting Commands 1 and 3, but Tones B and C (Command 2) were verified, indicating the beacon decoder was operational. The timer read decrease 22 (5611 seconds) and the payload reading was 05 (Gray Code 0111) at acquisition. Command 1 (timer increase/decrease) was issued six times but was not verified. Command 3 (reset) was issued at 60-degrees north latitude but was not verified. Command 2 (step) was issued and verified, and the timer then read decrease 21 (5600 seconds). The reset monitor came on nine seconds earlier than predicted. The desired timer period setting was 5675 seconds, based on the actual period of the satellite. Preliminary investigation of the Tone A verification problem indicated a possible difficulty with the [redacted] ground radar. The station reported that the peak-to-peak deviation of the center command pulse for Tone A had decreased from the nominal 2.75 microseconds to 1.5 microseconds during the hour prior to the estimated time of acquisition (ETA). The station was instructed to adjust Tone A to the nominal value. The timer period setting at [redacted] fade was decrease 21 (5600 seconds). Radar tracking was smooth and solid throughout the track. [redacted] and [redacted] both acquired the satellite. [redacted] was directed to send Command 1 (increase), but it was impossible to determine if the command had been verified, due to sporadic telemetry reception (caused by the satellite position being at an extreme range for [redacted]

Table 3-4

ORBITAL CONTACT SUMMARY
(System Time)

Pass	CW Acquisition Transmitter				Telemeter			Radar		
	Station	Acquire	Fade	Duration	Acquire	Fade	Duration	Acquire	Fade	Duration
Launch	[redacted]	71829	72284	455	71829	72283	427	71829	72256	427
Launch		71857	72286	429	71853	72289	436	71835	72329	494
Launch	AG 161	No Data			72079	72518	439	No Radar		
1	[redacted]	77103	77635	532	77103	77637	534	77133	77642	509
1		No Data			77717	77987	270	No Data		
1		77800	77804	4	77800	77802	2	77806	77900	94
2	[redacted]	82896	83218	322	82898	83207	309	82990	83195	205
2	Barking Sands	No Data			83413	83790	377	No Radar		
2	[redacted]	83421	83708	287	83431	83831	424	83421	83708	287
2	South Point	No Data			83493	83825	332	No Radar		
2	Christmas	83728	84115	387	No Data			No Radar		
6	[redacted]	17721	18501	780	No Data			No Data		
7	[redacted]	23429	24223	794	No Data			No Data		
8	[redacted]	28891	29705	814	29120	29625	505	No Data		
8		28862	29684	822	29120	29623	503	29125	29623	498
9	Christmas	34050	34770	720	No Data			No Radar		
9	[redacted]	34605	34829	224	34829	25081	252	No Data		
9		34608	35374	766	34877	35374	497	34800	35380	580
9		34745	35425	680	34794	35429	635	34866	35306	440
9		35000	35682	682	35004	35624	620	35245	35625	380
10	Christmas	No Data			40290	40600	310	No Radar		
10	[redacted]	39970	40285	315	40285	40927	642	40286	40510	224
10		40623	41435	812	40640	41238	598	40628	41230	602

[redacted]

Table 3-4 (Continued)

Pass	CW Acquisition Transmitter				Telemeter			Radar		
	Station	Acquire	Fade	Duration	Acquire	Fade	Duration	Acquire	Fade	Duration
13	[redacted]	59039	59439	400	No Data			No Data		
15	[redacted]	70055	70444	389	70189	70444	255	70204	70441	237
15		70474	70912	438	70474	70855	381	70503	70855	352
15		70516	70935	419	70518	70852	334	70550	70852	302
16	[redacted]	75735	76268	533	75743	76264	521	75796	76264	468
17	[redacted]	81505	81881	376	81505	81865	360	81587	81811	224
17		82027	82296	279	82109	82420	311	No Data		
		82362	82477	115						
24	[redacted]	33331	33602	271	33365	33602	237	No Data		
24		33220	34035	815	33364	34030	666	No Data		
24		33643	34250	607	33646	34214	568	No Data		
25	[redacted]	38550	39502	942	38880	39506	626	No Data		
25		27504	28262	758	No Data			No Data		
25		39227	40009	782	39227	39811	584	No Data		

Pass	Station	GE Capsule Beacon			Capsule Telemetry		
		Acquire	Fade	Duration	Acquire	Fade	Duration
17	[redacted]	81746	81865	119	No Data		
17	Barking Sands	No Contact					
17	[redacted]	82153	82230	77	No Data		
17	South Point	83105	83160	55	No Data		
17	Christmas	No Contact					
17	Dalton Victory	82425	84420	1995			
17	Haiti Victory	82010	82215	205			

SECRET

[redacted]

Pass 2

Prior to Pass 2, the deviation for Tone A at [redacted] was set at a nominal value of 2.75 microseconds as directed. [redacted] acquired six seconds early. As soon as a radar lock was obtained, Command 1 (increase) was sent and verified. The Pass 1 command problem appeared to be solved by correcting the ground equipment settings at [redacted] the timer was successfully reset (Command 3) and seven steps were verified, which increased the timer period to 28 (5675 seconds).

[redacted] acquired the satellite 37 seconds early and sent a decrease command which was verified. [redacted] reported that the satellite appeared to be rolling from minus 6 to plus 5 degrees, the pitch horizon scanner was off scale, and the control gas remaining (1240 psig) was below nominal. Contact with the JHU/APL Doppler beacon high- or low-frequencies was not verified. Impact prediction number 2 was issued, based on tracking data during Pass 2.

The Agena telemetry was also tracked at Christmas Island, Barking Sands, and South Point. The orbital timer readout at fade was decrease 28 (5675 seconds).

Pass 6

The [redacted] tracked the satellite on CWAT. Time-of-crossing at the station latitude was 18143 system time. The beacon signal strength was weak but steady, thus indicating satellite perturbations were not serious.

Pass 7

[redacted] tracked the CWAT for a duration of 794 seconds; the signal strength was steady. Radar and telemetry were not programmed to operate. The JHU/APL beacon was not monitored.

[redacted]

Pass 8

[redacted] and [redacted] provided telemetry readouts which indicated that the remaining nitrogen-gas pressure was 1000 psig. Agena acquisition and fade times were on schedule. Commands were not sent. [redacted] and [redacted] reported the reset monitor on 22 seconds before predicted. The orbital timer setting at fade remained at decrease 28 (5675 seconds).

Pass 9

Contact was achieved by [redacted] and Christmas Island. Telemetry readouts indicated that the remaining nitrogen-gas pressure was 920 psig.

The reset command was sent but was not verified by [redacted] at 35012 system time, and the reset monitor came on two seconds later. Signal strengths were relatively steady and nominal for CWAT and telemetry during the pass. [redacted] reported the possibility of some cyclic rate in the VERLORT automatic gain control (AGC), probably due to interference.

Near real-time evaluation of Agena performance was accomplished with telemetry data recorded at the Sunnyvale facility.

Pass 10

Command problems were again evident and difficulty was encountered in obtaining verification of Tone A. To test the command link, Command 1 (increase/decrease) was used. This command is composed of Tones A and B. The step of the increase/decrease switch permits verification of command capability of these tones without affecting the orbital timer operation. Attempts by [redacted] to reset the timer were unsuccessful. After attempting to send four commands, the total modulation deviation of Tone A was increased by 0.5 microsecond to compensate for the change in beacon characteristics and the successful verification of Tone A was accomplished.

Upon satellite acquisition, [redacted] was instructed to send Command 1 with the modulated deviation increased in steps for an additional 0.25 microsecond, or a total of 3.05 microseconds. During the rest of the pass, [redacted] succeeded in verifying four Command 1's (Tones A and B), indicating that, as far as [redacted] was concerned, a Tone A deviation of 3.05 microseconds was sufficient for command verification. The station was instructed to use this setting for all commands unless otherwise directed. Telemetry readouts indicated that the remaining nitrogen-gas pressure was 800 psig. Contact was also reported by Christmas Island.

Pass 13

The [redacted] tracked the CWAT beacon for a duration of 400 seconds. The signal strength was steady but weak. This was not a programmed pass.

Pass 14

Holloman AFB tracked the Agena telemetry and supplied the STC with real-time telemetry readouts as requested.

Pass 15

[redacted] acquired the CWAT at 70055 system time and the telemetry was observed at 70189 system time. The reported nitrogen-gas pressure was 520 psig. [redacted] issued a reset command which was held in for 30 seconds prior to the planned reset system time of 70303 seconds. The command button was then released, and the orbital timer was properly adjusted for a correct D-timer start on Pass 17.

[redacted] reported the reset monitor off at 70851 system time and the plate turned off at 70855 system time. This report established that the orbital timer was within two seconds of the programmed setting, verifying proper timer phasing for recovery sequence initiation.

S-band beacon frequency was reported to be 7 megacycles high by [redacted] and [redacted] Telemetry signal strength was solid and strong as reported

[redacted]

by [redacted] although [redacted] reported a cycling every five seconds and radar automatic gain control (AGC) cycling twice per second. Cycling was not noted by [redacted] or [redacted] on acquisition or during track.

Pass 16

[redacted] acquired and tracked normally. No abnormalities were noted. The decision was made not to send commands on this pass, since the proper adjustment of timer tape position had been accomplished on Pass 15. The Agena crossing of the reference latitude of 65 degrees north was 12 seconds late, crossing of 60 degrees north was 8 seconds late, and the reset monitor came on 3 seconds early based on computer predictions. The nitrogen-gas pressure was reported to be 470 psig, which was lower than nominal but considered sufficient for proper reorientation on the recovery pass.

All indications were that everything was in proper order for recovery.

Pass 17

Acquisition was normal and tracking was satisfactory. From Agena telemetry, [redacted] reported that D-timer start and capsule separation were observed within seven seconds of nominal time.

Other events were not verified by [redacted] or [redacted] since neither station acquired capsule telemetry. [redacted] and South Point reported contact with the VHF capsule beacon. The C-119 WV-2 and JC-54 Number 1 aircraft reported contact with the VHF beacon, the USS Dalton Victory and USS Haiti Victory contacted the VHF beacon, and the C-119 Number 9 aircraft made visual sighting of the capsule.

C-119 Number 9 successfully recovered the capsule as it was descending on the parachute, and the capsule was reeled into the aircraft 14 minutes later.

[redacted]

Subsequent Passes

During Pass 24, [redacted] sent one increase command which was verified, leaving the timer set in the increase mode. Subsequently, ten increase/decrease commands, two step commands, 35 payload commands, two Commands 5, and two Commands 6 were sent by [redacted] and [redacted] none were verified. The satellite CWAT was tracked satisfactorily by [redacted] and [redacted] on Passes 24 and 25. [redacted] and [redacted] reported the telemetry signal as very weak on Pass 24. All tracking stations discontinued tracking operations over the weekend and on Monday (22 August) the following attempts to acquire the Agena were made:

Pass	Station
60	[redacted]
61	
62	
63	

Failure of the stations to acquire on these passes indicates that the battery life was expended as predicted.

CAPSULE RE-ENTRY AND RECOVERY

Prerecovery operation briefings proceeded as planned with both the surface-element briefing and the air-element briefing accomplished on schedule. The operation was conducted with the same force composition as Discoverer XIII with the exception of the USS Pvt Joe E. Mann telemetry ship which completed its commitment to the program prior to the Discoverer XIV operation.

Revisions to the impact area were issued as refined ephemeris data and became available from the launch operation and succeeding orbital passes. The revisions as issued are listed in Table 3-5.

[redacted]

Table 3-5

IMPACT-AREA PREDICTIONS

Prediction	Time of Receipt (GMT)	ETPD* (GMT)	Latitude (deg N)	Longitude (deg W)	Pass
1 (Nominal)	1915, 16 August	2151:15.3	24°00.5'	158°49.8'	17
2	2340, 18 August	2252:17.2	24°00.0'	163°33.6'	17
3	0905, 19 August	2251:51.0	24°00.0'	163°26.8'	17
4	1020, 19 August	2251:50.0	24°00.0'	163°26.4'	17
5	1247, 19 August	2251:42.1	24°00.0'	163°24.0'	17
6	2008, 19 August	2251:32.5	24°00.7'	163°22.0'	17
7	2128, 19 August	2251:29.0	24°15.7'	163°24.5'	17

* Estimated time of Parachute Deployment.

The recovery operation on 19 August began with a fully operational force. All recovery-force aircraft were airborne by 2046 GMT and on station by 2137 GMT. The USS Haiti Victory and USS Dalton Victory were on station by 2047 GMT. At 1850 GMT, the RC-121 Number 1 and Number 2 aircraft were ordered to assume stations 100 nautical miles south of their planned stations. After [redacted] was able to command the satellite, the RC-121's were ordered at 1947 GMT to return to their normal stations. At 2045 GMT, RC-121 Number 3 reported that its Number 4 engine was out and the aircraft was aborting its mission. At this time, RC-121 Number 4 was advised to move northward 50 nautical miles to cover the southern recovery area. This order was revised immediately to proceed per plan and not to change position. Upon receipt of prediction 7, all force components were moved 16 nautical miles north. The force deployment at estimated time of parachute deployment (ETPD) is shown in Figure 3-1.

The first capsule VHF-beacon-signal acquisition by a recovery-force component was by the USS Haiti Victory at 2246:50 GMT (Table 3-6). At 2248 GMT, C-119J Number 8 acquired a Class C bearing. By 2250:30 GMT, eight recovery aircraft, the Haiti Victory, the WV-2, and JC-54 Number 1 had VHF beacon acquisition with either an indeterminate bearing or a northerly

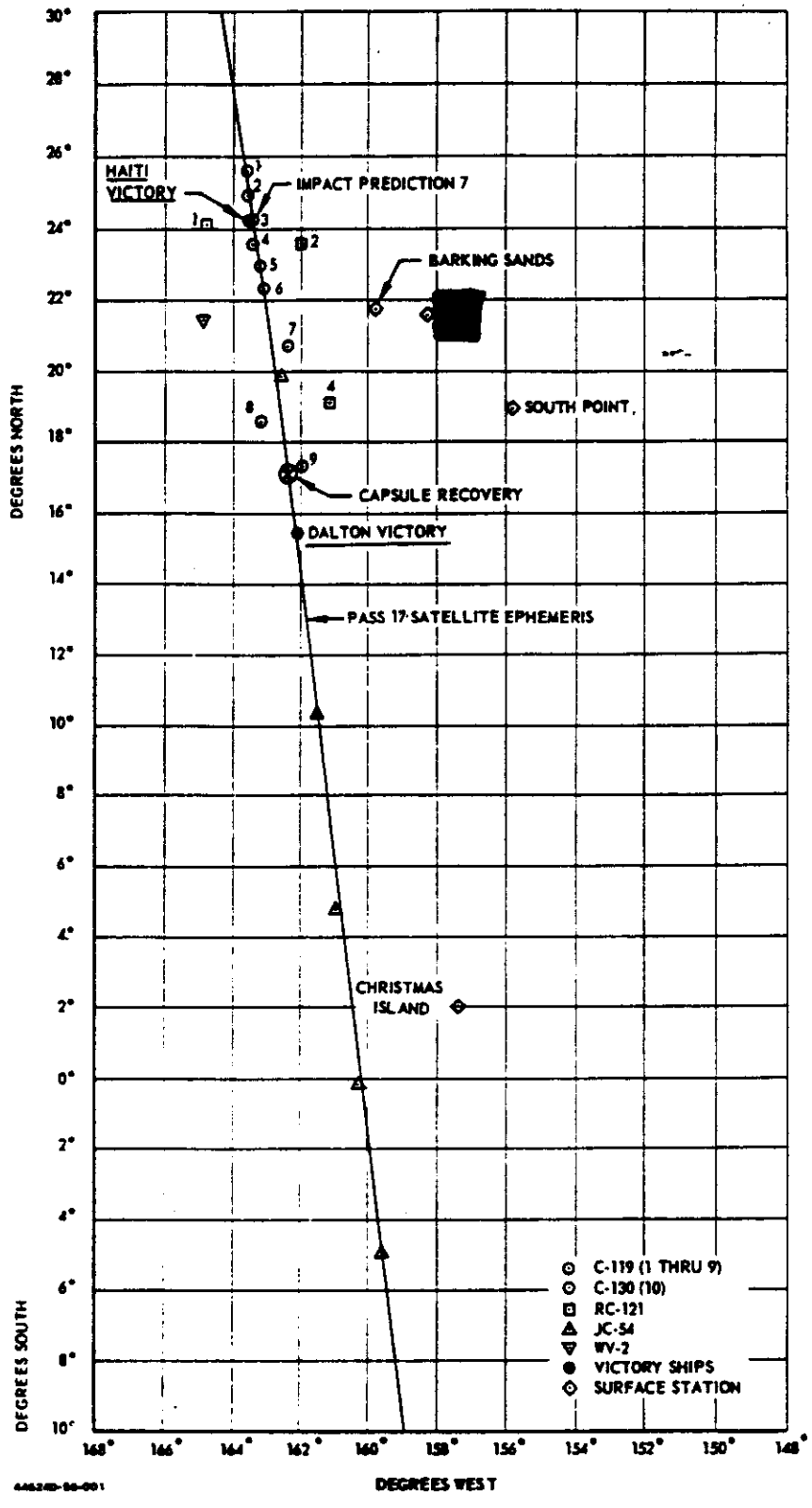

Figure 3-1 Recovery-Force Deployment at Estimated Time of Parachute Deployment

[redacted]

Table 3-6
CAPSULE ACQUISITION BY FORCE COMPONENTS

Unit	Acq Signal	Time Acq (GMT)	Time Fade (GMT)	Bearing Acq (deg true)	Bearing Fade (deg true)	Freq (mc)	Class
C-119 No. 1	GE	2248:30	2251	341°	291°	234.2	C
C-119 No. 2	GE	2250:30	2251	-	-	231.1	C
C-119 No. 3	GE	2248:30	2251	-	-	234.0	C
C-119 No. 4	GE	2248	2251	-	-	234.5	-
	GE	2259	2302	186°	179°	235.5	B to A
C-119 No. 5	GE	2248:30	2250:30	351°	-	234.2	A
	GE	2256		174°	-	235.0	A to B
	GE		2307		167°	235.0	B to C
C-119 No. 6	GE	2248:05	2250:00	-	-	235.0	A
	GE	2256:00	2308	181°	166°	235.0	B
C-119 No. 7	GE	2254:30	2323	186°	176°	234	A
C-119 No. 8	GE	2248	2252	-	-	238	C
	GE	2255:43	2323	136°	163°	236.5	A
C-119 No. 9	GE	2253:05	2304 (visual)	261°	266° (visual)	233 to 235.5	A
C-119 No.10	GE	2249	2251	346°		233	B
	GE	2305	2307	171°		233	B
JC-54 No. 1	GE	2249	2253	-	-	237.8	C to A
KV-2	GE	2248	2252	-	-	234 to 238	
	GE	2254	2308	171°		235	A
Dalton Victory	GE	2253:45	2322:40	340° to 0°	010°	234.5 to 234.8	Good
	GE	2312:49	2327	015°		234.5 to 234.8	Fading and Varying
Haiti Victory	GE	2246:50	2250:15	350°	355°		
P2-121	Chaff (APS-20)	2255	204° and 127 miles from area center				Excellent
	Chaff (APS-45)	2305	210° and 89 miles from area center 27,000 feet				Excellent
	Chute (APS-45)	2308	7400-foot altitude				Weak

[redacted]

bearing. By 2253 GMT, all of these signals were lost with the latest fade reported by JC-54 Number 1. At 2253:05 GMT, C-119 Number 9 acquired the VHF beacon on a bearing of 261 degrees. By 2259 GMT, six recovery aircraft, the WV-2, and the USS Dalton Victory acquired the VHF beacon in the general direction of the final recovery area (Fig. 3-2). Later, the C-130A aircraft also reported a short acquisition in this direction. At 2255 GMT, RC-121 Number 4 sighted chaff on its APS-20 radar at 204 degrees and 127 nautical miles. Subsequently, this aircraft sighted the chaff and possibly the parachute on its APS-45 radar.

At 2304 GMT, C-119 Number 9 reported visual sighting of the descending parachute capsule at a 16,000-foot altitude and at a distance of 5 to 6 nautical miles. Recovery was made at 2309 GMT on the third pass at an 8500-foot altitude. The recovery was accomplished at an indicated airspeed of 110 knots. The winch main-brake setting was 3.2 (static-winch brake setting of approximately 600 pounds) with a delay of 2 (5 drum revolutions before brake application) resulting in a line payout of 350 feet. One hundred, eighty-five feet of the 100-pound cord were carried in the energy-absorption trough. Contact with the parachute was made with the right pole and right bottom hook. Aerial recovery was normal and the recovered capsule was reeled aboard the aircraft at 2323 GMT.

The recovered capsule was not dented upon recovery and transfer into the recovering aircraft. Insulation on the cannon-plug wiring was reported to be burned off. The top of the capsule was sooted, and the two strobe lights appeared as if they had been melted or heated to near liquid form. The capsule was still warm to the touch when reeled into the aircraft. The top wires, antennas, and strobe lights were disconnected upon recovery. The parachute appeared to be undamaged during its descent and only slight oscillations were noticeable. It ripped on recovery and was reported to be slightly burned on top.

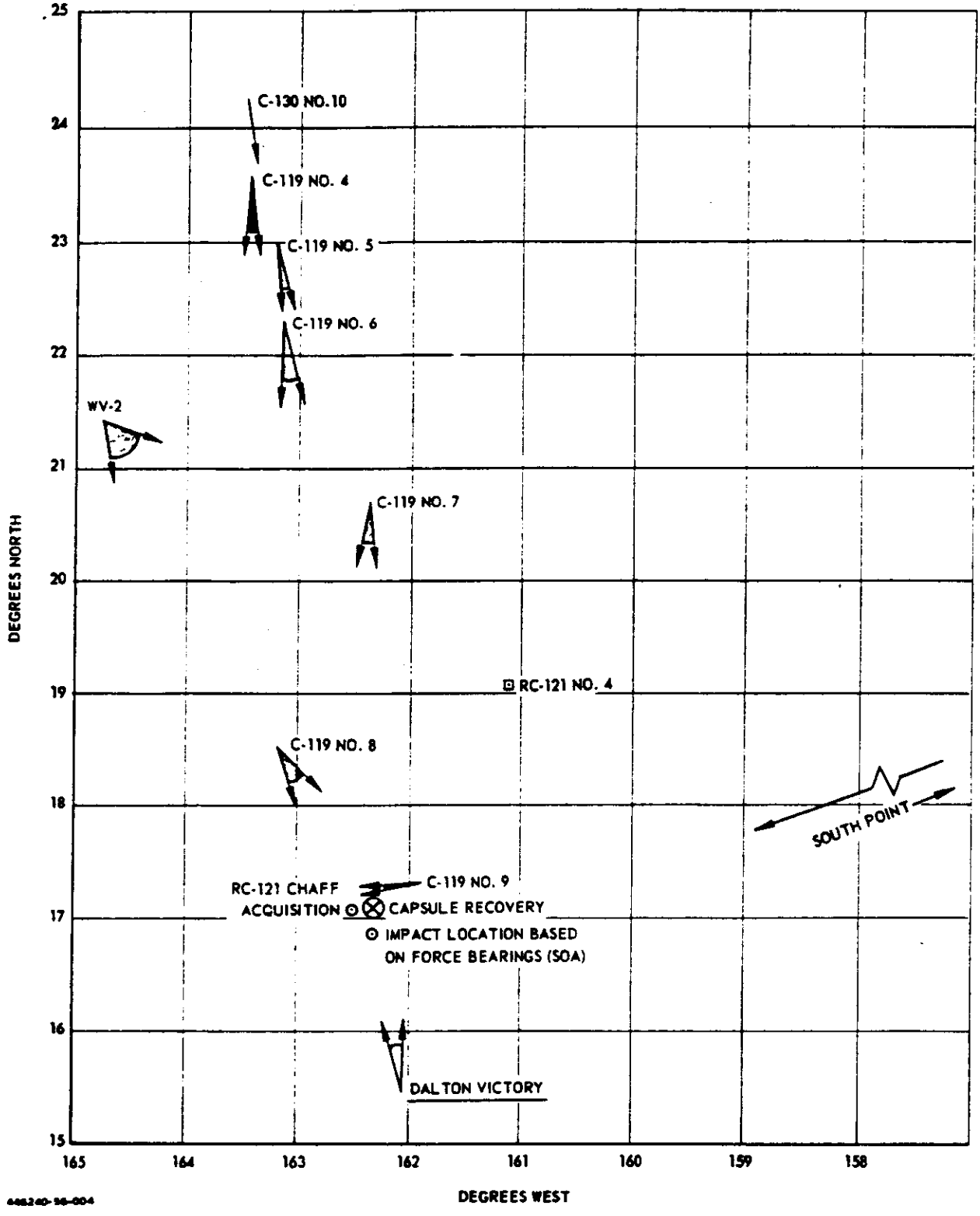

Figure 3-2 Recovery Force Beacon Bearings From 2253 GMT to Recovery

TEST EVALUATION

SECTION 4
TEST OBJECTIVES AND RESULTS

[redacted]

SECTION 4
TEST OBJECTIVES AND RESULTS

	Achievement		
	Yes	Partial	No
I. PRIMARY OBJECTIVES			
a. Place a Discoverer satellite with a recoverable capsule in orbit.	X		
b. Secure primary telemetered data on the test material and equipment for the length of time the recoverable capsule is in orbit (nominally 27 hours).	X		
c. Eject the capsule from orbit and recover for direct examination of the test material for data and analysis.	X		
In order to achieve the basic objectives, it was necessary that the following specific objectives be attained:			
1. The ground support equipment must provide adequate support and checkout required for the launch of the Discoverer satellite and Thor booster.	X		
2. The Thor booster must carry the Agena satellite to the planned separation altitude, achieve the planned attitude at separation, and provide the required velocity at separation.	X		
3. The Agena airframe and adapter must demonstrate the ability to withstand control system perturbation and flight environment.	X		
4. The Agena propulsion system must provide the additional total impulse required to attain orbital velocity following booster separation.	X		
5. The Agena auxiliary power unit must demonstrate acceptable performance of components and supply power requirements at least through the recovery orbit pass.	X		

[redacted]

	Achievement		
	Yes	Partial	No
6. The Agena guidance and control system must demonstrate the ability to:	X		
(a) Derive the time-to-initiate orbital boost and the velocity-to-be-gained during orbital boost, using automatic computation equipment.	X		
(b) Initiate and terminate orbital boost at the proper time.			
(c) Maintain proper satellite orientation during coast, orbital boost, and the orbiting phase until ejection of the recoverable capsule.		X	
7. The Discoverer satellite airborne and ground telemetry, tracking, and command system must demonstrate the ability to:			
(a) Satisfactorily monitor all primary functions (Thor and Agena) and produce adequate ground telemetry records of these functions.	X		
(b) Properly transmit, receive, act upon, and verify all required ground-space commands.		X	
(c) Determine an ephemeris of orbit sufficiently accurate to assure acquisition on each successive intercept and to allow the satellite timer to be adjusted with sufficient accuracy to program the required satellite functions.	X		
8. The Agena satellite recovery system must demonstrate:			
(a) The ability of the recoverable capsule components to obtain and transmit data.		X	
(b) Compatibility of the recoverable capsule with the Discoverer satellite in its ascent, orbit, and during the ejection phase.	X		

[redacted]

	Achievement		
	Yes	Partial	No
(c) Proper capsule functioning during re-entry to facilitate recovery by the related airborne and surface system.	X		
(d) Compatibility and suitability of the related surface and airborne recovery system components and techniques.	X		
II. SECONDARY OBJECTIVES			
a. Test and evaluate Agena satellite systems and their effective functional interrelationships.	X		
b. Test and evaluate temperatures at a sufficient number of locations on the Agena satellite so that the heat-flow patterns established in theoretical design can be verified and the temperatures environment for later flights can be established.	X		
c. Test and evaluate the interstation communications network.	X		
d. Demonstrate the capability of the system personnel to perform all checkout, launch, communications, orbital and recovery procedures necessary to the attainment of test objectives.	X		
III. TERTIARY OBJECTIVES			
a. Evaluate overall system performance for the planning of future programs.	X		

SECTION 5
FLIGHT PERFORMANCE

[redacted]

SECTION 5
FLIGHT PERFORMANCE

LAUNCH AND BOOST PHASE

Launch occurred normally with Thor Booster 237 performing adequately and meeting all test objectives (Summary of Critical Data, Table 5-1). Liftoff weight was 117,034 pounds. The launching pad suffered only minor damage.

Thor propulsion was normal with a liftoff thrust of 151,000 pounds. Roll to the programmed 172-degree launch azimuth was accomplished successfully (actual value 172.4 degrees). Main-engine cutoff occurred at 164.89 seconds with vernier-engine operation of 9.59 seconds following. Main-engine cutoff was due to oxidizer exhaustion with a propellant utilization of 99.35 percent. Some pitch-rate oscillations were observed (143 to 160 seconds) but were only about one-tenth amplitude of the previous flight (Discoverer XIII).

Structural loads and dynamic environment on the Agena were normal and less than design values. During separation, an unexplained 5-degree yaw angle was observed. The expected value is 2 degrees and the cause for the discrepancy is being investigated. Temperature environment was also within expected values (see Table 5-2). Power consumption was normal with all units operating properly (see Table 5-3). Flight data on the hydraulic battery is not available due to a failure of the monitor, but proper operation was evidenced by the hydraulic motor operation.

Guidance performance was normal from launch through yaw-around (Fig. 5-1). During coast, the gyros indicated a correct pitchover rate of 45 deg/min for 29 seconds. The horizon-scanner operation was also correct during the launch and boost phase. All transients of separation and Agena engine ignition were correctly damped, including the above-mentioned 5-degree of yaw at separation.

[redacted]

Table 5-1

SUMMARY OF CRITICAL DATA

Event	Predicted	Actual
Liftoff Weight (lb)	117,851	117,038
Thor Payload Weight (lb)	8,643	8,641
Agena Dry (lb)	3,015	3,011
Agena Oxidizer (lb)	3,762	3,762
Agena Fuel (lb)	1,866	1,868
Launch Azimuth (deg)	172	172.-
Thor Roll Program (deg)	9.48	9.1
Thor Main-engine Cutoff		
Time (sec)	164.84	164.89
Altitude (nm)	41.47	41.52
Velocity, Inertial (ft/sec)	13,760	13,756
Flight Path Angle, Inertial (deg)	17.63	18.38
Range (nm)	84.83	82.1
Vernier-engine Cutoff		
Time (sec)	173.84	174.-8
Start Separation		
Time (sec)	183.84	182.31
Weight	8,472	8,469
D-timer Hold		
Start (sec)	221	221.73
Stop (sec)	244.8	248.43
Command 5		
Start (sec)	223	224.18
Stop (sec)	244.8	248.43
Command 6		
Start (sec)	244.8	248.43
Stop (sec)	264.53	261.63
Thor Coast Apogee		
Time (sec)	345	346.2
Altitude (nm)	102	104.03
Range (nm)	455.73	444.-
Velocity, Inertial (ft/sec)	12,947	12,576