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DISCOVERER XIV

(AGENA 1056 / THOR 237)

SYSTEM TEST EVALUATION AND PERFORMANCE ANALYSIS REPORT

(35 - DAY REPORT)

CONTRACT AF 04(647)-558

LMSD-446240-56

Lockheed

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

Contract AF 04(647)-558

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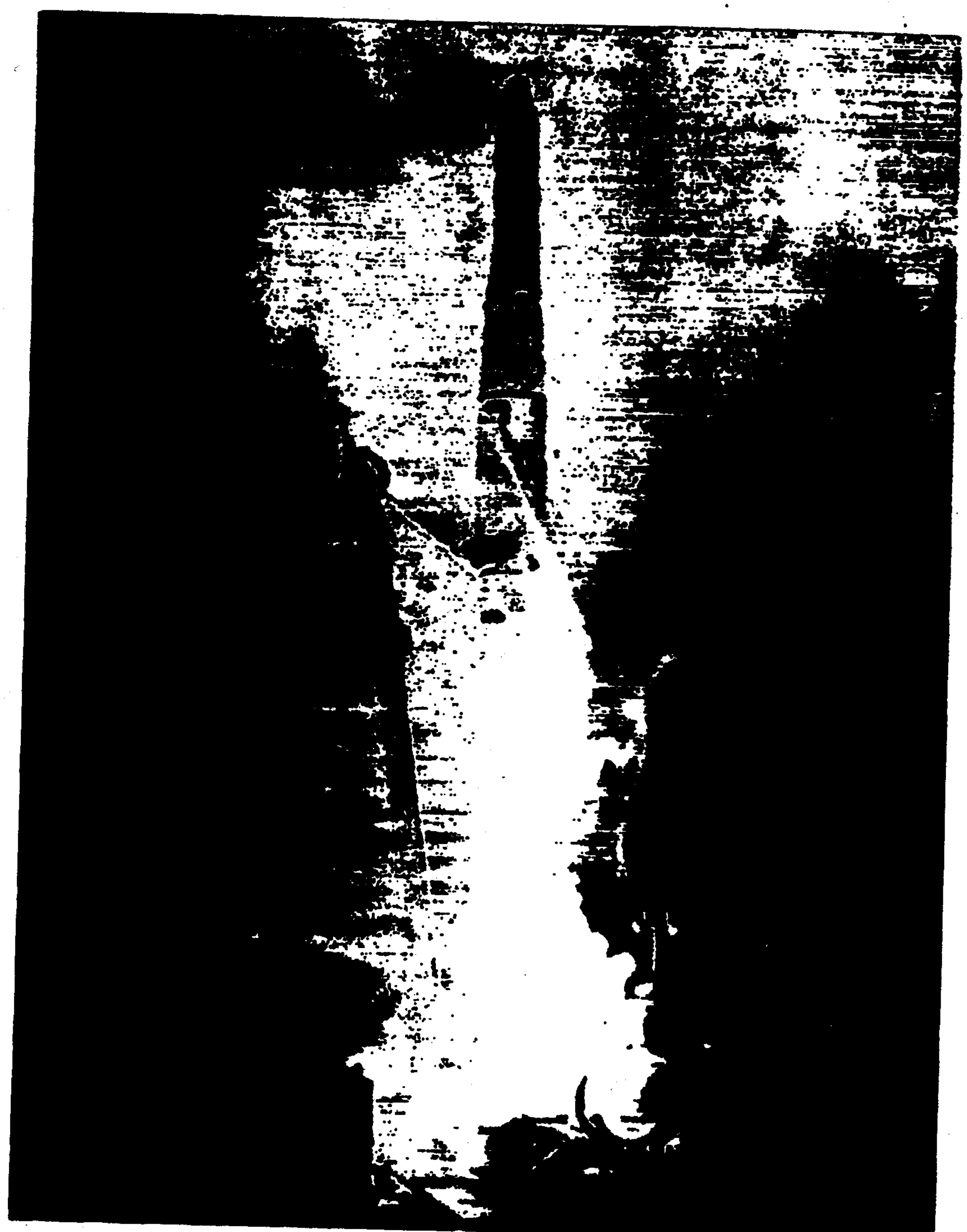

446240-56-002

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

446240-56-003

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

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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 AF 04(647)-558 in accordance with Paragraph 1.4.1 of LMSD-445158-B, Discoverer Program.

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 Kodiak Tracking Station (KTS), 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, KTS 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 Hawaiian Tracking Station (HTS), 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.

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)

ILLUSTRATIONS

ILLUSTRATIONS (Continued)

TABLES

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
HTS	Hawaii Tracking Station
IRP	Inertial Reference Package
JHU/APL	Johns Hopkins University/Applied Physics Laboratory
KIAS	Knots, Indicated Airspeed
KTS	Kodiak Tracking Station
MAB	Missile Assembly Building, VAFB
MPR	Main Power Relay
MTS	Point Mugu Tracking Station
NBTS	New Boston Tracking Station
PACC	Palo Alto Computer Center

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
VTS	Vandenberg Tracking Station

SECTION 1
INTRODUCTION

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.

SCOPE OF THE 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.

SUMMARY OF DISCOVERER FLIGHT TESTS

SUMMARY OF DISCOVERER FLIGHT TESTS

DISCOVERER VEHICLES AGENA/THOR	LAUNCH COMPLEX, TIME, AND DATE	COUNTDOWNS REQUIRED	PAYLOAD DESCRIPTION	RESULTS
1022/160	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 13:49:16 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 CIRT contact reported. Satellite believed damaged structurally and/or thermally at injection or during first pass.
Discoverer II 1018/170 (1959 Gamma)	Complex 4 13:18:39 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 13:09:20 PST 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 13:57:45 PST 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 12:00:08 PST 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 recovery battery. 45-day lifetime recorded.
Discoverer VI 1028/200 (1959 Zeta)	Complex 5 12:24:44 PST 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 12:28:41 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 lost signal and satellite tumbling caused. Nitrogen gas exhausted prior to Pass 2 contact by Kodiak. Capsule could not be ejected. 19 day lifetime recorded.
Discoverer VIII 1050/212 (1959 Lambda)	Complex 5 12:26:[illegible] 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 nm and apogee of 1067 nm. 103.7-minute period with satisfactory programming of capsule separation on Pass 2. Re-entry sequence caused. 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 + 56.26 seconds.
Discoverer XI 1055/234 (1960 Delta)	Complex 5 1230:27 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 1600:44 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 -3.3 degree injection plane.
Discoverer XIII 1057/231 (1960 Theta)	Complex 5 1237:54 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 420 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.

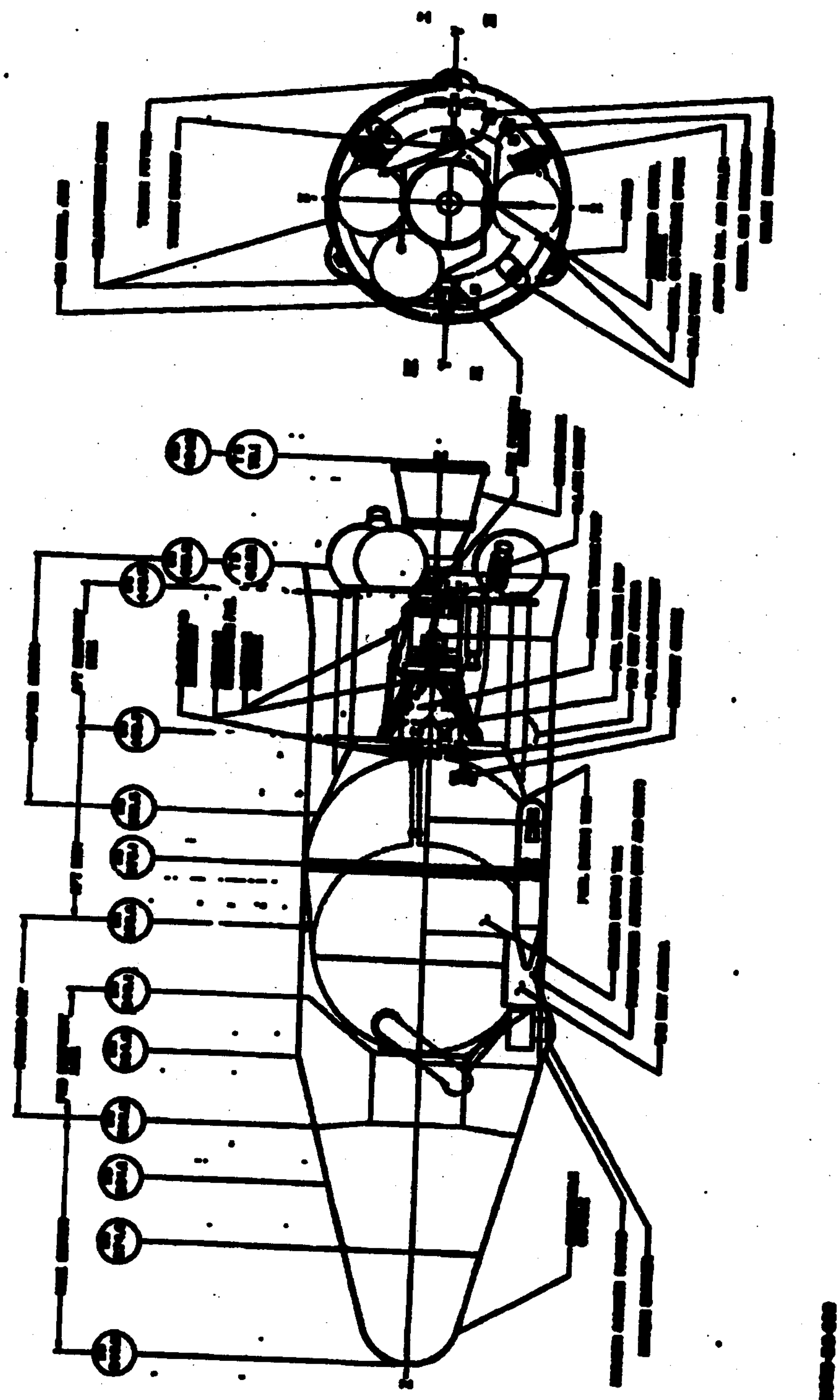

Figure 2-1 Agena Inboard Profile

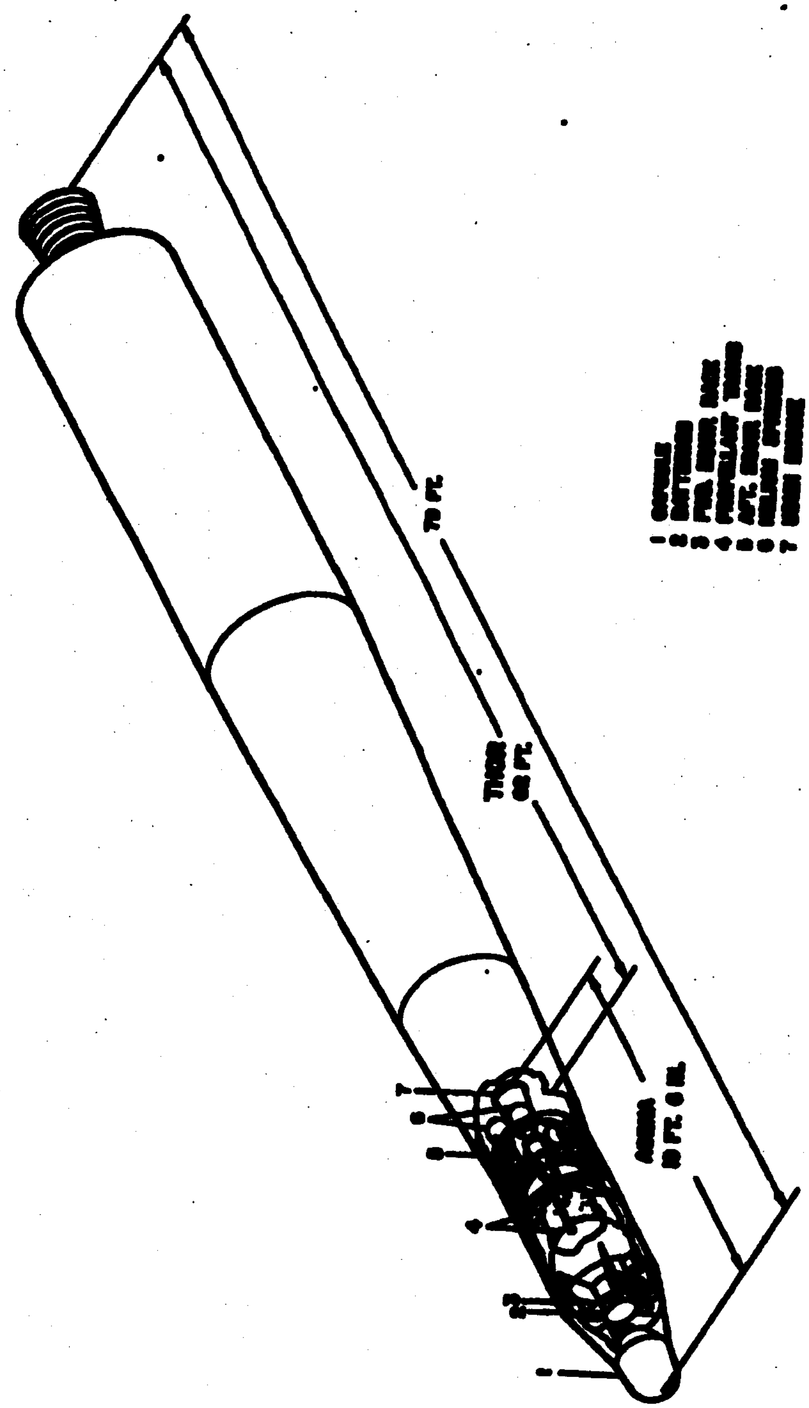

Figure 2-2 Agena 1056–Thor 237 Configuration

Table 2-1

AGENA 1056 WEIGHT STATEMENT

Weight	Predicted Subtotals (lb)	Predicted Totals (lb)	Actual Subtotals (lb)	Actual 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	2,411	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
On 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 Hawaiian Tracking Station, (HTS) Oahu, where, together with the HTS 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

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 SOTS
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: Start Time (min)	Time Scheduled: Duration (min)	Actual Countdown Time: Start Time (PST)	Actual Countdown Time: Start Time (min)	Actual Countdown Time: 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: Start Time (min)	Time Scheduled: Duration (min)	Actual Countdown Time: Start Time (PST)	Actual Countdown Time: Start Time (min)	Actual Countdown Time: 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).

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 Point Mugu Tracking Station (MTS) 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 MTS and VTS, 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	[redacted]	[redacted]
Vernier-engine Cutoff	[redacted]	[redacted]
Start Fairchild Timer	[redacted]	[redacted]
Explosive Bolts FIRE	[redacted]	[redacted]
Pneumatics ON	[redacted]	[redacted]
Retrorockets FIRE	[redacted]	[redacted]
Command -45 deg/min Pitch Rate	[redacted]	[redacted]
Command -2 deg/min Pitch Rate	[redacted]	[redacted]
Start D-timer Hold	[redacted]	[redacted]
(D-timer Hold Duration)	[redacted]	[redacted]
Command 5 ON	[redacted]	[redacted]
Command 5 OFF	[redacted]	[redacted]
(Duration Command 5)	[redacted]	[redacted]
Command 6 ON	[redacted]	[redacted]
Command 6 OFF	[redacted]	[redacted]
(Duration Command 6)	[redacted]	[redacted]
Ullage Rockets FIRE	[redacted]	[redacted]
Preactivate Hydraulics	[redacted]	[redacted]
Helium Bypass Valve Open	[redacted]	[redacted]
Thrust Attainment (90% P_c)	[redacted]	[redacted]
Engine Shutdown (70% P_c)	[redacted]	[redacted]
(Duration Engine Operation)	[redacted]	[redacted]
Command -40 deg/min Yaw Rate	[redacted]	[redacted]
Hydraulics Shutdown	[redacted]	[redacted]
Vent Valves FIRE	[redacted]	[redacted]

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

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

Table 3-3 (Continued)

Event	Predicted Time (sec)	Actual Timer (sec)
VTS Telemetry Fade	[redacted]	[redacted]
MTS Telemetry Fade	[redacted]	[redacted]
Remove -40 deg/min Yaw Rate	[redacted]	[redacted]
Downrange Ship Telemetry Fade	[redacted]	[redacted]

(b) Based on actual D-timer hold of 26.7 seconds acquisition message was generated and sent to the Kodiak Tracking Station (KTS) for Pass 1. Acquisition messages were also sent to the other tracking stations (HTS, VTS, and MTS) for use during Pass 1. Orbital tracking of the Agena is summarized in Table 3-4 for all types of signal.

Pass 1

[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	VTS	[redacted]								
Launch	[illegible]	[redacted]								
Launch	AS 161	[redacted]								
1	[illegible]	[redacted]								
1	VTS	[redacted]								
1	[illegible]	[redacted]								
2	[illegible]	[redacted]								
2	Barking Sands	[redacted]								
2	[illegible]	[redacted]								
2	South Point	[redacted]								
2	Christmas	[redacted]								
6	[illegible]	[redacted]								
7	[illegible]	[redacted]								
8	VTS	[redacted]								
8	[illegible]	[redacted]								
9	Christmas	[redacted]								
9	[illegible]	[redacted]								
9	[illegible]	[redacted]								
9	VTS	[redacted]								
9	[illegible]	[redacted]								
10	Christmas	[redacted]								
10	[illegible]	[redacted]								
10	[illegible]	[redacted]								

Table 3-4 (Continued)

Pass	CW Acquisition Transmitter				Telemeter			Radar		
	Station	Acquire	Fade	Duration	Acquire	Fade	Duration	Acquire	Fade	Duration
13	[illegible]	[redacted]								
15 15 15	[illegible] VTS [illegible]	[redacted]								
16	[illegible]	[redacted]								
17 17	[illegible] [illegible]	[redacted]								
24 24 24	[illegible] VTS [illegible]	[redacted]								
25 25 25	[illegible] [illegible] [illegible]	[redacted]								

Pass	Station					
17	[illegible]	[redacted]				
17	Barking Sands	[redacted]				
17	[illegible]	[redacted]				
17	South Point	[redacted]				
17	Christmas	[redacted]				
17	Dalton Victory	[redacted]				
17	Haiti Victory	[redacted]				

Page 2

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[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

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.

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 KTS 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

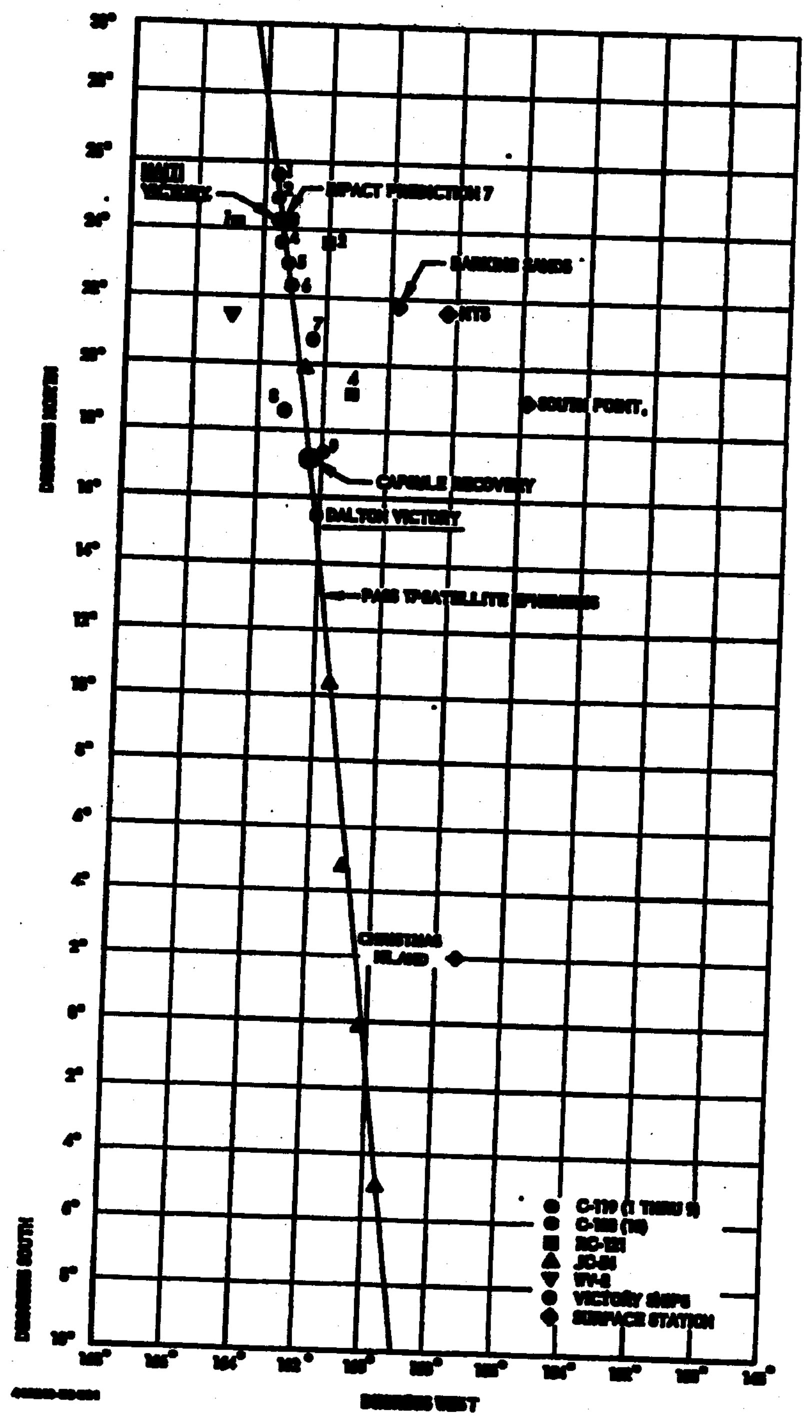

Figure 3-1 Recovery-Force Deployment at Estimated Time of Parachute Deployment

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	CW	2248:30	2251	341°	251°	234.2	C
C-119 No. 2	CW	2250:30	2251	-	-	231.1	C
C-119 No. 3	CW	2248:30	2251	-	-	234.0	C
C-119 No. 4	CW	2248	2251	-	-	234.5	-
	CW	2259	2302	186°	179°	235.5	B to A
C-119 No. 5	CW	2248:30	2250:30	351°	-	234.2	A
	CW	2256		174°	-	235.0	A to B
	CW		2307		167°	235.0	B to C
C-119 No. 6	CW	2248:05	2250:00	-	-	235.0	A
	CW	2256:00	2306	181°	166°	235.0	B
C-119 No. 7	CW	2254:30	2303	186°	176°	234	A
C-119 No. 8	CW	2248	2252	-	-	236	C
	CW	2255:43	2303	156°	163°	236.5	A
C-119 No. 9	CW	2253:05	2304 (visual)	221°	226° (visual)	235 to [illegible] 235.5	A
C-119 No. 10	CW	2249	2251	346°		235	B
	CW	2305	2307	172°		235	B
JC-54 No. 1	CW	2249	2255	-	-	237.8	C to A
WV-2	CW	2248	2252	-	-	234 to 238	
	CW	2254	2308	171°		235	A
Dalton Victory	CW	2253:45	2302:40	340° to 0°	010°	234.5 to 234.8	Good
	CW	2312:49	[illegible]	015°		234.5 to 234.8	Fading and Varying
Haiti Victory	CW	2246:30	2250:15	350°	355°		
RC-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

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.

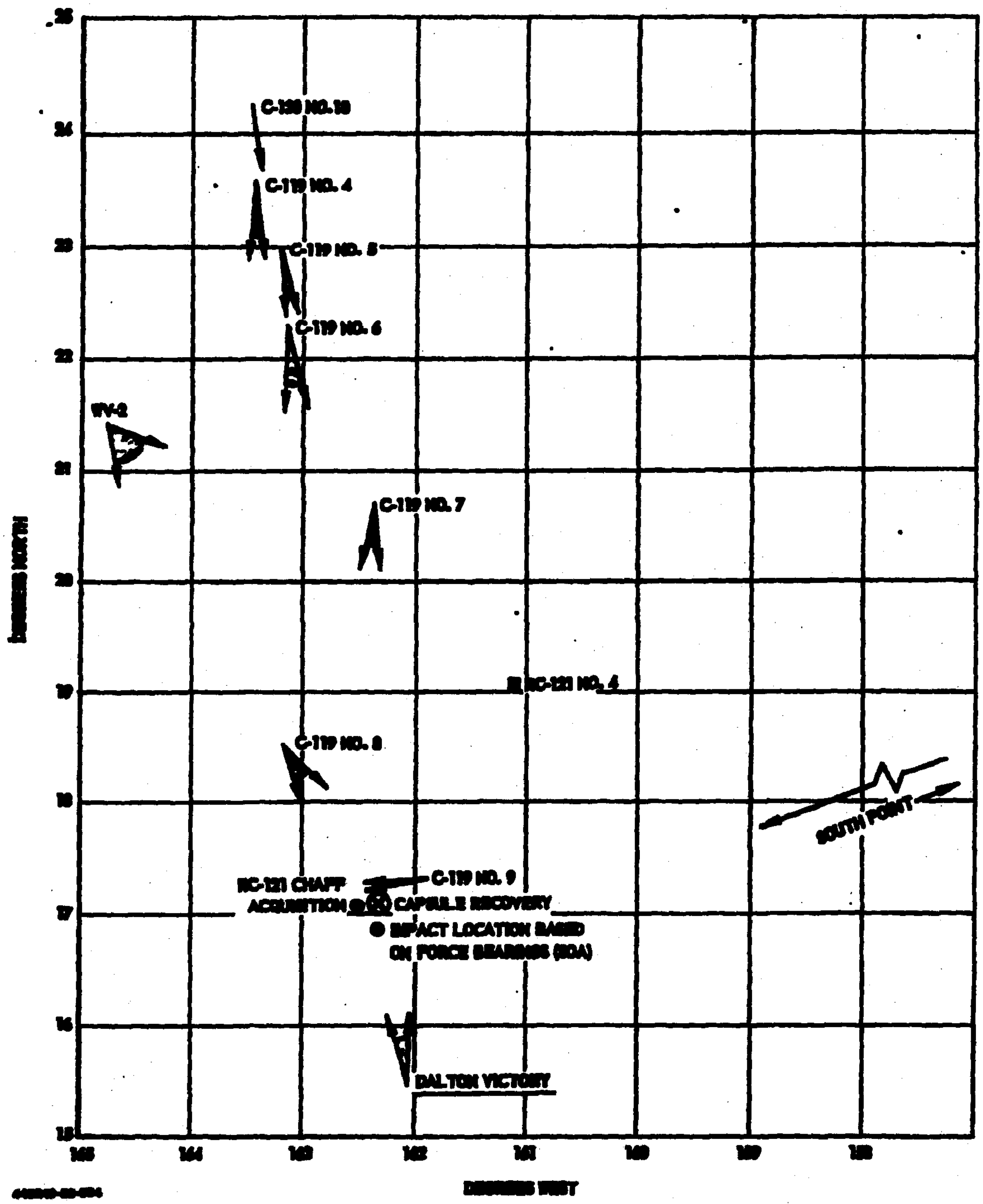

Figure 3-2 Recovery Force Beacon Bearings From 2253 GMT to Recovery

TEST EVALUATION

SECTION 4
TEST OBJECTIVES AND RESULTS

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		

	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		

Objective	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

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.

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)	2,015	2,011
Agena Oxidizer (lb)	4,762	4,762
Agena Fuel (lb)	1,866	1,868
Launch Azimuth (deg)	172	172.4
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	13,456
Flight Path Angle, Inertial (deg)	17.63	18.35
Range (nm)	84.83	82.1
Vernier-engine Cutoff		
Time (sec)	173.84	174.48
Start Separation		
Time (sec)	183.84	182.31
Weight	8,471	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	444.4
Velocity, Inertial (ft/sec)	12,947	12,576

Table 5-1 (Continued)

Event	Predicted	Actual
Agena — 90% Thrust Attainment		
Time (sec)	273.92/277.2 [a][b]	277.78
Weight (lb)	8,416	8,415
Altitude (nm)	93.36	95.14
Velocity, Inertial (ft/sec)	13,081	12,728
Flight-Path Angle, Inertial (deg)	7.36	7.28
Range (nm)	310.19	309.0
Orbital Boost		
Burning Time (sec)	112.71/112.7 [a][b]	115.78
Average Flow Rate, Total (lb/sec)	57.46	56.38
Specific Impulse (sec)	277.5	280.3
Horizontal Velocity-to-be-gained, Inertial, 90% P_c to 70% P_c (ft/sec)	13,073/13,164 [c][d] [c][e]	13,516
Agena Burnout		
Time (sec)	386.63/389.9 [a][b]	393.56
Weight (lb)	1,918	1,874
Altitude (nm)	104.3	104.62
Velocity, Inertial (ft/sec)	26,032	26,126
Injection Angle, Inertial (deg)	0	-.22
Range (nm)	629	632.6
Longitude (Geodetic)(deg)	119.15W	119.18W
Latitude (Geodetic)(deg)	24.33N	24.23N
Initial Orbit Parameters		
Eccentricity	.0371	.046
Perigee Altitude (nm)	104.3	103.5
Perigee Longitude Pass 0 (Geodetic)(deg)	119.15W	118.51W
Perigee Latitude Pass 0 (Geodetic)(deg)	24.33N	19.31N
Apogee Altitude (nm)	377.9	441
Apogee Longitude Pass 0 (Geodetic)(deg)	49.22E	50.63E
Apogee Latitude Pass 0 (Geodetic)(deg)	23.518	12.168
Period (min)	93.44	94.54
Inclination (deg)	79.63 [f]	79.63
Empty Weight with Gas (lb)	1,788	1,785
Expected Lifetime (days)	25	30 [g]

(a) Preflight prediction
(b) Prediction based on actual D-timer hold
(c) Does not include 33 ft/sec considered due to ullage-rocket firing and Agena ignition transients
(d) Aerodynamic preflight prediction
(e) Programmed in integrator
(f) Empty-weight-on-orbit calculation includes 35 lb of control gas
(g) Estimated

Table 5-1 (Continued)

Event	Predicted	Actual
Average Regression Rate, 17 Passes (deg/orbit)	23.52	23.78
Re-entry		
Retro Ignition Longitude (Geodetic) (deg)	165.59 W	169.67 W
Retro Ignition Latitude (Geodetic) (deg)	51.29 N	50.05 N
Impact Longitude (Geodetic) (deg)	158.82 W	162.35 W
Impact Latitude (Geodetic) (deg)	23.98 N	17.1 N
Re-entry Pass	17	17
Telemetry Ship Location (at Launch)		
AG-161	16.0° N 117.72° W	On Station

Table 5-2

TEMPERATURE FLIGHT DATA

COMPONENT	[illegible] AT LAUNCH T = 0 (°F)	[illegible]: [illegible] (°F)	[illegible] (°F)	[illegible] (°F)	[illegible] (°F)	[illegible] Rev 8	[illegible] Rev 9	[illegible] Rev 27
Beacon Transponder ([illegible])	69	55(a)	245	26(a)	27	[illegible]	[illegible]	[illegible]
Battery Case ([illegible])	[illegible]	[illegible]	[illegible]	[illegible]	8(b)	[illegible]	[illegible]	[illegible]
[illegible] Sensor ([illegible])	[illegible](c)	[illegible](d)	> [illegible]	[illegible](d)	[illegible]	[illegible]	[illegible]	[illegible]
2000-cps Inverter ([illegible])	[illegible]	[illegible]	240	37	25	[illegible]	[illegible]	[illegible]
IF Amplifier ([illegible])	75	227	[illegible]	[illegible]	35	[illegible]	[illegible]	[illegible]
T/M Transmitter ([illegible])	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Gyro Internal ([illegible])	NO CALIBRATION AVAILABLE FOR THIS SENSOR							

(a) From 0 to 700 seconds

(b) Bulk average temperature rise for the whole battery including the cells

(c) [illegible] temperature sensor located on motor case

(d) From 0 to 45 seconds. Data invalid beyond T + 40 seconds (signal intermittently out of band).

Table 5-3
POWER SUPPLY VOLTAGES

FUNCTION	PRE-LAUNCH	TIME FROM LAUNCH								PASS		
	-8 Sec	Lift-off	100 Sec	200 Sec	300 Sec	400 Sec	500 Sec	600 Sec	700 Sec	2	9	17
+28V Battery Bus	+27.3	+27.3	+27.3	+26.6	+25.6	+25.6	+25.4	+25.4	+25.5	+24.8	+24.8	+24
+28V Regulator 1	+28.5	NOT MONITORED										
-28V Regulator	-28.5	-28.5	-28.5	-28.5	-28.5	-28.5	-28.5	-28.5	-28.5	-28.5	-28.7	-28.5
400-cps 3φ Inverter												
φ AB	114.3	114.3	114.3	114.3	114.3	114.3	114.3	114.3	114.3	113.5	113	113
φ BC	114.5	114.5	114.5	114.5	114.5	114.5	114.5	114.5	114.5	114	113	113
2000-cps 3φ Inverter	113	113	113	113	113	113	113	113	113	120	120	120
Squib Battery	30.1											
Battery Case Temp (°F)		62°	62°	72°	73°	82°	82°	82°		60°	57°	49.6°

[redacted]

The D-timer brake command transmitted was for 24.6 seconds. A computer simulation using raw radar-tracking data yielded a value of timer brake command of 23.6 seconds with a 3σ error of plus or minus 5.7 seconds. The simulation value for Command 6 velocity correction was 14.5 seconds with an error of plus or minus 15 seconds. The actual command transmitted was 13.2 seconds, corresponding to an excess velocity of 68 ft/sec. The yaw reorientation program after engine burning was as required and the correct orbital pitch program was begun at the proper time.

The Agena engine performance was nominal. Shutdown occurred by integrator command after a velocity gain of 13,530 ft/sec, approximately 240 ft/sec more than the predicted available. Calculations indicate that the propellant utilization was better than predicted and that the specific impulse was 281.8 lb-sec/lb higher than the predicted (280.0 lb-sec/lb.).

Flow rates calculated from the turbine speed and the integrator indicate that the residuals on board and Agena burnout weight were 30 pounds less than predicted for oxidizer exhaustion. This reduction of satellite shutdown weight was caused by an increase of at least 24 pounds in the available impulse oxidizer. Since the engine was shut down by the integrator, and incipient propellant exhaustion was not indicated, an additional 12 pounds of oxidizer were probably available. This means that approximately 36 pounds of impulse oxidizer were available above that predicted. The residual weights as determined from the integrator data and from the trajectory simulation are in close agreement with those determined from turbine speed.

Oxidizer and fuel-pump inlet pressures were correctly maintained and the retro- and ullage-rocket performances were nominal as indicated by normal separation from the Thor booster and by the control-system offsets at the time of ullage-rocket ignition. A summary of propulsion performance is shown in Table 5-4. Beacon-tracking performance was satisfactory until normal loss of signal by both VTS and MTS. Commands 5 and 6 were properly transmitted and verified.

Table 5-4

PROPULSION PERFORMANCE

	SPECIFICATION	PREDICTED (a)	EXPERIENCED (b)	(c)	(d)
Performance Data					
Velocity Increment (ft/sec)	- - -	13,284	13,535	13,505	13,540
Specific Impulse (lb-sec/lb)	278.0 min	280.0	282.3	281.7	281.3
Total Impulse (10^6 lb-sec)	- - -	1.817	1.840	1.836	1.836
Thrust Duration (sec)	120 ± 6	113.50	115.78	115.78	115.78
Engine Thrust (lb)	- - -	16,005	15,890	15,856	15,860
Combustion-Chamber Pressure (psia)	500 nom	516.6	512.8	511.8	511.9
Engine Total Flow Rate (lb/sec)	- - -	57.16	56.29	56.29	56.38
Turbine Speed (rpm)	24,000 nom	24,900	24,640	- - -	- - -
Acceleration at Engine Shutdown (g)	- - -	8.31	8.38	8.31	8.41
Weight and Flow Data					
Total Oxidizer Loaded (lb)	4762	4762	4762	4762	4762
Total Fuel Loaded (lb)	1866	1866	1868	1868	1868
Total Propellant Loaded (lb)	6628	6628	6630	6630	6630
Oxidizer Flow Rate (lb/sec)	- - -	41.20	40.59	40.59	40.66
Fuel Flow Rate (lb/sec)	- - -	15.96	15.70	15.70	15.72
Total Flow Rate (lb/sec)	- - -	57.16	56.29	56.29	56.38
Agena Thrust-Attainment Weight, 90% P_c (lb)	- - -	8416	8415	8415	8415

(a) Predicted performance is based on the engine-acceptance performance and on oxidizer exhaustion.

(b) Based on telemetered propulsion data. Performance calculated from turbine speed (for flow rates) and the narrow-band chamber-pressure measurement (for thrust).

(c) Based on the acceleration integrator.

(d) Based on trajectory simulation of radar data. Velocity increment shown is calculated from specific impulse and thrust from the simulation. The simulation resulted in a net horizontal velocity increment of 13,514 ft/sec.

Table 5-4 (Continued)

	SPECIFI-CATION	PREDICTED (a)	EXPERIENCED (b)	(c)	(d)
Weight and Flow Data					
Agena Weight at Shutdown (lb)	- - -	1926 (e)	1896	1896	1885
Engine-Propellant Mixture Ratio	2.57 nom	2.581	2.586	2.586	2.586
Remaining Oxidizer Impulse Weight	- - -	0	-24	-24	-32
Remaining Fuel Impulse Weight (lb)	- - -	15	9	9	6
Oxidizer Total Residual (lb)	- - -	79	55	55	47
Fuel Total Residual (lb)	- - -	56	50	50	47
System Data					
Oxidizer-Pump Inlet Pressure (psia)	40 min	65 to 71	62 to 70	- - -	- - -
Fuel-Pump Inlet Pressure (psia)	34 max	55 to 57	55 to 57	- - -	- - -
Oxidizer-Pump Inlet Temperature (°F)	- - -	50	55 to 56	- - -	- - -
Fuel-Pump Inlet Temperature (°F)	- - -	50	55 to 56	- - -	- - -
Thrust Overshoot (%)	50 max	24	18.4	- - -	- - -
Thrust-Attainment Time (sec)	1.3 to 1.9	1.44	1.45	- - -	- - -

(a) Predicted performance is based on the engine-acceptance performance and on oxidizer exhaustion.

(b) Based on telemetered propulsion data. Performance calculated from turbine speed (for flow rates) and the narrow-band chamber-pressure measurement (for thrust).

(c) Based on the acceleration integrator.

(d) Based on trajectory simulation of radar data. Velocity increment shown is calculated from specific impulse and thrust from the simulation. The simulation resulted in a net horizontal velocity increment of 13,514 ft/sec.

(e) Based on actual propellant load and satellite weight.

In general, the telemetering performance was satisfactory. The horizon-scanner temperature monitor was intermittent during engine firing, and the hydraulic-motor battery indicated an open point. The hydraulic-pressure monitor and its excitation-voltage monitor were measured. Both monitors exhibited the same pressure shifts and the data are suitable only for telltale use. Through error the plus 28-volt monitor was not wired to the telemeter but, due to the flight schedule, it could not be corrected prior to launch.

TRAJECTORY

Discoverer XIV launch trajectory, as presented in Figures 5-2, 5-3, and 5-4, was determined from the MTS VERLORT data. The ascent data were substantiated by trajectory coverages from the VERLORT at Vandenberg Tracking Station (VTS) and the FPS-16 skin-track radar and metric optics of the Pacific Missile Range (PMR). A summary of critical data is included as Table 5-1.

At first-stage burnout, the velocity was approximately 304 ft/sec lower than predicted, with a flight-path angle approximately 0.7 degree higher than nominal. The altitude and burning time were approximately nominal. At the time of main-engine cutoff, the azimuth heading was about 0.4 degree west of nominal.

The combination of conditions at main-engine cutoff resulted in a flight which closely paralleled the predicted altitude trajectory during the coast phase. Thor apogee was 2.04 nautical miles higher and velocity was 371 ft/sec lower than the predicted coast apogee conditions.

Agena engine ignition (90% thrust attainment) occurred 3.86 seconds later and the burning time was 3.07 seconds longer than predicted.

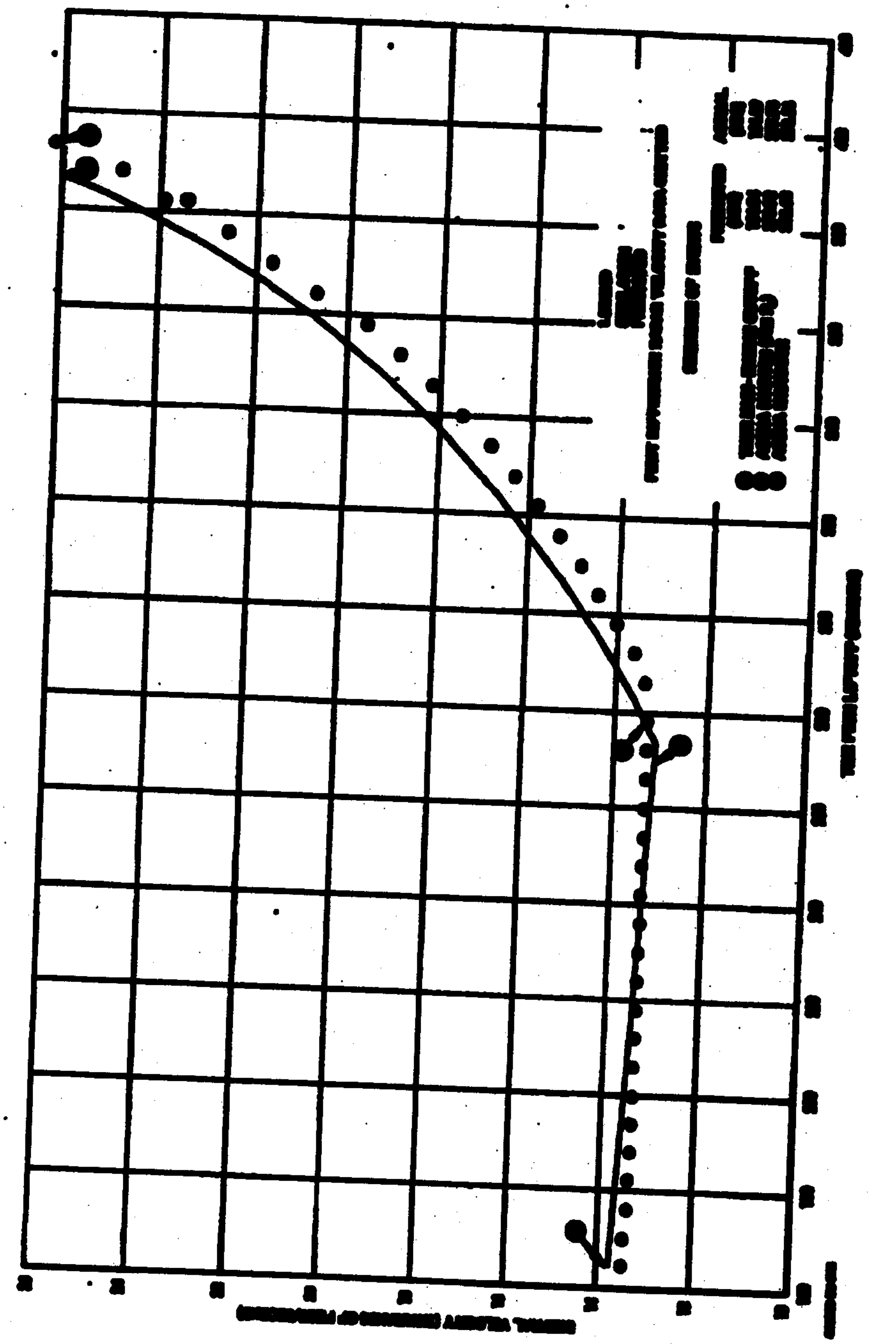

Figure 5-3 Inertial Velocity Related to Time

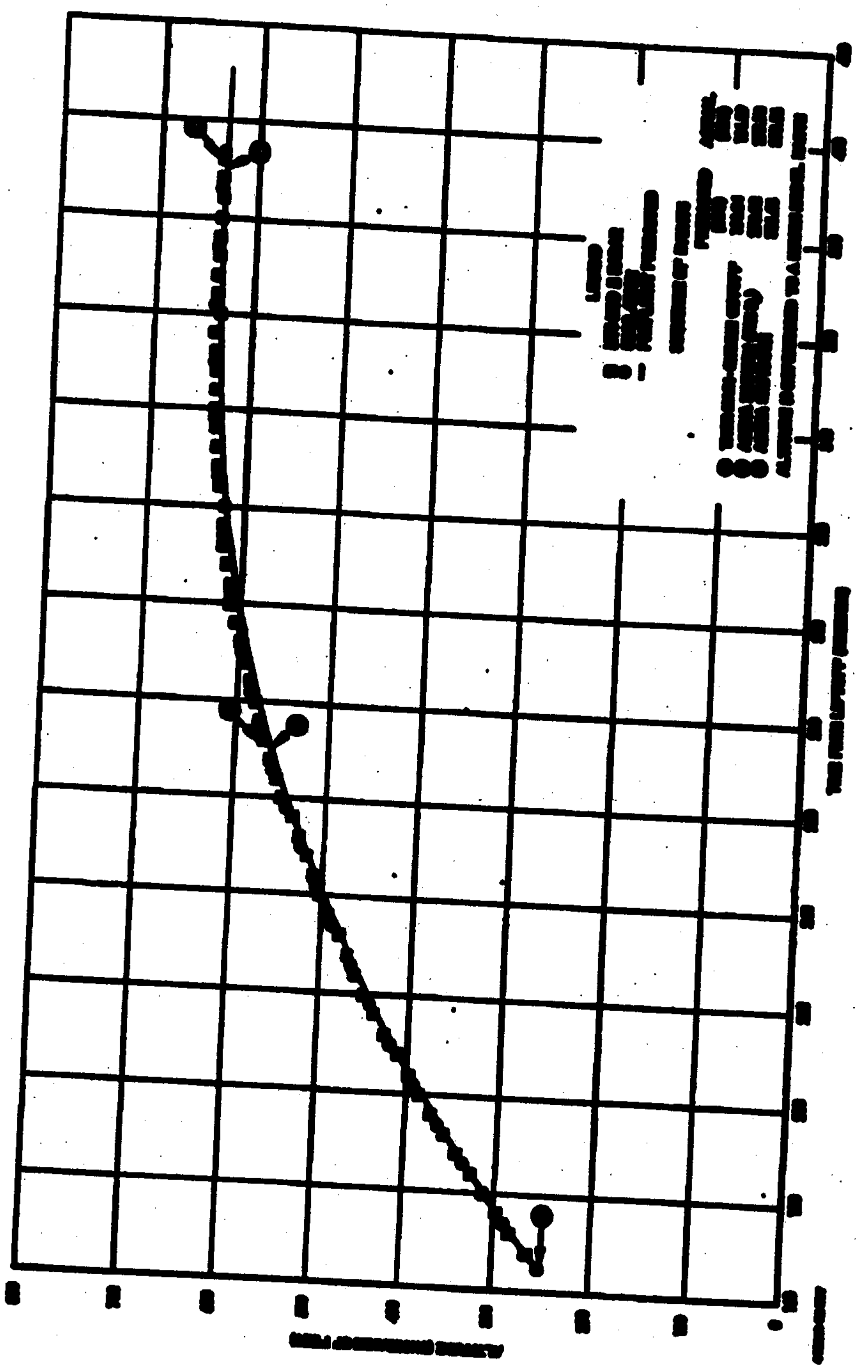

Figure 5-3 Altitude in Relation to Time

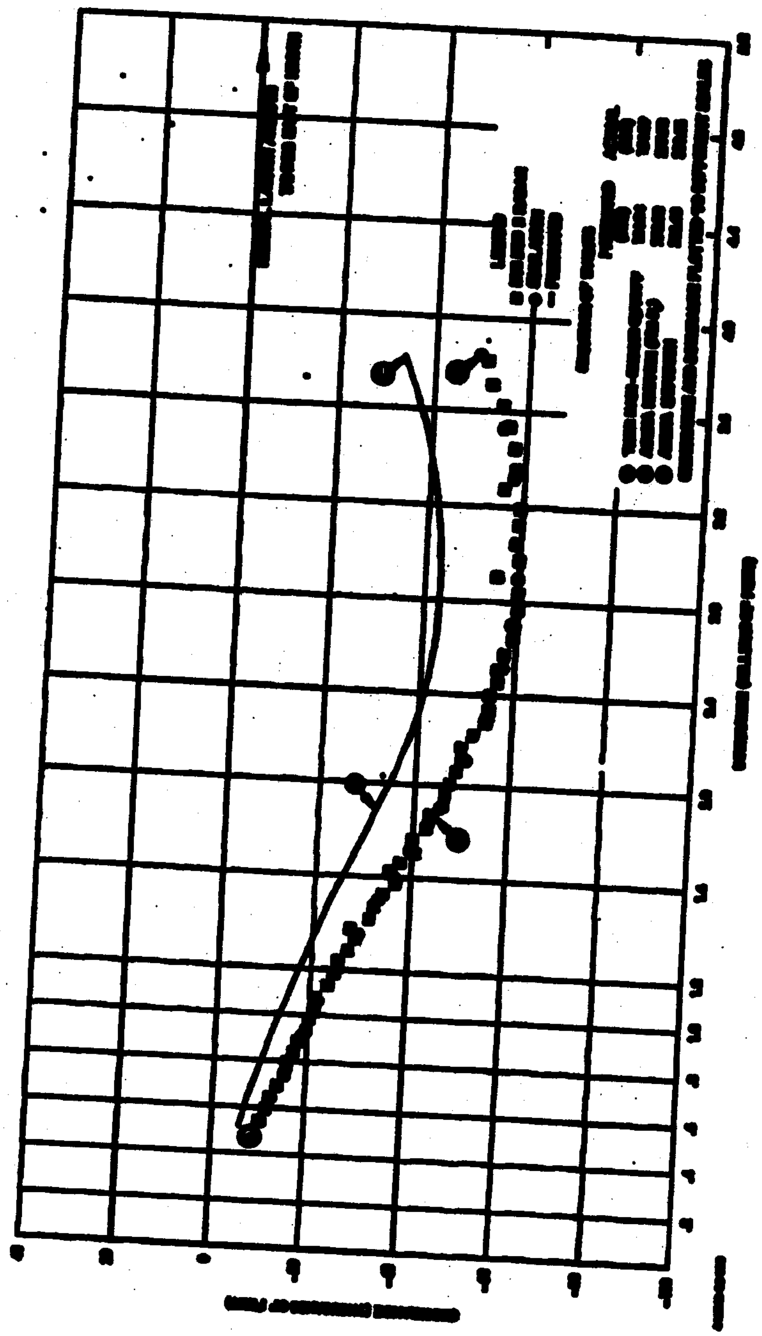

Figure 5-4 Crossrange Related to Downrange

Using a specific impulse of 281.3 seconds, the integrated longitudinal acceleration due to axial thrust was calculated to be 13,516 ft/sec. Based upon the Reeves computer calculation, a horizontal velocity-to-be-gained of 13,505 ft/sec was commanded.

At Agena engine ignition, the altitude was about 1.8 nautical miles above nominal, with the velocity about 350 ft/sec low. The Agena engine burning time was approximately three seconds longer than nominal. At shutdown, the altitude was near nominal, with the velocity about 94 ft/sec higher than nominal.

A successful orbit was attained. The eccentricity was slightly greater than nominal (.009) due to a small negative flight-path angle (minus .22 degree) at injection. The period was increased by 1.1 minutes.

Agena orbit tracks for Passes 0, 1, and 2, and 15, 16, and 17 are shown in Figures 5-5 and 5-6, respectively.

ORBITAL PHASE

Environmental and power measurements made during orbit were normal (Tables 5-2 and 5-3). The JUH/APL beacon failed to operate. Since the monitor of the hydraulic battery which powers this beacon in orbit was open, the indication of proper battery operation was the fact that the optical tracking lights, also operated from this battery, functioned properly. Examination of the associated circuitry (Fig. 5-7), shows that a ground on the negative side of the battery could have caused this failure. This circuit will not be used on future flights.

Orbital guidance and control was not correct during Passes 1 and 2 but became normal following Passes 1 and 2. Control-gas expenditure was normal after Pass 2 following abnormally high use during Passes 1 and 2. The only performance variance indicated subsequent to Pass 2 was the higher-than-normal pitch-horizon-scanner offset (Fig. 5-8).

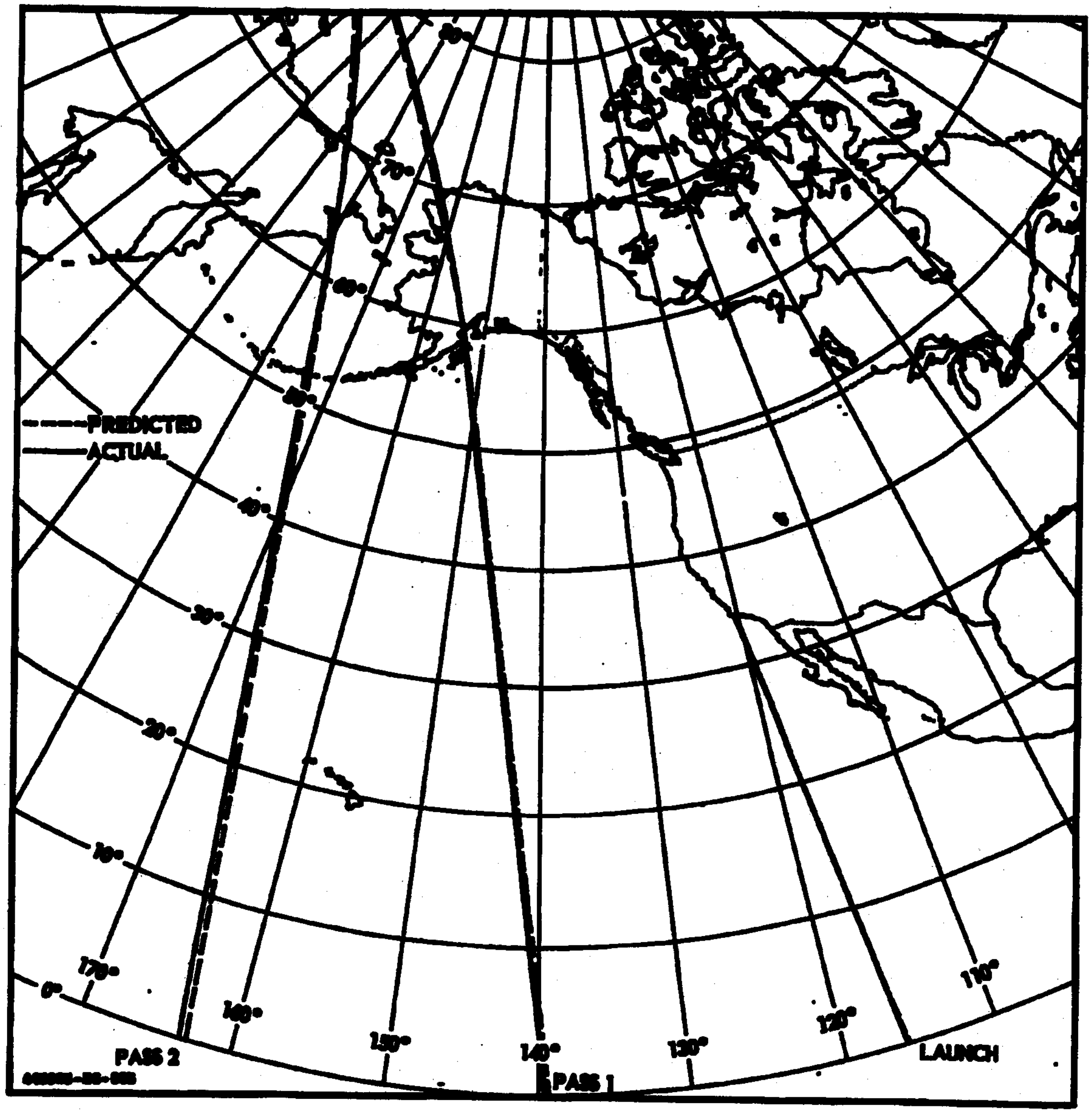

Figure 5-5 Agena Orbital Tracks Following Launch

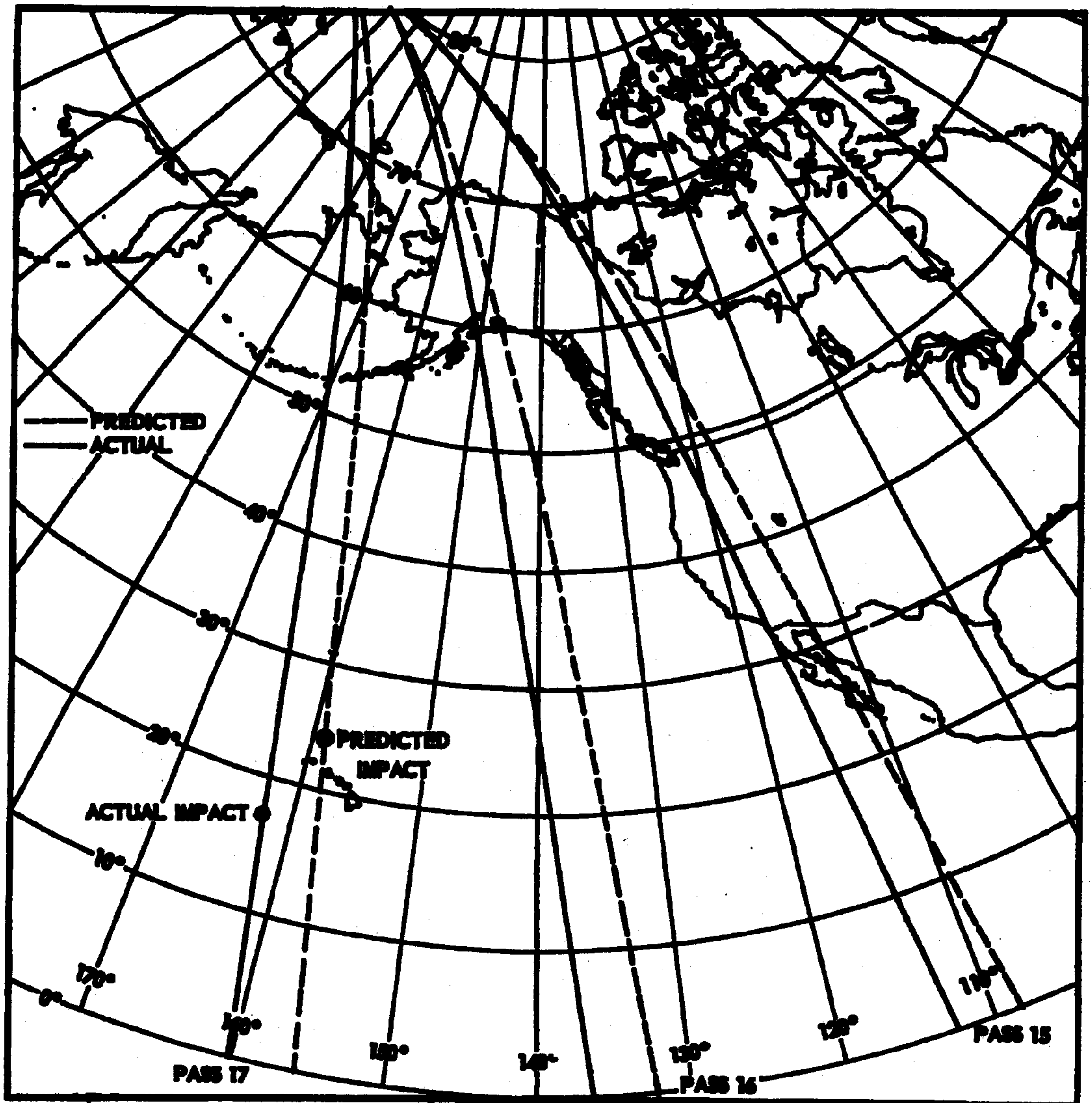

Figure 5-6 Agena Orbital Tracks Prior to Recovery

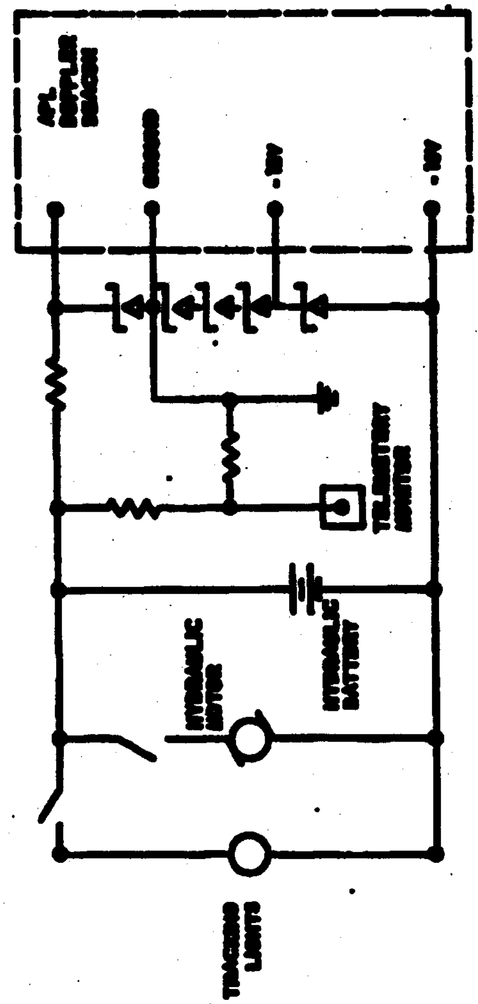

Figure 5-7 Hydraulic-Motor Battery System

[redacted]

Figure 5-8 Orbital-Attitude Control Performance

All flight data were reviewed in detail, and it was concluded that the failure occurred in an active element of the pitch-torquer circuit, specifically in either of the two inertial reference package (IRP) amplifiers (Fig. 5-9). Of the two possibilities, the power amplifier was most suspect since the pre-amplifier operates at a relatively low-power level and could not have produced the effects indicated.

Tests were conducted at the guidance laboratory in an effort to duplicate the apparent gain variance indicated in flight and shown in Figure 5-10. By simulating a power-transistor failure in the final stage of the test amplifier, its gain characteristics showed close correlation with that indicated. This appears to be the reason for failure to pitch down properly. Further, this mode-of-failure, if initially intermittent, would draw high currents from the power supply and explain the anomalies indicated by the Pass 1 data. Therefore, conclusions are that the transistor failed during Pass 2, and the mode-to-failure was intermittent, starting early in Pass 1 and terminating during Pass 2.

During this period, the horizontal-attitude reference was lost, due probably to the inability of the pitch-channel input to the pitch-gyro torquer to provide adequate signals for maintaining the required orbital pitch rate. Consequently, large attitude errors occurred after which the horizon scanner lost its ability to command the system intelligently. The scanner outputs under conditions of extremely large attitude errors become somewhat random in nature and cause equally random satellite attitude errors. It is believed that the random scanner outputs, together with the amplifier-failure effects to the power supplies, coupled with other elements of the control system to cause the high gas expenditure. After Pass 2, the IRP amplifier assumed the state shown in Figure 5-10 and functioned marginally but adequately at the low-orbital-rate inputs until control was resumed.

Although the mode-of-failure is clear, the exact cause of failure is as yet undetermined. The prelaunch test data, Missile Assembly Building (MAB), and pad systems test data indicate the amplifier performed properly during

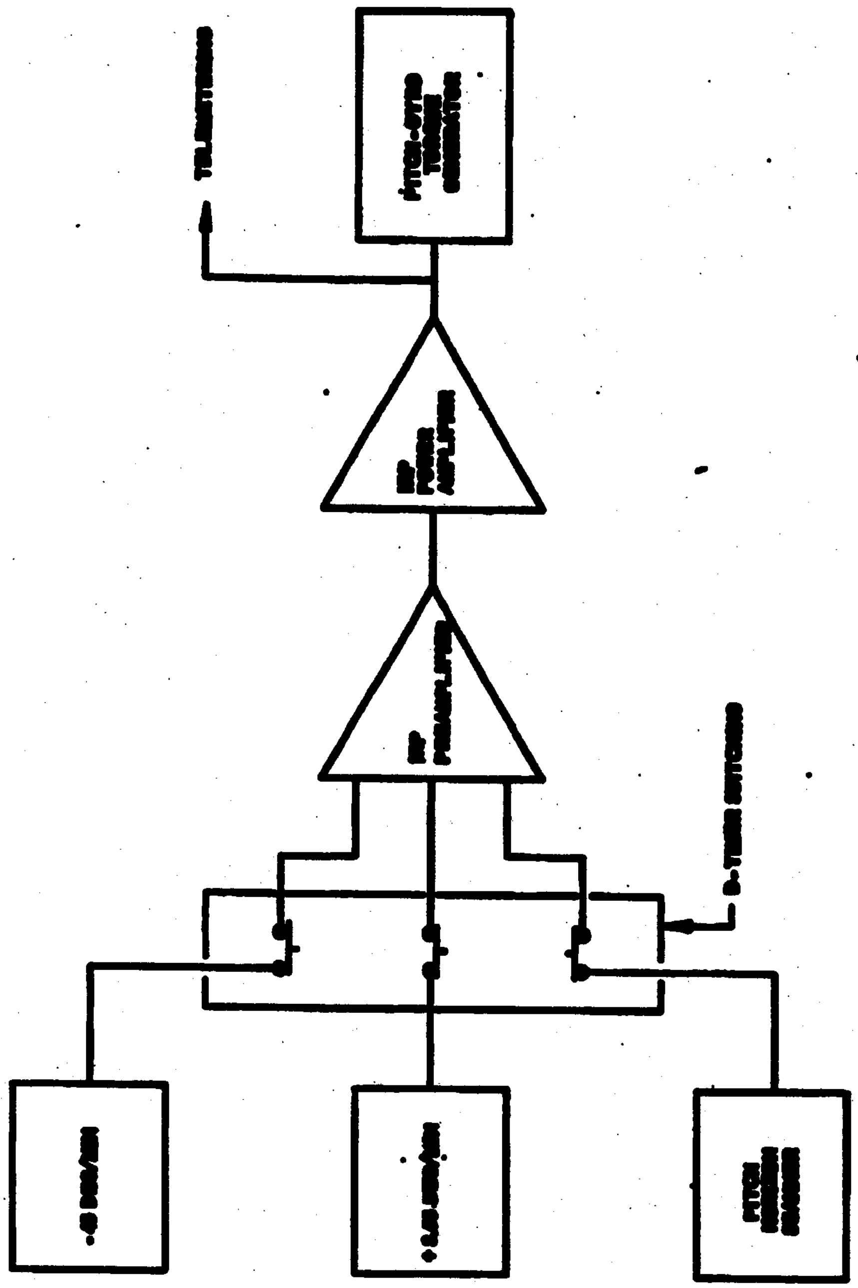

Figure 5-9 Torquing Circuitry

[redacted]

Figure 5-10 Amplifier Gain Characteristics

all test phases. Therefore, it appears that there were no design discrepancies at the time of launch. Also, no performance anomalies were indicated during the ascent phase of the actual flight. (During this period, the most severe environmental conditions are encountered.) One other flight anomaly was attributed to a failure of the same power amplifier: the accelerometer malfunction on Discoverer VIII (Agena 1050). The action taken as a result of an analysis of the problem at that time was to make modifications to the units in the form of improved insulation against electrical shorting. The units in Discoverer XIV contained said modifications and further effort along these lines would be superfluous. Tests of the units are continuing, and the history, with respect to failures, is being reviewed. Until those investigations are completed, no effective recommendation can be made.

S-Band Beacon

S-band beacon tracking on orbit was satisfactory; however, command difficulties were experienced during some passes and the transmitter exhibited an unusual frequency change while in orbit. The problem of command difficulties was not related to that of transmitter frequency shift, since the command problem could only be caused by ground station difficulties, satellite-borne receiver or decoder difficulties, or by interference from other radars. Commands sent by each station during each pass are listed in Table 5-5. Command difficulties were experienced by KTS during Pass 1, by VTS during Pass 9 and by KTS and HTS during Pass 10. When both the ground station and the satellite-borne equipment are functioning properly, two tone verifications are telemetered back to earth each time that a command is received and executed. In the cases of difficulties during Passes 1 and 10, only one of these verifications was telemetered back; Tone A was not verified in these instances.

After Pass 1, KTS ground equipment was checked and the Command Tone A modulation was found to be below nominal. This command tone was adjusted to the nominal value and KTS was able to command the satellite during Pass 2. VTS reported sending a command during Pass 9 without receiving verification.

Table 5-5
COMMAND SUMMARY (PRERECOVERY)

PASS	[redacted]
Launch	[redacted]
Launch	
1	
1	
1	
1	
1	
1	
1	
1	
2	
2	
2	
2	
2	
8	
9	
9	
10	
10	
10	
10	
10	
10	
10	
10	
10	

Table 5-5 (Continued)

PASS	[redacted]
10	[redacted]
10	[redacted]
10	[redacted]
15	[redacted]
	[redacted]
16,17,23	[redacted]

COMMAND SUMMARY (POSTRECOVERY)

STATION	COMMAND	TOTAL PER STATION
	[redacted]	[redacted]
KTS	[redacted]	[redacted]
VTS	[redacted]	[redacted]
NTS	[redacted]	[redacted]
HTS	[redacted]	[redacted]
Total Per Command	[redacted]	[redacted]

During Pass 10, HTS sent eight commands and received verification of only two. KTS sent one command during Pass 10 and, since it was not verified, the modulation of all command tones was increased to above-nominal values. KTS was then able to successfully command the satellite during Pass 10 and later passes.

In each of the above cases of command difficulty, verification of Command Tone A was not received by the ground station, but other tones were properly verified. These difficulties occurred because the decoder circuitry did not receive sufficient energy to operate the command relays. This condition can occur whenever the modulation of command tones in the ground station is set too low, when severe radar interference exists so as to jam the beacon receiver, when beacon decoder circuitry is marginal in operation, or when any other abnormality exists which prevents the receiver from receiving all pulses transmitted from the ground station. The decoder can be provided with more energy by either increasing the command tone modulation or by increasing the transmitter pulse recurrence frequency (PRF) at the ground station. In this instance, apparently early in the flight the decoder circuitry operational capability was marginal and further deteriorated during later passes.

The frequency of the beacon transmitter is normally set at 1 megacycle above the nominal frequency just prior to launch. As the beacon cools while in orbit, the transmitter normally drifts to 1 megacycle below nominal. However, in this case the drift was in the opposite direction. This transmitter was supposedly near-nominal frequency at launch; but, later investigations proved that it was 4 megacycles above nominal. At the end of Pass 9, the frequency had shifted to 8 megacycles above nominal, and it remained stable at this value throughout later passes. The temperature of this beacon dropped in the normal manner during the first few passes and remained stable at a value which is approximately normal for orbital operation.

The only factors, other than temperature, which affect the transmitter frequency are the position of the tuning slug in the transmitter cavity resonator and the voltage standing-wave ratio (VSWR) of the antenna circuit. Postflight investigations have shown that only slight loosening of the coaxial connector between the transmitter cable and the antenna will change the VSWR and also the transmitter frequency.

This fact suggests the possibility that this connector became slightly loosened during launch. Future occurrences of this type will be prevented by a rigid prelaunch inspection of the coaxial-cable connectors. A new type of antenna which utilizes more suitable connectors is under development and will be used when it is proven to be sufficiently reliable.

Orbital performance of the continuous-wave acquisition transmitter was normal and it was successfully tracked by all stations.

Orbital Timer

The orbital timer properly braked the D-timer during launch and operated satisfactorily through Pass 25. Difficulties in changing the timer period (Command 1) and resetting the timer (Command 3) involved the VERLORT ground radar and the S-band satellite radar beacon. Both timer Commands 1 and 3 utilized Tone A, the tone that was difficult to verify. Step commands (Command 2) used Tones B and C, thus no problem was encountered in obtaining proper verification.

Table 5-6 shows the timer period as indicated by stepping-switch position, preflight calibration, and actual period as determined from observed events. Timer drift was within specifications, with a total error of 13.7 seconds between Passes 8 and 10 "Reset Monitor ON" points. The average error (between switch setting and observed events) was approximately 7 sec/pass. The average error between "Reset Monitor ON, Pass 15" and "Reset Monitor ON, Pass 25" was greatly improved (1 sec/pass).

Since command difficulties were experienced during early passes, it was decided to transmit the reset command for 30 seconds continuously during Pass 15. The telemetry data show that the reset monitor responded approximately one-half second after the command was received; however, the reset monitor voltage fluctuated for the duration of the 30-second period. This was not a malfunction of timer circuitry but an indication that can be considered normal due to the long period of the command. One relay in the circuitry is normally energized only momentarily when command duration is for

Table 5-6

ORBITAL-TIMER ACCURACY

INTERVAL	Timer Period (Sec)			Error Between Switch Position And Observed Events (Sec/Tape Orbit)
	Observed Events	Preflight Calibration	Switch Position	
Reset Monitor "ON", Pass 8, to Reset Monitor "ON", Pass 10	[redacted]		1001	
Reset Monitor "ON", Pass 15, to Reset Monitor "ON", Pass 25	[redacted]			

1 second. This relay energizes several others, and the high currents required cause a drop in voltage at the reset monitor point. Since the first relay is connected so as to interrupt the current to its own coil after it becomes energized, it will keep cycling when a steady-state voltage is applied. This causes cycling of other relays and, consequently, a fluctuation of voltage at the reset monitor point. This fluctuation may be expected whenever the reset command is transmitted for long periods. The reset monitor remained stable at the reset position as soon as transmission of the command ended.

Beckman monitor readout equipment readings were still erratic during this flight and were unreliable from accuracy and dependability standpoints. It is felt that insufficient amplitude of the subcarrier signal is partially responsible for the poor quality of period readout. Action should be taken to assure proper pre-emphasis of this channel during prelaunch satellite checkout. Orbital-timer events are tabulated in Table 5-7.

Table 5-7
ORBITAL TIMER EVENTS
(SECONDS)

Event	System Time (Sec) Computed (ACQ)	Observed (TMX)	Resultant Period (Sec)	Observing Station
Launch				
Orbital Timer Start and B, T/M Plates Off	[redacted]	[redacted]	[redacted]	
Pass 1				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
Reset Monitor On	[redacted]	[redacted]		[redacted]
1 Step Command				
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	
Pass 2				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
Reset Monitor On		[redacted]		[redacted]
Reset Command				
7 Step Commands				
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	
Pass 8				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
Reset Monitor On		[redacted]		[redacted]
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	

Table 5-7 (Continued)

Event	System Time (Sec) Computed (ACQ)	System Time (Sec) Observed (TRK)	Resultant Period (Sec)	Observing Station
Pass 9				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
Reset Monitor On	[redacted]	[redacted]	[redacted]	[redacted]
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	
Pass 10				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
Reset Monitor On	[redacted]	[redacted]	[redacted]	[redacted]
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	
Pass 15				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
1 Reset Command		[redacted]	[redacted]	[redacted]
Reset Monitor On	[redacted]	[redacted]	[redacted]	[redacted]
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	
Pass 16				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
Reset Monitor On	[redacted]	[redacted]	[redacted]	[redacted]
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	

1001

Table 5-7 (Continued)

Event	System Time (Sec) Computed (AOQ)	Observed (TMX)	Resultant Period (Sec)	Observing Station
Pass 17				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
Reset Monitor On	[redacted]	[redacted]	[redacted]	[redacted]
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	
Pass 24				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
Reset Monitor On	[redacted]	[redacted]	[redacted]	[redacted]
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	
Pass 25				
B, T/M Plates On and Reset Enable	[redacted]		[redacted]	
Reset Monitor On	[redacted]	[redacted]	[redacted]	[redacted]
Reset Disable and B, T/M Plates Off	[redacted]		[redacted]	

SECTION 6
TELEMETRY AND INSTRUMENTATION

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TELEMETRY AND INSTRUMENTATION

SATELLITE TELEMETRY

No major problem areas were encountered with the satellite FM/FM data link and the primary telemetry objectives were achieved through launch and orbit. Signal strength appeared normal and the telemetry data received were of excellent quality. However, discrepancies were noted on the following individual data points:

a. Horizon-scanner temperature (D82) was intermittent during engine firing; data levels prior to and subsequent to this period seemed normal.

b. Separation monitor (A93) exhibited switch vibration at liftoff. At separation, the trace went beyond the synchronization level, but the step voltage was clearly discernible.

c. The 28v regulator monitor (C2) was not wired to the telemeter. This was noted prior to launch but the flight schedule precluded a fix.

d. Hydraulic-battery motor-voltage monitor circuit (C21) to the telemeter opened at approximately 106 seconds. It was apparently intermittent, since contact was remade prior to Pass 15 and a near-nominal reading was indicated. The appearance of the commutated record suggests an open circuit between the subcarrier input and the monitor itself.

e. Hydraulic pressure (D1) and excitation-voltage monitor (TI-2) for the D1 transducer appear to have been miswired. Both measurements exhibited the same pressure shifts and showed variance with predicted changes when correlated with the calibrations. The accuracy requirement for this measurement is only plus or minus 10 percent, but the data from this flight are suitable only for telltales.

f. Timer-motor frequency (H110) was reported as unsuitable for real-time operational use. Investigation of the pre-emphasis settings and laboratory test of this monitor are being conducted.

CAPSULE INSTRUMENTATION

A limited amount, three channels, of telemetered instrumentation was installed in the Agena 1056 recovery capsule to determine:

a. Operation of retro and recovery systems (breakwire and microswitch-type telltales)
b. Retro accelerations and velocity (one axial accelerometer)
c. Thrust cone and 2A8 thermal battery operation (voltage monitors).

Data were not obtained from these three channels due to failure of the telemeter to radiate. Information from sources other than telemetered data and capsule recovery indicate the capsule retro and recovery systems and programmers operated nominally.

CAPSULE TELEMETRY

Data were not obtained from the capsule telemetry data link. Postflight tests on the recovered telemetry system indicated that the squib in the telemeter battery shorted, activating the battery but causing a voltage drop that allowed less than a minimum pickup voltage to reach the relay. The relay did not close to allow voltage from the telemeter battery to reach the transmitter.

The wire carrying the telemeter-activating signal from the Agena to the capsule was 22 gage, and a short would drop the voltage well below the minimum pickup voltage at the relay, since the squib and relay were in parallel. This circuit will be changed in future Agenas by placing a fusible resistor in series with the telemeter battery squib to protect the wiring and allow the relay sufficient activation voltage.

Signal-Strength Studies

A special study was conducted to determine the extent of telemetry coverage which might have been obtained had the capsule telemetry unit operated. This study considered capsule trajectory, mobile tracking station deployment, and nominal signal strength from a 1.2-watt transmitter. Figure 6-1 depicts Agena 1055, 1056, and 1057 recovery telemetry coverage. The depicted chart was used in the study, results of which were:

KTS: Any reception at this station is considered improbable due to excessive range and low receiving-antenna angle.

Northern WV-2: About 50 seconds of data (81775 to 81825 seconds system time) should have been obtained, and these data would have included the separation sequence. However, the electric storm reported in this area might have caused sufficient interference to preclude satisfactory coverage.

Haiti Victory: Approximately 75 seconds of data (82150 to 82225 seconds system time) would have been obtained. These data might have covered the RF-blackout period but probably not the parachute-recovery phase.

Southern WV-2: About 50 seconds (82200 to 82250 seconds system time) of data would have been obtained. This coverage would partially duplicate that of the USS Haiti Victory but probably would not have included either the blackout area or the parachute-recovery phase

USS Dalton Victory: A few seconds of data might have been obtained during parachute deployment and descent.

Hawaii: Approximately 300 seconds of data (82200 to 82500 seconds system time) should have been acquired. These data probably would have included blackout and recovery areas, duplicating the data of both ships and the southern WV-2.

Failure to obtain capsule telemetry data was attributed to malfunction of the circuitry which applies power to the transmitter. In spite of the complete absence of telemetry signals, the time that the events of the retro phase occurred was accurately determined from KTS data. This was possible because the small explosions resulting from the firing of squibs caused ionized gas to surround the VHF-beacon antenna, producing severe drops in the beacon signal strength. Further, the retrorocket firing caused ionized gases to surround the Agena telemetry antenna resulting in a severe drop in

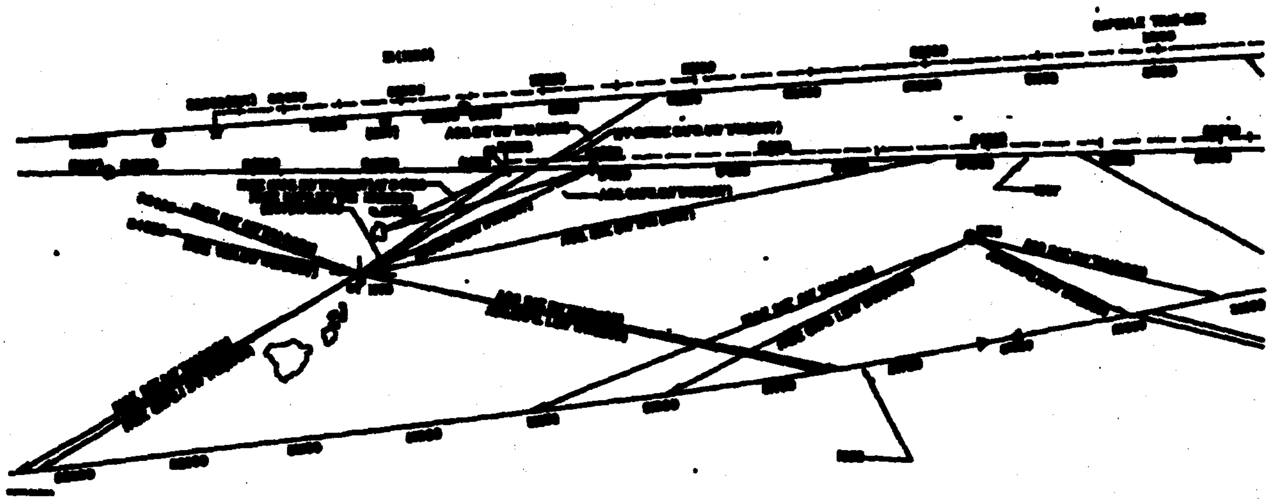
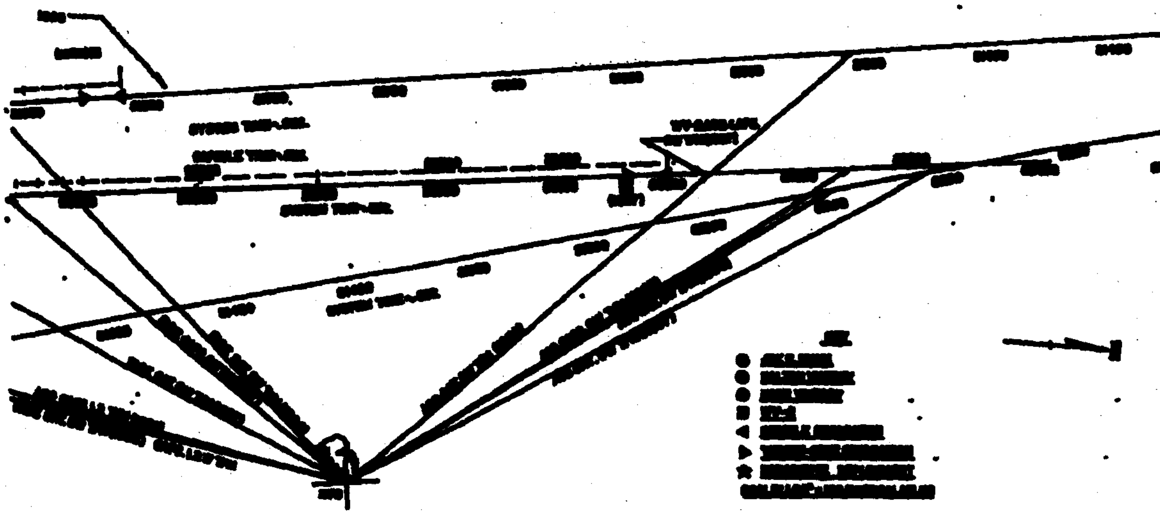


Figure 6-1 Agena 1055, 1056 and 1057 Recovery Telemetry Coverage

Agena-telemetry signal strength. A comparison of these drops in signal strength with the system time yielded the correct times for the occurrence of the retro-phase events.

The only event which could not be timed accurately was the initiation of the separation signal. Gases resulting from the electrical-disconnect squib firing were not yet dissipated at the time the separation signal occurred; therefore, the drops in beacon signal strength overlapped in time. The time at which the gases resulting from separation were dissipated was accurately observed and an approximate time for separation can be determined. Rotation of the capsule during the retro phase caused variations in the signal strength, since the beacon antenna position with respect to the ground station receiver was constantly changing. These variations made possible the calculation of the spin rate. Because the beacon signal faded shortly after the retro events were completed, insufficient data exist for calculation of the residual spin rate. The data from HTS are inadequate for calculation of residual spin rates, as Hawaii did not acquire the signal until more than 300 seconds after the retro phase was completed.



A reproduction of the KTS VHF-beacon and Agena-telemetry signal strength records is shown in Figure 7-3. The drops in signal strength which were used for timing of the retro-phase events are indicated in this figure. Event 1 is the electrical disconnect and Event 2 yields the time at which separation was completed. Events 3, 4, 5, and 6 represent spinup, retro-rocket ignition, despin and thrust-cone separation, respectively. The spin rate during the burning of the retrorocket is clearly visible in the signal variations. All retro events occurred in proper time relationships and actual versus nominal times for these events are included in Table 7-1.

SECTION 7
CAPSULE PERFORMANCE

SECTION 7
CAPSULE PERFORMANCE

The Discoverer XIV retrograde phase was initiated on Pass 17 and was preceded by the following orbital conditions:

Altitude	791,429 feet
Geodetic Latitude	50.05 degrees north
Earth Longitude	169.64 degrees west
Inertial Velocity	25,953 ft/sec
Local Azimuth Angle	163.799 degrees
Local Flight-Path Angle	-1.415 degrees.

With these conditions and with nominal theoretical retro conditions of V_R = 1166 ft/sec and a pitchdown angle of minus 60 degrees from the local horizontal plane, the Discoverer XIV capsule parachute deployment should have occurred at 23.68 degrees north latitude and 162.32 degrees west longitude.

However, the reported capsule position at 8500 feet altitude was 17.1 degrees north latitude and 162.35 degrees west longitude or 395-nautical miles downrange of the predicted point of parachute deployment.

CAPSULE ATTITUDE

The pitchdown rate as determined from Agena telemetry was considerably less than the required 45 deg/min, resulting in a significant error in pitch attitude at capsule ejection. Computations based on the actual data indicate a probable pitch attitude of minus 13.3 degrees with respect to the local horizontal at time of the capsule separation (Fig. 7-1). Pitchdown was determined in the following manner:

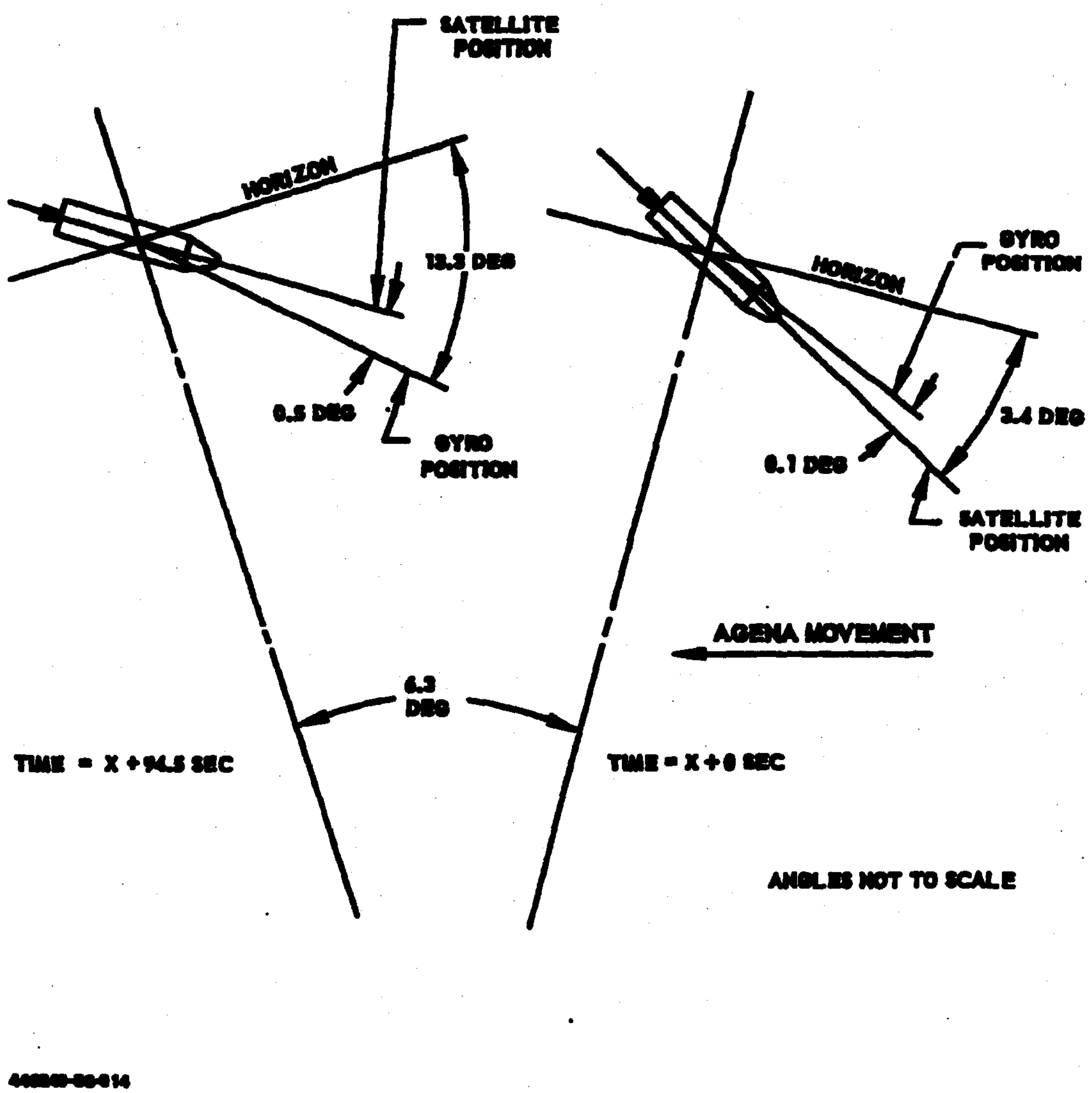


Figure 7-1 Pitchdown Performance

	Degrees
Initial Pitch-Gyro Offset from Horizon (as indicated by horizon-scanner and and gyro position)	-3.4
Pitch-Torque Program (+3.55 deg/min x 17.5 sec)	+1.0
Pitch-Torque Program (-4.0 deg/min x 77 sec)	-5.1
Change in Local Horizon (-4.0 deg/min x 94.5 sec)	-6.3
Satellite Lagged Gyro at Command Separation by . . .	+0.5
Satellite Position Relative to the Horizon at Capsule Ejection	-13.3

Possible variation of the above data could yield plus 1 to minus 5 degrees in determination of the relative position of the satellite to the horizon.

The pitch-torque program of 7 minus 4.0 deg/min was determined by investigating the pitch gyro, pitch-rate gyro and pitch-programmer data. These data were further substantiated by the data of the sun-position indicator which indicated a minus 17-degree pitchdown. The tolerance of the sun-position indicator angle is plus or minus 3 degrees.

Figure 7-2 shows the effect of the retrorocket firing angle on capsule-impact latitude under nominal retro conditions. From this curve, it can be seen that the retro-firing angle for the reported position of the capsule recovery was minus 15 degrees. This lies between the retro angular limits indicated by the sun-position indicator and guidance-control data.

RETRO PHASE

Capsule telemetry did not function on this flight, hence proper analysis of retro performance can only be accomplished by a study of VHF-beacon signal strength (Fig. 7-3, page 7-6), coupled with the knowledge that all events

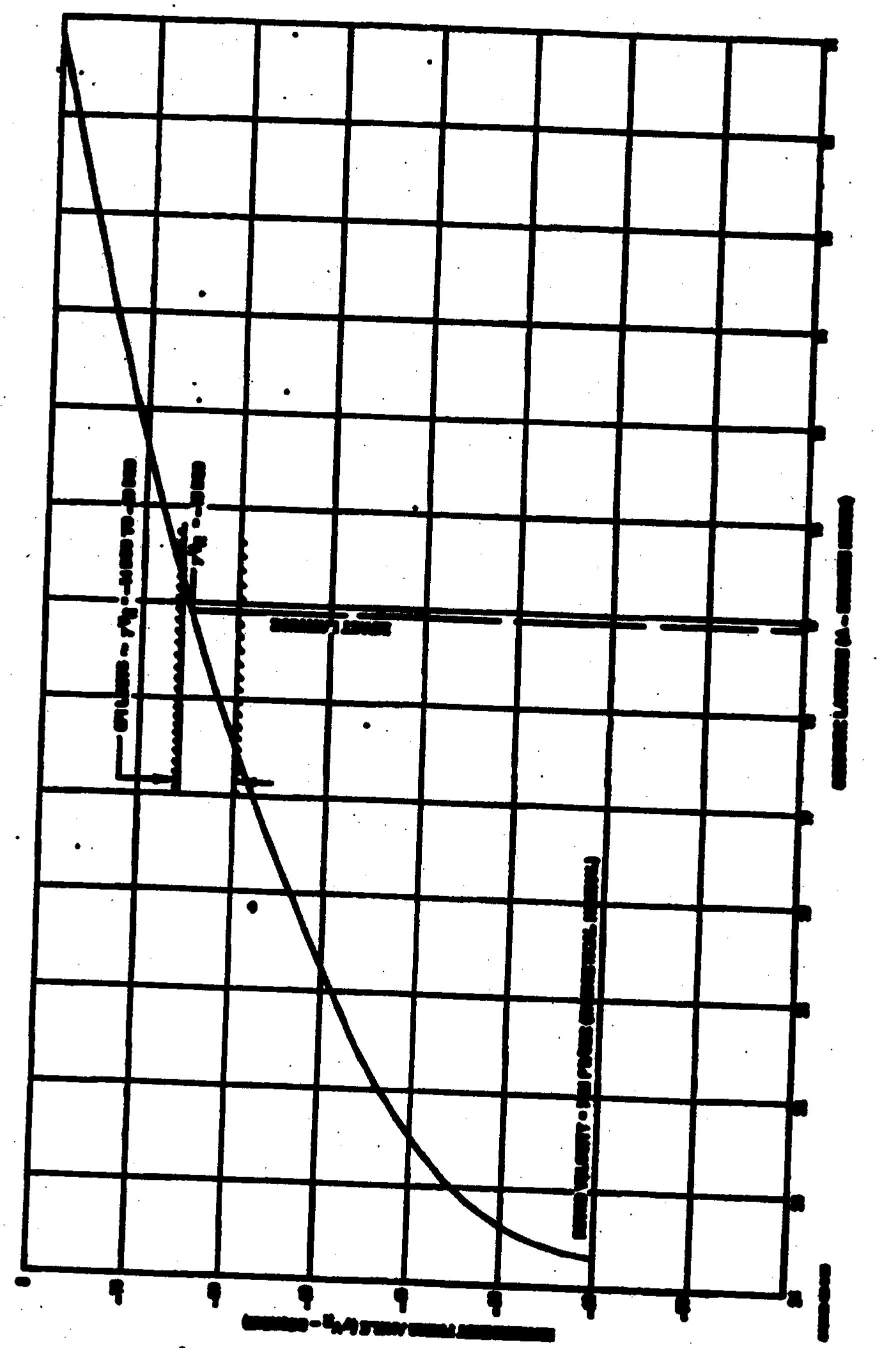


Figure 7-2 Effect of Retrorocket Firing Angle on the Impact Point

must have occurred properly for recovery to have been accomplished. This study revealed the precise times for all countdown events. These are listed in Table 7-1.

Table 7-1

RETRO EVENTS DETERMINED BY VHF-BEACON SIGNAL STRENGTH[(a)]

Event	Predicted Time (Sec)	Observed Time (Sec)	System Time (Sec)
Beacon-Signal Acquisition	----	----	81746
Electrical Disconnect	0 Ref.	0	81809.45
Separation (capsule-Agena)	----	----	81811.50
Spinup	3.4±.17	3.45	81812.90
Retro Ignition	1.25±.1	1.2	81814.10
Despin	10.75±.54	10.95	81825.05
Thrust Cone off	1.5±.15	1.53	81826.58

Actual	Nominal
Spin Rate: 64.7 rpm	Spin Rate: 78 rpm
Despin Rate was not obtainable	

(a) Obtained from KTS. Figure 7-4 shows the Agena and capsule trajectories during the re-entry phase for the minus 15-degree retro-angle case.

SUBNOMINAL SPIN-UP

As in the retro phase of the Agena 1057 flight test (see LMSD-446240-57), the capsule spin rate was subnominal for Agena 1056. In the latter case, the prescribed spin of 78 rpm was somewhat higher than in the former (55 rpm), but the observed rotation was subnominal by roughly the same percentage in both cases. According to the signal-strength traces of the capsule-borne VHF beacon, the Agena 1056 capsule rotated at 64.7 rpm before despin.

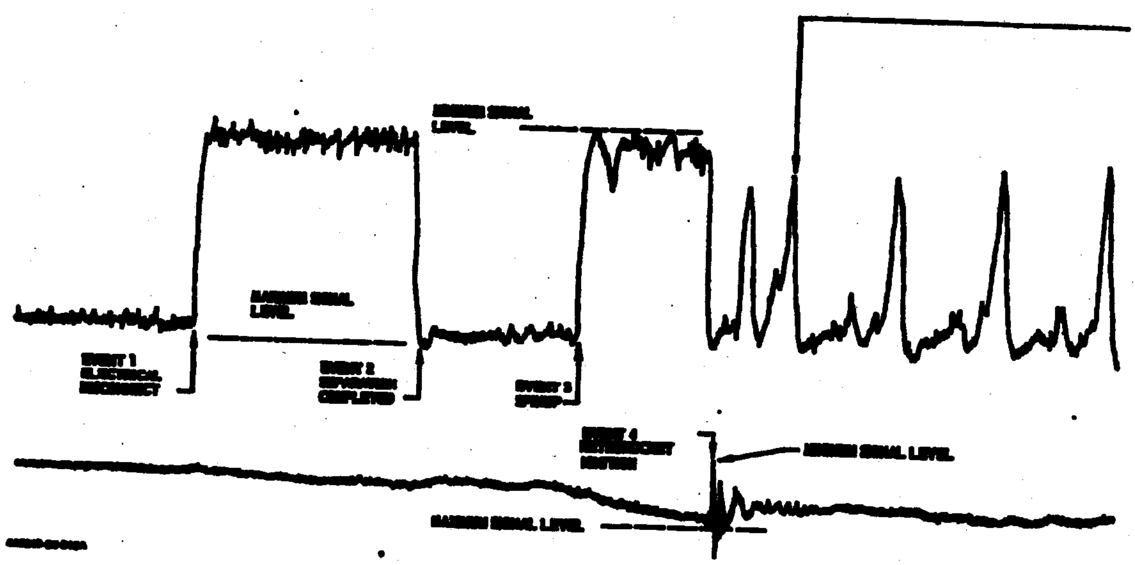
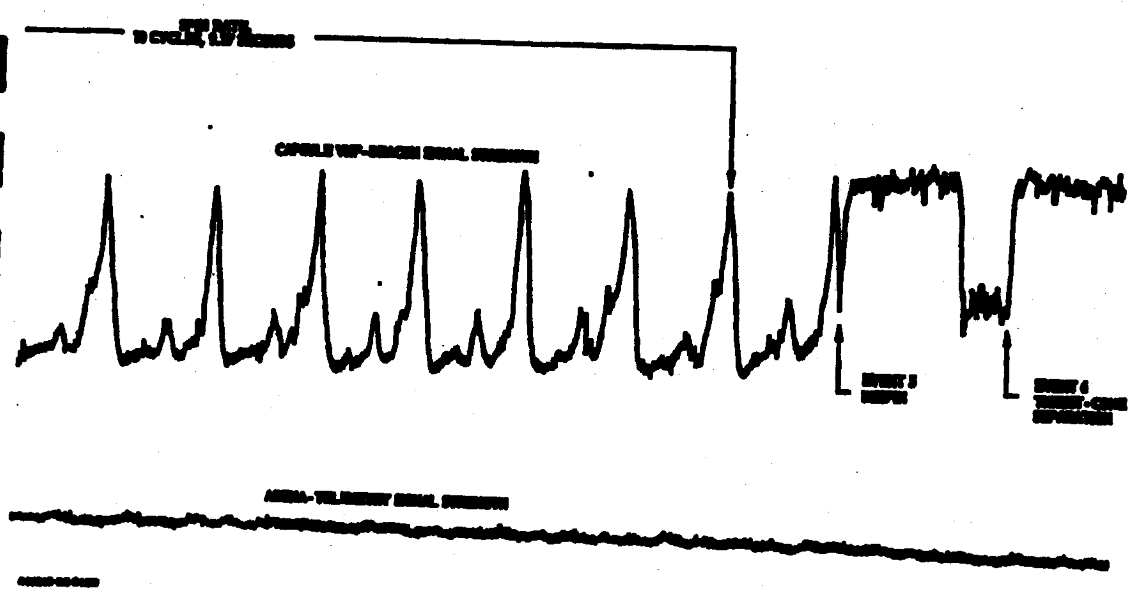


Figure 7-3 KTS VHF-Beacon and Agena-Telemetry Signal-Strength Records



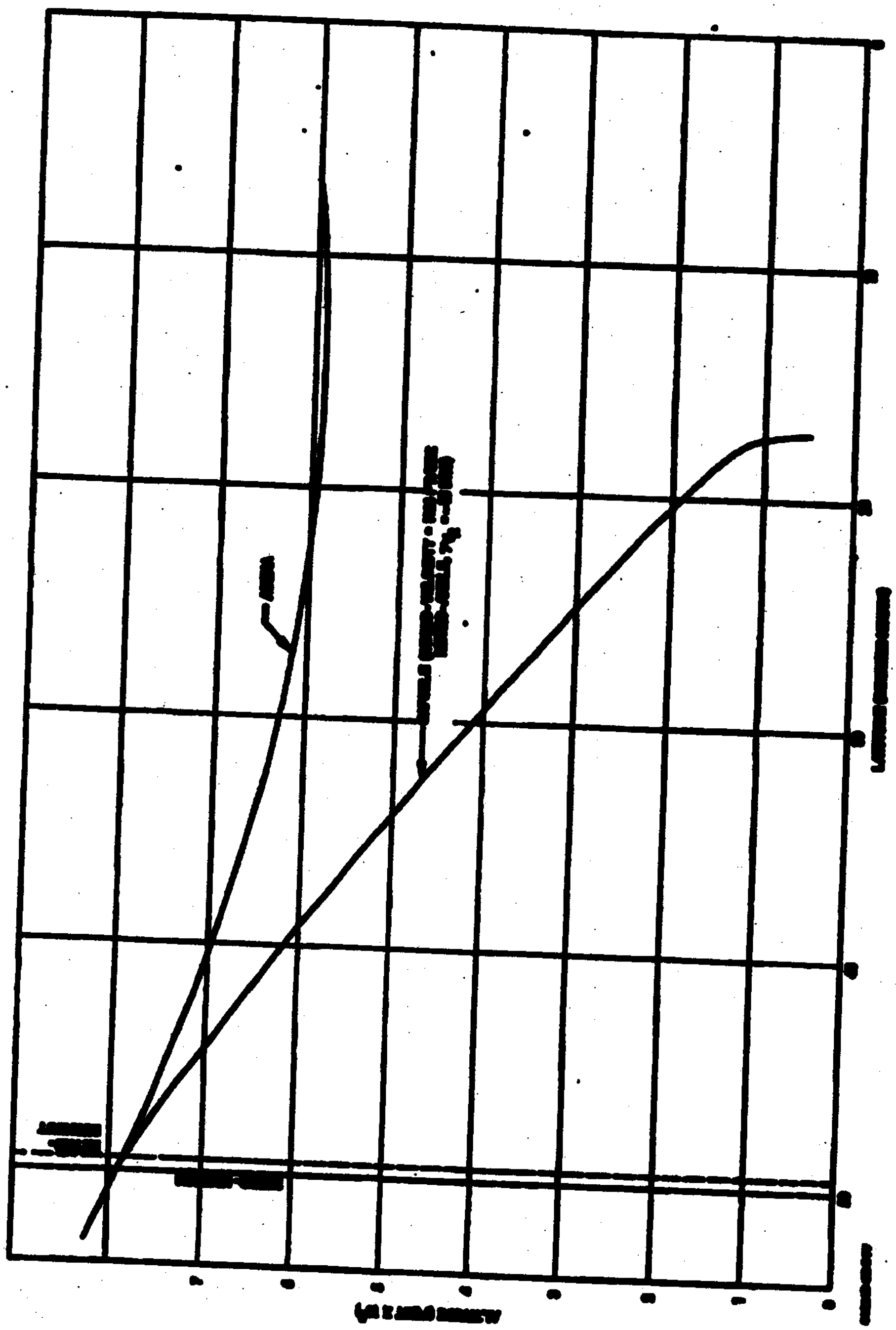


Figure 7-4 Agena and Capsule Trajectories During Re-entry

Under nominal temperature and inertia conditions, the percentage by which the spinup is subnominal would reflect the density of an actuating medium of nearly pure molecular nitrogen rather than the prescribed mixture of 90 and 10 percent of nitrogen and Freon, respectively.

It has been past practice well before launch to introduce the two gases into a diffusion bottle, and subsequently to withdraw what was presumed to be the proper mixture for introduction into the capsule-borne reservoir. For the flight test of Agena 1057, the time for premixing was about three hours, and since the diffusion time proved insufficient in that case, the premixing period was increased to some 70 hours for the Agena 1056 flight test. However, little or no improvement resulted.

With the wide difference between the two specific densities (0.07807 for molecular nitrogen and 0.33 1/3 for CCl_2F_2, a typical Freon), the gravitational force of separation manifestly predominated over the diffusion force, which, in the absence of continued mechanical agitation, must have relied upon the Brownian effects arising from ambient thermal conditions.

Henceforth, the two gases will be individually introduced directly into the capsule reservoir. The agitation effects of the ascent dynamics would promote some degree of mixture, which should persist fairly well under the low-gravity conditions encountered on orbit. There would be separative influence from the centrifugal effects of spinup itself, but since the spin phase endures for only about a dozen revolutions, and these at relatively low rates (about one cps), the influence should be trivial.

SECTION 8
RECOVERY OPERATIONS

SECTION 8
RECOVERY OPERATIONS

The Discoverer XIV recovery operation was successfully completed by aerial recovery of the capsule at 2309 GMT, 19 August 1960. Recovery was accomplished by C-119 Number 9 at 17 degrees, 6 minutes north latitude; 162 degrees, 21 minutes west longitude. This was the first aerial recovery of a capsule ejected from an orbiting satellite and the second capsule recovery during the Discoverer series, both recoveries having been accomplished in a period of eight days. The operation proceeded in a generally satisfactory manner as evidenced by the successful recovery.

PRERECOVERY OPERATIONS

All prerecovery briefings were accomplished in an orderly manner. Both Victory ships were on station at their normal times and all units participated in the operation with the exception of RC-121 Number 3 which was forced to abort its mission when one engine went out. Changes in impact area were of sufficiently small magnitude to allow all units to correct accordingly prior to estimated time of parachute deployment (ETPD).

CAPSULE TRACKING OPERATIONS

The flight objective of tracking the re-entering capsule was attained by the combined tracking of the Agena satellite prior to separation, tracking of the capsule VHF-beacon transmitter during the re-entry phase, and by radar tracking of the chaff cloud. The capsule telemetry transmitter did not function during the recovery operation, and there was no S-band beacon on the capsule. Tracking of the capsule VHF beacon was very successful and radar tracking of the chaff cloud was of assistance in the final phase of the recovery operation.

Surface Tracking Stations

No acquisitions were reported by Christmas Island or Barking Sands. The Hawaiian Tracking Station (HTS) acquired the capsule VHF beacon at 2249:13 GMT and was able to track until 2250:30 GMT (Fig. 8-1), but the distance was too great to allow complete tracking and data recording. South Point reported capsule VHF-beacon acquisition at 2305:05 GMT for a period of 55 seconds. Both Victory ships were able to acquire and track the capsule by means of the VHF-beacon transmissions.

Tracking of the VHF Beacon. The Kodiak Tracking Station (KTS) was tracking the Agena by both radar and satellite telemetry signals at the time the capsule VHF beacon began transmitting. The beacon came up to full power, and KTS received a strong signal at 81746 seconds system time. This was approximately 64 seconds prior to capsule separation, and KTS received strong signals for a total of approximately 84 seconds, successfully tracking the beacon through all retro-phase events.

The capsule VHF-beacon signals were received by 12 aircraft of the recovery force, by the USS Haiti Victory, the USS Dalton Victory, HTS, and the South Point tracking station. Barking Sands and Christmas Island stations reported no contacts. The first unit of the recovery force which reported reception of the beacon signal was the USS Haiti Victory at 82010 seconds system time. The longest contact was reported by the USS Dalton Victory which tracked the beacon for a total of approximately 30 minutes.

The VHF-beacon frequency was sufficiently stable for tracking purposes. KTS reported that the frequency was 0.1 megacycle low at the time of fade. The recovery force reported various changes or drifts in frequency which ranged from 2 megacycles below nominal to 3 megacycles above nominal. The USS Dalton Victory, having the longest period of reception, reported variations of 0.2 to 0.5 megacycles below nominal.

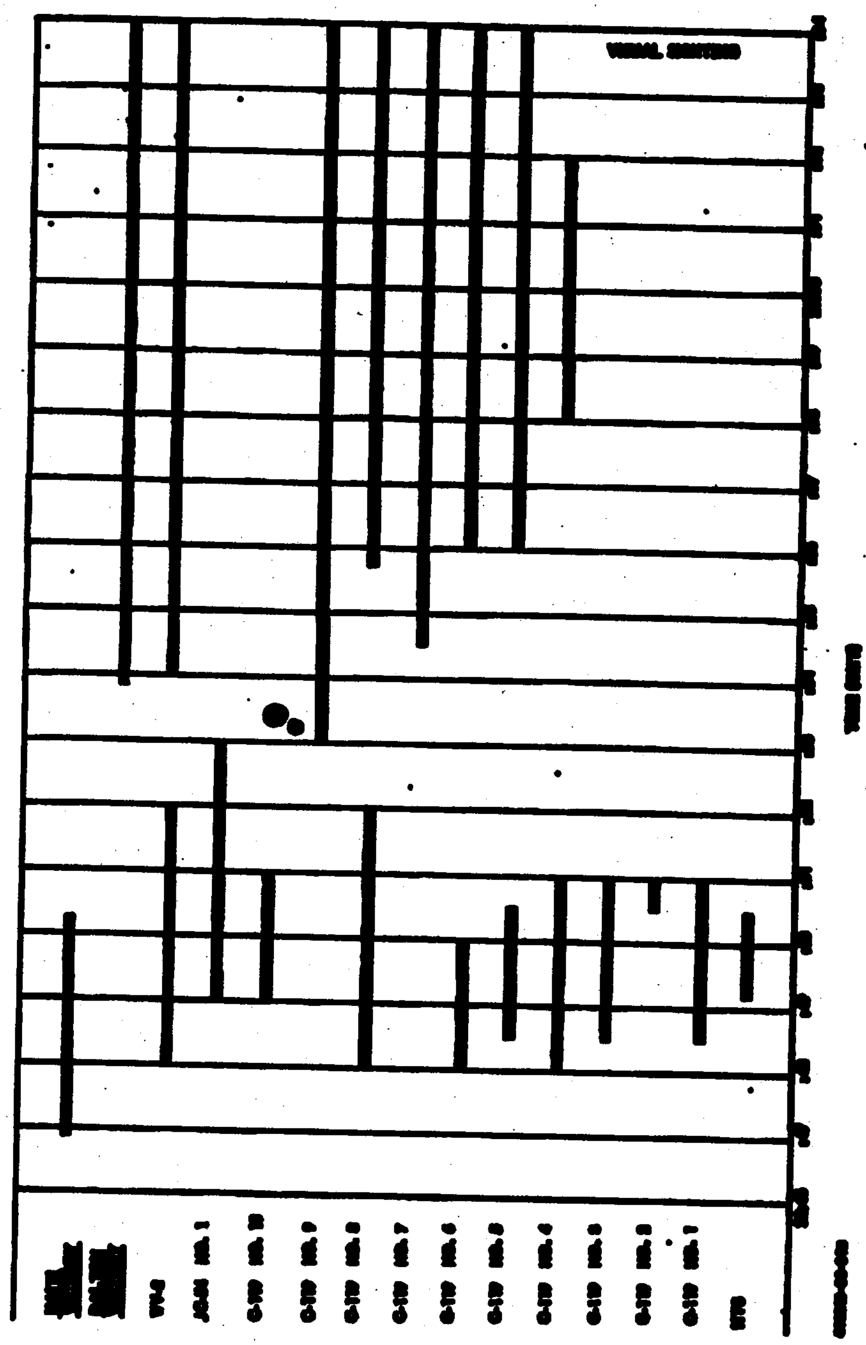


Figure 8-1 Recovery-Force VHF-Beacon Acquisition History

Airborne Telemetry Stations

Only the JC-54 Number 1 aircraft was able to track the capsule on the VHF-beacon frequency. The duration of VHF-beacon track was four minutes (2249 to 2253 GMT) at 237.8-mc frequency. No bearing information was obtained by JC-54 Number 1, because the aircraft does not have direction-finding (DF) capability. JC-54 Number 4 acquired a signal at 228.2 mc, the capsule telemetry frequency. However, both the aircraft's location with respect to the point of recovery and the time of acquisition (2315 to 2338 GMT) indicate that the signals were erroneous.

The WV-2 aircraft, serving in the capacity of prerecovery frequency-interference control and tracking/recording of capsule acquisition during recovery, successfully tracked the VHF beacon during recovery. Acquisition was reported from 2248 to 2252 GMT and then from 2254 to 2308 GMT on a bearing of 171 degrees true (Fig. 8-2). No telemetry was observed. Prior to ETPD, four extraneous signal frequencies were noted; none were considered to have negative effects on the recovery with the exception of a signal at 234.9 mc. This signal was evident from 2035 to 2237 GMT. The signal would appear for a short period of time, disappear for a period of 10 to 15 minutes, and then reappear again. The signal was never present long enough to enable the WV-2 to obtain a directional bearing. The signal could have had a considerable effect on the operation if it had continued beyond ETPD.

The C-119 Number 9 aircraft obtained a Class A Capsule VHF-beacon signal approximately 10 minutes before visually sighting the parachute and capsule. Noted that this same aircraft reported a saturated signal on the Discoverer XIII operation and was the recovery aircraft on the Discoverer XIV operation. However, when it passed directly beneath the descending Discoverer XIV capsule prior to its first recovery pass, it experienced no saturation on its equipment. Accurate bearings were obtained by most of the stations receiving the signal; however, several of the northern aircraft received signals for only short periods and could not obtain accurate bearings.

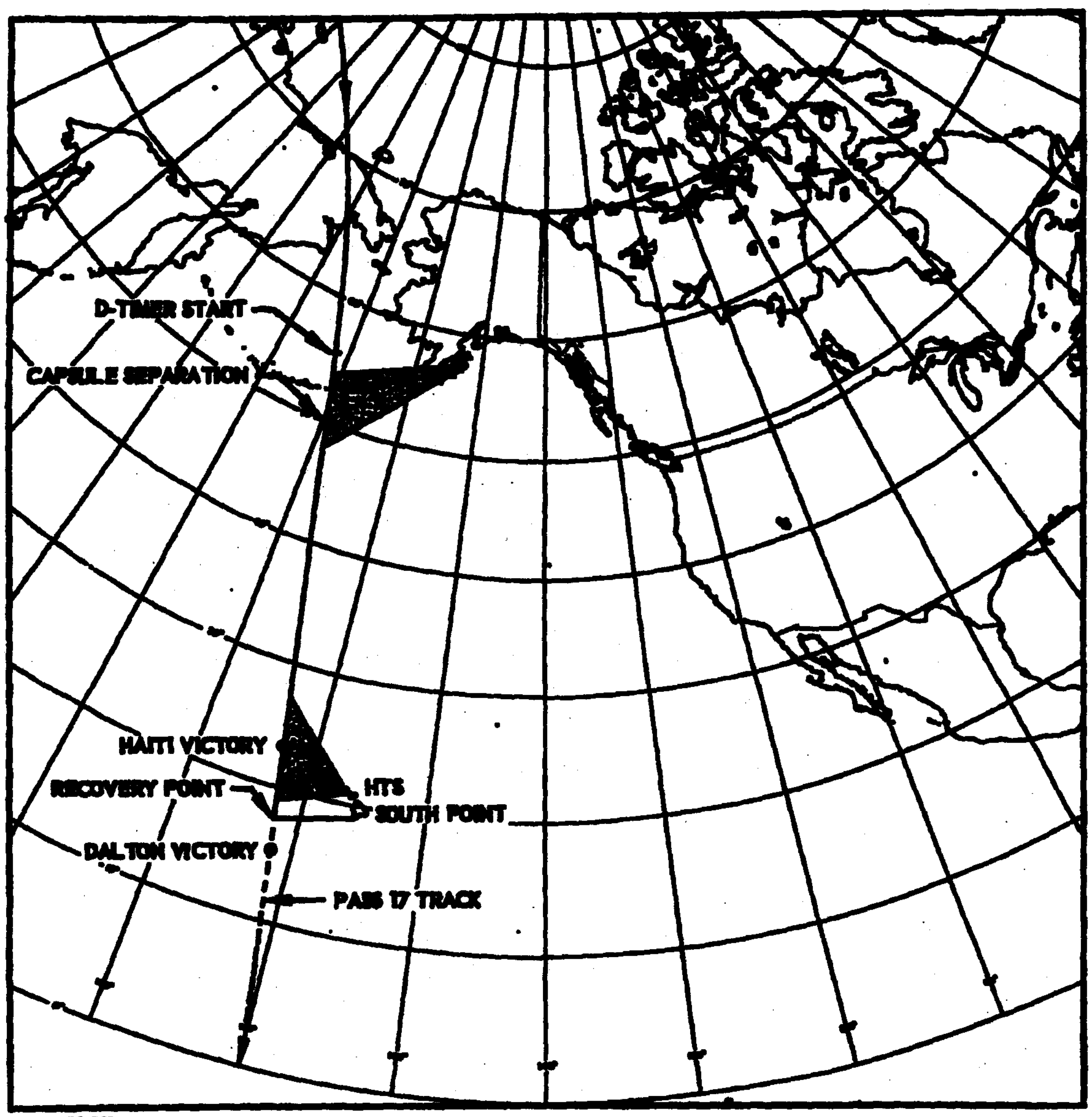


Figure 8-2 Capsule-Beacon Coverage on Recovery Pass

Radar Tracking of The Chaff Cloud. The operation was accomplished with three RC-121 aircraft after Number 3 aborted due to loss of Number 4 engine. Two aircraft registered possible chaff contacts. RC-121 Number 4 aircraft contacted the chaff on both radar sets. At 2255 GMT, the APS-20 radar, operating in the S-band, identified the chaff cloud at a range of approximately 127 nautical miles. At 2305 GMT, the APS-45 radar, operating in the X-band, had chaff indication at the 27,000-foot altitude and approximately 90 nautical miles. At 2308 GMT, the APS-45 very weakly indicated a possible parachute target at the 7400-foot altitude (recovery occurred at 8500 feet). Radar contact with the chaff cloud was maintained for approximately 15 minutes, at which time the success of the recovery operation was assured. The radar operators were unable to positively identify the chaff cloud and parachute as two distinct targets. Since the radar acquisition coincided with the C-119 DF bearing already being pursued, no additional vector was given. The C-119 Number 9 aircraft reported positive visual sighting of the descending parachute and capsule approximately 13 minutes before the air recovery was accomplished.

The RC-121 Number 2 aircraft reported a radar contact at a range of approximately 45 nautical miles prior to the radar contacts which were made by the RC-121 Number 4 aircraft. As the bearing to this radar target was in approximate agreement with the reported bearings on the VHF beacon, a possibility existed that this RC-121 had contacted the chaff cloud or parachute. Later reports from the RC-121 Number 4 and C-119 Number 9 aircrafts proved the RC-121 Number 2 contact to be some other object and the identity of this target was not established.

The beacon lights were not specifically necessary on this operation and recovering aircraft reported that the lights were not visible during the recovery passes although they were operable.

RECOVERY FORCE OPERATIONS

Surface Recovery Units

Although not called upon to recover, the surface units were ready for recovery if necessary. An air pickup of data from the USS Dalton Victory was made by a C-119 from Hickam AFB on 20 August, the day following recovery.

Airborne Recovery Units

All nine C-119 aircraft and the one C-130 aircraft acquired the VHF-beacon transmissions during the recovery operation. All aircraft were at or near station location at ETPD. C-119 Number 9, the recovering aircraft, obtained reliable DF bearings from 2253:05 GMT through recovery at 2309 GMT. C-119 bearing data compared to the recovery point shows that bearing data were reasonably accurate, based on the fact that, as the aircraft approached the capsule, bearings could be refined and thus pinpoint the capsule location. Possible capsule passage through the ionization layer is shown by an average loss of signals at 2251 GMT and then the reacquisition of signals at an average of 2255 GMT (Fig. 8-1). The high-speed passage of the capsule over the northern aircraft would then be apparent by their inability to obtain reliable bearings and rather short time of acquisition prior to "blackout".

Control of the force was considered good. Changes to impact location were handled adequately, and all essential equipment on the three aircraft was operational at ATPD. Reliability of the aerial method of recovery and the recovery gear was proven by the successful recovery of the capsule and by the lack of damage to the capsule during aerial recovery.

CONTROL, COMMUNICATIONS, AND WEATHER

Hawaiian Control Center (HCC) Operation

Control of the operation by the Hawaiian Control Center (HCC) was acceptable. The center is crowded by personnel and equipment, but this condition can be expected to diminish by elimination of some operations considered essential only for the first successful recovery operations. With the increased amount of radio equipment, the HCC has become handicapped by lack of radio operators who are familiar with the program.

With the large recovery force, the HCC has become handicapped by a limited number of personnel available and qualified to debrief the returning recovery units. The majority of the units return to the base at the same time, making it difficult to accomplish the task smoothly. In addition, numerous other tasks of reporting and analysis are being accomplished simultaneously, making the overall workload for the period following recovery difficult to accomplish under the conditions.

Communications

Communications for this mission were generally good. The conversion to one frequency was satisfactory with no indication of an overloaded channel. The single-sideband equipment operated reasonably well for the first time since its installation and was useful as an HCC to RC-121 net. Some difficulty was apparent, because some information from the C-119 aircraft did not appear on the HCC acquisition-information board. This condition was apparently a reception problem within the HCC. A continuing investigation of the entire recovery-operation communication system is being performed.

Weather

Weather for the operation proved, in nearly all cases, to be as predicted just prior to the operation. The weather in the recovery area was as follows: cumulus clouds 3/8 from 3000 to 6000 feet (occasionally 8000 feet) and cirrus clouds 2/8 with tops at 30,000 feet. The southern area also had alto-stratus at 10,000 to 12,000 feet. Visibility was 15 nautical miles to unlimited. The ballistic drift from 40,000 feet to sea level was 20 knots at 60 degrees. One aircraft, JC-54 Number 1, reported that weather affected his equipment to the extent that he was forced to change his position 50 nautical miles northward.

CAPSULE CONDITION

When transferred into the recovery aircraft, the capsule condition was good with no exterior damage apparent due to recovery procedures. The capsule was still warm when pulled aboard the aircraft and had a burned smell. Insulation on the cannon-plug wiring was reported to be burned off. The capsule was soot covered and the lights were slightly melted, indicating high temperatures during the re-entry phase. The wires on top, the antennas, and the strobe lights were disconnected after recovery. The gold-plated portion of the capsule was polished and undamaged. The parachute was stable, undamaged, and descending normally prior to recovery. The recovery operation shredded and slightly burned the parachute.

OPERATIONS SUMMARY

As shown, some problems still exist in the operation, although none of them were of a nature to preclude successful recovery. The synchronized operation of all personnel was again satisfactory before, during, and after the operation. Efforts are being made to change or alleviate problem areas prior to future recovery operations.

SECTION 9
GROUND SYSTEMS

SECTION 9
GROUND SYSTEMS

Ground system elements satisfactorily accomplished prelaunch-, launch-, ascent-, orbit-, and recovery-operation functions. Tracking and telemetry data obtained by the tracking stations during the operation were of good quality for online evaluation, orbital computations, and postflight analysis.

SATELLITE TEST CENTER (STC)

System operations were satisfactorily conducted by the Satellite Test Center (STC). Direction of launch, orbit, and recovery operations by the system test director was efficient.

Although intermittent outages of the communications network were experienced during the operation (Table 9-1), the network was expeditiously restored to operation, and no serious loss of time or information resulted.

PALO ALTO COMPUTER CENTER (PACC)

The Palo Alto Computer Center (PACC) functioned successfully during all phases of the operation. Nominal acquisition messages were sent to tracking stations for system-run checks, and at T - 48 hours, the first impact prediction was sent. From T - 6 to T - 3 hours, system readiness runs were made and all systems were evaluated as ready. Difficulties were experienced in sending KTS data tapes (probably due to line disturbances) but were cleared up before launch time.

Launch data were received quickly from the Vandenberg Tracking Station (VTS) and the Point Mugu Tracking Station (MTS) and were put immediately into the computer. MTS radar data were used for first-pass predictions based on 29 data points. MTS obtained very accurate data with a

Table 9-1

COMMUNICATIONS PROBLEMS

DATE	TIME (PDT)	PROBLEMS
8-17	0131	VTS Doppler equipment inoperative for estimated two hours
8-17	0131	VTS acquisition-programmer equipment marginal to poor for estimated four hours
8-17	1615	VTS Doppler equipment inoperative
8-17		WV-2 aircraft at KTS single-sideband equipment inoperative for the operation; AM and CW to be substituted
8-18	0020-0053	New Boston 60-wpm teletype No. 10336 picking up characters
8-18	0820	VTS radar had jitter in scope visual display for estimated one hour
8-18	0852	WV-2 aircraft at KTS single sideband would not operate in flight
8-18	0928	VOC-STC 10750 data-link voice line had steady audio ring in data position. The ringing stopped when voice position was selected; data position was then reselected and 100-wpm checkout repeated
8-18	0931-0934	KTS 100-wpm teletype inoperative (running open)
8-18	0931	VTS reported STC's hotline level was low
8-18	1030	HTS-STC weak and distorted with echo on hotline in either direction
8-18	1032	KTS had malfunctioning transmitter distributor, believed to be on the 100 wpm
8-18	1035	VTS VERLORT acquisition programmer evaluated as operative, but 15 Reeves computer data words were dropped near the tape leader
8-18	1104	VOC impressed a squeal on the hotline due to the tape-recorder sensitivity set too high. Problem was promptly rectified

DISTRIBUTION

Addressee	Quantity
Commander Air Force Ballistic Missile Division Attention: WDAT Air Force Unit Post Office Los Angeles 45, California	20
Air Force Plant Representative (SMAMA) Lockheed Aircraft Corporation Missiles and Space Division P. O. Box 504 Sunnyvale, California	1
6594th Test Wing (Satellite) (ARDC) Attention: TWRAT Satellite Test Center Building 171, Plant 1 Sunnyvale, California	6
AFBMD Field Office Attention, Lt. Col. W. F. Heisler Vandenberg AFB, California	1
Commander Pacific Missile Range Attention: DCOS-AF Col. S. G. Curtis USN Missile Test Center Point Mugu, California	1
D. McCallum Douglas Aircraft Company Space Systems (Systems Test) 3000 Ocean Park Boulevard Santa Monica, California	2
LMSD Organizations	69
Total	100

Produced by Satellite Systems Publications and Services (61-62)

Table 9-1 (Continued)

DATE	TIME (PDT)	PROBLEMS
8-18	1105	STC read MHS low but tolerable; VTS read MHS loud and clear; VTS read STC "low but readable"; MHS read STC "low and in a barrel"; Telephone Company (TELCO) notified
8-18	1125-1200	TELCO had intermittent 1000-cycle tone on GF8344 VCC-STC hotline. Impossible to check liftoff tone under these conditions. TELCO notified, replied "it was up at San Jose". VCC-STC hotline lost due to the 1000-cycle tone. VCC sent TWX to STC requesting TELCO to stay off the line
8-18	1200	VCC-STC hotline tolerable both directions, with party receiving reporting the transmitting party with a slight barrel sound
8-18	1233	New Boston acquisition-programmer equipment inoperative
8-18	1249	Station interference on single sideband between VCC and downrange telemetry ship; believed caused by WV-2 at KHS. Trouble ceased after second admonition from VCC
8-18	2030-0000	Hickam, Hawaii, to STC 10315- 60-wpm teletype out
8-19	0315-0515	Hickam, Hawaii, 10315-A 60-wpm teletype running open
8-19	0440-0600	KHS 10321 60-wpm teletype garbled
8-19	During Recovery	SOA unable to contact test directory by designated phone line to revise impact prediction
8-22	1320-1324	Hickam, Hawaii, 10315-A 60-wpm teletype running open.

root-mean-square (rms) deviation of 0.72 mile. Based upon launch data, a period of 93.8 minutes was predicted, then revised to 94.5 minutes on the basis of Pass 1 data. This error in orbit period has been attributed to a refraction effect caused by a temperature inversion. This effect caused the radar to give higher elevation angles and longer ranges as the actual elevation angle decreased below 15 degrees. A study is now being conducted on the magnitude-of-error that temperature inversions will introduce.

Predictions and acquisition messages were sent to the tracking stations from 50 to 60 minutes prior to station acquisition. Figure 9-1 shows the error in

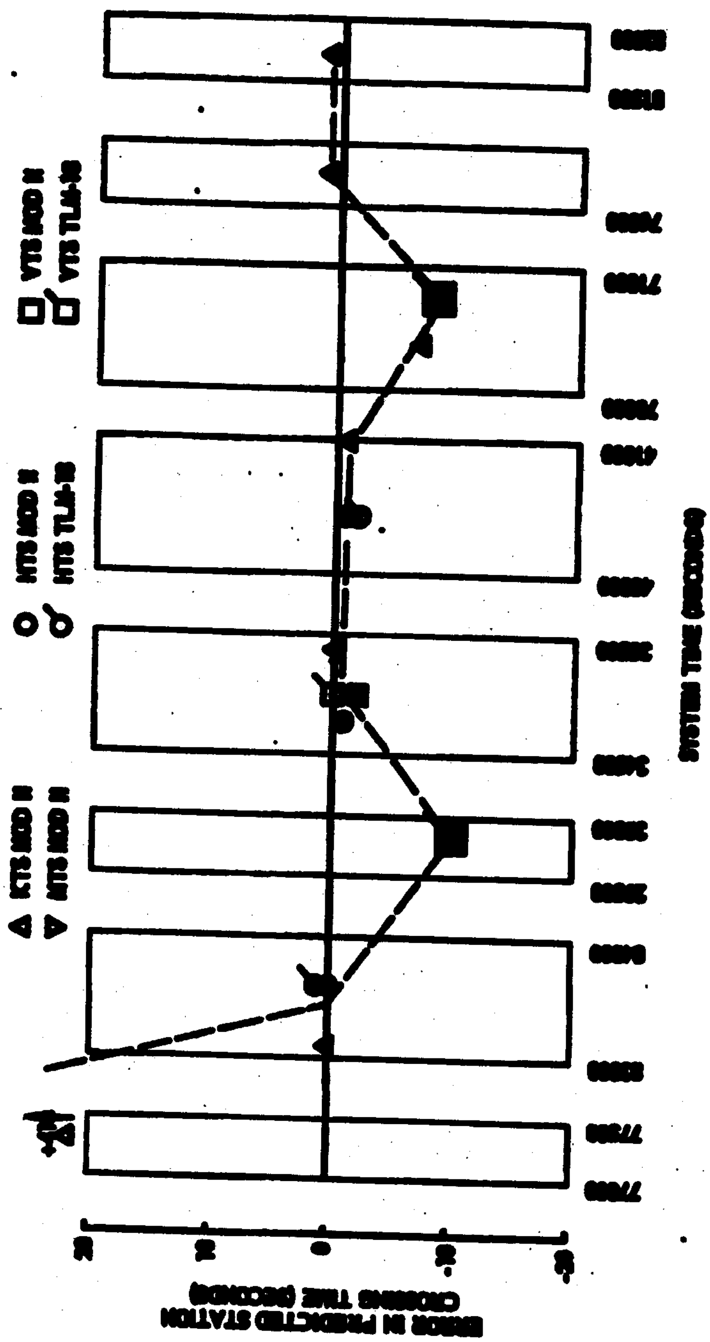


Figure 9-1 Errors in Predicted Time of Station Crossing

the predicted time-of-crossing of each station's latitude. The error in Passes 8 and 15 was probable due to the accumulated error in the passes that were not tracked.

The time of D-timer start and reset monitor ON was obtained over the hot-line from KTS. The D-timer start was seven seconds later than predicted. TLM-18 re-entry data from HTS were of no value due to complete lack of lockon.

Impact predictions were given following Passes 2, 8, 9, 10, 15, and 16. The prediction after Pass 10 was based on the condition of no subsequent timer reset. The final prediction was made after Pass 16, using all available information.

The predicted impact point was about 7 degrees north of the actual point. The error in the predicted point is believed to have been primarily caused by incorrect satellite attitude at the time of capsule ejection.

SYSTEM OPERATION ANALYSIS (SOA)

The System Operation Analysis (SOA) Section areas in the STC and at the PACC were manned at T - 1 hours. At this time, the operational areas were readied for launch activities. Communications with the PACC, the Operation Support area, and the test directors were checked for readiness.

Times of events, Command 5 and 6, and tracking oata were displayed during launch and compared with nominal values. All data indicated a nearly nominal ascent and successful orbital injection.

Using predicted Pass 1 data, the first-pass time command nomogram was prepared for the test director. Required timer correction was determined to be increase and Step 2, and reset command at reset latitude. With the satellite apparently deaf to Tone A on Pass 1, a timer command sequence to be sent on Pass 2 was prepared to properly adjust the timer for Passes 9 and 10. This sequence required decreasing the orbital timer period to the lowest setting, at which time the timer recycles to the top position, and then down from the top step position to a timer switch position of 32 (5717 seconds). This would have correctly positioned the "Plates ON" time during Passes 9 and 10, and also left 2 steps (decrease) for further refinement as required. This plan would have been used on Pass 2, if KTS had not been successful in sending Commands 1 and 3.

Passes 1 and 2 and the nighttime passes were monitored. Updated orbital parameters and impact predictions were issued to the STC Program Information Center and the Operations Support areas, as well as acquisition messages to the tracking stations.

Because of the Tone A command problem, it was recommended by SOA that the timer be reset on Pass 15 so that further adjustment on Pass 16 would not be required. This procedure was followed, with an alternate method in case of a problem. The reset command was issued, held, and verified by KTS as directed. New impact predictions were issued based on the latest ephemeris information.

Recovery Pass 17 was monitored in the STC, PACC, and at the HCC. Ship sightings of the VHF beacon were reported and plotted. Almost immediately following, a number of bearings from the C-119 aircraft were reported. The USS Dalton Victory bearings then became approximately stationary at 015 degrees true azimuth. C-119's 5, 7, and 9 gave intersecting bearings and a 55-second contact from South Point on a bearing at 250 degrees true azimuth intersected with both the C-119 and the USS Dalton Victory bearings.

Based on the ship and C-119 bearings being reported, SOA personnel attempted to inform the test director of the approximate location so HTS and Barking Sands might train their antennas. Because of telephone line difficulties, this vital information had to be handcarried to the Operation Support area. The azimuth from HTS was further refined to 215 degrees, but a connection to the director was again impossible. Apparently the designated telephone was off the hook or busy. It was believed that if HTS TLM-18 repositioning data had reached Hawaii, a bearing fix would have been attained.

An impact point of 16 degrees, 52 minutes north latitude and 161 degrees, 52 minutes west longitude was generated but never issued due to the announcement of air recovery by C-119 Number 7. The announcement made the SOA prediction appear completely in error until it was announced that C-119 Number 9 instead of Number 7 had actually recovered. The final recovery location was reported to be 17 degrees, 6 minutes north, approximately 30 nautical miles from the SOA triangulation impact point.

HUMAN FACTORS

Communications and control performance were generally good. Stations were requested to compile sufficient information and formulate procedures prior to the operation. As a result, reporting and communications were excellent.

The inability of KTS to transmit and verify Command 1 was correctly diagnosed before Pass 2. KTS had initially adjusted the command-tone deviations to specifications, but after the first pass, a recheck disclosed an out-of-specification condition. Remedial procedures were established and twice sent to KTS before ETA minus 5 minutes, Pass 2. HTS also experienced Tone A difficulties on Pass 10, and thus was directed to increase deviation of the command tone by 0.5 microsecond, which allowed the station to send two verified Command 1's. KTS was directed to transmit the vital Pass 15 reset command. To assure verification, the station was instructed to begin sending reset 30 seconds before nominal reset time.

When the telemetered control-gas pressure was first observed to be low, STC requested real-time readout by all tracking stations of control-gas pressure. The stations made prompt reports of this item as the readouts became available.

TRACKING STATIONS

Tracking station performance was satisfactory. VERLORT radar tracking was successfully accomplished on programmed passes, and telemetry monitored all instrumented satellite functions. The general quality of the space-position data is indicated in Figure 9-2. Total number of data points transmitted to the PACC are compared with the usable number of points. VERLORT and telemetry coverage during launch and ascent is presented in Figure 9-3.

Orbital VERLORT tracking was satisfactorily accomplished, but difficulty was experienced in getting Commands 1 and 3 to the satellite. These commands contain the Tone A modulation. Of 35 total commands sent between Passes 1 and 17, only 18 were verified by the satellite. (Table 5-6.) Since several stations experienced command difficulties, radar-beacon malfunction is considered a contributing factor. Telemetry reception by the tracking stations during orbit was satisfactory except during the recovery pass, when no contact with the capsule telemetry (1.2-watt) transmitter was made. Orbital contacts, with durations of track for each station, are shown in the Orbital Contact Summary, Table 3-4. Near real-time data evaluation was made possible by telemetry reception at the Sunnyvale facility. Holloman AFB, New Mexico, and the recently activated station at New Boston (NBTS), New Hampshire, also provided tracking information. Four tracking-light sightings were reported by Smithsonian South African stations. Satisfactory contact with the capsule VHF beacon was made during the recovery operation (Fig. 8-2) but none with the capsule telemetry. Further investigation has shown that the transmitter was not activated (see Telemetry and Instrumentation).

<u>Vandenberg Tracking Station (VTS)</u>

Track station operations were successfully carried out during launch and succeeding orbital operations. Active VERLORT tracking was maintained until T + 165 seconds, when the radar went passive as planned.

The VERLORT then tracked on MTS's return until T + 516 seconds, when fade occurred at an elevation of 3.9 degrees and azimuth of 173.4 degrees. A beacon "countdown" of 20 percent was reached prior to launch. During Task 4, instability of the modulator and beacon-coder triggers was noted on

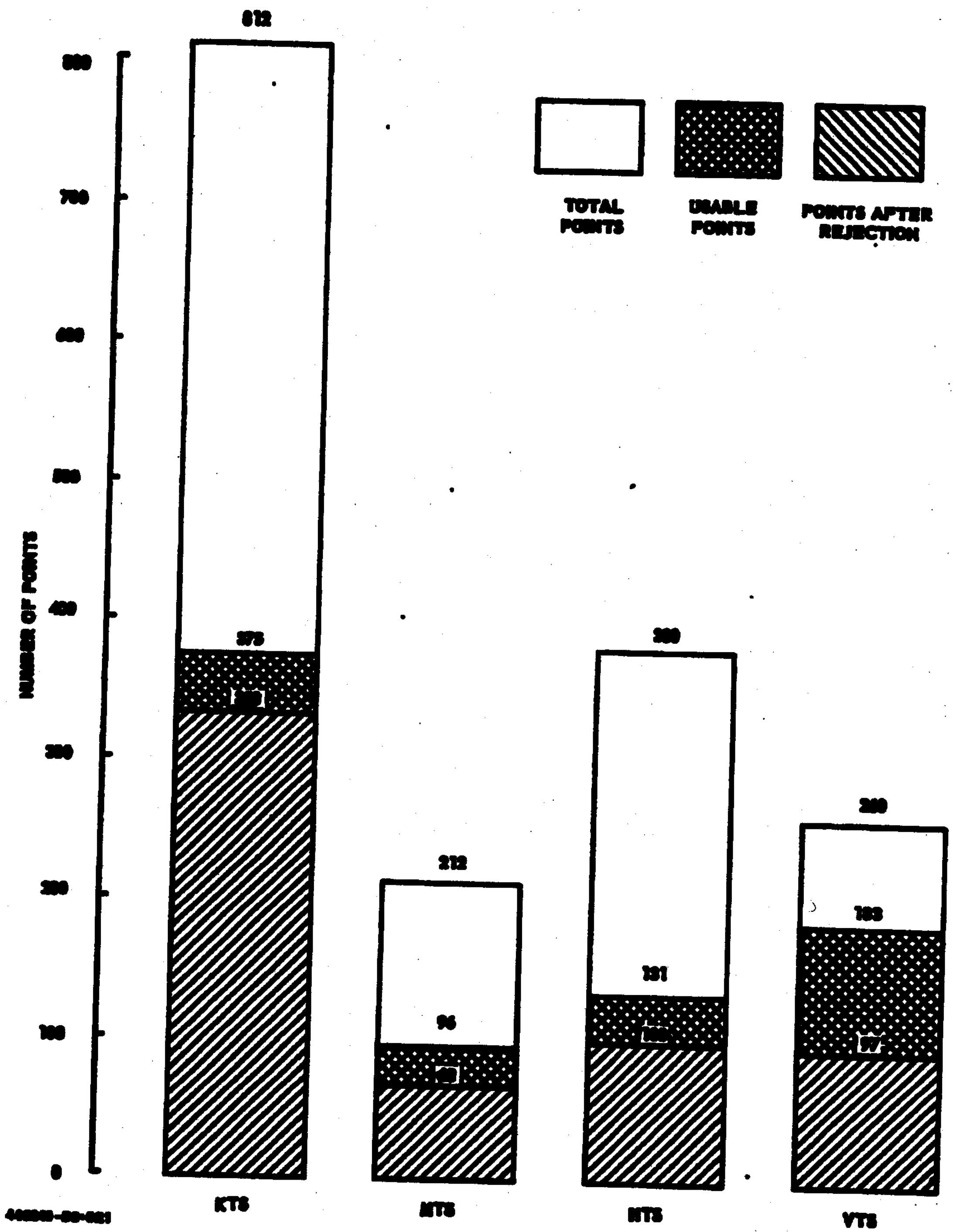


Figure 9-2 Tracking-Station Positional-Data Quality

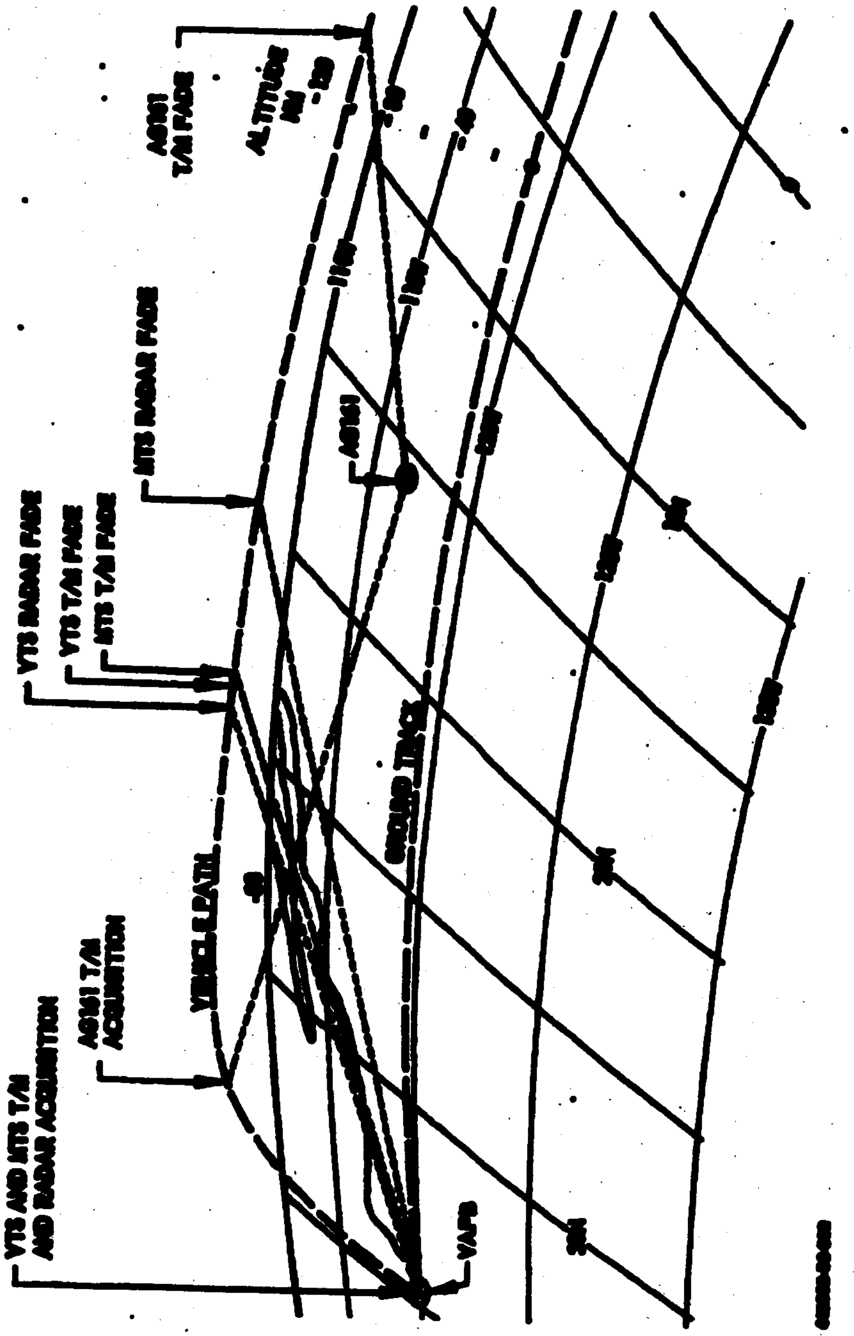


Figure 9-3 Launch Radar and Telemetry Coverage

the range scopes. A check of transmitted pulses out did not show instability and a check with the blockhouse confirmed this. The problem was traced to the VERLORT van and corrected. The system-time generator at the VERLORT site was inoperative, and thus times recorded on the Brush recordings were invalid. Beacon countdown continued during launch and ascent, with peaks reaching 30 percent and averaging 5 to 10 percent. The countdown appeared to be caused by three search-type radars, scanning at a rate of about 11 seconds per revolution. Telemetry tracking and data acquisition was successfully carried out by both the TLM-18 and tri-helix antennas. Orbital contact was also achieved on Passes 1, 8, 9, 15, 16, and 24. The only command sent by VTS, a reset command on Pass 9, was not verified.

Point Mugu Tracking Station (MTS)

Performance of equipment and personnel was satisfactory during launch and subsequent orbital passes. Radar-beacon returns were received at T + 25 seconds, and automatic track was achieved soon thereafter. Contact was maintained until T + 500 seconds. Command 5 (D-timer hold) and Command 6 (velocity-to-be-gained) were successfully computed and transmitted for durations of 26.70 seconds and 13.20 seconds, respectively. Slight countdown was noted during track but caused no difficulty. Agena telemetry was acquired at T + 25 seconds by the tri-helix antenna and continued to be tracked until T + 460 seconds.

Orbital tracking was also successful on Passes 8, 9, 15, and 25. No orbital commands were transmitted. Slight countdown was observed during orbital passes.

Downrange Telemetry Ship (AG 161)

The downrange ship was on station and performed satisfactorily during launch operations. Telemetry contact was achieved at T + 251 seconds and lasted until T + 740 seconds. The ship provided positive verification of successful Agena reorientation (yaw-around), switchover of antennas from exit to orbit, and the plus 3.55-deg/min pitch rate.

Kodiak Tracking Station (KTS)

Acquisition of the VHF transmitters by KTS at 87.9 minutes after launch verified that orbital status had been achieved. A drift in command pulse-modulation deviation from 3 to 1.5 microseconds was discovered after Pass 1 and resulted in command difficulty on Pass 1, when increase and reset commands could not be verified. Readjustment of command pulse deviation to 2.75 microseconds on Pass 2 resulted in successful Tone A verification. On Pass 10, four out of five Command 1's were successful with Tone A modulation increased to 3.05 microseconds. A final reset command on Pass 15 adjusted the orbital timer for correct initiation of the retro sequence on Pass 17. The reset command was initiated 30 seconds before the actual reset latitude was reached. It was sent continuously, and KTS was instructed to make any changes in Tone A deviation necessary to obtain proper verification. No adjustment was necessary, however, since verification was achieved immediately. When the command was terminated, the timer was properly adjusted for recovery initiation on Pass 17.

Orbital telemetry acquisition was satisfactory. On Pass 17, no contact was made with the capsule telemetry signal, although a weak VHF-beacon contact was made.

Command exercises were carried out on postrecovery orbits. Satellite telemetry data were transmitted to Sunnyvale by telephone line after Passes 2 and 17. Data quality was very good, and sun-position indicator and horizon-scanner data proved to be of value in evaluating satellite attitude before the recovery pass. Personnel proficiency was excellent.

Hawaii Tracking Station (HTS)

Performance of the HTS during the operation was satisfactory. All scheduled contacts with satellite transmitting equipment were successfully made.

Difficulties were experienced on Passes 1 and 10 in obtaining verifications for commands containing Tone A. Four reset commands were sent in succession on Pass 10 without success, but after the modulation deviation was increased by an additional 0.5 microsecond, successful verification was achieved. During the recovery pass, HTS made contact with the capsule VHF beacon for a duration of 77 seconds.

Barking Sands

The recently activated tracking station at Barking Sands on the island of Kauai was utilized to track capsule signals during the recovery pass, although contact was made with the satellite telemetry signal during orbit operations as well. No contact with the capsule VHF beacon was made.

South Point

The capsule VHF beacon was acquired for a duration of 77 seconds at a bearing of 250 degrees during Pass 17.

Christmas Island

Because of the southerly location of this station, no capsule contact was accomplished.

WV-2 Telemetry Aircraft

A WV-2 aircraft equipped for telemetry reception was positioned below the capsule-separation point (approximately 50 degrees North latitude, 170 degrees West longitude) to receive and record capsule telemetry data. No capsule telemetry contact was made although the VHF beacon was satisfactorily acquired.

GROUND SUPPORT EQUIPMENT (GSE)

Blockhouse

Performance of the blockhouse GSE was satisfactory except for the propellant-tanking problem mentioned below.

Agena

During Countdown Task 5, the lanyard to the fuel-fill umbilical disconnect was found to be too short and a longer lanyard had to be made. Apparent damage to a pneumatic hardline in the umbilical mast was noticed during Task 9 of the countdown. Pad personnel inspected the hardline which apparently had been struck by a hammer and found it mechanically sound.

When fuel flow was turned on at the blockhouse during Task 14 (propellant tanking), flow was not recorded at the blockhouse meters. At first, it was thought that the flowmeters were inoperative, but investigation revealed that there was no flow. The fuel-tank flow valve was checked and found to be working properly; however, the interflow valve on the umbilical was stuck in the closed position. The valve was freed by simultaneous application of current to the valve solenoid and tapping the valve. Even after freeing the valve, the fuel flow could not be started from the blockhouse and had to be turned on at the fuel truck on the pad. No reason for this lack of blockhouse control is available at this time.

Thor

A hydraulic power unit malfunction was experienced during Task 3 of the countdown. In addition, the pad water-deluge system was inadvertently activated during Task 8 of countdown. This caused delay while GSE at the pad was inspected for possible damage. No reason for this malfunction is available at this time.

Pad Damage

Pad damage was minor and confined to the normally expendable items such as hydraulic flex lines, air-conditioning ducts, and electrical cables.

SECTION 10
OPERATIONS SUPPORT

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Adequate support was provided by the following participating agencies:

- 6594th Test Wing
- 1st Missile Division
- Alaskan Air Command
- Spacetrack
- Lookout Mountain Laboratories
- Pacific Missile Range
- Flight Test Working Group, VAFB
- Douglas Aircraft Company
- LMSD Data Services
- LMSD Palo Alto Computer Center
- 6594th Recovery Control Group.

The 10-hour Vandenberg data shipment was delayed because of weather conditions at VAFB. It was delivered by car to Paso Robles where it was picked up by the courier aircraft.

The capsule containing original data from the telemetry ship, USS King County, was dropped in an attempted pickup, but a second capsule containing duplicate data was successfully picked up. The first capsule was later recovered by the telemetry ship.

LMSD Data Services and Modification and Checkout receiving stations provided early launch and orbit data. Part of Pass 2 and Pass 17 data from KTS were transmitted by telephone line, permitting early evaluation of orbit and re-entry events.

For the first time, an aerial pickup of data from the USS Dalton Victory was attempted and accomplished. Pickup was made by a Hawaiian-based C-119 aircraft.