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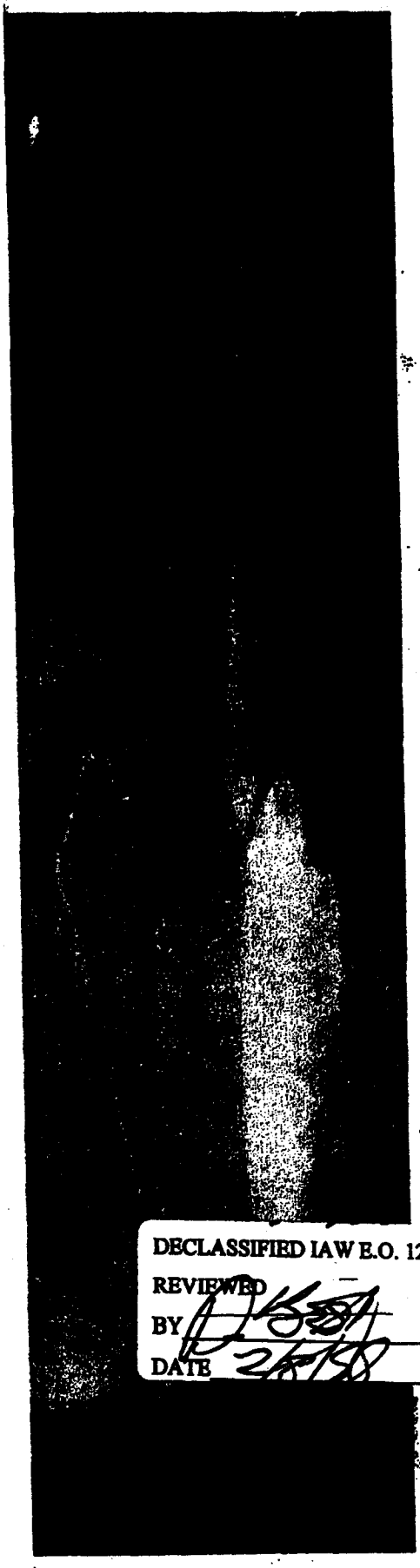

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DISCOVERER
LAUNCH REPORT

Agena 1110 / Thor 322

4 AUGUST 1961

DOWNGRADED AT 3 YEAR INTERVALS; DECLASSIFIED AFTER 12 YEARS
DOD DIR 5200.10

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6565th Test Wing
Vandenberg Air Force Base

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DISCOVERER
LAUNCH REPORT

Agena 1110/Thor 322

DOWNGRADED AT 3 YEAR INTERVALS;
DECLASSIFIED AFTER 12 YEARS
DOD DIRECTIVE 5200.10

LUCIUS A. PERRY, JR., COL. USAF
Deputy Commander for Space Systems

6565TH TEST WING
VANDENBERG AIR FORCE BASE

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LOCKHEED AIRCRAFT CORPORATION
MISSILES and SPACE DIVISION

PREFACE

Discoverer Launch Report 1110/322 presents the launch evaluation, analysis, and documentation of the launching of the twenty-seventh Discoverer system flight tested from Vandenberg Air Force Base. The report is prepared by the Flight Test Evaluation Staff for the Satellite Systems Division of the 6565th Test Wing (Development)(AFSC) at Vandenberg Air Force Base. Contributions to Section IV, Thor Systems Analysis, and Appendix C, Thor 322 Preparation History, were made by base operations of Douglas Aircraft Company. Agena documentation in the appendix was contributed by base operations of Lockheed Missiles and Space Company, who also provide reproduction and distribution of the report.

Launch data for the analysis was furnished by the following organizations:

Lockheed Missiles and Space Company (LMSC) -- primary tracking and telemetry data and blockhouse landline recordings.

Douglas Aircraft Company (DAC) -- analog records of first stage telemetry.

Bell Telephone Laboratories (BTL) -- command guidance radar plotboard chart, tabulated command guidance events and values.

Pacific Missile Range (PMR) -- metric optic and FPS-16 radar tabular position data, missile flight safety plotboard charts, first stage telemetry, and radiation interference monitoring record.

1st Strategic Aerospace Division, USAF -- weather data and engineering surveillance and documentary photography.

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DISCOVERER LAUNCH REPORT

AGENA 1110/THOR 322

I. LAUNCH SUMMARY

Discoverer XXVII (Agena 1110/Thor 322), composed of an Agena-B satellite (Model 6205) and a Thor booster (Model DM-21) was launched from Complex 75-3, Pad 4, Vandenberg AFB at 1535:00.46 PDT on 21 July 1961. The primary launch objective -- to place the Agena, equipped with a recoverable Advanced Engineering Test (AET) capsule, into near polar orbit -- was not achieved: the vehicle destroyed itself after approximately 60 sec of flight as a result of a Thor control malfunction which caused divergent pitch oscillations to develop, exceeding the structural limits of the vehicle. The cause of the malfunction is attributed to an open in the Thor flight controller pitch-rate loop.

The events leading up to the destruction of the vehicle and post-destruct phenomena are tabulated below.

TIME FROM LIFTOFF (sec)	EVENT
0	Liftoff. 1535:00.46 PDT. Vehicle pitch oscillation started.
30	Agena normal acceleration due to pitch oscillations reached peak levels of ±0.3 g.
40	Agena normal acceleration peak levels decreased to ±0.1 g.
48	Agena normal acceleration predominately negative with peak levels between -0.8 g and -0.25 g.
57.5	Magnitude of Agena normal acceleration started increasing rapidly.
59.2	Magnitude of Agena normal acceleration reached -3.0 g and continued increasing beyond the accelerometer calibration. Photographs show first flash at vehicle forward section.

TIME FROM LIFTOFF (sec)	EVENT
59.6	Second flash seen on photographs.
59.61	Agena telemetry signal lost.
59.7	Fire in forward section of vehicle apparent in photographs.
59.71	MECO (Thor main engine cutoff) indicated on Thor sequential events channel.
59.85	Thor main engine flame shortens in photographs indicating MECO.
59.88	Thor MECO (70% of stable chamber pressure).
59.9	Some Thor data (guidance) lost from telemetry carrier.
60	Agena acquisition beacon signal lost.
60.6	Photographs show vehicle enveloped in flame.
62	Optical trackers reported vehicle break-up.
65	Range Safety MPS-19 radars reported loss of track on Agena beacon.
68.6	Range Safety destruct transmitter switched from low power to high power.
78.7	Photographs show explosion in vehicle.
79.5	Remaining data lost from Thor telemetry carrier.
93.6	Range Safety transmitted DESTRUCT ARM signal.
94.9	Range Safety transmitted DESTRUCT signal.
185	Vandenberg Tracking Station VERLORT radar lost track on Agena beacon. Tracking data indicate Agena impact.
312	Thor telemetry carrier lost by Vandenberg Tracking Station TLM-18.

The debris resulting from the vehicle's disintegration fell in the ocean about 4300 yd from the pad. Search and salvage operations were conducted from 22 July through 28 July in an attempt to recover components which might show the type and cause of the vehicle failure. The impact area was searched by PMR divers using self-contained underwater breathing equipment and by a Navy minesweeper using SONAR equipment. Portions of the Thor engine section and fuel tank were located and identified but no salvage was attempted. No Agena components were located in this operation, however, the nitrogen and helium pressure spheres were washed on to the beach.

[redacted]

II. REMEDIAL ACTION

As a result of this launch the following action has been taken by Douglas Aircraft Company to increase the reliability of the Thor flight controller:

(1) Simplification of the design of the shaping network to provide a more reliable checkout. (Page 17)

(2) Encapsulation of the network boards to preclude vibration damage. (Page 17)

(3) Implementation of a more reliable checkout procedure for verification of total loop response of the HIG and rate gyros. (Page 17)

III. LAUNCH EVALUATION

A. AGENA PERFORMANCE

For the most part the flight termination during boost did not permit the Agena subsystems to perform their normal roles and thus an extensive evaluation is not possible. The following evaluation applies to observations prior to T+60 sec.

The space airframe (SS/A) appeared to remain intact under abnormal environment until excessive stress due to aerodynamic loading (high dynamic pressure, adverse angle of attack) probably caused structural failure.

The Agena propulsion system (SS/B) was not active. However, telemetered data indicated it was in a satisfactory standby condition.

The auxiliary power supply system (SS/C) appeared to provide normal voltages from all batteries, inverters, and regulators until loss of the Agena telemetry signal at T+59.61 sec.

The guidance and control system (SS/D) with the exception of the D-timer was on a normal standby status. The rate gyros, caged attitude gyros, and roll accelerometer responded properly to the dynamic disturbances preceding flight termination. The D-timer monitor indicated that the timer brake was released by J-900 umbilical pullaway at approximately T+1.0 sec.

Telemetry and communications system (SS/H) performed satisfactorily until T+59.61, after which the telemetry signal was no longer received. Return from the radar S-band beacon was observed until T+185 sec. During countdown some difficulty was experienced in setting the secondary programmer period. This difficulty, apparently due to the ground monitor loading the programmer's timing oscillator, was resolved prior to launch.

B. COUNTDOWN AND THOR PERFORMANCE

The evaluation of the countdown and Thor performance is provided by two time-event tables which compare the actual launch performance to pre-launch criteria established to define the conditions and functions which must be met to achieve primary launch objectives.

[redacted]

Table 1 evaluates the countdown from its initiation through liftoff. In doing this it does not attempt to describe all activities connected with the countdown, but defines the technical points whose specifications must be met, or whose function must be verified. The specifications and tolerances are given in the criteria column "Test and Function"; the values measured or events verified are given in the "Performance Evaluation" column.

Table 2 evaluates the performance of the Thor vehicle by comparing the functional results in flight to the criteria. In the table, the columns "Time from Liftoff" and "System and Function" repeat the criteria. The column "Performance Evaluation" correlates the actual flight performance of the vehicle to the criteria.

At the end of the section, trajectory and velocity information derived from VERLORT and PMR FPS-16 radar tracking data is illustrated in Figure 1.

Table 1. Discoverer XXVII Countdown Criteria and Performance Evaluation

Nominal Duration of Test	Test and Function	Performance Evaluation
10 min	PRE-COUNTDOWN OPERATION AND COUNTDOWN INITIATION	5 min duration. All stations manned and communications established. Countdown initiated at 0615.
45 min	PAYLOAD MATING	10 min duration. So that Task 8 (orbital stage electronics warm-up) could be extended due to electrical interference with Task 10 (payload checkout), most of payload mating was accomplished during pre-countdown operation. (This problem was peculiar to this vehicle.)
60 min	VEHICLE ERECTION AND PREPARATION	60 min duration. Upon erection, the mast momentarily failed to settle into the cradle due to high winds. When the wind momentarily subsided the mast settled into proper position.
	(1) Guidance and flight control pre-power conditioning checks.	Normal operation.
	(2) External power checks.	Normal operation.
	(3) Check mast position and mast hook operation.	Normal operation.
	(4) Verify all umbilicals and quick disconnects installed and safety wired. Verify all lanyards connected.	Verified.
40 min	COMMAND GUIDANCE POLARITY AND PHASING CHECKS	37 min duration. All checks showed nominal operation.
30 min	DESTRUCT CHECKS - Install destruct safety pin, connect both destruct simulators. Verify destruct simulators. Verify destruct signal being received on the Thor and Agena.	27 min duration. Destruct signal on Thor and Agena verified.

Table 1. (Continued)

Nominal Duration of Test	Test and Function	Performance Evaluation
40 min	ORBITAL STAGE ARM	40 min duration.
	(1) Check voltage on P522 (ullage rocket).	Normal.
	(2) Check for voltage on J4104 (engine).	Normal.
	(3) Install destruct package.	Normal operation.
40 min	CONNECT FIRST STAGE DESTRUCT SYSTEM	34 min duration.
	(1) Check liftoff signal received by all stations.	Verified.
	(2) Connect primacord to S and A mechanisms.	Verified.
	(3) Check safety pins and liftoff pins safety wired.	Verified.
	(4) Check no continuity between pins on EET receptacle J-20-195.	Verified.
	(5) Connect IMSC umbilical disconnect cable (Plug P-20-195) to EET receptacle J-20-195.	Verified.
	(6) Remove cap on LOX start tank vent.	Verified.
90 min	ORBITAL STAGE ELECTRONICS WARM-UP	28 min duration.
	(1) Regulate vehicle air-conditioning to 50 F and verify.	Verified.
	(2) Check vehicle power monitor meters.	All power normal.
	(3) Relay temperature conditioning.	Normal.
	(4) IRP temperature conditioning.	Normal.
	(5) Gyro block temperature 145 ±5 F.	Gyro block temperature 144 F.
	(6) Spin motors.	Normal operation.
	(7) Turn on external power bus voltage -- 23.5 v (min).	26.1 v.

Table 1. (Continued)

Nominal Duration of Test	Test and Function	Performance Evaluation
50 min	ORBITAL STAGE RF CHECKOUT	1 hr 50 min duration. Following program loading of the orbit time into the H-timer, a variation existed between the timer motor frequency and the orbital time. Re-checks made later during the same task indicated agreement between the timer motor frequency and orbit time. The initial disagreement between the two measurements is possibly due to a frequency shift because of insufficient warm-up when the program was loaded.
40 min	PAYLOAD CHECKOUT	23 min duration. Normal operation.
30 min	RANGE RF CHECKS	13 min duration. Normal operation.
25 min	ORBITAL STAGE GUIDANCE AND FLIGHT CONTROL CHECKOUT	27 min duration.
	(1) Timer motor operation.	Normal.
	(2) Horizon scanner continuity checks.	Normal.
	(3) Integrator continuity checks.	Verified.
	(4) Gyro torquing sensitivity tests.	Verified.
	(5) Control system tests.	Verified.
	(6) Gyro drift checks.	Verified.
	(7) Hydraulic servo command tests.	Normal.
20 min	TEST PLUG REMOVAL AND FINAL BOOSTER PREPARATIONS	54 min duration. Normal operation. During the task, evaluation of the H-timer problem and H-timer checks were made. Normal operation was verified. Time required for checking H-timer -- 45 min.

Table 1. (Continued)

Nominal Duration of Test	Test and Function	Performance Evaluation
70 min	ORBITAL STAGE PROPELLANT TANKING AND SECURE ORBITAL STAGE TRANSFER SETS	1 hr 34 min. At completion of 10% fuel tanking, a small fuel leak occurred in the fuel transfer set plumbing. The leak was eliminated by tightening one fitting.
	HOLD NO. 1	Hold 45 min duration imposed by Range Safety due to train schedule. During the hold period orbital stage pressurization was started at 1357 and completed at 1420. Hold released at start of countdown evaluation. (Task 18)
	(1) Propellant transferred to vehicle (lb): IRFNA 9527 ±10; UDMH 3762 ±4	IRFNA 9529; UDMH 3762
25 min	ORBITAL STAGE PRESSURIZATION	23 min duration. Operation normal.
	(1) Freon sphere pressure: 3300 - 3400 psig	3400 psig
	(2) Freon sphere temperature: 160 F (max)	80 F
	(3) Helium tank pressure: 3000 - 3400 psig	3300 psig
	(4) Oxidizer tank pressure: 58-62 psig	62 psig
	(5) Fuel tank pressure: 0-4 psig less than oxidizer tank.	58 psig
	(6) Lip seal pressure: 2-17 psig	8 psig
	HOLD NO. 2	Hold 9 min duration imposed at T-11 min 10 sec due to train schedule.

Table 1. (Continued)

TERMINAL COUNTDOWN

Nominal Time Before Liftoff	Test and Function	Performance Evaluation
T-11 min 10 sec	PHASE I	28 sec duration. Terminal count started at T-11 min 10 sec (2 min 25 sec earlier than normal due to planned technical hold to be imposed at the beginning of Phase V.
	Pressurize missile bottle to 3000 psig.	3000 psig verified.
T-10 min 40 sec	PHASE II	30 sec duration.
	(1) Check hydraulic return pressure.	Normal.
	(2) First stage telemetry and command destruct receivers on.	Verified.
T-9 min 55 sec	PHASE III	57 sec duration.
	(1) Hydraulic return pressure.	Normal.
	(2) Guidance loop check complete.	Normal operation.
	(3) Loading fine fuel.	Normal operation.
	(4) Main LOX tank vent closed.	Verified.
T-8 min 25 sec	PHASE IV	4 min 29 sec duration.
	(1) Thor main LOX tank vent open.	Verified.
	(2) Rapid load LOX to 95 per cent.	Verified.
	(3) Rapid load fuel to 97 per cent.	Verified. At 97% fuel, the computer failed to order fine load. The 97% fuel simulator was activated followed by actuation of the 100% fuel simulator. Predicted fuel loading was achieved.

Table 1. (Continued)

Nominal Time Before Liftoff	Test and Function	Performance Evaluation
T-8 min 25 sec cont'd	(4) Load fine fuel to 100%.	Verified.
	(5) Orbital stage telemetry on.	Verified.
	(6) Orbital stage beacon on.	Verified.
	(7) Programmer in increase mode step position 14, and both re-entry selectors reading 1 v.	Verified.
	(8) First stage telemetry and command destruct on internal power.	Verified.
T-4 min 25 sec	PHASE V	4 min 44 sec duration. Two minutes 26 sec required to provide proper chill-down of the vernier engine and to permit decay of the LOX tank top pressure to the maximum allowable level of 3 psi.
T-120 sec	(1) Orbital transfer to internal power.	Verified at T-1 min 49 sec.
T-110 sec	(2) Orbital stage destruct arm.	Verified.
T-110 sec	(3) Umbilical mast enabled.	Verified.
T-100 sec	(4) Umbilical release light on.	Verified.
T-90 sec	(5) Orbital stage timer and horizon scanner on.	Verified.
T-90 sec	(6) Transporter clear to fire.	Verified.
T-70 sec	(7) Timer motor on.	Verified.
T-60 sec	(8) Command guidance ready for launch.	Verified.
T-50 sec	(9) Turn on recorders.	Verified.
T-40 sec	(10) Main LOX tank pressure at 3 psia.	Verified.

Table 1. (Continued)

Nominal Time Before Liftoff	Test and Function	Performance Evaluation
T-30 sec	(11) LOX load resume.	Verified.
T-30 sec	(12) Main fuel tank pressure.	Ready for launch.
T-30 sec	(13) High speed recorders on.	Ready for launch.
T-20 sec	(14) Advise SSD/LC orbital stage ready.	Ready for launch.
T-20 sec	(15) Advise SSD/LC command guidance ready.	Ready for launch.
T-10 sec	(16) Air-conditioning off.	Verified.
T-10 sec	(17) Main LOX tank top pressure.	Ready for launch.
T-5 sec	(18) Turn all cameras on.	Verified.
T-0	LIFTOFF	Satisfactory liftoff occurred at 1535:00.46. The accelerometer data indicates normal transients. Launcher release, mast retraction, and Thor and Agena umbilical release times were normal and within specifications.

Agena umbilical release times were as follows:

(a) Fuel fill coupling: 0.18 sec (Photo)
(b) Fuel vent coupling: 0.15 sec (Landline)
(c) Acid fill coupling: 0.19 sec (Photo)
(d) Acid vent coupling: 0.195 sec (Photo)
(e) Helium fill coupling: 0.17 sec (Photo)
(f) Freon fill coupling: 0.18 sec (Photo)
(g) J-900 disconnect: 0.76 sec (Landline)
(h) J-100 disconnect: 0.17 - 0.18 (Landline)

Pad damage was not excessive and normal turnaround time is expected.

Table 1 Concluded

Table 2. Thor 322 Criteria and Performance Evaluation

Nominal Time From Liftoff (sec)	System and Function	Performance Evaluation
T-0	Propulsion and Autopilot. Liftoff and vertical climb for 17 sec. Zero time based on microswitch closure at nominal 1 in. of vertical motion. Thor sea level thrust: 167,000 (+3000 -7000)lb.	Propulsion system operation during the ignition and mainstage sequence was normal. Chamber pressure telemetry indicated that thrust was within tolerance limits. Immediately after liftoff, pitch-plane oscillations of approximately 0.3 cps occurred and became divergent in amplitude reaching a limit condition at T+15 sec.
T+2 to T+15	Autopilot. Roll about a vertical axis at a rate of 0.72936 deg/sec to a pitch plane azimuth of 172 deg.	The scheduled roll program was executed correctly. Roll-rate telemetry shows that the vehicle began its desired roll at T+2 sec and maintained the correct rate until T+15 sec. At approximately T+10 sec, rate-gyro telemetry for both yaw and roll begin to show oscillatory motion of the same frequency (0.3 cps), the result of cross-coupling between roll and pitch.
T+17 to T+130	Autopilot. Preset pitch program with a pitch command rate as follows: Time (sec) / Pitch Command Rate (deg/sec) 17-35 / -0.48753 35-70 / -0.64964 70-90 / -0.32304	The autopilot pitch program occurred at the correct time sequence and at the correct rates during the duration of gyro telemetry reception which ended at approximately T+60 sec. Vehicle instability which began at liftoff and became divergent, resulted in structural failure and fire at approximately T+60 sec, as observed by camera coverage. The film shows initial fire

Table 2. (Continued)

Nominal Time From Liftoff (sec)	System and Function	Performance Evaluation
T+17 to T+130 cont'd		in the Agena section at T+59.2 sec, and the entire vehicle enveloped in flames and crosswise to the direction of flight by T+72 sec. An explosion was observed at T+79 sec followed by the break-up of the vehicle with separate pieces emerging from the explosion cloud. Thor propulsion system telemetry indicates that vernier engine cutoff occurred essentially simultaneously with main engine cutoff at T+60 sec, coincident with vehicle structural failure. It is concluded that vehicle strains or failure caused an electrical interruption or grounding with resultant relay actuation and valve closure. Propulsion system telemetry continued until after MECO/VECO with LOX and fuel float switch actuation occurring intermittently until telemetry stopped abruptly at T+79 sec. The transmitter carrier continued to transmit until T+312 sec, approximately 100 sec later than impact time based upon tracking data. It is concluded that the telemetry components plus electrical power items remained afloat after impact for a significant period. A destruct signal was sent by Range Safety at T+94.9 sec with no discernible effect because of the previous complete break-up of the vehicle. The divergent pitch-plane oscillations, which began at liftoff and resulted in structural failure at T+60 sec, was

Table 2. (Continued)

Nominal Time From Liftoff (sec)	System and Function	Performance Evaluation
T+17 to T+130 cont'd		caused by an electrical malfunction in the pitch-rate loop, probably an open circuit in the shaping network.

Table 2 Concluded

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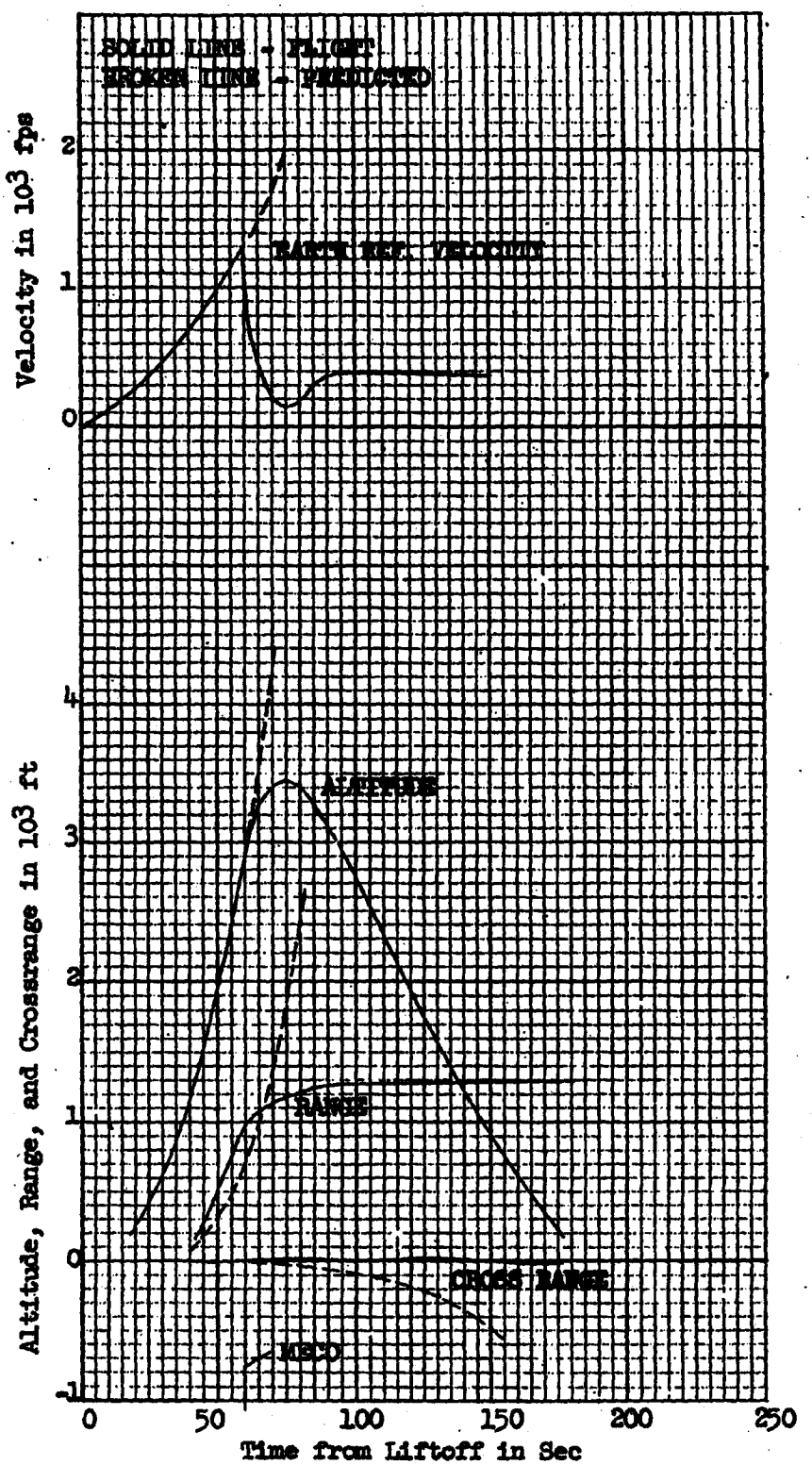

Fig. 1. Discoverer XXVII Velocity and Trajectory

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IV. THOR SYSTEMS ANALYSIS

A. GUIDANCE AND CONTROL

1. Command Guidance System

No malfunction was detected in the command guidance system performance. Functional operation of the equipment was normal until the missile-borne guidance equipment was damaged by vehicle break-up at T+59.70 sec. The nominal time for the earliest command guidance missile control function was T+90 sec.

2. Control System

Diverging rigid-body oscillations (0.3 cps) in pitch began at liftoff and continued until T+60 sec. They exceeded telemetry calibration levels at T+10 sec. The pitch rate gyro bottomed at T+16 sec.

Attitude loop gains, as measured in the first 10 sec of flight, were approximately 20 per cent higher than expected. Cross-coupled oscillations in yaw and roll reached maximum peak-to-peak amplitudes at T+30 sec. At that time gyro rates of 1.1 deg/sec in yaw and 1.4 deg/sec in roll and attitude errors of 0.8 deg in yaw and 0.6 deg in roll were recorded.

Calculations indicate an open circuit in the pitch rate loop. The gain and phase of the pitch rate signal out of the demodulator were proper; however, the signal was not present at the main engine pitch d-c amplifier. The loss of the damping signal caused the booster control system to become unstable at its rigid-body frequency.

For future flights, the series-connected 8-mfd capacitor in the rate shaping network and the 16-mfd capacitor/4.5-megohm resistor parallel combination in the engine feedback shaping network (Figure 2) will be removed. Their removal will simplify the circuitry and facilitate a more reliable checkout of the system. In addition, the shaping network boards will be modified and encapsulated to preclude malfunctions produced by vibration. A new procedure has been generated for verification of total loop response of the HIG and rate gyros.

[redacted]

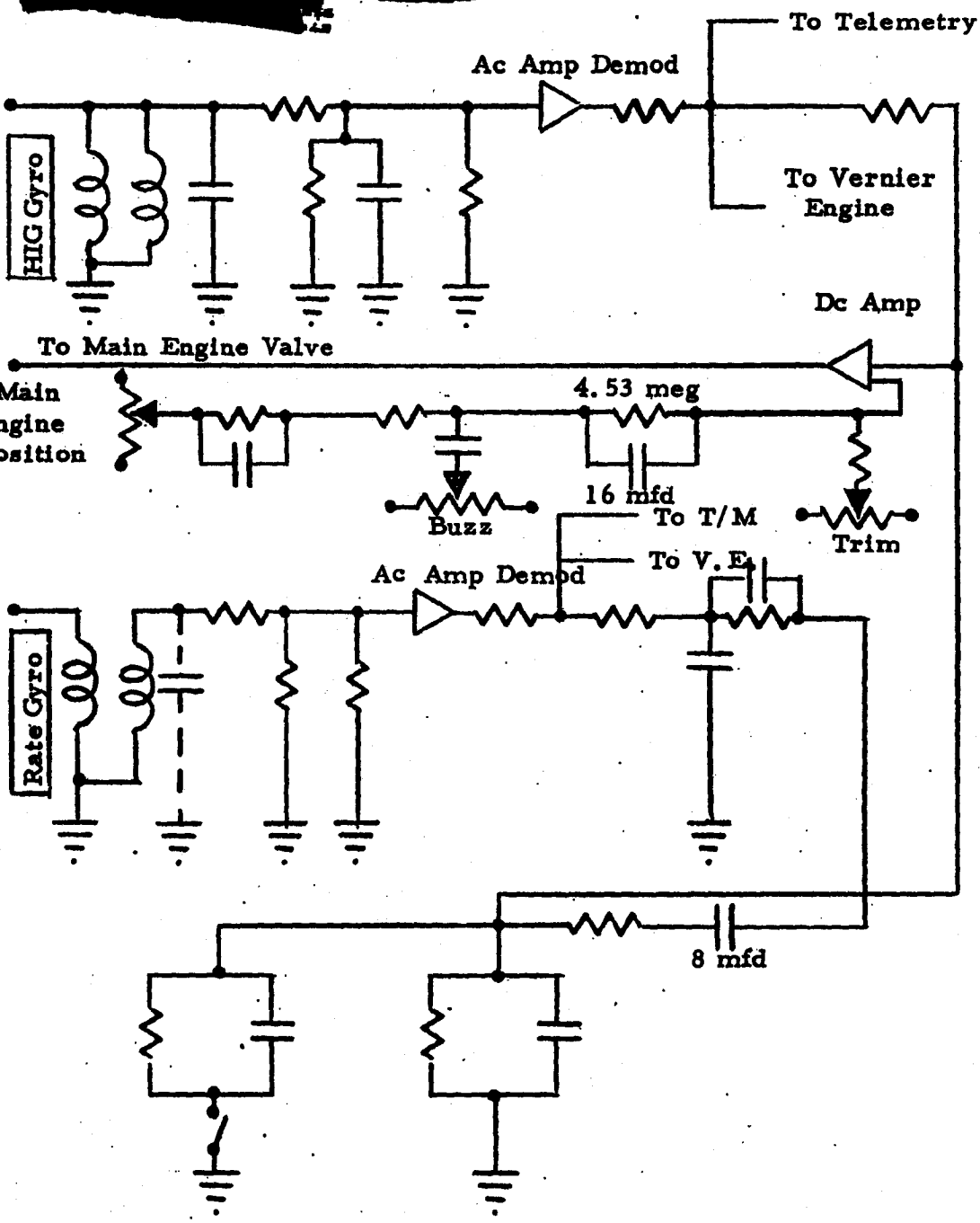

Fig. 2. Simplified Schematic Diagram of Thor Pitch Attitude and Rate Loops

[redacted]

[redacted]

All auxiliary shaping network assemblies at the Vandenberg Field Station (DAC) have been inspected for possible open or short circuits. The leads on several of the 8-mfd capacitors were of questionable reliability; one lead was cracked half-way through at the solder bend next to the capacitor.

B. PROPULSION SYSTEM

Propulsion system performance was normal during start, flight, and cutoff.

The 2-min hold at the beginning of Phase V of the terminal countdown succeeded in producing a normal buildup of vernier engine chamber pressure and, consequently, a normal start sequence. Direct observations, confirmed by photographic data, indicate that the amount of LOX bleed for vernier engine No. 2 was marginal despite the hold. The hold was not intended as a permanent procedure. In order to achieve optimum bleed rate in future launches, the LOX-fill-flow rate will be reduced. This reduction will provide a longer period during Phases IV and V for vernier-engine chilldown.

At T+59.71 sec, the engines were cut off by a vernier cutoff signal. Measurements of vernier engine chamber pressure confirm that VECO, which automatically commands MECO, was the initial event. Apparently the VECO wiring shorted to 28 v. Wiring from the VECO circuit to sequence of events telemetry apparently failed at the same time, since the VECO command was not indicated on the telemetry channel. A MECO command signal, of approximately 1/3 sec duration, was evident on the sequence channel. Transients in all propulsion system functions are typical of a command cutoff.

Measurements of fuel pump inlet pressure at cutoff indicate that the fuel tank was ruptured at VECO $\pm$0.3 sec.

C. ELECTRICAL POWER SYSTEM

The electrical power system functioned properly. The timing and rates of commands generated in the programmer were correct. Inverter phase-A voltage, actuator potentiometer positive and balance voltages, and guidance supply voltages were maintained at proper levels throughout the flight.

D. HYDRAULIC SYSTEM

Hydraulic pressures were maintained at satisfactory levels throughout the powered portion of the flight; hydraulic return pressure was slightly lower than normal, but it remained within tolerance until after engine shutdown. Oscillations in hydraulic return pressure paralleled engine movements during the period of powered flight. Data indicate no evidence of hydraulic fluid depletion.

Hydraulic return pressure decayed abnormally after T+62 sec. The significance of the behavior cannot be determined because of the unknown extent of vehicle breakup.

E. INSTRUMENTATION

Instrumentation equipment operated satisfactorily throughout the flight; data were returned for all guidance and control functions until T+59.9 sec. Propulsion and hydraulic system data continued until T+79.5 sec.

F. GROUND SUPPORT EQUIPMENT

The ground support equipment operated satisfactorily in the preparation and launch of the vehicle.

1. Fuel Computer

During phase IV of the terminal countdown, the fuel computer failed to order fine load at 97 per cent due to a high-speed computing relay malfunction.

2. Pad Damage

Pad damage was normal. Refurbishment can be accomplished within the normal turnaround schedule.

[redacted]

V. RANGE SUPPORT

A. METRIC OPTICS

Film prints were received from MOTU cameras located at Vandenberg AFB and Pt. Arguello and from an ME-16 camera located on Tranquillon Peak, Pt. Arguello. The MOTU coverage was limited to several seconds after liftoff because of a low overcast. The ME-16 coverage extends from the time that the vehicle breaks through the overcast until T+131 sec.

Events of possible significance and their times (±0.02 sec) taken from the ME-16 film print include (1) two bright flashes of light at T+59.15 sec and at T+59.58 sec, which appear to be sun glints off the Agena nose section area; (2) a fire, first visible at T+59.69 sec, apparently located near the Agena forward equipment rack but possibly in the Agena adapter section; (3) a visual indication of Thor MECO at T+59.85 sec, based on shortening of the flame; (4) flames that envelop the vehicle at approximately T+60.6 sec; (5) an explosive-appearing fire cloud which first starts to develop at T+78.67 sec; and (6) two large objects emerging from the explosive fire cloud at T+79.35 sec. The above observed events appear to correlate closely with vehicle events seen on telemetry, namely: (1) loss of Agena telemetry at T+59.61 sec; (2) MECO indications (T+59.71 sec from sequential events and T+59.88 sec from 70 per cent main engine chamber pressure); (3) loss of first stage guidance and control telemetry data at T+59.9 sec; and (4) complete loss of first stage telemetry signals at T+79.5 sec. Just prior to the Agena fire indication at T+59.69 sec, the film indicated that the vehicle was yawing at a considerable angle. This observed attitude correlates with the Agena normal accelerometer reading of -3.0 g at T+59.2 sec, and subsequent increase beyond telemetry bandwidth.

Tabular data in tangent plane coordinates were provided every 1/4 sec from T+3.3 sec to T+11.3 sec on the booster space position, velocity, velocity components, acceleration, and acceleration components. Tabular data on pitch and yaw were given every 1/4 sec from T+3.5 sec to T+8.5 sec and roll tabular data every 1/4 sec from T+2.0 sec to T+11.5 sec. The short duration of metric optical coverage was caused by a low overcast.

[redacted]

B. METRIC RADAR

Tabular data in tangent plane coordinates on the booster space position, velocity, velocity components, acceleration, and acceleration components were provided every 1/4 sec from T+27 sec to T+59.5 sec, based on trajectory data from FPS-16 radars on Tranquillon Peak, Pt. Arguello. Also provided were smoothed original tabular polar data for the Tranquillon Peak FPS-16 radar and polar tabular data transformed from the FPS-16 radar site to the Vandenberg Tracking Station VERLORT radar site.

Graphical plots of the optic-radar data were satisfactory.

C. PMR TELEMETRY

PMR tracking and recording of the first stage telemetry were generally satisfactory. Frequent data dropouts and noise of 1-sec or less duration occurred from T+36 sec until final loss of telemetry signal at T+79.5 sec. At T+59.6 sec, PAM telemetry traces of guidance parameters and command guidance functions went to zero while propulsion and hydraulic system parameters went to mid-band or stayed at their normal level until T+78.6 sec, dropping to zero level before T+79.5 sec. MECO was indicated at T+59.7 sec by the sequential events trace and at T+59.9 sec by 70 per cent chamber pressure criterion. Pitch oscillations drove the peak of the pitch rate signal out of band after T+10 sec.

D. MISSILE FLIGHT SAFETY

Tracking data were provided to Missile Flight Safety by COTAR, FPS-16 radar, MPS-19 radar, and by the FPN-33 electronic skyscreens. The optical skyscreens were operational but their coverage was limited by the low (700 ft to 1000 ft) cloud cover.

Operators of the optical trackers on Tranquillon Peak who were above the overcast reported that the vehicle was breaking up at T+62 sec. At T+65 sec the MPS-19 radar lost track on the Agena radar beacon. Because the vehicle was obviously out of control, the range safety officer transmitted the destruct system ARM command at T+93.6 sec and the vehicle DESTRUCT command at T+94.9 sec.

[redacted]

Available data indicate that the destruct charge may have been actuated at T+78.7 sec as a result of structural failure of the vehicle. No evidence of an explosion at the time of the destruct command was noted.

E. RADIATION INTERFERENCE CONTROL

The flight test radiation frequency bands were monitored for interfering radiation by PMR ground stations and airborne stations. The ground stations are located at Pt. Mugu, San Nicolas Island, and Pt. Arguello. The airborne stations were in two aircraft flying various flight paths between Paso Robles, Bakersfield, Palmdale, George AFB, Oceanside, Catalina Island, and Pt. Mugu at an altitude of approximately 15,000 ft. The monitoring reports for launch time were as follows:

FLIGHT TEST USE	FREQUENCY BAND (Mc/s)	MONITORING REPORT
Destruct Transmitter	414 to 418	Clear
Beacon Interrogation	2835 to 2865	Clear. Nearest adjacent signals were at 2830 Mc/s and at 2875 Mc/s.
Beacon Response	2910 to 2930	Clear
BTL Ground Transmitter	8525 to 8535	Clear
BTL Airborne Transmitter	9564 to 9575	Clear
Telemetering	227.2 to 247.3	Clear

F. METEOROLOGY

The surface weather conditions in the launch pad area at launch time were as follows:

Visibility	7 miles
Temperature	59 F
Relative Humidity	86%
Wind Direction	270 deg
Wind Speed	9 knots
Barometric Pressure	29.681 in. Hg (MSL)
Sky Cover	10/10. Broken cloud layer at 700 ft and overcast at 1000 ft.

Rawinsonde soundings were made before the launch and immediately after launch to determine the weather conditions at altitude. The post-launch sounding shows a maximum wind shear of 27.3 fps per 1000 ft at an altitude of 7500 ft and with a length of approximately 1000 ft.

G. ENGINEERING SEQUENTIAL PHOTOGRAPHY

Engineering sequential photographic coverage was satisfactory. Tracking cameras had short coverage because of a low overcast, however, first stage pitch oscillations were evident. Timing was missing on six cameras (Items 11.4, 11.12, 11.14, 11.15, 11.17, and 11.20). Items 11.11 to 11.13 (first stage engine ignition cameras) had a late start which was attributed to an abbreviated T-5 sec warning. Special project camera items were two airborne tracking cameras mounted in a C-47 circling at 6000 ft. Track was erratic and coverage of one camera very short but the films included the vehicle fire and self-destruct, supplementing the photographic record of the PMR ME-16 camera on Tranquillon Peak.

H. DOCUMENTARY PHOTOGRAPHY

Documentary photographic coverage was satisfactory. Tracking cameras had short track because of a low overcast.

APPENDIX A

GLOSSARY OF TECHNICAL TERMS

(1) Thor thrust attainment - The point in time at which the Thor main engine chamber pressure first reaches 90 per cent of its steady-state level.

(2) Liftoff - The time at which the 1000 cycle liftoff tone is first shown on the data records. The liftoff tone is triggered by a microswitch on the launcher which is actuated from 3/4 to 1-1/4 inch vertical movement of the Thor booster.

(3) Thor main engine cutoff (MECO) - The time at which the Thor main engine chamber pressure has dropped to 70 per cent of its steady-state level.

(4) Thor main engine operating time - The elapsed time between Thor thrust attainment and Thor main engine cutoff.

(5) Thor vernier engine cutoff (VECO) - The time at which the vernier engine chamber pressure has dropped to 70 per cent of its steady-state level.

(6) Start of separation sequence - The time at which the monitor records indicate reception of the separation command S3. The separation sequence includes thereafter the firing of the separation squibs and the retro-rockets, and the indication of relative motion by the separation monitor.

(7) End of separation - The time at which the separation monitor record assumes its new steady-state level.

(8) Orbital stage engine ignition - The time at which the main power relay closes.

(9) Orbital stage thrust attainment - The time at which the orbital stage engine chamber pressure first reaches 90 per cent of its steady-state level.

(10) Orbital stage engine cutoff - The time at which the orbital stage engine chamber pressure drops to 70 per cent of its steady-state level during the engine shutdown sequence.

APPENDIX A (Continued)

(11) Orbital stage engine operating time - The elapsed time between orbital stage engine ignition and orbital stage engine cutoff.

(12) Orbital stage thrust duration - The elapsed time between orbital stage thrust attainment and orbital stage engine cutoff.

(13) Beacon countdown - Failure of beacon to send a reply for each interrogation pulse code train transmitted.

(14) Agena velocity correction - The adjustment of the Agena velocity integrator setting accomplished through the guidance system command. The magnitude of the in-flight correction is derived from the recorded duration of the discrete command D1 and the correction scale factor.

(15) Timer hold command - The adjustment of the Agena timer braking time accomplished through the guidance system command for the purpose of delaying Agena engine ignition. The magnitude of the in-flight correction is the combined duration of discrete commands D1 and D2.

(16) Pad reference velocity - The missile velocity relative to the launching pad coordinate system.

(17) Inertial velocity - The missile velocity relative to non-rotating coordinates at the earth's center.

(18) Flight path elevation angle - The angle between the missile inertial velocity vector and a plane perpendicular to a line between the missile and the center of the earth.

(19) Sensible velocity gain - The time integral of longitudinal acceleration as sensed by an errorless accelerometer-integrator co-located with the longitudinal accelerometer.

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APPENDIX B

DISCOVERER 1110/322 WEIGHT BREAKDOWN

First Stage (Thor 322)	Liftoff Weight (lb)
1. Booster Dry Weight	6,573
2. Pressurization Gas	94
3. Trapped Propellants	395
4. Vernier Propellants	85
5. Lube Oil	127
6. Fuel in Main Tank	32,044
7. LOX in Main Tank	67,673
8. Orbital Stage Adapter	258
9. Retro-rockets and Attachments	10
10. Destruct Package	11
TOTAL FIRST STAGE WEIGHT (INCLUDING ADAPTER)	107,270
Orbital Stage (Agena 1110)	
1. Agena Dry Weight	2,285
2. Pyrotechnics	1
3. Control Gas (Nitrogen-Freon)	138
4. Helium	3
5. Fuel (UDMH)	3,762
6. Oxidizer (IRFNA)	9,529
TOTAL ORBITAL STAGE WEIGHT	15,718
TOTAL DISCOVERER LIFTOFF WEIGHT	122,988

[redacted]

APPENDIX C

THOR 322 PREPARATION HISTORY

DATE	EVENT
4-13-61	Received booster 322.
4-24-61	Began receiving inspection.
5-6-61	Completed receiving inspection. Began modifications.
5-12-61	Began pneumatic leak checks.
5-18-61	Began continuity checks.
5-30-61	Completed leak checks. Began control system checks. (Problems with flight controller and the telemetry package required trouble-shooting.)
6-8-61	Began instrumentation checks.
6-13-61	Accomplished final acceptance test. Completed control system checks.
6-20-61	Delivered booster to launch emplacement 4. Began indexing.
6-21-61	Completed mating.
6-22-61	Installed Rocketdyne kits. Began GSE simulator checks.
6-29-61	Completed GSE simulator checks. Began launcher checks. Checked azimuth and vertical alignment.
6-30-61	Completed launcher checks. Began missile leak checks.
7-3-61	Replaced the fuel start tank pressure switch. Began calibration of inflight transducers.
7-5-61	Removed and sent the flight controller to the electrical laboratory for trajectory change.
7-6-61	Completed calibration of the waveguide.
7-7-61	Began hydraulics checks.
7-11-61	Returned the flight controller from the electrical laboratory. Began electrical checks after the flight controller was installed. Completed leak checks and calibrations of inflight transducers.
7-12-61	Accomplished the all-systems test, completing electrical checkouts.
7-13-61	Completed guidance phasing and polarity checks. Completed a dry countdown. Discovered a malfunction in the fuel computer during a second day count; replaced the computer but it remained inaccurate. Began troubleshooting.

[redacted]

APPENDIX C (Continued)

DATE	EVENT
7-14-61	Repaired the fuel computer. Installed the telemetry package from booster 323 in place of the original package because of intermittent dropouts apparent in the all-systems test.
7-15-61	Completed successful LOX and simultaneous flow exercises. (In unloading from the simultaneous exercise, approximately 4000 gal of LOX were spilled into the LOX pit, the complex pit, and on adjacent areas. The No. 2 relief valve in the LOX main line froze open. Only superficial damage resulted.)
7-17-61	Completed R-4 preflight procedures.
7-18-61	Completed R-3 preflight procedures, except for the dry countdown which was re-scheduled for R-2 day.
7-19-61	Completed the R-3 dry countdown and R-2 preflight procedures.
7-20-61	Completed R-1 day preflight procedures.
7-21-61	Launched the vehicle on the first attempt.

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APPENDIX D

AGENA 1110 PREPARATION HISTORY

DATE	EVENT
6-28-61	Received vehicle 1110 at LMSC/VAFB Missile Assembly Building. Performed receiving inspection.
6-29-61	Performed SS/D validation checks.
6-30-61	Completed SS/D validation checks. Performed SS/B leak checks.
7-1-61	Performed SS/B leak checks.
7-2-61	No work scheduled.
7-3-61	Cleared SS/B leaks. Performed TIM calibrations.
7-4-61	No work scheduled.
7-5-61	Changed diplexer. Performed VSWR checks.
7-6-61	Performed TIM calibration. Re-ran VSWR checks due to multiplexer replacement.
7-7-61	Performed destruct checks.
7-8-61	Performed payload fit checks.
7-9-61	No work scheduled.
7-10-61	Transferred vehicle 1110 to complex 75-3, pad 4. Performed electrical compatibilities.
7-11-61	Performed SS/B checks. Performed Countdown and Flight System Check preparations.
7-12-61	Performed successfully Countdown and Flight System Check.
7-13-61	Performed umbilical drop tests.
7-14-61	Performed SS/B leak checks. Performed modifications.
7-15-61	Performed dual flows on the Thor booster (DAC).
7-16-61	No work scheduled.
7-17-61	Performed R-4 Day activities.
7-18-61	Performed R-3 Day activities.
7-19-61	Performed R-2 Day activities.
7-20-61	Performed R-1 Day activities.
7-21-61	Launched Discoverer 1110/322 from complex 75-3, pad 4 at 1535:00.46.

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APPENDIX E

PAD COUNTDOWN AND FLIGHT SYSTEM CHECK

The first and final countdown and flight systems check on Agena 1110 was performed on 12 July 1961.

Prior to the start of the countdown and flight systems check, the complex chief was notified that the payload would not be available until later in the day. In order to accelerate the completion of the check, a coordinated decision was made between SSD/VAFB, LMSC/Sunnyvale, and LMSC/VAFB that Phase II would be performed first and the simulator substituted in place of the payload. Due to this decision, Test Procedure 1412358, dated 10 July 1961, was performed with the following deletions and deviations for this portion of the check:

(1) Task 2A, Payload Mating -- All payload items deleted.
(2) Task 4A, RF Checkout -- Items 28, 30, 31, 32, 33, 34, 37, and 40 deleted.
(3) Task 12A, Payload Checkout -- Task deleted.
(4) Task 19A, Terminal Count -- Task deleted.
(5) Phase I -- Deleted.
(6) Preparation for Phase II -- Deleted.

The check was initiated at 1100 and proceeded normally through tasks 1A, 2A, 11A, 4A, 16A, 19A, and Phase II. This portion of the check was completed satisfactorily at 1327.

Post-test items 2, 5, 6, 8, 9, 10, 11, 12, 13, 14, and 15 were performed in order to return the vehicle to the proper configuration to perform Phase-I checkout.

Upon the arrival of the payload to the pad, the necessary payload preparations were made and the countdown and flight systems check was initiated at 1605.

The test procedure was performed as written for a Phase-I checkout except the following deletions:

[redacted]

APPENDIX E (Continued)

(1) Task 4A, RF Checkout -- Items 12 through 28, 42 through 72, and 76 through 87 were deleted.

(2) Task 19A, Terminal Count -- Items 17, 18, and 23 were deleted.

Tasks 1A, 2A, 11A, 4A, 12A, 19A, and Phase I were completed at 2326 with only minor problems arising.

Upon satisfactory completion of the post-test items, a successful countdown and flight systems check had been performed on Vehicle 1110.

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APPENDIX F

DISCOVERER LAUNCH DATA DIGEST

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DISCOVERER DESIGNATION AND REPORTS ISSUED NO.	VEHICLE SERIAL NUMBER	PAD NO.	LAUNCH DATE AND TIME (PST)	ORBITAL ACHIEVEMENT	CAPSULE TYPE AND RECOVERY	VEHICLE CHANGES INCORPORATED	FLIGHT DESCRIPTION	INJECTION AND ORBITAL PARAMETERS
System Test Report LMSD	1019/160	4	1-21-59	No	Simulated Capsule		Malfunction during countdown caused ullage rockets, retrorockets, separation bolts, and horizon scanner fairing to fire when hydraulic motor was turned on. Design problem. Launch was aborted.	
I LR# 280005) PAR# LMSD49	1022/163	4#	2-28-59 1349:16	Probable (Not confirmed)	Simulated Capsule (Recovery not programmed)	Hydraulic motor circuit separated from pyrotechnics circuit.	Injection angle - 1.7°, partially attributable to erratic hydraulic control at engine ignition. No telemetry or radar orbital contacts made. Questionable radio and radar contacts reported.	Azimuth: 182.8° Altitude: 18# nm Velocity: 25,600 fps REMARKS: Inclination: 89.96° Eccentricity: 0.046 Period: 96 min. Perigee: 99.3 nm Apogee: 605 nm
II LR 280009 PAR LMSD50	1018/170	4	4-13-59 1318:12	Yes	Biomedical Research (BMD) No	WRNN fuel incorporated. Horizon scanner active during engine burning phase, and gains altered to tighten control system.	Premature Agena engine shutdown by command — source unknown, but believed resulting from a main power relay malfunction. Orbit achieved, but inadvertent SS/S reset command caused loss of recovery timing. Capsule ejected, with re-entry over Spitsbergen.	Azimuth: 182.8° Altitude: 167.2 nm Velocity: 25,582 fps Inclination: 90° Eccentricity: 0.007 Period: 89.7 min. Perigee: 158 nm Apogee: 216 nm
III LR 280139 PAR LMSD51	1020/174	4	6-6-59 1209:21	No	BMD (Live payload)	Fairchild Timer Incorporated.	Premature Agena engine shutdown from either propellant interruption or exhaustion prevented vehicle reaching orbital velocity. Indicated cause — vortexing or sloshing of oxidizer within tank..	Azimuth: 182.8° Altitude: 165 nm Velocity: 24,950 fps
IV LR 280145 PAR LMSD52	1023/179	5	6-25-59 1347:16	No	Advanced Engineering Test (AET)	None.	Within tolerance but below nominal Thor and Agena engine performance; increased Agena payload to propellant ratio; and premature engine shutdown combined to prevent reaching orbital velocity. Integrator output incorrect. Umbilical mast failed to retract.	Azimuth: 177.3° (175° nom.) Altitude: 108 nm Velocity: 25,000 fps
V LR 280210 PAR LMSD53	1029/192	4	8-13-59 1100:08	Yes	AET No	Vehicle and payload weight reduced. Fuel slosh screens removed. Vortex suppressor installed. Propellant capacity increased. RJ-1 fuel used in Thor. Delta V increased to yield elliptical orbit and longer period.	Burnout due to propellant exhaustion. High propellant utilization. Capsule ejected but not recovered. Recovery sequence believed not accomplished due to extreme cold effects on Mercury battery. Capsule in orbit.	Azimuth: 169.8° Altitude: 138 nm Velocity: 25,890 fps Inclination: 82° Eccentricity: 0.0107 Period: 94.18 min. Perigee: 134 nm Apogee: 480 nm
VI LR 280218 PAR LMSD54	1028/200	5	8-19-59 1124:48	Yes	AET No	Paint removed from nose cap area to improve capsule thermal characteristics. Weight further reduced by 13 lb.	Integrator output low. Burnout resulted from propellant exhaustion. Transients during separation. Thor roll program set for incorrect azimuth heading. Capsule ejected but not recovered. Recovery sequence again believed not accomplished.	Azimuth: 175.6° (170° nom.) Altitude: 140 nm Velocity: 25,995 fps Inclination: 85° Eccentricity: 0.0160 Period: 95.27 min. Perigee: 137.2 nm Apogee: 533.9 nm
VII LR LMSD54-S1 PAR LMSD54-S1	1051/206	4	11-7-59 1220:41	Yes	AET No	Approximates FTV-1026, except as follows: horizon scanner installed with deeper depression angle (15.8°) to allow better control at Apogee. Modified capsule, i.e., telemetry installed; redesign of coupling between ablative shell and capsule; more reliable batteries; and thermostat for batteries. Sun position indicator device and instrumentation gyro installed to provide attitude data.	Separation slow. Agena propulsion and guidance satisfactory. After loss of telemetry 400-cycle power failed causing vehicle tumbling. Nitrogen supply gas exhausted prior to orbit 2 contact by Kaena Station. Capsule could not be ejected.	Azimuth: 172° Altitude: 105 nm Velocity: 26,345 fps Inclination: 81.6° Eccentricity: 0.019 Period: 94.65 min. Perigee: 102 nm Apogee: 525 nm
VIII LR LMSD56-S0 PAR LMSD56-S0	1050/212	5	11-20-59 1125:28	Yes	AET No	Similar to FTV-1051 with the exception that a counting circuit has been added to the 400-cps output in order to detect excessive overloads and/or inverter failure.	Accelerometer malfunction resulted in excessive velocity and eccentric orbit. Agena engine operated to propellant exhaustion. Erratic attitude during ullage rocket firing. Umbilical release defective. Apogee beyond horizon scanner capability. Extended period required capsule ejection on orbit 15. No beacon for recovery.	Azimuth: 172° Altitude: 120 nm Velocity: 26,090 fps Inclination: 80.8° Eccentricity: 0.102 Period: 103.7 min. Perigee: 115.2 nm Apogee: 1087 nm

• LR — Launch Report (WTR)
•• PAR — Performance Analysis Report (SV)

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APPENDIX F (Continued)

DISCOVERER DESIGNATION AND REPORT LMSD NO.	VEHICLE SERIAL NUMBER	PAD NO.	LAUNCH DATE AND TIME (PST)	ORBITAL ACHIEVEMENT	CAPSULE TYPE AND RECOVERY	VEHICLE CHANGES INCORPORATED	FLIGHT DESCRIPTION	INJECTION AND ORBITAL PARAMETERS
XI LR 447936-52 PAR ** 446840-52	1052/218	4	2-4-60 1051:45	No	Advanced Engineering Test (AET)	Similar to FTV-1050 with the exception of the following: a. AFL Doppler acquisition transition transmitter added. b. Two lights (Baker-Nunn) added for ground acquisition. c. Control gas mixture changed to provide total impulse of 2050 lb-sec instead of 1800 lb-sec.	Umbilical mast failed to retract. Helium coupler torn from Agena; No supply pressure lost. Thor, with MECO occurring 20 sec early, failed to reach boost velocity. Agena pitch actuator malfunction resulted in vehicle tumbling. Excessive g-loads caused Agena engine cutoff at 15.6 sec. Impact occurred about 400 nm downrange.	Azimuth: 173°
X LR 447936-53 PAR 446840-54	1054/223	5	2-19-60 1215:14	No	AET	Similar to FTV-1052.	A malfunction occurred in the Thor pitch control loop, causing the Discoverer vehicle to enter into a divergent pitch oscillation immediately after liftoff. The oscillation caused the vehicle trajectory to deviate. The vehicle was destroyed by Missile Flight Safety after 56 sec of flight.	Azimuth: 182° (171° intended)
XI LR 447936-55 PAR 446840-55	1055/234	5	4-15-60 1230:37	Yes	AET No	Similar to FTV-1052.	Liftoff and Thor boost normal. Agena engine cutoff premature due to error in calibration of command-6 integrator scale factor. The resulting approximately 1 min shorter than planned period did not affect recovery. Horizon-scanner transients during orbit. Failure to recover capsule attributed to spin deficiency.	Azimuth: 178° Altitude: 108.7 nm Velocity: 25,035 fps Inclination: 80.37° Eccentricity: 0.038 Period: 98 Perigee: 106.0 nm Apogee: 379.3 nm
XII LR 447936-57 PAR 446840-57	1057/231	5	6-29-60 1400:44	No	Magnetic No	Similar to FTV-1052.	Orbital injection not achieved due to an erratic horizon-scanner output. As a result, negative flight path angle caused the Agena to re-enter the atmosphere. Thor boost somewhat low in velocity and altitude. From 150 to 162 sec, 22-cps Thor oscillations occurred. A moment on the Agena after burnout indicated blocking of one oxidizer vent nullifier outlet.	Azimuth: 171.7° Altitude (max): 127.7 nm Altitude (BO): 104.7 nm Injection Angle: -7°
XIII LR 447936-57 PAR 446840-57	1057/231	5	8-10-60 1237:34	Yes	Magnetic Yes--first capsule recovery. Recovery made by helicopter at sea.	Vehicle weight reduced for heavier payload. AET equipment, AFL beacon, and optical tracking lights removed. Horizon scanner modified to reduce transient susceptibility. Gas jet system replaced spin rockets on payload.	Successful liftoff achieved on first countdown. Boost altitude high but within tolerance. Thor pitch plane oscillations after 134 sec attributed to pitch-rate feedback loop. A similar but lesser moment than with Agena 1053 (oxidizer vent nullifier problem) noted. All systems performed to launch, boost, and inject the Agena into near polar orbit under controlled attitude and in a condition suitable to effect recovery.	Azimuth: 174° Altitude: 160.2 nm Velocity: 25,706 fps Inclination: 82.81° Eccentricity: .0336 Period: 94.1 min Perigee: 137.7 nm Apogee: 436.1 nm
XIV LR 447936-56 PAR 446840-56	1056/237	4	8-18-60 1157:07	Yes	AET Yes--first successful air recovery	AFL beacon and optical tracking lights restored. Continued use of gas jet spin system on payload.	Liftoff on first countdown. Account trajectories, and injection velocity within specifications. Indicated attitude instability during orbital passes 1 and 2. Satellite stabilized by pass 8, sharply reducing control gas consumption. Capsule recovered 430 n.m. downrange from predicted impact area by C-119 aircraft.	Azimuth: 178.4° Altitude: 120.4 nm Velocity: 25,126 fps Inclination: 79.63° Eccentricity: 0.046 Period: 94.54 min Perigee: 119.1 nm Apogee: 507.5 nm
XV LR 447936-58 PAR 446840-58	1058/246	5	9-13-60 1413:39	Yes	AET No	Similar to FTV-1056	Launch successful on first countdown. Liftoff abnormal in that Agena umbilicals ejected before actual liftoff. Thor boost normal. Thor oscillation noted. Momentary drop in thrust following Agena engine ignition. Pneumatic attitude control system (gas jet) malfunction depleted control gas before recovery pass. Capsule located about 960 n.m. southeast of predicted impact point. Squall prevented sea recovery before capsule sank.	Azimuth: 175° Altitude: 131.4 nm Velocity: 25,015 fps Inclination: 80.9° Period: 94.2 min Perigee: 131.4 nm Apogee: 478.7 nm

* LR — Launch Report (WAFB)
** PAR — Performance Analysis Report (SV)

[redacted] APPENDIX F (Continued)

DISCOVERER DESIGNATION AND REPORTS LMSD NO.	VEHICLE SERIAL NUMBER	PAD NO.	LAUNCH DATE AND TIME (PST)	ORBITAL ACHIEVEMENT	CAPSULE TYPE AND RECOVERY	VEHICLE CHANGES INCORPORATED	FLIGHT DESCRIPTION	INJECTION AND ORBITAL PARAMETERS
XVI LR 445936-61 PAR 446840-61	1061/853	4	10-26-60 1836:03	No	AET	First Agena B (Model 6809)	Launch on second attempt. Inoperative D-timer prevented programming of Agena functions. No separation: combined Discoverer vehicle followed ballistic trajectory after Thor burnout. Thor vernier and main engines cutoff nearly simultaneously. Thor structural oscillations during final 13 sec of boost.	
XVII LR 445936-62 PAR 446840-62	1062/897	5	11-12-60 1842:38	Yes	AET Yes--air recovery	Similar to 1061 (Agena B)	Satisfactory launch after initial cancellation on previous day due to umbilical connector J-900 (D-timer) being separated from Agena when the transporter-erector was lowered. All systems performed to launch, boost, and injected the Agena into near polar orbit under controlled attitude and in a condition suitable to effect recovery. Capsule recovery by aircraft at predicted point of descent. Thor longitudinal oscillations prior to MECO similar to missiles 160, 846, and 853.	Azimuth: 172° Altitude: 118 nm Velocity: 25,870 fps Inclination: 81.6° Eccentricity: 0.056 Period: 96.45 min. Perigee: 116.5 nm Apogee: 616.1 nm
XVIII LR 445936-63 PAR 446840-63	1103/896	4	12-7-60 1820:59	Yes	AET Yes --air recovery	Agena B with 8096 engine (dual start--not used on this launch) Thor Block-E engine (165,000 lb thrust) used for first time with Discoverer.	Launch on first attempt. Liftoff and Thor boost normal. Higher amplitude longitudinal oscillations (3.5 g) than with previous vehicles. All Agena functions effected. Orbit close to that desired. Aerial capsule recovery after 48 passes (three days), the longest time in orbit before initialing recovery.	Azimuth: 172° Altitude: 156.9 nm Velocity: 25,860 Inclination: 81.49° Eccentricity: 0.0307 Period: 93.67 min Perigee: 152.8 nm Apogee: 437.3 nm
XIX LR 445936-01 PAR 446840-01	1101/898	5	12-20-60 1836:21	Yes	Midas Radiometer RM-1 Non-recoverable Capsule	Agena B with 8081 engine Thor with Block-A engine	Launch on second attempt. Liftoff and Thor boost normal. All Agena functions effected. Orbital boost satisfactory to obtain orbital status. Attitude control lost after orbital injection because of depletion of control gas, apparently due to a malfunction in the gas-valve control amplifier.	Azimuth: 172° Altitude: 134.2 nm Velocity: 25,890 fps Inclination: 83.5° Eccentricity: 0.033 Period: 98.9 min Perigee: 133.9 nm Apogee: 400.5 nm
XX LR 445936-04 PAR 446840-04	1104/898	4	2-17-61 1825:02	Yes	AET No	Agena B with 8096 engine (dual start not used) Thor Block II engine (165,000 lb thrust). Open loop test of RTL Guidance System. Scheduled 4 day active orbital life.	Launch on second attempt. Liftoff, Thor boost, and Agena boost satisfactory to obtain orbit but Agena guidance difficulties during boost and intermittent on orbit. Thor 17-21 cps longitudinal oscillation of about 1.5 g's prior to MECO. Orbital timer malfunction on pass 31 precluded recovery attempt.	Azimuth: 172° Altitude: 203.5 nm Velocity: 25,690 fps Inclination: 80.91° Eccentricity: 0.0366 Period: 99.31 min Perigee: 186 nm Apogee: 502 nm
XXI LR 445936-02 PAR 446840-02	1102/861	5	2-18-61 1A37:58.1	Yes	Non-recoverable radiometer	Agena B with 8096 engine equipped and programmed for first dual start.	Launched on first attempt. Lift-off and boost phase normal although oscillations were noted in accelerometer and booster propellant pressure data. Coast phase and orbital stage boost phase normal except for excess velocity gain. Orbit period and eccentricity were high as a result of the high injection velocity. Engine restart and operation for 1 sec during first pass was accomplished.	Azimuth: 171.6° Altitude: 127.3 nm Velocity: 26,010 fps Inclination: 80.7° after first burn 80.7° after second burn Eccentricity: .0383 after first burn .0389 after second burn Period: 93.9 min. after first burn 97.8 min. after second burn Perigee: 159 nm after second burn Apogee: 670 nm after second burn

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[redacted]

REDSTONE DESIGNATION AND REVISED LIKE NO.	VEHICLE SERIAL NUMBER	PAD NO.	LAUNCH DATE AND TIME (EST)	ORBITAL ACHIEVEMENT	CAPSULE TYPE AND RECOVERY	VEHICLE CHANGES INCORPORATED	FLIGHT DESCRIPTION	INJECTION AND ORBITAL PARAMETERS
XXII LR 649936-07 TAR 648580-07	1105/300	4	3-30-61 1234:43	No	AET	Agena B with 8096 engine (dual start not used). Thor with Block II engine and BTL guidance	Launch on first attempt. Lift-off and Thor boost normal. BTL guidance, actively used for the first time, successfully computed and transmitted Thor steering and sequence commands and discretes for Agena engine start and velocity cuts. Orbit not established due to control system malfunction -- loss of hydraulic pressure approximately 80 sec prior to engine shutdown. Resulting loss of altitude control caused erroneous injection velocity vector and possibly low injection velocity due to premature engine shutdown.	Azimuth: 172 deg
XXIII LR 649936-06 TAR 648580-06	1106/307	5	4-7-61 1121:07	Yes	AET No	Similar to XXII	Launch on first attempt. Liftoff, Thor boost, and Agena orbital injection were normal. Added instrumentation indicates that stress on Agena from 20-cps Thor oscillations is less severe than previously calculated. Between Pass 6 and Pass 7 the horizon scanner failed; between Pass 9 and Pass 10 control gas was suddenly lost. Capsule re-entry was not effected due to vehicle tumbling.	Azimuth: 172 deg Altitude: 159.8 n.m. Velocity: 25,660 fps Inclination: 32.3 deg Eccentricity: 0.005 Period: 94.1 Perigee: 109.5 n.m. Apogee: 436.6 n.m.
XXIV LR 649936-08	1108/308	4	6-8-61 1316:08	No	AET	Similar to XXII	Launch on first attempt. Agena transient voltage dropout just prior to liftoff, clearing with umbilical J-100 release. Thor boost and guidance normal. During boost, Agena aft section registered excessive heating starting at T+30 sec, indicating small fire; voltage transient dropout occurred from T+77.5 sec to T+87.3 sec and T+137 sec to T+144 sec; at T+144 sec telemetry was lost. Failure of the electrical power system, probably as a result of fire, prevented normal functioning of Agena subsystems, precluding orbital injection.	Azimuth: 172 deg
XXV LR 649936-07	1107/303	1	6-16-61 1302:52	Yes	AET Yes--sea recovery	Agena B. Thor DM21 with Block II main engine, Block I vernier engines.	Launch on first attempt and first launch from Complex 75-1, recently modified to Discoverer configuration. Technical hold -- 28.16 min. Liftoff normal. Thor executed largest roll program to date: 87°30'. Error in Thor first step of pitch program corrected by command guidance after steering commands initiated. All Agena subsystem operated properly to establish a near nominal orbit. Capsule ejection on 33 pass.	Azimuth: 172 deg Altitude: 180 n.m. Velocity: 25,649 fps Inclination: 32.1 deg Eccentricity: 0.014 Period: 90.87 min Perigee: 180 n.m. Apogee: 256 n.m.
XXVI LR 649936-09	1109/308	5	7-7-61 15:29:49	Yes	AET Yes--air recovery	Similar to XXV	Launch on first attempt. Thor thrust greater than predicted after slow engine start sequence. Agena coupling P-100 appeared to hang up on the vehicle at umbilical release with corresponding drop in battery-bus and regulated +28v powers. Greater Agena eccentricity and orbital period attributed to integrator error.	Azimuth: 172 deg Altitude: 146.8 n.m. Velocity: 25,000 fps Inclination: 82.96 deg Eccentricity: 0.042 Period: 93 min Perigee: 146.2 n.m. Apogee: 504.4 n.m.

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APPENDIX F (Continued)

DISCOVERER DESIGNATION AND LOCKHEED MTO NO.	VEHICLE SERIAL NUMBER	PAD NO.	LAUNCH DATE AND TIME (PST)	ORBITAL ACHIEVEMENT	CAPSULE TYPE AND RECOVERY	VEHICLE CHANGES INCORPORATED	FLIGHT DESCRIPTION	INJECTION AND ORBITAL PARAMETERS
XXVII SS 44.0[illegible]6-10	1110/322	4	21-7-61	No	A-T	Similar to XXV	Liftoff on first attempt. Immediately after liftoff, a malfunction in the Thor autopilot caused the vehicle to enter into divergent pitch accelerations. At T+9.2 sec, a -3 g moment which increased beyond calibration limit, was measured by the Agena accelerometer, starting destruction of the vehicle. At T+60 sec, the vehicle was enveloped in flame, and at T+78.7 sec the vehicle exploded. The cause of the malfunction is attributed to an open in the Thor flight controller pitch-rate loop.	