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FLIGHT TEST ENGINEERING ANALYSIS REPORT
FOR
THE HEXAGON PROGRAM SATELLITE VEHICLE NUMBER SEVEN (S)

Contract

Prepared and Submitted by the
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FOREWORD

This report describes the performance of the seventh HEXAGON Program Satellite Vehicle (SV-7). The vehicle was launched 10 November 1973, and after a 103 day primary mission and a 21 day Solo mission, was deboosted on Rev 1998 on 13 March 1974.

This report does not explicitly cover the Solo mission; however, results from Solo are used as appropriate when they contribute substantially to the understanding of primary mission events.

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SECTION I
SUMMARY

1.1 INTRODUCTION

The seventh HEXAGON Satellite Vehicle (SV-7) was placed into the nominal 88 X 154 nm orbit by the Titan IIID Booster on 10 November 1973. Ascent events were all nominal and proper stabilization of the SV allowed initiation of deployment of the Solar Arrays at the first station contact, INDI. [redacted] (+Y) was properly ejected on Rev 2. The SSU (-Y) Subsatellite was properly ejected on Rev 13. The Panoramic Camera operated throughout the mission and its RVs were aerially recovered on Revs 229, 602, 1039, and 1656, which occurred on Mission Days 15, 38, 65 and 103. All of the film was transported into the RVs including 5010 feet of SO 255 color film in RV-1. A metering capstan resonance at peak Vx/h values was determined to be affecting the image quality during Post Flight Analysis (PFA) on RV-1 and the perigee altitude was raised two miles by OA 8 on Rev 289. All other Panoramic Camera operations were normal. All the Mapping Camera operations were normal and 98.4 percent of the film was transported to RV-5 which was aerially recovered on Rev 942. Solo tests were completed and the SV was deorbited on Rev 1998 (during Mission Day 124).

SECTION II
MISSION OVERVIEW

2.1 PREFLIGHT PLANNING

Mission 1207 represents the first of the HEXAGON Block II Vehicles and panoramic camera systems. Soft seat RCS Valves were provided and because of their expected leak free performance, RCS fuel was to be drawn from RCS Tanks 1 and 2 (3 and 4 were removed) before using the OA Tank. The OA Tank was loaded with 3200 pounds of fuel. The panoramic camera system deleted the antitelescope cage of the supply unit and was instrumented to monitor the SU response during launch.

2.2 PREFLIGHT CONSTRAINTS

The Mission 1207 orbit was designed to:

A. Maintain solar angle (Beta) within +2° to -8° for the planned 90 days.

B. Have orbit adjusts to occur on a three-day cycle with every third OA to be a positive and negative burn for close control of argument of perigee.

2.2.1 Panoramic Camera System Constraints

The following were the constraints imposed on the panoramic cameras:

A. Rewind velocity limited to 5 inches/second.

B. No 120° scans.

C. No 30° scans at ±45° scan centers.

2.3 LAUNCH BASE

The SV was delivered to the launch pad and mated to the BV on 25 October 1973. The vehicle was launched on 10 November 1973, at 1210:00.45 PST at the opening of the launch window.

2.4 ASCENT

The BV successfully injected the SV into an 88.67 X 154.40 nm orbit. The achieved orbit was close to nominal with the deviations shown as follows:

Apogee Altitude (nm)	+0.442
Perigee Altitude (nm)	+0.476
Period (second)	-0.42
Eccentricity	-0.000290
Argument of Perigee (degrees)	-4.6
Inclination (degree)	+0.028

2.5 ORBIT AND RECOVERY

2.5.1 1207-1 (Fourteen Days Duration)

Solar Array deployment was executed over INDI on Rev 1 with normal deployment and erection. At KODI Rev 1 the Solar Arrays were repositioned from +18 to 0°. [redacted] was ejected on Rev 2 and the SSU Subsatellite was ejected on Rev 13. The DBS Antenna was deployed on Rev 12.

Operational photography began on Rev 5 following successful completion of constant velocity and health checks. An unexplained telemetry loss during a portion of the health checks on Rev 3 precluded verification of OOAA nominal setting execution then but these commands were reissued and verified on Rev 5. Normal operation was exhibited throughout this segment. Approximately 29,000 feet of forward-looking camera film and 27,400 feet of aft-looking camera film (including 5,010 feet of SO-255 color film) were exposed and stowed in RV 1 (values include prelaunch footage on take-up).

Post-flight analysis (PFA) of the recovered film showed the overall quality of the acquired photography to range from very good to fair with the majority rated as good. Exposure reduction and OOAA in-track smear adjustments of the aft-looking camera were established and a forward-looking camera metering capstan resonance at peak Vx/h values affecting image quality was identified. A recommendation was made to raise orbit perigee altitude to avoid the troublesome region and thereby improve image quality.

RV-1 loaded to 100% of capacity was successfully reentered and aerially recovered on Rev 229 (Day 15).

2.5.2 1207-2 (Twenty-Three Days Duration)

Normal operational photography continued throughout this segment. PFA recommended aft-looking camera OOAA and exposure adjustments were made on Revs 282 and 285 respectively while the perigee adjustment recommended for the forward-looking camera metering capstan resonance was made on Rev 289. Approximately 26,000 feet of film per camera were exposed and stowed in RV-2. PFA showed overall quality of acquired photography to range from very good to poor with the majority rated as fair. This general decrease was attributed to increasing haze and to decreasing illumination and contrast in the northern latitudes.

RV-2 loaded to 88.5% capacity was successfully reentered and aerially recovered on Rev 602 (Day 38).

2.5.3 1207-3 (Twenty-Seven Days Duration)

Normal photographic operation continued throughout this segment. Approximately 29,000 feet of film per camera were exposed and stowed in RV-3. PFA showed overall quality of acquired photography to range from good to poor but with the majority still rated fair. Generally poor weather and snow cover were additional factors contributing to lower quality. A "U" shaped tear was found on one frame of aft-looking camera film. The review of telemetry showed only slight disturbances in the coarse film path at this point and good imagery on this frame made it appear that the tear occurred after exposure but there was no conclusive evidence of the source or reason for the tear.

RV-3 loaded to 99.3% capacity was successfully reentered and aerially recovered on Rev 1039 (Day 65).

2.5.4 1207-4 (Thirty-Eight Days Duration)

Normal photographic operation continued through this final segment. Approximately 23,400 feet of film per camera were exposed and stowed in RV-4. PFA showed overall quality of acquired photography to range from good to poor with the majority rated as fair. A large portion of this segment's photography was significantly better than that of the previous segments because of more low latitude acquisitions and improved weather conditions. Poor weather and poor illumination were the causes of low quality rather than system degradation with life.

RV-4 loaded to 80.4% capacity was successfully reentered and aerially recovered on Rev 1656 (Day 103). Some parachute cone damage occurred and one suspension line was broken.

2.5.5 1207-5 (Fifty-Eight Days Duration)

The performance of both the Stellar and Terrain cameras was judged successful and only a minor light leak in the Stellar Chute detracted from an otherwise excellent ST mission. A puncture in an aft Stellar Chute section resulted in superimposed imagery (pin hole camera effect) of PMS equipment on one Stellar frame pair of each operation. Weather conditions were fair to good and 71% of the photography was 90% cloud free. Exposure levels for photography acquired on this mission were within the accuracy of the exposure algorithm and no changes are recommended for Mission 1208. The results obtained using 3414 film in the Terrain Camera were excellent. Exposure levels were correct and the increase in performance noted on the small sampling confirmed the optimism toward using 3414 as the primary film load for Mission 1209 Terrain Camera.

2102 Terrain frames and a corresponding number of Stellar frame pairs were exposed in the ST System. Included in these frames were 18 frames on 3414 film and 15 frames exposed for in-flight starfield calibration.

Photography of the Comet Kohoutek was planned to follow the calibration; however, on the first frame the film left the supply unit and mistracking probably occurred due to the lack of supply tension. This resulted in stalling the terrain camera transport system. The cut and seal operation (part of the recovery sequence) separated the tag end since the system could not complete the film runout. After the RV-5 was ejected, the system was run using the backup mode. No corrective action is contemplated for MCM 4

(SV-8). Possible future action will be to increase the length of the tag end to assure that all the calibrate material is recovered.

The ST-RV was successfully reentered and aerially recovered on Rev 942 (Day 59) with 98.4% of the predicted film weight in the RV.

2.6 ANOMALY SUMMARY

Significant anomalies are listed chronologically in Table 2-1. The list includes a brief description of the anomaly and its effect on the mission. A more detailed discussion can be obtained in the reference paragraphs.

TABLE 2-1

SUMMARY OF ANOMALIES

DAY	DESCRIPTION	IMPACT	REFERENCE PARAGRAPH
15	Solar Array Leg 1 reduced output by 1/2 panel on Rev 232.	No mission impact. Attributed to break in solder connection. Jumper wires added to SV-8 and up.	3.6.1
18	Forward camera metering capstan resonance at peak Vx/h	RV-1 PFA identified problem. Perigee raised 2 nm on Rev 289.	4.1.2
31	Solar Array Leg 2 reduced output by 1 panel on Rev 495.	No mission impact. Similar to Solar Array Leg 1 incident.	3.6.1
58	Light leak in Stellar chute section of MCM.	Superimposed image. Cause unknown. Will increase inspection and sealing.	2.5.5
65	PFA on RV-3 revealed tear in film.	No mission impact. Cause of tear unknown.	4.1.1
89	Horizon Sensor Inhibit as result of incomplete yaw reverse. Failure to VBE allowed OA to occur.	OA 38 only partially effective. OA 39 needed to lower perigee on Rev 1447. See reference paragraph.	3.2.6
103	RV-4 missing one VHF Antenna.	No loss in data. Reason and time of loss unknown. No action contemplated.	5.3
103	RV-4 Main Battery vented electrolyte during shipment.	No mission impact. Corrective action in process.	5.3

SECTION III
SATELLITE BASIC ASSEMBLY SUBSYSTEMS

3.1 INTRODUCTION

The following paragraphs summarize those requirements from the Satellite Basic Assembly (SBA) subsystems that could be verified from flight data.

3.2 ATTITUDE CONTROL SYSTEM (ACS)

The ACS performed as expected with the exception of a yaw maneuver attempted with low force level thrusters which is discussed in Paragraph 3.2.6.

3.2.1 BV/SV Separation

BV/SV separation was completed at approximately 534.5 seconds vehicle time (vehicle time started 67.21 seconds prior to liftoff). Master Clear Off, which enables the pitch, roll and yaw integrators to accumulate angle, was at 510.8 seconds and SECO, which terminates BV attitude control, occurred at 522.5 seconds vehicle time. The SV attitude changes from SECO to BV/SV separation and the attitude and rates as measured at BV/SV separation are shown in Table 3-1. This table also presents the times in which the SV attitudes and rates came back within the specified limits following BV/SV separation (capture).

3.2.2 Subsatellite/SV Separation

The Subsatellite/SV separation events of Rev 13 were as follows:

Event	Vehicle Time
Start Neg Yaw Man	70220.4 sec
Stop Yaw	70253.8 sec
Separation	70313.6 sec
Start Pos Yaw Man	70330.8 sec
Stop Yaw	70364.2 sec

TABLE 3-1

BOOSTER VEHICLE/SATELLITE VEHICLE (BV/SV) SEPARATION

Axes	RATE AND ATTITUDE AT BV/SV SEPARATION						CAPTURE			
	RATE (deg/sec)		ATTITUDE (DEGREES)				ATTITUDE		RATE	
			H/S at Sep		Δ (SECO to Sep)					
	Spec	Actual	Spec	Actual	Spec	Actual (5) H/S/ Integrator	Spec (1) (deg)	Actual (2) (Time in Sec)	Specified (3) (deg/sec)	Actual (4) (Time in Sec)
Pitch	±0.752	-0.109	+13.0 to -21.7	+0.77	±3.5	-0.01/-0.52	±0.70	(6)	±0.014	(6)
Roll	±0.786	-0.193	±10.6	+3.92	±3.5	1.12/1.81	±0.70	(6)	±0.021	(6)
Yaw	±0.752	+0.131	+11.1 to -11.4	---	+4.5 to -3.5	---/3.46	±0.64	(6)	±0.014	(6)

(1) Attitude in degrees to be achieved in 1500 seconds.

(2) Actual time required to achieve specified attitude (switch to fine mode plus settling time).

(3) Rate in degrees/second to be achieved in 1500 seconds.

(4) Actual time required to achieve specified rate.

(5) Relative to the local horizontal.

(6) Normal performance indicating the pointing requirements are satisfied was observed at a nominal settling time of 520 seconds after the commanded switch to fine mode (672 seconds after separation). The total 1192 seconds is well within the spec of 1500 seconds and no closer study was performed.

The ACS parameters just prior to the instant of separation (70313.6 seconds vehicle time) are presented in Table 3-2.

TABLE 3-2

RATE AND ATTITUDE PARAMETERS AT SUBSATELLITE SEPARATION

PARAMETER	SPECIFIED	ACTUAL
Pitch H/S	±1.0 deg	+0.23 deg
Roll H/S	±1.0 deg	-0.70 deg
Roll Integrator	---	-0.17 deg
Yaw Integrator	---	-0.14 deg
Pitch Integrator	---	+0.29 deg
Yaw Attitude	(-23.5 deg desired)	
Pitch Gyro Rate (1)	±0.1 deg/sec	-0.06 deg/sec
Roll Gyro Rate	±0.1 deg/sec	+0.03 deg/sec
Yaw Gyro Rate	±0.1 deg/sec	0
Maximum rates following separation:		
Pitch Gyro Rate (1)		-0.09 deg/sec
Roll Gyro Rate		+0.21 deg/sec
Yaw Gyro Rate		+0.08 deg/sec

3.2.3 Payload Operations

[redacted]

3.2.4 Mapping Camera Module (MCM) Operations

3.2.4.1 MCM Calibration Maneuvers

The calibration maneuver on Rev 936 consisted of yawing the SV 180 degrees, then pitching down 142.0 deg followed by an inertial period for the calibration. Geocentric rate was then connected and disconnected an additional time to provide a total of two pitch attitudes for MCM calibrations. The second pitch attitude was 154.1 degrees. The vehicle was pitched back to local horizontal and yawed 180 degrees to nose forward geocentric control. The pitch attitude as measured with the H/S upon returning to nose forward horizontal flight was -0.56 degrees, indicating successful execution of the calibration sequence.

Table 3-3 presents the two calibrations. The settling time for Cal 1 is the time from initiation of the pitch down maneuver to the start of Frame 1. The settling time for Cal 2 is the time from the removal of geocentric rate to the start of Frame 1.

3.2.4.2 MCM Recovery

The ST-RV (RV-5) recovery is performed with the SV yawed 180 degrees and pitched down, with the release taking place along the SV X-Axis. The vehicle rate and attitude parameters at RV-5 separation (Vehicle Time 825231.8 on Rev 942) are listed in Table 3-4.

3.2.5 Recovery

The pitch down maneuvers preceding RV-1 through RV-4 separations were all within specification and are summarized in Table 3-5. The RV separation performance summary is shown in Table 3-6. It appears that the RV-4 separation impulse may have been in excess of the 166 lb-sec specification limit.

3.2.6 Unsuccessful Yaw Maneuver for OA 38

Although the thrust of REA 1 had reached a value below that recommended for continued use (the mini yaw maneuver on Rev 1395 had shown a value of 0.97 lbf), the vehicle was still being controlled within specification. In the desire to extend the use of RCS 1 to the maximum and since no danger to the vehicle was involved, it was decided to execute the yaw around maneuver for OA 38 on RCS 1. To avoid a long continuous on burn with expected further deterioration of the thruster, the vehicle was commanded to yaw reverse by gyrocompassing on Rev 1441. Gyrocompassing pulses the thrusters and past studies indicated that the maneuver times should be independent of the thrust level of the thrusters. At Rev 1442 POGO the Roll Horizon Sensor (H/S) outputs were observed to be inhibited on both PACS and RACS. The continued presence of the pitch H/S output indicated a single head inhibit had occurred.

TABLE 3-3

MAXIMUM VEHICLE RATES DURING MCM CALIBRATION

Calibration	Duration ST+ to ST- (sec)	Vehicle Time at Frame 1 (sec)	Settling Time (sec)	MAXIMUM VEHICLE RATES DURING CALIBRATION (DEG/SEC)		
				Pitch	Roll	Yaw
1	160	791234.506	339.3	0.006	0.009	-0.002
2	240	791706.796	11.6	0.008	-0.007	0.001
Specified	Not to Exceed 300	---	600 Allowed	±0.014	±0.021	±0.014

TABLE 3-4

RATE AND ATTITUDE PARAMETERS AT RV-5 SEPARATION

Axes	Attitude (degrees)	Source	Rate (degrees/second)
Pitch	-62.7	PDWN	+0.069 (includes Geocentric Program Rate)
Roll	+ 0.08	H/S	-0.001
Yaw	- 0.13	Integrator	-0.001

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TABLE 3-5

PITCH DOWN PERFORMANCE PRECEDING RECOVERY VEHICLE SEPARATION

RV/Rev	PITCH DOWN ANGLE		MANEUVERING TIME TO ≤ 0.1 DEG/SEC		PITCH DOWN COAST RATE		
	Desired ±3.0 deg	Actual (PDWN)	Spec (sec)	Actual (Sec)	Command Rate (Deg/Sec)	Coast Rate Expected (Deg/Sec)	Coast Rate Actual - PGR (Deg/Sec)
1/229	-34.5	-33.8	150	79	-0.705	-0.75 ±0.05	-0.71
2/602	-38.6	-37.5	150	92	-0.705	-0.75 ±0.05	-0.68
3/1039	-39.9	-40.6	150	86	-0.705	-0.75 ±0.05	-0.71
4/1656	-38.4	-37.4	150	84	-0.705	-0.75 ±0.05	-0.71

TABLE 3-6

SUMMARY OF RV/SV SEPARATION PERFORMANCE

RV/Rev	Peak Pitch Rate (deg/sec)	Max. Pitch Integrator Angle (degrees)	Induced Impulse By RV (lb-sec)	Pitch Down Prior to Sep (deg)	Pitch Up Following RV Sep to Removal of Manvr Cmd (deg)	Pitch Inertia (slug-ft^2)	Pitch Thruster Moment Arm (ft)	ROLL ANGLE	
								Spec (deg)	Meas H/S (deg)
1/229	1.39	5.2	129	-33.8	98.3	143112	16.4	±1.0	-0.06
2/602	1.37	5.6	133	-37.5	100.1	121872	15.9	±1.0	-0.20
3/1039	1.51	8.4	140	-40.6	99.4	93916	14.6	±1.0	-0.08
4/1656	1.40	9.2	169	-37.4	35.7	84455	14.5	±1.0	+0.12

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Attempts to VBE the negative OA and subsequent yaw forward failed. These commands were in PMU A, whereas VBE of PMU B was executed. There was insufficient time remaining before station fade to send VBE of PMU A.

On Rev 1443 POGO following the negative OA and yaw forward, the vehicle was stable and flying nose forward (no H/S inhibit).

Evaluation of playback data from Rev 1442 POGO (recorded on Rev 1441) showed that the H/S inhibit occurred during the fine mode portion of the yaw reverse.

Due to the longer than anticipated time to reach the gyrocompassing coast rate of 0.19 deg/sec (coarse mode PWM saturation limit) the 2500 second coarse mode gyrocompassing period was insufficient to complete the major portion of the 180 degree maneuver.

The observed time to reach coast rate (2200 seconds) was approximately 600 seconds longer than expected from previous analyses. This time comparison assumes an initial yaw error of 0.1 degree, whereas the actual error is unknown.

Since the time to reach coast rate is dependent upon the magnitude of the initial error, it is uncertain as to whether the unexpectedly long time to reach coast rate was because of a small initial error, or a combination of low and unbalanced thrust levels from RCS 1. Subsequent gyrocompassing computer simulations indicate a definite dependence of time to coast rate on the thruster force levels and thruster imbalance observed on SV-7. Results of these simulations will be summarized along with the post RV 4 gyrocompassing tests in the Solo report.

When the ACS was switched from coarse to fine mode, the roll gyro was sensing an orbital rate component of approximately -0.06 deg/second. This is beyond the 0.021 deg/sec PWM saturation limit in fine mode. Thus, the SV roll attitude increased in a positive direction until H/S inhibit occurred, (approximately 12 degrees), resulting in a tumble. Subsequent orbit evaluation revealed an approximate vehicle attitude of -28.7 deg in pitch and 148.0 deg in yaw at the time of the OA burn.

After OA 38 while the SV was gyrocompassing back to nose forward attitude, the H/S reacquired the earth and completed the gyrocompassing maneuver within the expected time. The direction of yaw for the return was in the negative yaw direction. The direction of gyrocompassing is dependent upon the polarity of the initial error signal. Following this maneuver, the vehicle was in the normal nose forward attitude at Rev 1443 POGO. An M1V1 to M2V2 transfer was executed on Rev 1447 with M1 remaining on.

As a result of this anomaly, no changes are contemplated in the vehicle or command sequences since no standard sequence will be established for gyrocompassing. Time for the coarse mode portion of any future use of this maneuver will be selected utilizing the results of the study of this anomaly. The ACS operation was normal.

3.3 REACTION CONTROL SYSTEM (RCS)

3.3.1 Flight Summary

SV-7 was the first vehicle with a complete set of soft seat valves for the thrusters and propellant for the RCS was drawn only from the small RCS Tanks for the first 1013 revs. With the hard seat valves used on SV-1 through SV-6, it was proven that non-volatile residues (NVR) from fuel stored in the RCS Tanks would eventually cause the valves to leak. No leaks were observed on SV-7. On Rev 1013, Isolation Valve 2 was opened connecting RCS Tanks 1 and 2 (3 and 4 were not installed) to the OAS Tank and RCS propellant was drawn directly from the OA Tank.

RCS flight history is shown in Figure 3-1. The Primary Reaction Control System (RCS 1) was used through Rev 1449 (Day 90) when control was switched to the standby system (RCS 2). Switch to RCS 2 was occasioned by the unsuccessful yaw maneuver on Rev 1442 as discussed in Paragraph 3.2.6.

The REA and REM temperatures have been closely watched in the past to signal RCS leaks. As seen in Figure 3-1, the temperature levels for SV-7 remained constant throughout the flight.

3.3.2 Propellant Consumption

Since SV-7 was the first vehicle to be leak free operating off the small RCS Tanks, it was possible for the first time to get an accurate average daily consumption rate. Over the first 1000 revs, propellant consumption averaged 2.6 lb/day. As far as could be determined with the less accurate measurements when the OA Tank was connected, the rate remained constant until Solo when the duty cycle changed.

3.3.3 Thruster Performance

Thrust levels were determined using the individual REA chamber pressures with the exception of REA 1 where thrust was determined from gyro data. Figure 3-2 is a plot of the normalized thrust over the mission life. The dashed lines are the ±8 percent run to run tolerance allowed per specification. As can be seen all of the yaw thrusters and the two low activity pitch roll thrusters degraded while the active Thrusters 3 and 7 remained healthy throughout flight. All REA duty cycles were slightly lower than previously experienced.

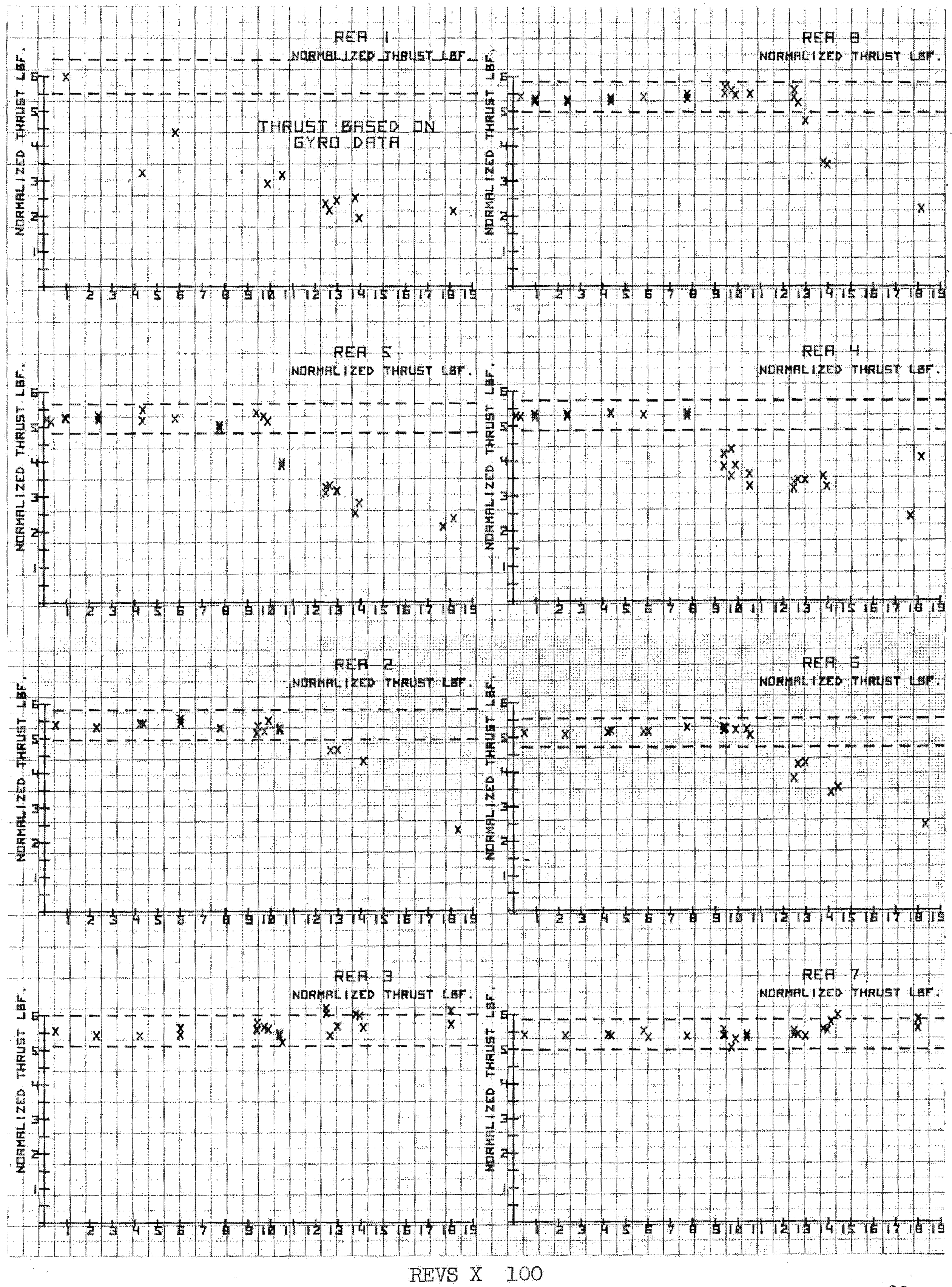


Figure 3-2
Normalized Thrust History

Total pulse count for RCS 1 through Rev 1449 is shown in Figure 3-3. The method used to determine pulse count was checked during Solo by comparing continuous record sequences with the sampling system used for Figure 3-3. For the high duty REAs 3 and 7, the accuracy is ±30%; for the other thrusters, the technique does not give an accurate count and can be used only to verify the thruster has a low duty cycle.

3.4 ORBIT ADJUST SYSTEM (OAS)

3.4.1 Orbit Control

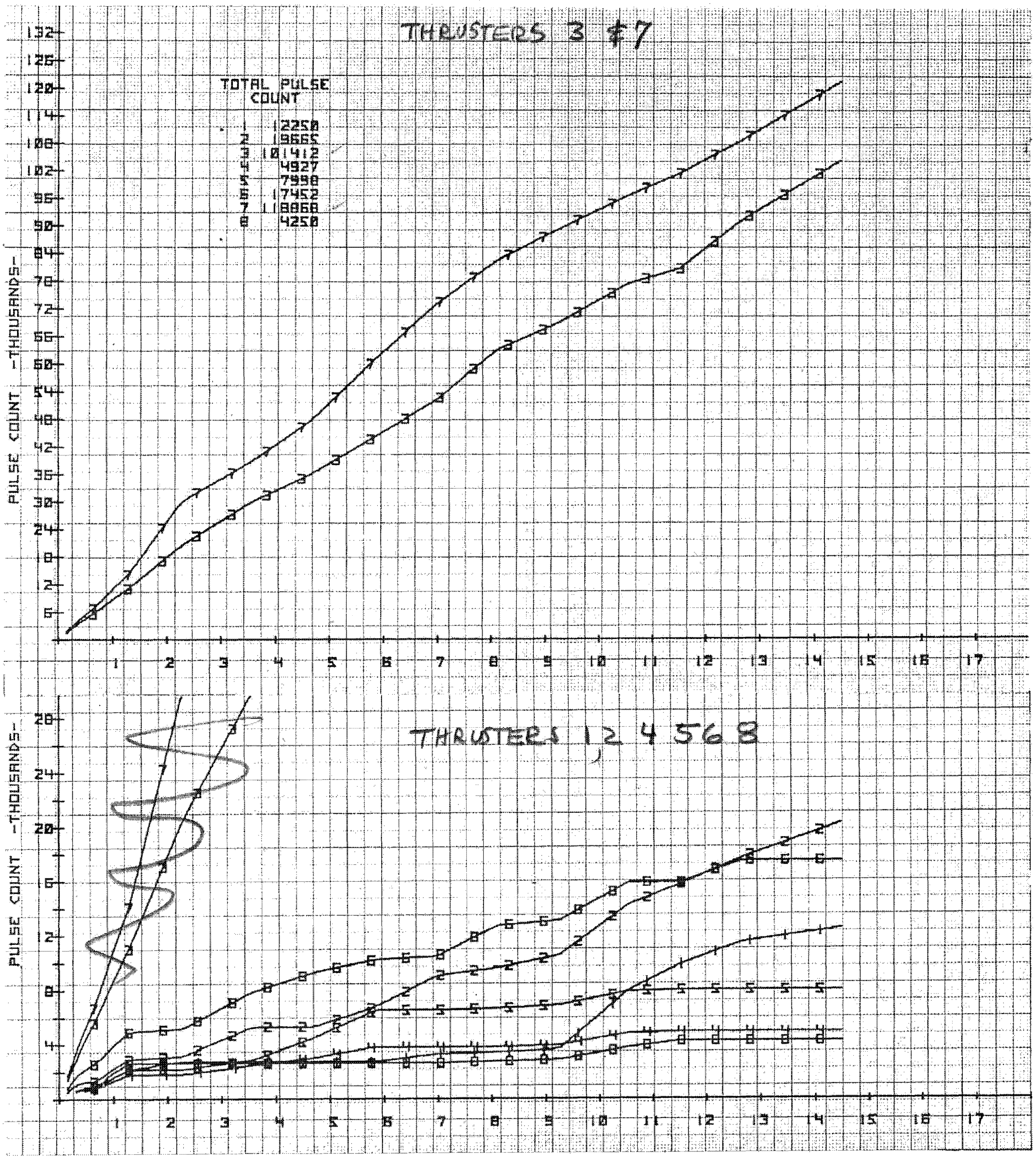
The OAS was utilized 43 times during the active mission and 21 times during the Solo phase.

The OA firings were all normal and engine performance was well within specifications. Because of the uncompleted yaw reverse maneuver discussed in Paragraph 3.2.6 the vehicle was yawed 148.0 degrees and pitched -28.7 degrees at the time of burn for OA 38. This resulted in the ΔV shown in Table 3-7 whereas the burn actually produced a ΔV of -17.15 fps along the vehicle X Axis which is within 4% of the planned. This burn should have been prevented by the VBE which was sent to the wrong PMU.

Catalyst bed pressure drop exhibited an early gradual decline; however, it subsequently stabilized at approximately 15 psi.

3.4.2 Deboost

The deboost was successfully accomplished with five engine pulses (OAs 59 through 63). This consisted of four 74 second firings and one 215 second firing with off-times of 5 seconds between firings. Total firing duration was 515 seconds to achieve a planned negative velocity increment of 188 feet/second. A sixth firing was programmed for 180 seconds to bring about propellant depletion; depletion was observed at approximately 85 seconds into this burn. The engine performance during all burns was nominal.



REVOLUTIONS X 100

Figure 3-3

Thruster Pulse Count History

TABLE 3-7

ORBITAL ADJUST SYSTEM PERFORMANCE

OA Firing Number	Revolution Number	Impulse Delivered (lb-sec)	Planned ΔV (ft/sec)	Achieved ΔV (ft/sec)	ΔV Error (percent)
1	46	9176	13.69	13.79	+0.71
2	94	23660	35.32	35.70	+1.08
3	97	12711	-19.20	-19.30	+0.51
4	143	11514	17.24	17.49	+1.42
5	192	11192	16.80	17.05	+1.48
6	240	24822	40.54	41.02	+1.19
7	242	12690	-20.76	-21.06	+1.45
8	289	11700	19.31	19.46	+0.80
9	338	8800	14.56	14.67	+0.80
10	386	8804	14.25	14.72	+3.31
11	435	24014	39.67	40.32	+1.61
12	437	9971	-16.47	-16.81	+2.01
13	484	3206	5.28	5.41	+2.55
14	534	13330	22.34	22.56	+1.00
15	581	20187	34.40	34.31	-0.27
16	583	14398	-24.50	-24.57	+0.28
17	630	9629	17.65	17.91	+1.47
18	678	11496	21.20	21.44	+1.14
19	727	7828	14.50	14.64	+0.99
20	776	19775	36.69	37.12	+1.16
21	778	9606	-17.88	-18.10	+1.20
22	824	8846	16.36	16.71	+2.15
23	873	9131	17.06	17.30	+1.41
24	922	7736	14.55	14.69	+0.95
25	970	20797	40.03	40.62	+1.50
26	972	11509	-22.27	-22.57	+1.37

TABLE 3-7 (Continued)

OA Firing Number	Revolution Number	Impulse Delivered (lb-sec)	Planned ΔV (ft/sec)	Achieved ΔV (ft/sec)	ΔV Error (percent)
27	1019	24638	47.35	48.59	+2.63
28	1052	12309	-26.61	-26.97	+1.33
29	1100	15024	32.28	33.07	+2.44
30	1149	6384	13.96	14.10	+0.96
31	1197	11185	24.15	24.77	+2.54
32	1246	16568	36.18	36.83	+1.78
33	1248	7928	-17.61	-17.69	+0.49
34	1295	9780	21.60	21.91	+1.39
35	1343	7729	17.07	17.39	+1.90
36	1392	8833	19.66	19.95	+1.48
37	1440	15809	35.47	35.79	+0.90
*38	1443	7518	-16.63	-12.75	-24.30
39	1459	3817	-8.16	-8.69	+6.54
40	1489	10327	23.14	23.58	+1.89
41	1538	11394	25.60	26.10	+1.96
42	1587	8153	18.70	18.73	+0.15
43	1635	10582	24.07	24.42	+1.45
44	1684	6288	16.00	16.26	+1.63
45	1700	6267	16.00	16.28	+1.72
46	1717	6270	16.00	16.32	+2.00
47	1733	6143	16.00	16.04	+0.25
48	1749	6121	16.00	16.0	0
49	1767	6081	-16.00	-15.9	-0.63
50	1782	6097	16.00	16.03	+0.19
51	1798	6103	16.00	16.08	+0.51
52	1814	6118	16.00	16.14	+0.86

* Vehicle improperly oriented.

TABLE 3-7 (Continued)

OA Firing Number	Revolution Number	Impulse Delivered (lb-sec)	Planned Δ V (ft/sec)	Achieved Δ V (ft/sec)	Δ V Error (percent)
53	1830	6268	16.00	16.59	+3.69
54	1846	5829	-16.00	-15.47	-3.32
55	1863	5981	16.00	15.91	-0.57
56	1895	8963	23.65	23.92	+1.15
57	1960	10052	27.00	27.65	+2.42
58	1976		18.08		
59	1998		-27.37		
60	1998		-27.31		
61	1998		-27.29		
62	1998		-27.37		
63	1998		-78.62		
64	1998		To Fuel Depletion	-31 (Estimated from length of depletion burn)	

3.5 LIFEBOAT II SYSTEM

3.5.1 Bay 10 Battery Induced Errors

Again for this flight, two Type 29 Batteries were installed in Bay 10 adjacent to the Lifeboat Magnetometers in Bay 9 and introduced errors. A Calibration Test on Rev 52 produced these results:

A. Telemetry bias on both D201 and D202 channels is 0 to 1.5 milligauss (mG); therefore, no correction of data for telemetry bias is required.

B. Induced magnetism errors are similar to those on SV-5 and SV-6 and the Lifeboat System would operate within its attitude specification.

Additional confirmation of Lifeboat capability was obtained during recoveries when magnetometer readings indicated errors of less than 0.5 degrees in pitch and yaw for RV-1 and less than 1.0 degree for RV-4. These values are well within the allocated error of 2.5 degrees.

3.5.2 Yaw Attitude Determination

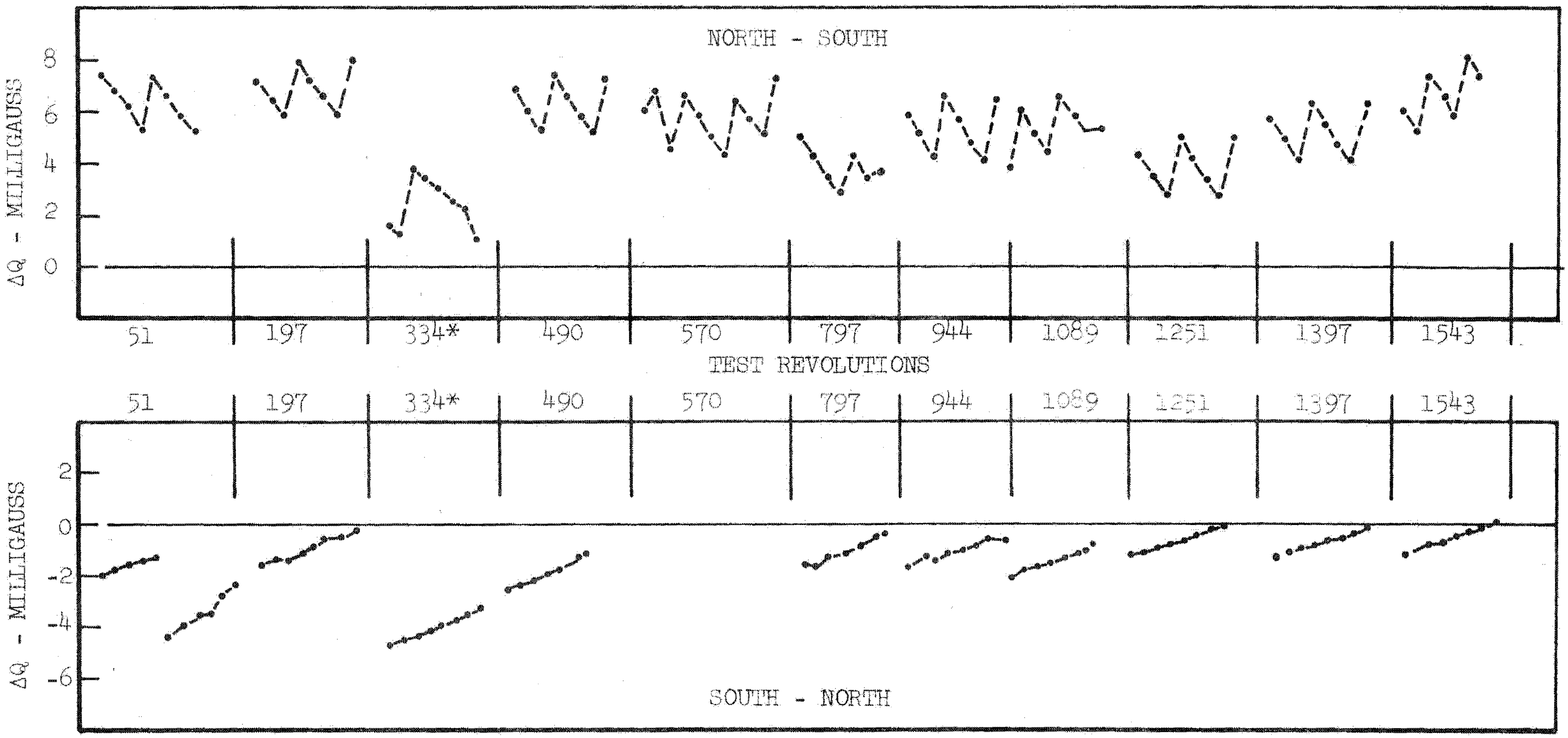
Periodic yaw attitude determination tests results are shown in Figure 3-4. These tests are performed as a backup in the event of an ACS malfunction. Since a 1 degree yaw error would result in a 6 milligauss change in the ΔQ magnetometer, a 1 degree error would be difficult to detect without establishing the magnetometer distortion error while ACS control is normal.

Based on these same tests, errors of 0 to 1 degree in yaw and 1 degree in pitch would be expected if Lifeboat were used to deboost.

3.6 ELECTRICAL DISTRIBUTION AND POWER (EDAP)

3.6.1 Solar Arrays

Solar arrays were extended on Rev 1. Power output from each leg exceeded the specification value. Degradation from normal orbit environments was 4.7% after 103 (1656 revs) days. However, an anomaly occurred on Solar Array Leg 1 on Rev 232 which reduced the output by 1/2 panel for approximately 15 minutes during the illuminated period. Solar Array Leg 2 exhibited a



* Performed in non standard latitude and longitude.

ΔQ is difference between magnetometer reading and predicted reading (DGMAP)

Figure 3-4
Yaw Attitude Determination Tests

similar problem on Rev 495 reducing the output by 1 panel for 7 minutes during the illuminated period. The reduced output time for both legs increased each week of flight until Rev 1266 when the reduction extended throughout the illuminated period. This power loss did not compromise the mission objectives since power generated continued to be greater than power used.

The fault was traced to a change in solder on the connecting boards which was more susceptible to thermal fluctuations. This more brittle solder led to separation between the trace and the post connector. All future Solar Array connectors have jumper wires installed in addition to the traces, which will eliminate the problem on future flights.

3.6.2 Main Bus Voltage

The Main Bus voltage varied from a low of 25.9 to a high of 31.5 volts. The allowable range is 25.5 to 33.0 volts. Low range voltage was obtained during payload operations with a bus load of 51 amps. High voltage data was gathered during charge cycles.

3.6.3 Power Capability and Usage

Power usage ranged from 313 to 412 amp hours/day. The 412 amp hours/day exceeded the 390 calculated amp-hours/day capability. K2s did occur during this period indicating the generating capability exceeded 390 amp-hours/day when loaded heavily. Excess capacity was demonstrated with K2s occurring on Rev 3 and on random revs until Rev 28 after which K2s occurred essentially every rev except those with heavy payload operations.

All Type 29 Batteries operated in a desirable environment (44°F to 50°F) and performed normally throughout the mission.

3.6.4 Pyro Battery Performance

Pyro Battery 1 stabilized at 49 to 50°F which minimizes self discharge during the mission. Lift off capacity was 11.194 amp-hours and after 103 days, the usage for instrumentation and self discharge was 5.22 amp-hours which left a residual capacity of 5.97 amp-hours. Cell degradation life still available was 21 days.

Pyro Battery 2 followed the same pattern with the exception of 23 days cell wearout life remaining.

3.6.5 Lifeboat Battery Performance

The Lifeboat battery operated normally in a 48°F to 49°F environment throughout the entire mission. A total of 214 amp-hours remained at the end of 103 mission days from an initial 35 amp-hours at launch. Remaining cell degradation life was 23 days.

3.7 TRACKING, TELEMETRY AND COMMAND (TT & C)

3.7.1 Tracking

There were four reported data losses on SV-7 which have been attributed to new antenna pattern "holes". The principal characteristics of the station passes during which the data losses occurred are summarized in Table 3-8.

TABLE 3-8

STATION PASS CHARACTERISTICS WHEN DATA LOST

Pass	RTS	Vehicle Side	Maximum Elevation	Antenna Used	Range at Maximum Elevation	Elevation Angle* of Loss	Duration of Loss
125	GUAM	Right	67°	60 ft	158 nm	59°A to 46°D	37 sec
146	COOK	Left	63°	60 ft	125 nm	41°D to 29°D	20 sec
154	COOK	Right	60°	46 ft	151 nm	54°D to 45°D	16 sec
1208	COOK	Left	68°	46 ft	136 nm	40°A	2 sec

*The A or D code refers to whether the elevation angle is on the ascension to the maximum elevation angle or descending from the maximum elevation angle.

In the first three instances, real time data was lost. At 1208 COOK, only Tape Recorder playback data on the 1.7 MHz Subcarrier was lost.

Review of signal strength data from several passes having similar characteristics but with no data dropouts revealed rapid and high fluctuations of signal strength at high elevation angle. It is, therefore, concluded that the data losses were due to new, very small area antenna holes in the antenna pattern for SV-7. In particular, the 2 second loss of Tape Recorder data on Pass 1208 COOK coincided with a signal strength decrease of 31 dBm and a return to the previous signal strength level of -84 dBm within two seconds.

Although it is probable that the initial loss of data is due to the antenna holes, the duration of the data loss is influenced by the ability of the RTS to reacquire the downlink signal once it is realized that data loss has occurred.

3.7.2 Telemetry

3.7.2.1 General Performance

Telemetry system performance was satisfactory throughout the flight. PCM Side 1 was utilized on all active station contacts except Revs 9 and 18 when PCM Side 2 was checked. SGLS 1 was utilized on all active station contacts except for periodic checks of SGLS 2 at the following revs: 9, 18, 130, 243, 373, 471, 584, 697, 811, 924, 1054, 1151, 1265, 1378, 1477, 1492 and 1606. Operation of both SGLS links was satisfactory, except as noted in Paragraph 3.7.1. In addition, operation of the PCM System during tape recording and operation of the Tape Recorders (Tape Recorder 1 and 2) was normal throughout the flight. Tape Recorder 2 was used satisfactorily on Revs 0 (ascent), 124-125, 140-141, 162, and 936 for read-in and Revs 2, 133, 149, 166, and 936 for read-out, respectively.

3.7.2.2 Instrumentation

Table 3-9 presents the instrumentation anomalies at lift-off.

TABLE 3-9

INSTRUMENTATION ANOMALIES AT LIFT-OFF

ID NO.	ITEM	DESCRIPTION
B001	Primary REA Chamber Pressure Monitor	Inoperative due to defective transducer.
B053	Thruster 3 Temperature Monitor	Erratically indicated incorrect temperature, usually 80° high.
B242	Lifeboat Regulator Valve Close Monitor	Will occasionally indicate a "1" (closed) with the Regulator Valve open and gas flowing. This is an instrumentation anomaly only.

3.7.3 Command

3.7.3.1 General

The vehicle SGLS command equipment was utilized to receive more than 20 million bits with no vehicle problem indications.

3.7.3.2 GFE Command System

A. Extended Command System

The ECS responded satisfactorily in all command modes resulting in the loading of 249,965 SPCs in memory. Of these 249,965 SPCs loaded, 110,539 were output by both PMUs for decoder processing. The remainder were erased prior to their time label matches. In loading the 249,965 SPCs, there were no command rejects attributable to the ECS.

The accuracy and stability of the ECS Clock, as computed for each flight segment, are listed in Table 3-10.

TABLE 3-10

ECS CLOCK PERFORMANCE

Segment	Accuracy	Stability (Average 6 Hour Period)
1207-1	2.28 parts in 10^7	6.28 parts in 10^{10}
1207-2	2.71 parts in 10^7	3.89 parts in 10^{10}
1207-3	3.02 parts in 10^7	1.62 parts in 10^{10}
1207-4	3.25 parts in 10^7	1.09 parts in 10^{10}

B. Minimal Command Subsystem (MCS)

The MCS responded correctly to all commanding.

C. Remote Decoder/Backup Decoder

Both sides of the Remote Decoder were used for each of the five recoveries. Performance of both sides was determined to be acceptable through analysis of telemetry data.

D. Command System Usage Summary Through Rev 1656

System	Total Operating Time - Hours
ECS	2432.6
MCS	10.4
Remote Decoder	2.6
Backup Decoder	0.1

3.8 MASS PROPERTIES

A history of SV mass properties throughout the flight are tabulated in Table 3-11.

TABLE 3-11

SV-7 MASS PROPERTIES

Description	Weight (lb)	CENTER OF GRAVITY (inches)			MOMENT OF INERTIA (slug-ft^2)			PRODUCT OF INERTIA (slug-ft^2)		
		$\bar{X}$	$\bar{Y}$	$\bar{Z}$	I_x	I_y	I_z	I_{xy}	I_{xz}	I_{yz}
Prelaunch	24958	1970.4	-0.21	3.01	7228	204080	204123	-648	524	17
Sep from Stage 2	21945	1981.2	-0.26	3.39	5037	172902	172354	-668	741	17
Arrays Deployed 0°	21945	1981.7	-0.26	3.39	6238	173973	175187	-668	748	3
After Subsat Eject	21423	1985.7	0.28	3.35	5988	170682	171748	-241	1115	-28
Prior to Drop 1	21079	1974.2	0.28	4.51	5958	175310	176391	-254	1512	-28
After Drop 1	19529	1997.8	0.30	3.48	5746	143112	144344	-226	110	-25
Prior to Drop 2	18821	1983.7	0.31	4.26	5724	142572	143315	-244	337	-26
After Drop 2	17329	2004.5	0.34	3.14	5516	121872	123260	-219	-769	-23
Prior to Drop 5	16914	1994.1	0.35	3.88	5506	121445	122833	-232	-609	-24
After Drop 5	16518	2003.2	0.36	4.56	5407	108904	110382	-219	325	-27
Prior to Drop 3	16259	1998.9	0.37	4.81	5400	107815	109297	-225	318	-28
After Drop 3	14711	2019.1	0.40	3.47	5191	93916	95544	-199	-590	-24
Prior to Drop 4	13894	2004.6	0.43	4.35	5197	90384	91994	-218	-531	-25
After Drop 4	12463	2019.9	0.48	2.91	4998	84091	85839	-199	-1108	-22
Prior to Deboost	11946	2013.2	0.50	3.03	4997	81329	83078	-208	-1160	-22
End Deboost	11580	2008.1	0.51	3.13	4996	79228	80977	-214	-1200	-22

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3.9 PREFLIGHT WINDS ALOFT LOADS ANALYSIS

Table 3-12 presents a chronological tabulation of the winds aloft computer runs for SV-7. The results are plotted in Figure 3-5.

The loads and control analysis computer simulations leading to launch were accomplished without violating any of the established vehicle constraints and resulted in repeated Go for launch recommendations. An R-17 day preliminary winds loads data check run was accomplished on 29 October 1973. These data checked the Martin Marietta Corporation (MMC) independently generated data well within all specified limits. MMC verified the SBAC data results as being acceptable by letter (MMC 73-Y-31890) dated 23 October 1973.

3.10 SOLAR ARRAY (SA)

Deployment and erection of the left (-Y) SA is shown in Figure 3-6 and for the right (+Y) SA in Figure 3-7. The arrays were deployed at the first station pass, INDI, and were repositioned from +18° to 0° at KODI on Rev 1 for maximum output at the flight beta angle of 0°.

3.11 THERMAL CONTROL

3.11.1 Mid and Forward Sections Including MCM

The flight temperatures of the Mid, Forward Section and MCM are summarized in Table 3-13. This data indicates that the thermal design of these sections provided the required orbital temperature control. No design changes are forthcoming as a result of SV-7 flight performance.

3.11.2 Active Thermal Control (ATC)

The reference temperature, T_{REF}, for the Mid Section film path ATC remained relatively constant for the first three segments of the mission and then experienced a gradual cooling of approximately 3°F during the fourth segment as shown in Figure 3-8. The rate of change in T_{REF} is approximately the same as the rate observed on SV-5. The RV Heater control zones, which are actively controlled relative to T_{REF}, were generally within 1°F of T_{REF}. No reason for the cooling has been determined.

TABLE 3-12

WINDS ALOFT ANALYSIS SUMMARY

	BALLOON RELEASE TIME					
	T-30	T-12	T-6	T-3	T-90 Min	T-0
	3800 RUN AT STC TIME					
	T-24	T-8.5	T-3	T-1	---	---
SV Structural Loads:						
Bending Mom, % Limit Load	56.61	60.42	58.26	55.98	58.22	55.73
Critical SV Station	1,902.	1,902.	1,902.	1,902.	1,902.	1,902.
Elapsed Time, seconds	45.73	60.57	27.88	64.27	29.94	51.05
Altitude, feet	24,388.	42,000.	9,000.	47,000.	10,390.	30,293.
SRM Side Force:						
% Allowable	32.30	48.09	49.44	31.0	38.19	32.40
SRM Number	1	1	1	1	1	1
Pitch or Yaw	Pitch	Pitch	Pitch	Pitch	Pitch	Pitch
TVC Usage for Control:						
% Allowable Expended	76.	90.	86.	81.	81.	79.
SRM Number	1	1	1	1	1	1
Vehicle Response:						
Maximum αq, % allowable	36.45	53.39	51.99	44.91	53.16	46.68
Maximum αq, deg-psf	1,137.	1,845.	1,815.	1,564.	1,848.	1,623.
Elapsed Time, seconds	33.62	30.04	29.74	29.88	29.90	29.92
Altitude, feet	13,146.	10,470.	10,260.	55,158.	10,363.	10,384.

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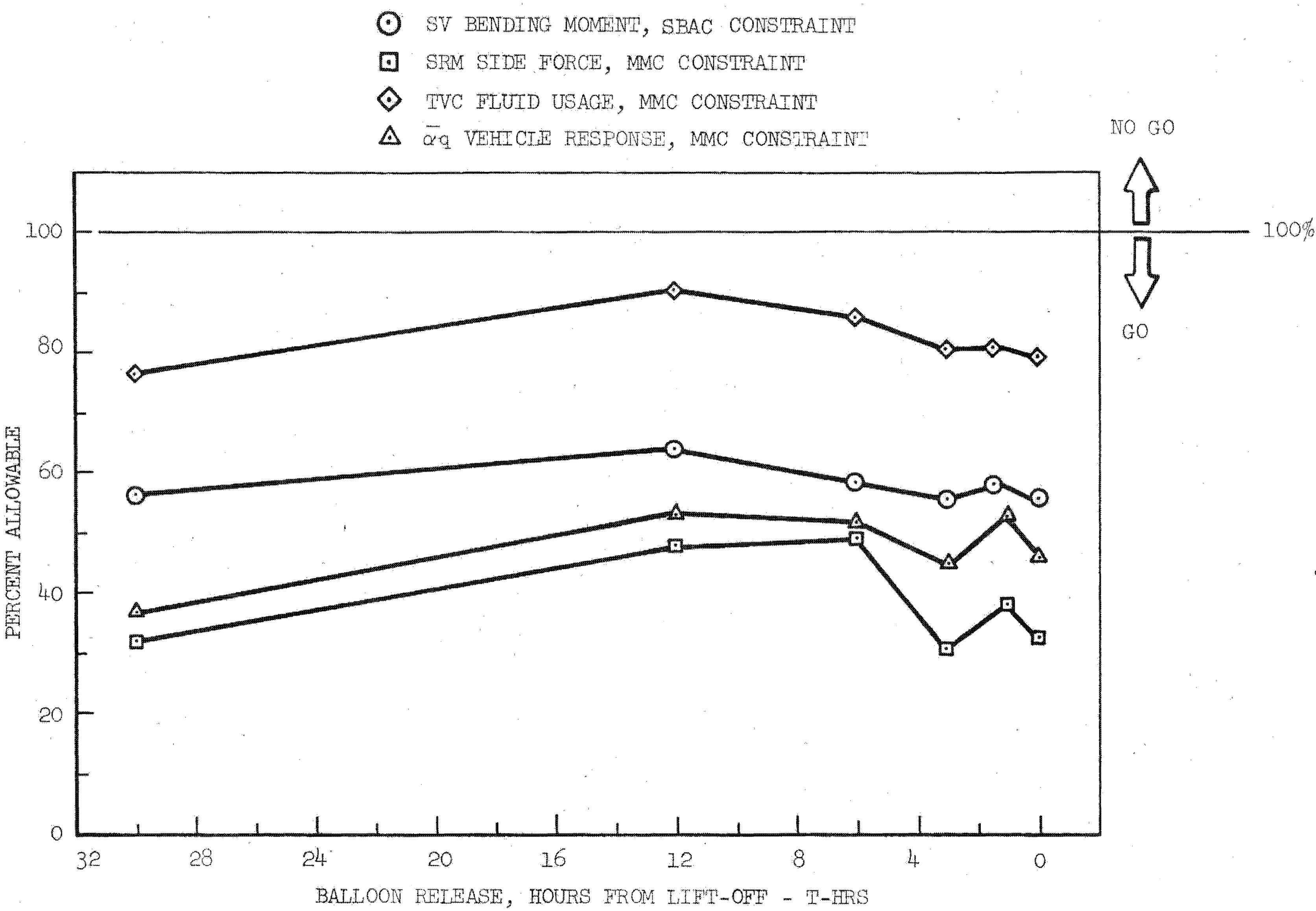

Figure 3-5

Critical Launch Parameter Summary

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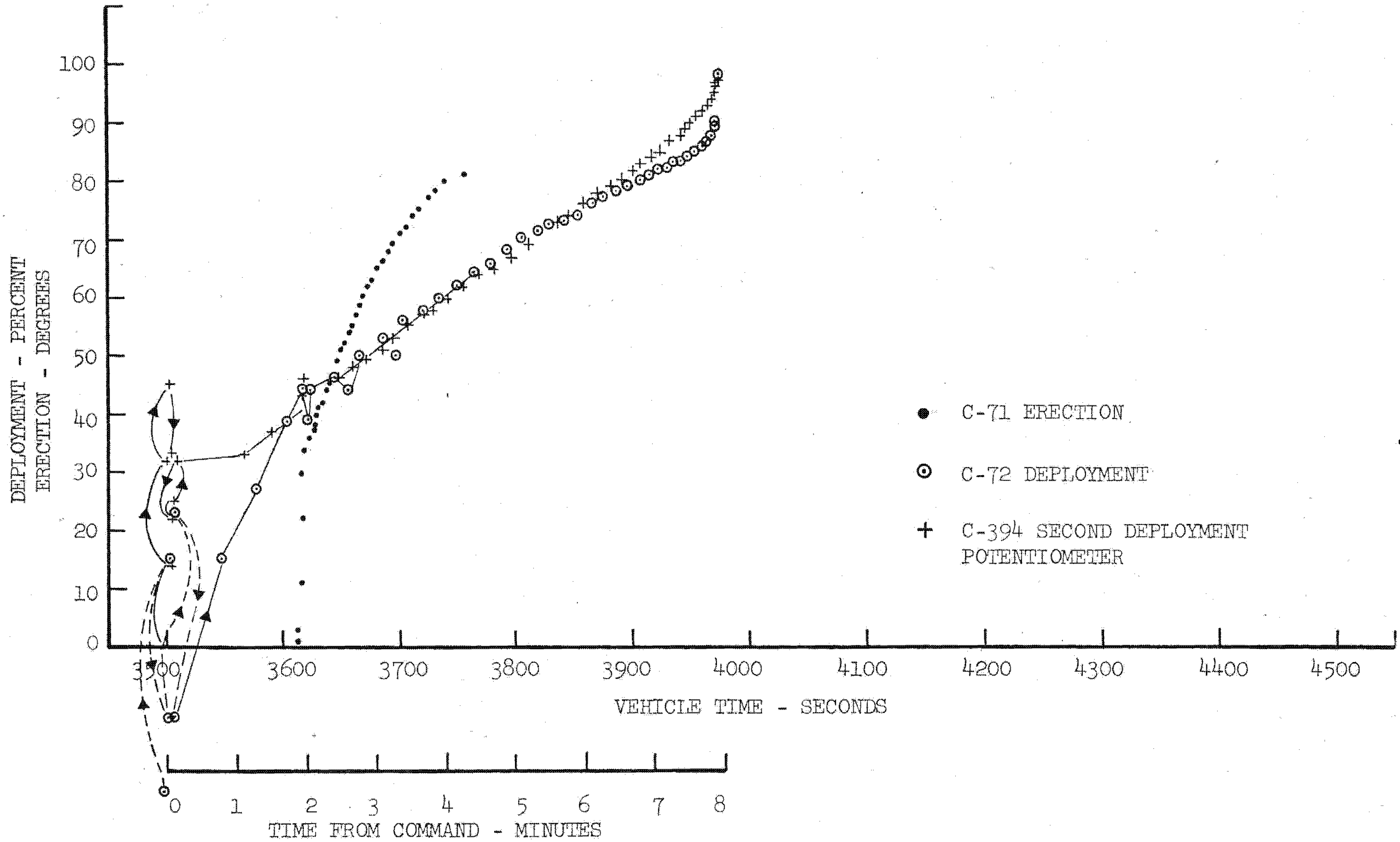

Figure 3-6

Left Solar Array Erection and Deployment Time Histories

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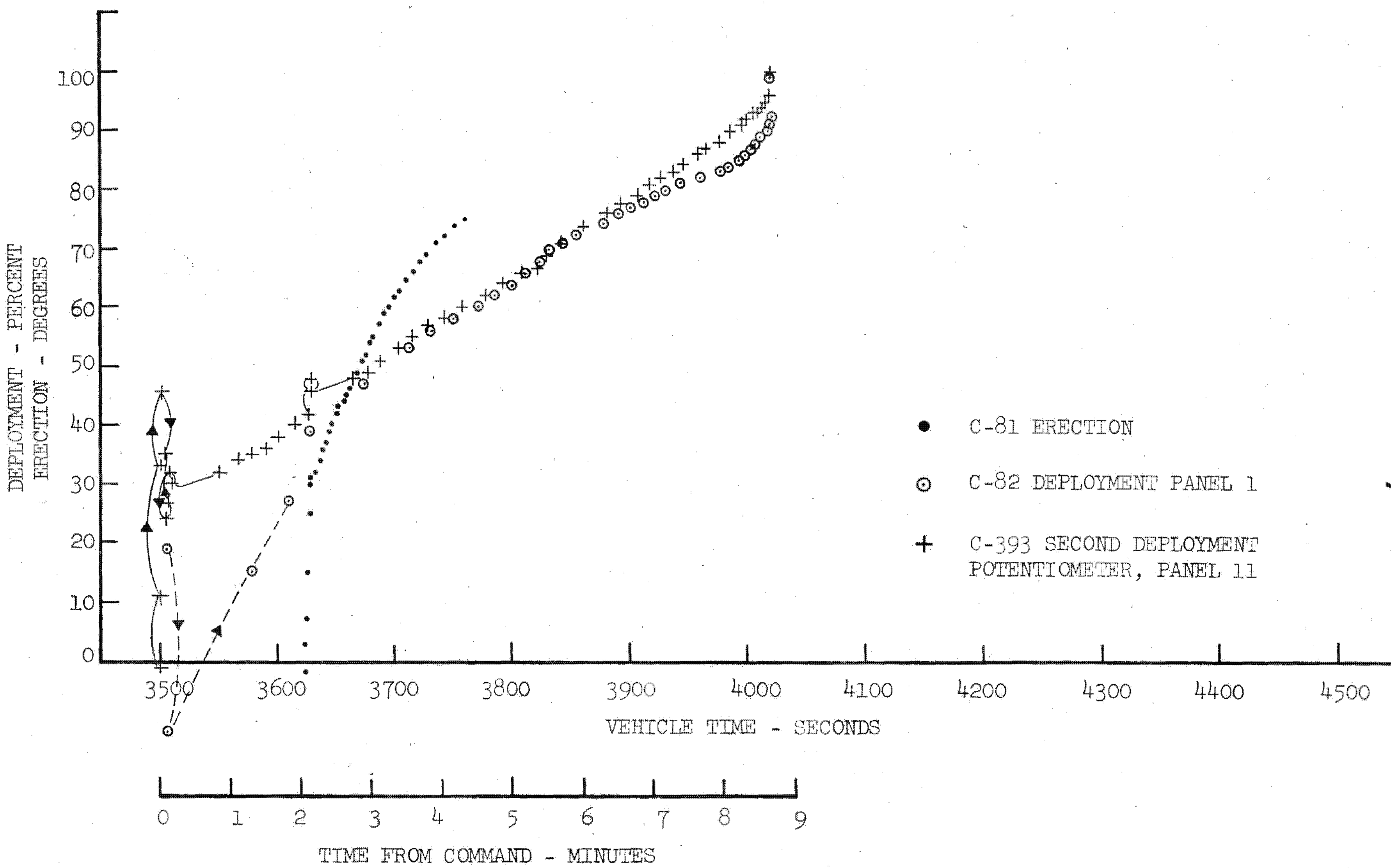

Figure 3-7

Right Solar Array Erection and Deployment Time Histories

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TABLE 3-13

THERMAL DATA SUMMARY

Vehicle Section	Parameter	Design Limits	SV-7 Actual
Mid Section	T_{TCA}	49/91	70
	T_{SU}	47/93	72
	$T_{SU} - T_{TCA}$	5/-4	2
Forward Section	T_{FWD}	47/93	71/80
	$T_{FWD} - T_{TCA}$	±20	10/1
APSA	T_{ENC}	32/69	54
	T_{TU}	30/85	50
	DBS Panel	32/90	55/60

DEFINITIONS

T_{TCA} = Orbit average radiation temperature of the TCA Compartment structure.

T_{SU} = Orbit average radiation temperature of the SU Compartment structure.

T_{FWD} = Orbit average temperature of each Forward Section bay based on the average temperature of the bulkheads.

T_{ENC} = Orbit average temperature of the MCM enclosure.

T_{TU} = Orbit average Satellite Recovery Vehicle takeup temperature.

Temperatures are in °F.

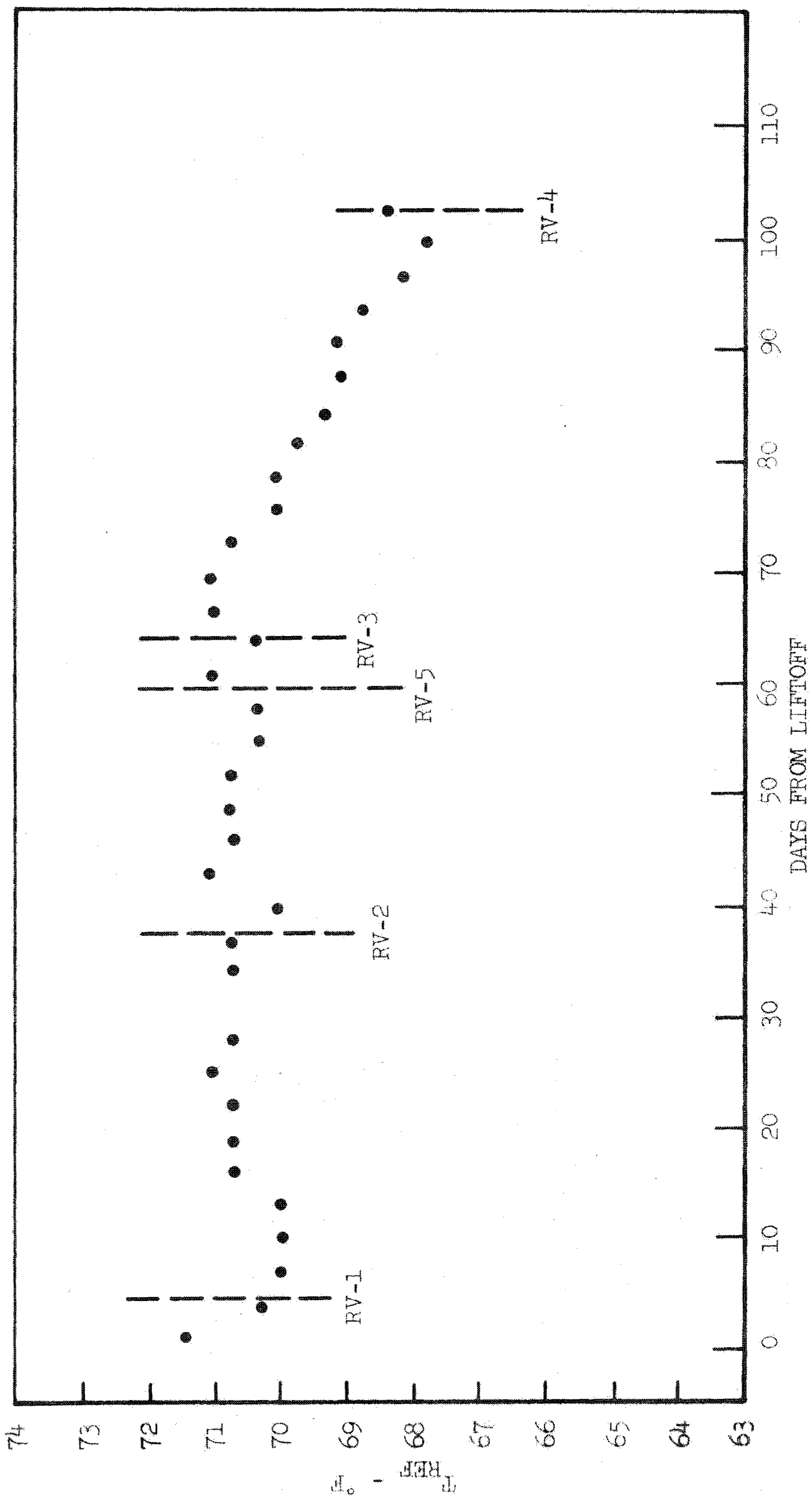


Figure 3-8

SV-7 T_{REF} History

3.11.3 Aft Section

Acceptable Aft Section temperature control was maintained throughout the flight. All equipment temperatures remained within design limits as shown in Table 3-14.

The SV-7 Aft Section was configured as follows:

- o The external paint pattern as well as the Battery and ARM Modules are configured as on SV-5 and SV-6.
- o The forward web of the Reaction Control Section (RCS) has been replaced with a truss network. (Block change).
- o The RCS Tanks 3 and 4 in Bays 5 and 7 have been removed.

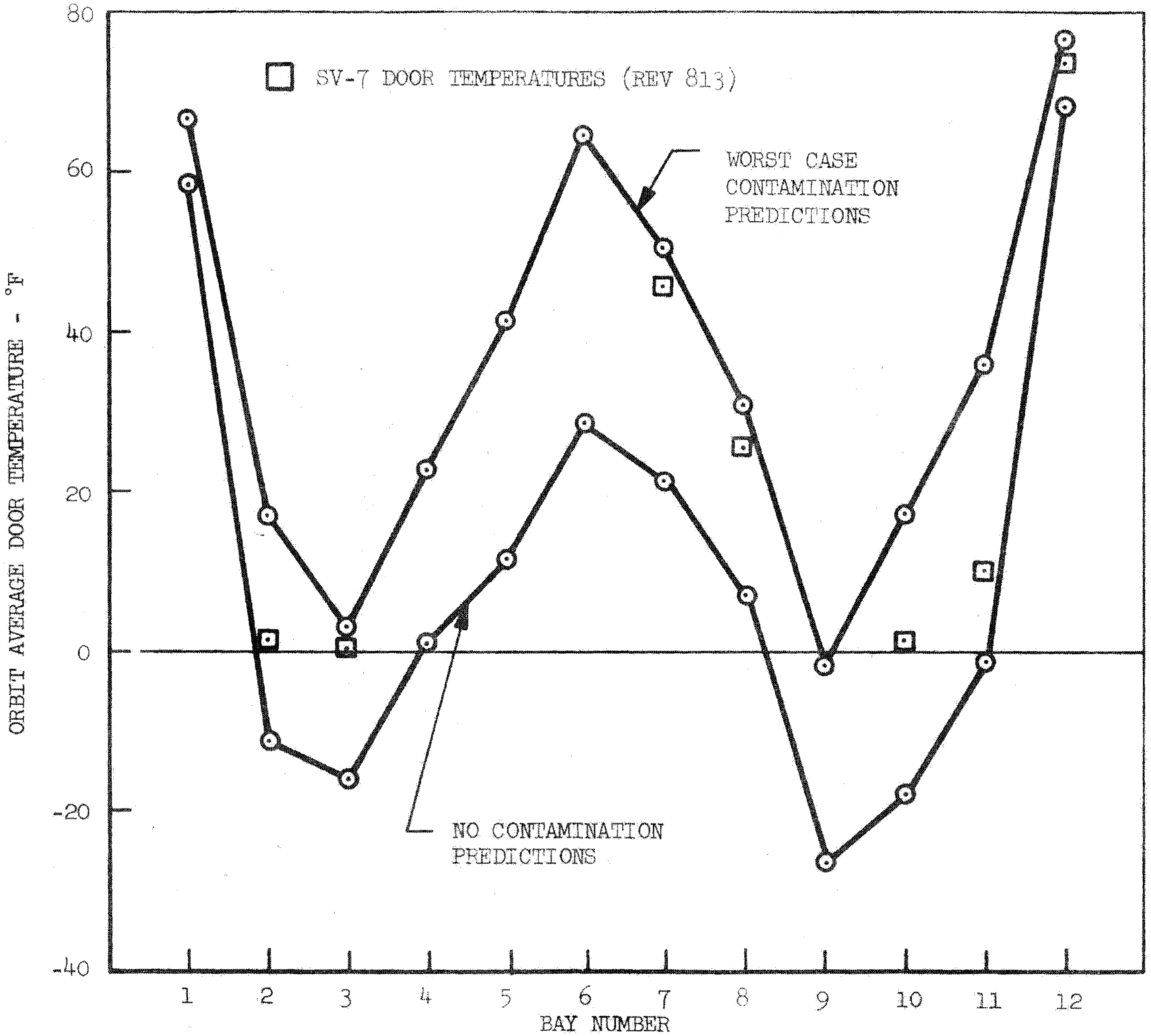
Equipment and structural temperatures indicated contamination degradation to external vehicle thermal control surfaces similar to that of all other flights. The amount of degradation was within the bounds of preflight analysis as indicated in Figure 3-9.

TABLE 3-14

AFT SECTION CRITICAL COMPONENT TEMPERATURES (°F)

Critical Component	Design Limit	Actuals (1)
Power Distribution Junction Box	-30/170	74/78
Charge Current Controller 2	-30/170	72/83
Type 29 Batteries, Bay 3	35/70	43/50
Type 30 Battery	40/90	47/49
Type 31 Batteries	30/90	47/50
Type 29 Batteries, Bay 10	35/70	43/50
Positional Drive Assembly	-30/160	58/86
Solar Arrays	-125/225	-78/165
Inertial Reference Assembly	50/130	105/117
Horizon Sensor Assembly Heads	0/130	79/86
Gyros	50/200	157/197
Tank	65/100	72/87
Quad Valve	35/200	111/118
Catalyst Bed	---	126/160 (2)
Tape Recorders	20/130	73/92
Transmitters	-30/170	76/87
Pulse Code Modulator	-30/170	79/94
Programmable Memory Unit A	-40/145	77/80
Programmable Memory Unit B	-40/145	85/92
Clock	-40/153	89/98
Minimal Command Subsystem	-40/149	52/73
RCS Tanks	40/140	70/91
Plumbing Bay 12	35/140	74/92
Plumbing Bay 6	35/140	79/92

(1) Steady-state.
(2) OA not firing.



NOTE:

Predictions are for Beta = 0 Deg; Battery Bays adjusted for heat dissipation. Predictions corrected for annual variations in solar constant.

Figure 3-9

SV-7 Equipment Door Temperatures

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SECTION IV
PAYLOADS

4.1 SENSOR SUBSYSTEM

4.1.1 Coarse Film Path

Both coarse film paths (supply, loopers steerers, articulators and takeups) generally exhibited nominal operation throughout the mission. However, a small tear was found on one frame of aft-looking camera film in Segment 3. Film path telemetry data and image analysis indicated that the tear had most probably occurred after exposure, therefore, in the coarse film path, but there is no conclusive evidence of the source or reason. There were no repeats of this anomaly.

The now standard 5 ips maximum rewind velocity and scan-angle restrictions to preclude mistracking were imposed throughout the mission.

4.1.2 Fine Film Path

Both fine film paths performed nominally throughout the mission except for a resonance exhibited by the forward-looking camera metering capstan at peak Vx/h values of the original orbit. Corrective action was modifying the orbit by raising perigee altitude 2 nautical miles on Rev 289 to avoid the troublesome region. Operation was nominal thereafter.

4.1.3 Command and Control

The command and control subsystem functioned normally throughout the mission in both stereo and mono modes. The OOAA nominal and slit width of the aft-looking camera were adjusted to optimum values as determined by PFA.

4.1.4 Optical Bar Performance

Mechanical and optical performance of both optical bars was nominal throughout the mission.

4.1.5 Instrumentation

The instrumentation subsystem functioned normally throughout the mission. When the data was lost on Rev 3 there was a loss of signal strength which is unexplained. The loss does not appear to be a "hole" since it did not repeat. No corrective action is indicated.

4.1.6 Pneumatics

Pneumatics subsystem performance was normal throughout the mission. Total N_2 gas usage was 29.5 lb of the 34.0 pounds loaded.

[redacted]

4.3 SUBSATELLITES

Two Subsatellites were carried into orbit on SV-7. A 450 pound Subsatellite Unit (SSU) was carried on the -Y side of the Forward Section. Separation of this Subsatellite occurred on Rev 13.5 following an SV yaw maneuver of -23.5°. Separation occurred at -11.8° latitude on the descending node. All Subsatellite separation sequence events were within specified limits and the Subsatellite went on to achieve its desired orbit.

[redacted] Subsatellite was carried on the +Y side of the Forward Section. Separation of this Subsatellite occurred on Rev 2.9 which coincides with 22.1° South latitude on an ascending node. The Subsatellite separation sequence was within desired tolerances and the Subsatellite achieved its intended orbit.

4.4 MAPPING CAMERA SUBSYSTEM

The operation and performance of the third ST Camera System flown on SV-7 is considered excellent. No functional anomalies were encountered.

The light leak which developed in the Stellar Chute was determined to be located directly over the Pressure Makeup System Assembly. The reason the hole developed cannot be determined. Extensive light leak testing on subsequent systems has not revealed any defects in the chute design. Additional sealing and inspection have been incorporated in subsequent chute installations.

SECTION V
REENTRY VEHICLE SUMMARY

5.1 SUMMARY

The recovery statistics are shown in Table 5-1 and Figure 5-1. Performance of the RV subsystems is summarized in Table 5-2. All RV events (on-orbit, reentry and recovery) occurred as planned and the RV flights followed the predicted trajectories.

The outer wraps of film on RV-2, RV-3 and RV-4 were torn and loose due to relative motion between the film stacks and the RV after aerial retrieval induced shearing of the core pins. Aerial retrieval loads exceeding the core pin strength are expected. The payload on RV-1 was recovered without loose wrapping.

All subsystems performed satisfactorily and met all mission requirements, see Table 5-2.

5.2 REENTRY VEHICLE PERFORMANCE

All RV on-orbit functions were normal and occurred on time. The SV provided a satisfactory pitch angle for each RV separation. All other SV/RV interface functions were nominal.

The RVs were adequately spin stabilized during the vacuum coast phase and aerodynamically stable during the atmospheric phase of the reentry trajectory. Figure 5-1 shows the entry conditions to be well within previously established entry boundaries. Also shown are the conditions at the time of drogue deployment which are also within the design evelope.

5.3 REENTRY VEHICLE SUBSYSTEM PERFORMANCE

Two secondary discrepancies were observed during the post flight examination of the recovered vehicles.

TABLE 5-1

RV RECOVERY SUMMARY

	RV 1	RV 2	RV 3	RV 4
RV Serial Number	32	31	30	29
Recovery Rev Number	229	602	1039	1656
Recovery Date	24 Nov 1973	17 Dec 1973	13 Jan 1974	20 Feb 1974
Payload Weight (lb) (Measured Weight from Recovered RV)				
Forward	227.7	203.0	228.3	184.6
Aft	230.3	204.0	228.7	185.4
Unbalance Percent	1.0	0.4	0.2	0.3
SV Orbit (hp x ha/ωp)*	88.29 X 153.76/122.92	90.31 X 147.76/145.42	90.57 X 166.17/147.73	90.22 X 153.66/130.21
SV Pitch Angle (Degree)	-33.8	-37.5	-40.6	-37.4
Nominal PIP Latitude (°N)	31.00	26.00	17.00	25.50
Impact Location Error (EPPD Versus Teapot Evaluation)				
Overshoot (nm)	18.5	2.1	10.9	
Undershoot (nm)				3.4
Cross Track (nm)	2.5E	1.0E	4.2E	4.3E
Recovery (Aerial)				
Altitude (ft)	14,000	12,300	10,800	10,300
Parachute Condition	No Damage	Normal	Normal	Minor cone damage. One suspension line broken.
Retrieval Pass	1	1	1	2
RC/Payload Condition	Good	Good	Good	Good

*hp = Altitude of Perigee (nm), ha = Altitude of Apogee (nm), ωp = Argument of Perigee (deg)

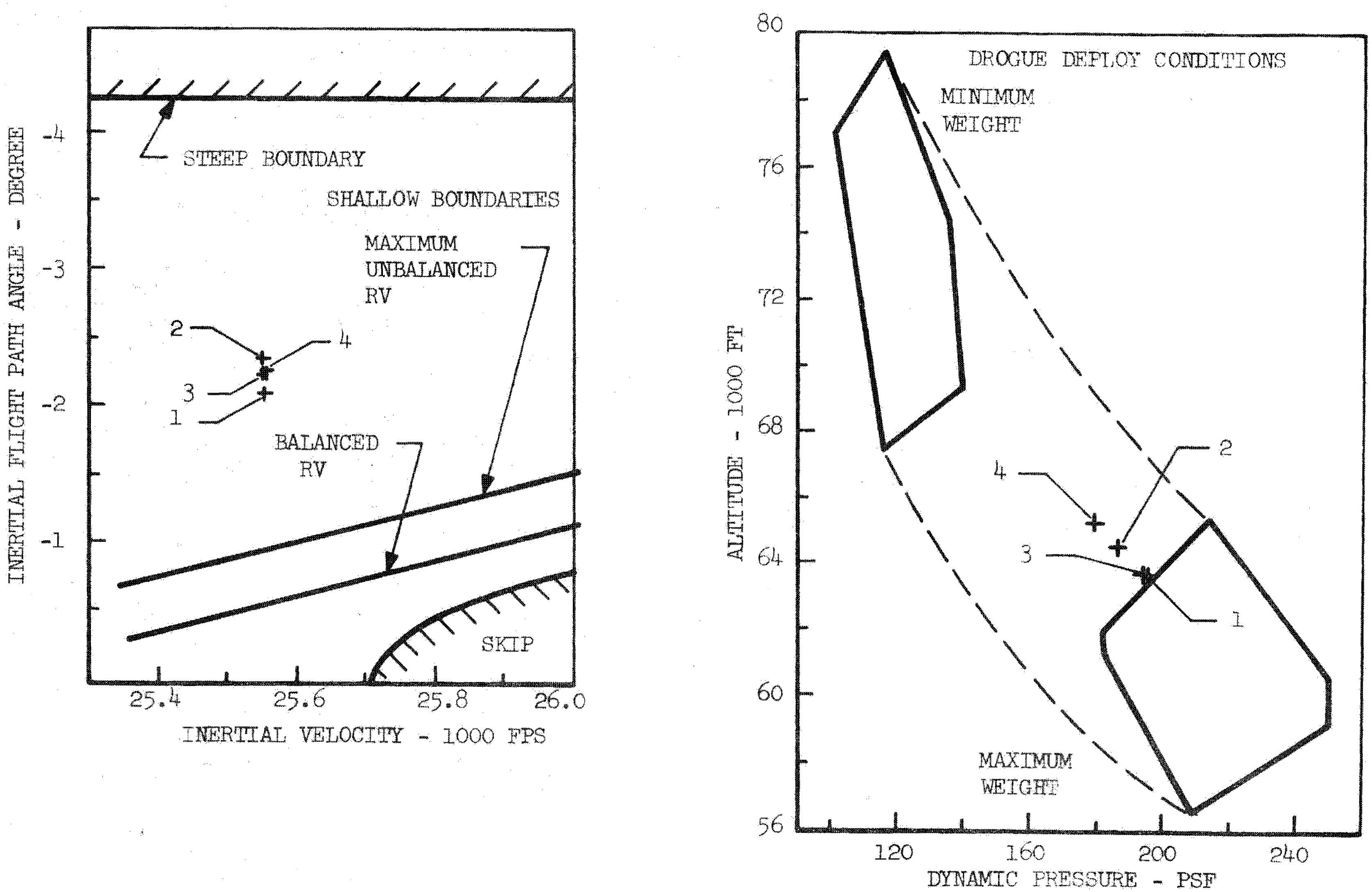

Figure 5-1

SV-7 Reentry Parameter Comparisons

A. Batteries

On RV 4, the Main Battery vented a small quantity of electrolyte through the overboard vent during post retrieval shipment. Corrective action consisting of a case leak test has already been incorporated into the battery design.

B. VHF Antenna

One antenna was missing at the time of boarding RV 4 on the recovery aircraft. Signal strength recordings indicate that the strength levels and patterns appear normal by comparison with previous flights. No data indicates the antenna was missing prior to aerial recovery.

5.4 STELLAR TERRAIN RECOVERY (RV-5)

RV 5 was successfully recovered on Rev 942. Recovery statistics are shown in Table 5-3. All RV subsystems performed normally. The SV provided a satisfactory pitch angle after a yaw reverse and all other interface functions were nominal.

The predicted impact point (PIP), the estimated point of parachute deployment (EPPD) and the air snatch point are shown in Figure 5-2. The miss distance between the PIP and EPPD was calculated to be 33.46 nm short and 1.94 nm East of the ground track. The capsule was recovered at 12,000 feet on the first pass.

TABLE 5-3

ST-RV (RV-5) RECOVERY SUMMARY

Recovery Rev	942
Date	7 January 1974
Payload Weight (98.4%)	68.78 lb
SV Recovery Orbit	
Perigee (nm)/Apogee (nm)/Perigee Angle (deg)	90.24/154.4/124.9
SV Pitch Angle (after yaw around) (deg)	-63.3

	PIP	EPPD	Air Catch
Latitude	16° 0.4'	16° 33'	16° 20'
Longitude	154° 1.2'	153° 53'	153° 45'
Altitude			12,000 ft

TABLE 5-2

RV SUBSYSTEM PERFORMANCE SUMMARY

RV SUBSYSTEM/FUNCTION	PERFORMANCE ASSESSMENT
On Orbit Thermal Protection	Normal o T_{PL} Container = $T_{REF}\,{}^{+0°F}_{-5°F}$ o Power Usage (Watts/RV) Maximum 18.7 (First day in orbit) Stabilized 7.1 (Ninth day in orbit) Allowable 20
Trim and Seal	Normal
Electrical Power and Distribution	Normal o All batteries activated. o All voltages at least 25 volt open circuit voltage. o RV 4 Main Battery vented small amount of electrolyte overboard after retrieval
Structure	Normal
Pyro Subsystem	Normal
Spin Stabilization	Normal
Retro Motor	Normal
Tracking, Telemetry and Instrumentation	Normal operation even though one VHF Antenna was missing on RV 4 at boarding on recovery aircraft.
Heat Shield	Normal
Base Thermal Protection	Normal
Sequential	Normal
Recovery	Normal

TOP SECRET / H

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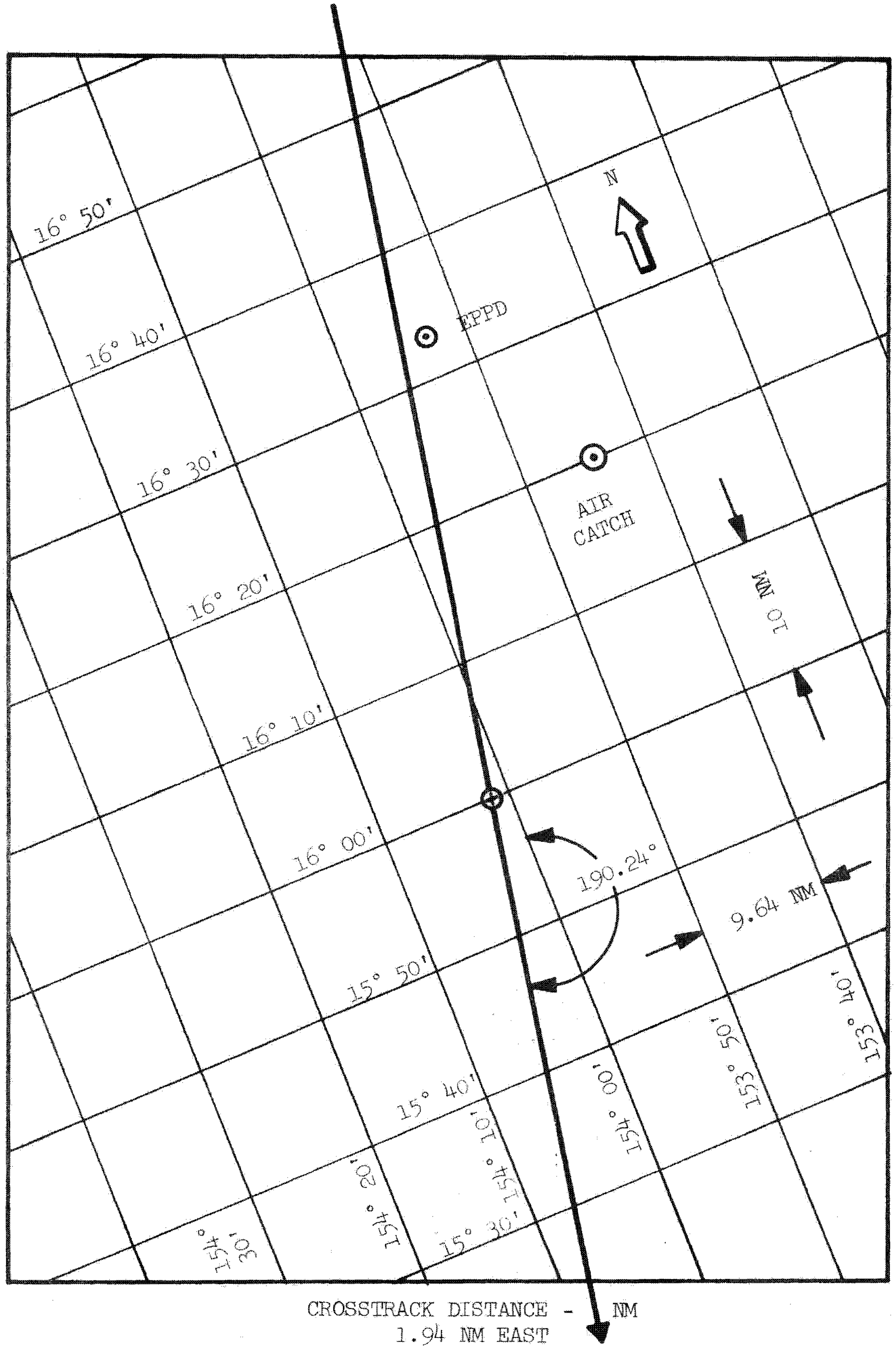

Figure 5-2

ST-RV (RV-5) Recovery Locations

APPENDIX A
GLOSSARY OF TERMS

ACS	Attitude Control System
ATC	Active Thermal Control
BV	Booster Vehicle
BV/SV	Booster Vehicle/Satellite Vehicle
DBS	Doppler Beacon System
ECS	Extended Command System
EDAP	Electrical Distribution and Power
EPPD	Estimated Point of Parachute Deployment
GFE	Government Furnished Equipment
H/S	Horizon Sensor
ips	inch(es) per second
MCM	Mapping Camera Module
MCS	Minimal Command System
MMC	Martin Marietta Corporation
nm	nautical mile
NVR	Non Volatile Residue
OA	Orbit Adjust
OAS	Orbit Adjust System
OOAA	On-Orbit Adjust Assembly
PACS	Primary Attitude Control System
PCM	Pulse Code Modulator
PDWN	Pitch Down
PFA	Post Flight Analysis
PGR	Pitch Gyro Rate
PIP	Predicted Impact Point
PMS	Pressure Makeup System

APPENDIX A (Continued)

PMU	Programmable Memory Unit
PST	Pacific Standard Time
PWM	Pulse Width Modulator
RACS	Redundant Attitude Control System
RCS	Reaction Control System
REA	Reaction Engine Assembly
REM	Reaction Engine Module
Rev	Revolution
RTS	Remote Tracking Station
RV	Reentry Vehicle
SBA	Satellite Basic Assembly
SBAC	Satellite Basic Assembly Contractor
SECO	Stage II Engine Cut-Off
Sep	Separation
SGLS	Space Ground Link System
Solo	System Engineering Test after Fourth RV Separation
SPC	Stored Program Command
SRM	Solid Rocket Motor
SSU	Subsatellite Unit
ST	Stellar Terrain
ST/RV	Stellar Terrain/Reentry Vehicle
SU	Supply Unit
SV	Satellite Vehicle
TT & C	Telemetry, Tracking and Command
TVC	Thrust Vector Control
VBE	Variable Block Erase
Vx/h	Orbit Angular Rate, In-Track