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

Prepared and Submitted by the
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HANDLE VIA BYEMAN
CONTROL SYSTEM ONLY

FOREWORD

This report describes the performance of the fifth HEXAGON Program Satellite Vehicle (SV-5). The vehicle was launched on 9 March 1973 and after a 64-day primary mission and a 7-day SOLO mission was deboosted on Rev 1139 on 18 May 1973.

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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ABBREVIATIONS

ACS	Attitude Control System
ATC	Active Thermal Control
ARM	Attitude Reference Module
BV	Booster Vehicle
CCC	Charge Current Controller
DBS	Doppler Beacon System
DIU	Data Interface Unit
ECS	Extended Command System
EDAP	Electrical Distribution and Power
ELTET	Extended Life Thruster Evaluation Test
EPPD	Estimated Position of Parachute Deployment
FCEA	Flight Control Electronics Assembly
FOSR	Flexible Optical Solar Reflector
F/S	Forward Section
FT	Film Transport
FTFD	Field Test Force Director
H/S	Horizon Sensor
IC	Integrated Circuit
IRA	Inertial Reference Assembly
ISCCU	Instrumentation System Command and Control Unit
MCLR	Master Clear Off
MCM	Mapping Camera Module
MCS	Minimal Command System
MG	Milligauss
MMC	Martin Marietta Corporation
M/S	Mid Section

NVR	Non Volatile Residue
OA	Orbit Adjust
OAS	Orbit Adjust System
OOAA	On-Orbit Attitude Adjust
PACS	Primary Attitude Control System
P/B	Play Back
PCM	Pulse Code Modulator
PFA	Post Flight Analysis
PGR	Pitch Gyro Rate
P/L	Payload
PIP	Predicted Impact Point
PMU	Programmable Memory Unit
PRN	Pseudo Random Noise
RACS	Redundant Attitude Control System
RC	Recovery Capsule
RCS	Reaction Control System
REA	Reaction Engine Assembly
REM	Reaction Engine Module
RTS	Remote Tracking Station
RV	Re-entry Vehicle
SBAC	Satellite Basic Assembly Contractor
SCO	Sub Carrier Oscillator
SECO	Stage II Engine Cut-Off
SEP	Separation
SGLS	Space-Ground Link System
SPC	Stored Program Command
SRM	Solid Rocket Motor
SSC	Sensor System Contractor
SS	Sensor System
ST	Stellar Terrain
STC	Satellite Tracking Command
SV	Satellite Vehicle
TM	Telemetry

T/R	Tape Recorder
TT&C	Tracking, Telemetry and Command
TU	Takeup Unit
TVC	Thrust Vector Control
VCTS	Vehicle Command and Transponder Set
VTT	Vandenberg Targeting Team

Section 1
SUMMARY OF GENERAL SYSTEM PERFORMANCE

1.1 SV MISSION PERFORMANCE

The SV-5 was injected into a nominal 85 by 154 nm orbit on 9 March 1973 by a Titan IIID Booster Vehicle. 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. The four RVs were successfully recovered in the air on Revs 196, 424, 651, and 1024 which occurred on Mission Days 13, 27, 41 and 64. The ST-RV (RV-5) was successfully recovered in the air on Rev 683 in Mission Day 43. Following a seven day SOLO operation (which is not described in this report), the SV was successfully deboosted on Rev 1139 in the 71st day on orbit. The performance of the SV with respect to the primary mission objectives is summarized for each of the four mission segments and for the ST-RV as follows:

<u>Segment One</u>

Operational photography did not begin until Rev 11 because of a failure of the Instrumentation System Command and Control Unit (ISCCU) about 500 seconds after lift-off which delayed successful completion of the Sensor Subsystem (SS) health checks. The SS was operated with constraints of 5 inches per second (ips) maximum rewind velocity and no 120° scan angles nor 30° scan angles at $\pm 45^{\circ}$ center of scan locations to preclude mistracking except for 19 operations between Revs 141 and 176 when higher rewind velocities were permitted. On one of these operations a brief disturbance was indicated during film path startup, suggesting rubbing, and the 5 ips limit was reimposed for the rest of the mission. All other SS operations throughout RV-1 demonstrated nominal characteristics. Approximat ely 27,300 feet of film per camera (including prelaunch footage) were exposed and stowed in RV-1. Post-flight analysis (PFA) showed the overall quality of the acquired photography ranging from very good to poor in both cameras with the bulk rated fair. A significant portion of the poor rated photography was attributed to haze and other weather conditions.

Segment Two

Operational photography exhibiting nominal characteristics continued with the same constraints imposed during RV-1. On Rev 243 the focus of the aft looking (B) camera was adjusted with a 12 micron advance on the basis of RV-1 photography evaluation, the forward looking (A) camera not having to be changed.

Approximately 27,400 feet of film per camera were exposed and stowed in RV-2. PFA showed photographic quality about the same as on RV-1 with haze and weather continuing to degrade quality but with improved B camera imagery from the aforementioned focus adjustment.

Segment Three

Nominal operational photography continued with the same restraints except for a minor telemetry anomaly on Rev 324 which did not effect operations. The A Camera film speed (v_f) was adjusted with the OOAA as indicated by PFA of RV-2 photography. On Rev 523, an SV yaw attitude error developed and V_y compensation was employed to minimize image degradation as was done on SV-4. Approximately 28,460 feet of A camera film and 28,620 feet of B camera film were exposed and stowed in RV-3. (The difference in footage was produced by the first mono operation of the B Camera required to utilize the greater length of film on this side which did not contain any color film.) PFA again showed similar imagery with the best comparable to that of the previous RVs and also showed that the V_y compensation for the yaw error was effective in correcting for most of the error which caused as much as 30 lines/mm loss of resolution prior to the compensation.

Segment Four

Operational photography continued to exhibit nominal characteristics with the same constraints imposed previously. Further adjustments of V_y and OOAA were made to compensate for the yaw error which fluctuated between 0° and 3° during this segment. The transition from black-and-white film to the 2000 feet of SO-255 color film on the A Camera was successfully completed on Rev 971. The A Camera film supply was depleted on Rev 1015 and the B Camera's on Rev 1016. Approximately 24,760 feet of A Camera film, and 26,420 feet of B camera film were exposed and stowed in RV-4. The overall quality of the acquired photography was rated good by PFA with reduced haze and better weather than in previous segments. The best imagery of both cameras was very good and at least equal to the best on the other segments. The color photography was comparable to that of SV-4 and the best color frame nearly equal to the corresponding B camera black-and-white frame.

Stellar Terrain Cameras

During 42 days of operation, 1982 frames were exposed on both stellar and terrain cameras of which 19 were used for inflight calibration. An additional 195 frames were cycled at the completion of the calibrate mode to deplete the stellar film supply. The terrain camera photography was excellent significantly exceeding predicted quality levels (ground resolved distance) based on acceptance test results. Numerous man-made features were recognized, e.g., baseball diamonds, homes with driveways, aircraft on runways, etc. – outstanding for this scale. Exposure levels were basically correct with only a small percentage falling in the overexposed category and the majority of these were of snow or sand covered areas. The lens and filter design produced correct exposure over the entire format, a feature not normally observed in wide angle camera photography. The stellar photography also exceeded predicted results providing an average of 50 to 100 star images per frame with many recording as high as 150. Weather conditions were generally good with approximately 75 percent of the ST photoggraphy being cloud free. Two anomalies involving the malfunction of the terrain thermal door and the tape stop switch were encountered.

1.2 ANOMALY SUMMARY

Significant anomalies and malfunctions are listed chronologically in Table 1-1. The list includes a description of the anomaly, the mission consequences, the changes indicated for subsequent vehicles and a cross-reference to the appropriate paragraphs where detailed discussions may be found.

Table 1-1

ANOMALIES

Day	Description	Impact	Cross Reference Paragraph
1	ISCCU failure.	Start of P/L ops delayed to Rev 11. Flight continued with only film chute pressure available.	7.5
1	ST thermal door failed to open	No effect on mission. Switched to redundant electronics on Rev 16.	11.2
1	DBS antenna did not deploy	No effect on mission. System performed satisfactorily in stowed position. Thermal tape may have prevented deployment. Inspection augmented.	11.5
3	ST thermal door failed to open.	No effect on mission. Attributed to telemetry based on factory tests.	11.2
5.	H/S inhibit one rev only	No effect on mission. Probable cause was solder joint crack or poor bond. Design changes and added burn-in on Block II. Additional 100 hour burn-in on SV-6.	2.1.6
6	ST thermal door failed to close	Operations restricted to latitudes less than 50°N. Doors being redesigned.	11.2
7	RTS unable to achieve range lock	No impact on mission. All RTS except HULA and COOK increased mod index to 0.3 radian.	4.1
10	TM indicated possible rubbing of film during startup	Reinstated 5 ips rewind restriction that was relaxed on Revs 151 to 176.	7.1
13	RV 4 temperature deviated from T_{ref} by more than 0.7°F as heater failed to come on.	No mission impact-anomaly disappeared after Rev 207. Probable cause was bad bond or solder connection. Added burn-in time for SV-6 during testing.	12.4

Table 1-1

ANOMALIES

Day	Description	Impact	Cross Reference Paragraph
15	PACS pitch rate bias	No effect on mission. Disappeared on Day 17. Internal short in gyro torquer circuit. Design being modified.	2.1.5
22	Noted excessive ST film frame count	Total loss 31 frames. ST tape stop switch failed. More frames transported than commanded. Switched to backup system on Rev 503.	11.3
31	TU3 select discrete lost	No effect on mission. After transfer on Day 41 TU4 select discrete indicated properly.	7.5
32	RCS 2 REM leak	No effect on mission. RCS 2 valves started to leak as expected. Switched to RCS 1 on Day 32 and completed flight using OAS propellant.	2.2
33	RACS yaw rate bias	P/L ops continued with V_y and OOAA adjustments for rest of mission. Gyro rate bias similar to PACS pitch gyro rate bias. Thought to be internal short in torquer circuit. See Reference Paragraph.	2.1.5
36	PACS pitch rate bias	No effect on mission since control previously shifted to RACS on Day 32. See Reference Paragraph.	2.1.5
41	RV 3 recovery light flashing on "reel-in"	No mission impact. Water sensor switches shorted by debris. Protective cap being installed.	8.3
42	ST thermal door failed to open.	ST calibration unsuccessful. Calibration done in coldest part of orbit. Doors being redesigned.	11.2

Section 2
ATTITUDE CONTROL

2.1 ATTITUDE CONTROL SYSTEM (ACS)

The ACS performed as expected during the mission except for three anomalies - PACS pitch bias, RACS yaw bias and RACS H/S inhibit. The summaries in this section detail those requirements that could be verified from flight data. The performance of the Reaction Control System equipment is reviewed in Subsection 2.2.

2.1.1 BV/SV Separation

BV/SV separation was completed at approximately 544.7 seconds vehicle time (Vehicle time started 67.6 seconds prior to lift-off). Master clear-off (MCLR), which enabled the pitch, roll and yaw integrators to accumulate angle, was at 513.4 seconds and SECO, which terminates BV attitude control, occurred at 532.7 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 2-1. Also, the times in which the SV attitudes and rates came back within the specified limits following BV/SV separation (capture) are shown in Table 2-1.

2.1.2 Payload Operations

The SV attitude specification during payload operations is the same as shown for capture in Table 2-1. There were no payload operations during the first PACS pitch gyro rate bias anomaly that occurred when the bias was present and control was switched to RACS before the pitch bias reappeared. Also since the RACS H/S Inhibit on Rev 67 occurred when PACS was controlling the vehicle, the inhibit did not affect payload operations.

Subsequent to Rev 519 the yaw gyro rate bias anomaly, discussed in Section 2.1.5, resulted in SV roll and yaw attitude offsets. The roll attitudes as measured with the horizon sensor and the yaw attitudes as calculated with the relationship below are tabulated in Table 2-2 for each SS payload operation from Rev 519 to the end of the mission.

$$\psi_\epsilon = \frac{H_\phi}{\omega_o H_\psi} \omega_z + \psi_I$$

Table 2-1
BV/SV-5 SEPARATION

	Rate and Attitude at BV/SV Separation						Capture			
	Rate (deg/sec)		Attitude (degrees)				Attitude		Rate	
			H/S at SEP		Δ (SECO-SEP)					
	Specified	Actual	Specified	Actual	Specified	Actual H/S/Int.	Specified (1) (deg)	Actual(2) (time in sec)	Specified (3) (deg/sec)	Actual(4) (time in sec)
Pitch	±.752	-.244	-22.85 to +9.63	2.80	-0.49 to -4.03	-1.28/ -1.49(5)	±0.70	(6)	±0.014	(6)
Roll	±.786	-.197	-7.50 to +10.94	1.40	+2.99 to +0.45	1.3/ 0.95	±0.70	(6)	±.021	(6)
Yaw	±.752	0.156	-7.66 to +11.50	—	+4.48 to +0.66	—/ 2.29	±0.64	(6)	±.014	(6)

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

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

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

(4) Actual time required to achieve specified rate.

(5) Relative to the local horizontal.

(6) Nominal performance indicating the pointing requirements are satisfied was observed at a nominal settling time of 520 seconds after the commanded switch to fine mode (662.1 seconds after separation). The total 1182.1 seconds is well within the spec of 1500 seconds and no closer study was performed.

Table 2-2

P/L OPS DURING YAW GYRO BIAS PERIOD

Rev	SSC Ops No.	Yaw Attitude (deg)	Roll Attitude (deg)	P/L Yaw Comp. (deg)
519	346	-0.6	-0.32	0
523	347	-0.2	-0.24	
524	348	-0.2	-0.24	
525	349	-0.5	-0.28	
525	350	-0.5	-0.28	
525	351	-0.5	-0.30	
525	352	-0.5	-0.26	
526	353	-1.3	-0.42	
526	354	-1.4	-0.48	
528	355	-1.3	-0.48	
528	356	-1.4	-0.52	
529	357	-1.0	-0.40	
534	358	-0.7	-0.26	
535	359	-0.7	-0.28	0
541	360	-0.9	-0.36	-1.0
541	361	-0.8	-0.34	
541	362	-0.7	-0.34	
544	363	-0.5	-0.24	
544	364	-0.5	-0.28	
544	365	-0.7	-0.26	
546	366	-0.7	-0.28	
550	367	-0.5	-0.28	
551	368	-0.7	-0.30	
556	369	-0.5	-0.30	
557	370	-0.5	-0.32	
558	371	-0.5	-0.30	
559	372	-0.7	-0.28	
559	373	-0.7	-0.32	
560	374	-0.5	-0.32	
560	375	-0.7	-0.34	
560	376	-0.6	-0.34	
561	377	-0.5	-0.20	
562	378	-0.5	-0.20	
565	379	-0.6	-0.28	
566	380	-0.2	-0.24	
568	381	-0.2	-0.20	
572	382	-0.2	-0.22	
574	383	0.0	-0.18	
575	384	0.0	-0.10	
575	385	-0.2	-0.20	
576	386	0.0	-0.18	-1.0

Table 2-2 (Cont.)

Rev	SSC Ops No.	Yaw Attitude (deg)	Roll Attitude (deg)	P/L Yaw Comp (deg)
576	387	0.0	-0.18	-1.0
576	388	-0.2	-0.12	-1.0
578	389	-0.2	-0.20	-0.5
578	390	-0.2	-0.18	↓
578	391	-0.2	-0.26	
578	392	-0.5	-0.24	
582	393	-0.2	-0.24	
589	394	0.0	-0.20	
590	395	-0.2	-0.20	
591	396	-0.2	-0.20	
591	397	-0.2	-0.22	
592	398	-0.8	-0.38	
592	399	-0.7	-0.32	
592	400	-0.7	-0.36	
593	401	-0.2	-0.20	
594	402	-0.3	-0.16	
594	403	-0.2	-0.18	
606	404	-0.5	-0.26	
606	405	-0.5	-0.26	
606	406	-0.2	-0.24	
606	407	-0.2	-0.20	
606	408	-0.2	-0.24	
607	409	-0.2	-0.24	
608	410	-0.2	-0.22	
608	411	-0.2	-0.20	
609	412	-0.2	-0.20	
610	413	-0.2	-0.20	
610	414	-0.5	-0.12	
616	415	-0.2	-0.20	
620	416	-0.5	-0.22	
622	417	-0.2	-0.20	
622	418	-0.2	-0.20	
624	419	-0.2	-0.16	
624	420	-0.3	-0.22	
626	421	-0.2	-0.24	
626	422	-0.2	-0.20	
626	423	-0.2	-0.24	
631	424	0.0	-0.20	
636	425	-0.2	-0.26	
637	426	-0.5	-0.28	
639	427	-0.2	-0.22	
640	428	-0.2	-0.22	
640	429	-0.2	-0.22	
642	430	-0.5	-0.28	
642	431	-0.5	-0.20	-0.5

Table 2-2 (Cont.)

Rev	SSC Ops No.	Yaw Attitude (deg)	Roll Attitude (deg)	P/L Yaw Comp (deg)
642	432	-0.2	-0.28	-0.5
654	433	-0.5	-0.20	↓
655	434	-0.5	-0.32	
655	435	-0.3	-0.32	
655	436	-0.7	-0.30	
657	437	-0.2	-0.20	
658	438	-0.5	-0.24	
659	439	-0.2	-0.22	
662	440	-0.2	-0.10	
667	441	-0.5	-0.32	
669	442	-0.5	-0.32	
670	443	0.0	-0.18	
671	444	-0.3	-0.20	
671	445	-0.2	-0.16	
671	446	-0.2	-0.16	
672	447	-0.2	-0.20	
672	448	-0.2	-0.24	
674	449	-0.5	-0.26	
674	450	-0.3	-0.24	
675	451	-0.2	-0.20	
677	452	-0.2	0.0	
686	453	-0.5	-0.22	
689	454	-0.2	-0.10	
690	455	-0.2	-0.24	
691	456	-0.2	-0.16	
691	457	0.0	-0.20	
696	458	-1.9	-0.54	
697	459	-1.7	-0.50	
699	460	-1.3	-0.48	
700	461	-1.7	-0.56	-0.5
706	462	-0.5	-0.30	-1.0
707	463	-0.5	-0.26	-1.0
707	464	-0.2	-0.22	-1.0
713	465	0.0	-0.16	-0.6
714	466	0.0	-0.16	-0.6
716	467	0.0	-0.16	-0.6
719	468	-0.2	-0.24	0.0
720	469	-0.2	-0.22	↓
721	470	-0.2	-0.20	
722	471	-0.5	-0.32	
723	472	-0.5	-0.26	
723	473	-0.5	-0.28	
724	474	-0.7	-0.30	
724	475	-0.8	-0.28	0.0

Table 2-2 (Cont.)

Rev	SSC Ops No.	Yaw Attitude (deg)	Roll Attitude (deg)	P/L Yaw Comp (deg)
729	476	-1.2	-0.40	-0.6
732	477	-1.0	-0.38	
738	478	-1.1	-0.32	
738	479	-1.1	-0.32	
738	480	-1.1	-0.32	
739	481	-1.1	-0.30	
739	482	-1.1	-0.30	
739	483	-1.1	-0.30	
739	484	-1.1	-0.30	
740	485	-0.8	-0.36	-0.6
746	486	-0.7	-0.32	0.0
752	487	-0.5	-0.10	-0.5
752	488	-0.5	-0.10	
752	489	-0.5	-0.10	
754	490	-0.5	-0.26	
755	491	-0.6	-0.24	
755	492	-0.6	-0.24	
756	493	-0.3	-0.20	
765	494	-0.5	-0.26	
768	495	-0.6	-0.20	
769	496	-0.6	-0.22	
769	497	-0.6	-0.22	
771	498	-0.6	-0.24	
771	499	-0.6	-0.24	
772	500	-0.2	-0.24	
781	501	-0.8	-0.26	
783	502	-0.5	-0.28	
784	503	-0.7	-0.22	
784	504	-0.7	-0.22	
785	505	0.0	-0.08	
785	506	0.0	-0.08	
787	507	0.0	-0.16	
787	508	0.0	-0.16	
787	509	0.0	-0.16	
788	510	0.0	-0.16	
788	511	0.0	-0.16	
788	512	0.0	-0.16	
791	513	-0.3	-0.08	
794	514	0.0	-0.14	
794	515	0.0	-0.14	
795	516	-0.4	-0.16	
800	517	-0.0	-0.12	-0.5

Table 2-2 (Cont.)

Rev	SSC Ops No.	Yaw Attitude (deg)	Roll Attitude (deg)	P/L Yaw Comp (deg)
801	518	-0.1	-0.10	0.0
801	519	-0.1	-0.10	↓
802	520	0.0	-0.10	↓
802	521	0.0	-0.10	↓
802	522	0.0	-0.10	↓
803	523	0.0	-0.16	↓
803	524	0.0	-0.16	↓
803	525	0.0	-0.16	↓
804	526	0.0	-0.08	↓
805	527	0.0	-0.12	↓
810	528	-0.2	-0.10	↓
810	529	-0.2	-0.10	↓
815	530	-0.6	-0.20	↓
817	531	-0.8	-0.30	↓
817	532	-0.8	-0.30	↓
817	533	-0.8	-0.30	↓
817	534	-0.8	-0.30	↓
817	535	-0.8	-0.30	↓
818	536	-0.8	-0.28	↓
818	537	-0.8	-0.28	↓
819	538	-0.5	-0.20	↓
819	539	-0.5	-0.20	↓
820	540	-0.8	-0.32	↓
820	541	-0.8	-0.32	↓
820	542	-0.8	-0.32	↓
821	543	-1.1	-0.36	↓
821	544	-1.1	-0.36	↓
821	545	-1.1	-0.36	↓
821	546	-1.1	-0.36	0.0
834	547	-1.2	-0.50	-0.5
835	548	-1.7	-0.54	-0.6
836	549	-1.2	-0.46	↓
836	550	-1.2	-0.46	↓
837	551	-1.3	-0.50	↓
837	552	-1.3	-0.50	↓
844	553	-1.6	-0.44	-0.6
850	554	-2.9	-0.80	-1.0
851	555	-2.8	-0.72	-1.4
851	556	-2.8	-0.72	↓
852	557	-2.8	-0.84	↓
853	558	-2.9	-0.80	↓
853	559	-2.9	-0.80	↓
853	560	-2.9	-0.80	-1.4

Table 2-2 (Cont.)

Rev	SSC Ops No.	Yaw Attitude (deg)	Roll Attitude (deg)	P/L Yaw Comp (deg)
853	561	-2.9	-0.80	-1.4
854	562	-2.9	-0.72	-1.4
860	563	-1.3	-0.44	-2.5
865	564	-2.0	-0.64	-1.4
865	565	-2.0	-0.64	↓
866	566	-1.2	-0.40	
866	567	-1.2	-0.40	
866	568	-1.2	-0.40	
867	569	-1.2	-0.30	
868	570	-0.8	-0.32	
868	571	-0.8	-0.32	
869	572	-1.9	-0.60	
869	573	-1.9	-0.60	
869	574	-1.9	-0.60	
869	575	-1.9	-0.60	
870	576	-2.1	-0.54	
876	577	-0.5	-0.32	
884	578	-1.9	-0.30	
884	579	-1.9	-0.30	
884	580	-1.9	-0.30	
884	581	-1.9	-0.30	
885	582	-0.9	-0.32	
886	583	-0.9	-0.26	
891	584	-0.5	-0.40	
902	585	-0.5	-0.30	
902	586	-0.5	-0.30	
902	587	-0.5	-0.30	
902	588	-0.6	-0.26	
902	589	-0.2	-0.26	
907	590	-0.3	-0.24	
908	591	-0.3	-0.24	-1.4
915	592	-1.0	-0.40	-0.6
915	593	-1.0	-0.40	↓
918	594	-0.5	-0.32	
918	595	-0.5	-0.32	
918	596	-0.5	-0.32	
923	597	-0.8	-0.32	
930	598	-1.2	-0.44	
934	599	-1.1	-0.42	
934	600	-1.1	-0.42	
941	601	-1.4	-0.54	
947	602	-0.6	-0.28	-0.6

Table 2-2 (Cont.)

Rev	SSC Ops No.	Yaw Attitude (deg)	Roll Attitude (deg)	P/L Yaw Comp (deg)
947	603	-0.6	-0.28	-0.6
947	604	-0.6	-0.28	↓
948	605	-0.5	-0.28	
949	606	-0.5	-0.26	
950	607	-0.5	-0.28	
957	608	-0.5	-0.22	
963	609	-0.3	-0.10	
963	610	-0.3	-0.10	
963	611	-0.3	-0.10	
964	612	-0.3	-0.20	
964	613	-0.3	-0.20	
964	614	-0.3	-0.20	
965	615	-0.3	0.0	
965	616	-0.3	0.0	
965	617	-0.3	0.0	
966	618	-0.3	-0.10	
967	619	-0.6	-0.26	
973	620	-0.3	-0.22	
979	621	-1.6	-0.50	
979	622	-1.6	-0.50	
980	623	-2.0	-0.50	
989	624	-1.8	-0.50	
995	625	-0.6	-0.28	
996	626	-0.6	-0.26	
998	627	-0.6	-0.20	
999	628	-0.3	-0.26	
999	629	-0.3	-0.26	
1000	630	-0.8	-0.30	
1003	631	-0.5	-0.10	
1006	632	-1.1	-0.36	
1011	633	-0.6	-0.32	
1012	634	-0.8	-0.36	
1014	635	-0.8	-0.36	
1014	636	-0.8	-0.36	
1015	637	-0.8	-0.36	
1016	638	-1.1	-0.40	-0.6

where

ψ_ϵ = yaw attitude

H_ϕ = roll H/S to roll gain, 0.0055 $\sec^{-1}$

H_ψ = Roll H/S to yaw gain, 0.01667 $\sec^{-1}$

ω_o = orbital rate, 0.0012 rad/sec

ω_z = yaw gyro rate as observed on controlling ACS, deg/sec

ψ_I = yaw integrator output, deg

Some yaw compensation was used by the payload and the reported amount is also shown in Table 2-2. The SV rates were within the required limits during all SS operations.

2.1.3 Mapping Camera Module (MCM) Operations

The SV behavior during the ST operations and the calibration maneuvers is discussed in this section. The ST-RV recovery is discussed in Section 2.1.4.

2.1.3.1 ST Operations. A PACS pitch gyro rate bias started on Rev 230 and was intermittent until Rev 276. This rate bias resulted in pitch attitude offsets of varying magnitudes. The only significant offset occurring during an ST operation was on Rev 273 where from 615716 to 615996 sec vehicle time, the SV pitch attitude was as great as -1.2 deg as measured with the pitch H/S. The SV attitude specification during ST operations is:

Pitch	±1.2 deg,	±0.014 deg/sec
Roll	±1.2 deg,	±0.021 deg/sec
Yaw	±1.14 deg,	±0.014 deg/sec

The RACS yaw gyro rate bias started on Rev 519 and continued through Rev 683. This rate bias resulted in yaw and roll offsets of varying magnitudes. The magnitudes of these offsets are tabulated for each SS payload operation in Table 2-2 and may be correlated with the ST operations which occurred at similar times.

2.1.3.2 MCM Calibration Maneuvers. Two large negative pitch maneuvers were executed on Revs 665 and 668 for the purpose of MCM calibration. The command times for the maneuvers were such as to effect a -153.0 deg pitch-down on Rev 665 and a -160.5 deg pitch-down on Rev 668.

Rev 665 Maneuver

The yaw rate bias (section 2.1.5) at the start of the pitch-down was zero. The maximum yaw rate bias at any time from the start of the pitch-down to the start of pitch-up was +0.002 deg/sec. A rate bias of +0.002 deg/sec results in a vehicle rate of -0.002 deg/sec with gyrocompassing disconnected.

The maximum vehicle rates measured during the calibrate period from 187841.4 to 187948.2 sec vehicle time were:

	Actual	Specification
Pitch Rate, max	+0.004 deg/sec	±0.014 deg/sec
Roll Rate, max	+0.012 deg/sec	±0.021 deg/sec
Yaw Rate, max	-0.004 deg/sec	±0.014 deg/sec

Since the maneuver was not performed over a station, PDWN (which integrates the rates to compute the attitudes) information is not available. However, as all rates were within spec and times were as commanded, the vehicle attitude should have been within the ±3.0 degrees of the desired value. During pitchdown the H/S is inhibited so there is no direct confirming evidence of the attitude.

Rev 668 Maneuver

The yaw rate bias at the start of the pitch-down was +0.004 deg/sec. The bias rate did not exceed that value for the remainder of the calibration sequence. The maximum vehicle rates measured during the calibrate period from 203701.4 to 204035.4 sec vehicle time were:

	Actual	Specification
Pitch Rate, max	+0.006 deg/sec	±0.014 deg/sec
Roll Rate, max	+0.016 deg/sec	±0.021 deg/sec
Yaw Rate, max	-0.007 deg/sec	±0.014 deg/sec

For the same reasons discussed for the Rev 665 maneuver, the attitude requirements were not verified.

2.1.4 Recovery

The pitch-down maneuvers preceding the 4 RVs and ST-RV (RV-5) separations were all within specification and are summarized in Table 2-3. The RV separation performance summary is shown in Table 2-4.

The RV-5 recovery is performed with the SV yawed 180 deg and pitched-down, with the release taking place along the SV X-axis. The yaw rate bias was present during the maneuvering and separation sequence. The vehicle rate and attitude parameters at RV-5 separation were as follows:

Pitch Rate	+0.067 deg/sec
Roll Rate	0
Yaw Rate	-0.003 deg/sec
Pitch Attitude	-63.8 deg
Roll Attitude	+1.8 deg
Yaw Attitude	-2.0 deg

The yaw attitude is estimated based on simulation and analysis results.

Table 2-3

PITCH DOWN PERFORMANCE PRECEDING RV SEPARATIONS

RV/Rev	Pitch-Down Angle		Maneuvering Time to ≤ 0.1 Deg/Sec		Pitch-Down Coast Rate		
	Desired ±3.0 Deg	Actual (PDWN)	Specified (sec)	Actual (sec)	Command Rate (deg/sec)	Coast Rate Expected (deg/sec)	Coast Rate Actual (PGR) (deg/sec)
1/196	-33.6	-33.0(1)	150	71	-.705	-.75 ±.05	-.72
2/424	-37.5	-36.7	150	75	-.705	-.75 ±.05	-.72
3/651	-37.6	-37.5	150	75	-.705	-.75 ±.05	-.73
4/1024	-37.2	-36.7	150	78	-.705	-.75 ±.05	-.71
5/683(2)	-64.4	-63.8	—	—	-.705	-.75 ±.05	-.70

(1) Data dropouts

(2) Pitch-down maneuver performed while nose aft.

Table 2-4

SUMMARY OF RV/SV SEPARATION PERFORMANCE

RV/Rev	Peak Pitch Rate (deg/sec)	Max Pitch Integrator Angle (deg)	Induced Impulse by RV (lb-sec)	Pitch-Down Prior to Separation (deg)	Pitch-Up Following RV Sep to Removal of Manvr Cmd (deg)	Pitch Inertia (After Sep) (slug-ft^2)	Pitch Thruster Moment Arm (ft)	Roll Angle	
								Spec (deg)	Meas H/S (deg)
1/196	1.49	5.7	137.7	-33.0	98.8	142464	16.4	±1.0	-.12
2/424	1.36	5.1	131.0	-36.7	99.1	122532	15.6	±1.0	-.08
3/651	1.22	3.9	134.2	-37.5	99.3	109698	14.9	±1.0	-.20
4/1024	1.33	8.4	145.0	-36.7	33.7	86196	13.8	±1.0	-.06

2.1.5 IRA Anomalies

The PACS developed a gyro pitch rate offset (.016 degree per second) on Rev 230 that continued intermittently to Rev 276. It did not reappear until Rev 577 after which the offset was always present. Since control was shifted to RACS on Rev 512, this did not affect control of the SV. At Rev 596 the positive offset changed to a negative offset of −.014 deg/sec and subsequently changed signs at random intervals. During Rev 671 there was a rapid mode switching between high and low mode with a cycle period of .167 sec.

The RACS developed a positive gyro yaw rate offset (.003 degree per second) on Rev 519 which continued throughout the remainder of the flight producing the attitude history shown in Table 2-2. The maximum yaw rate offset was .007 deg/sec.

The most probable cause of the rate offsets seen from IRA 1005 (PACS) and 1016 (RACS) is one or more high impedance shorts from the torquer circuits to the case inside gyros X17 (PACS) and Y7 (RACS). This is believed to be the same anomaly that occurred on the yaw channels of SV-4.

The yaw and positive pitch offsets observed correlate well with the characteristics of a torquer short one of which is a function of the input rate between high and low modes and another which distinguishes between Pin 14 as compared to Pins 2, 9, or 21. The negative pitch offset correlates in the high mode but was too erratic to correlate positively in the low mode.

A single torquer short would not allow a sign change in the offset rate; therefore, the PACS pitch offset changes of sign indicate either two shorts or another cause may be present. It is thought two shorts were present: (1) one on Pin 14 of the high torquer estimated between 8K ohms and 1 megohm since a short with a resistance between 8K and 20K ohms will cause mode switching as seen during Rev 671; and (2) one on Pins 2, 9 or 21 in the 100K ohm range which does not vary as much as the Pin 14 short.

Two remedial steps are being taken:

(1) Isolation of the torquer circuits and their returns from signal or case ground

(2) Insertion of a diode in the collector circuit of the torquer switching semiconductors to eliminate reverse offset currents

Ground testing of Y14R exhibited a rate bias anomaly while installed in IRA 1019. It was then installed in Test Bed IRA 1003 which was modified to permit isolation of the torquer circuit. When the rate bias occurred, it was removed by isolating the torquer circuit. Gyro Y14R is to be disassembled to determine the shorting mechanism causing the rate bias.

2.1.6 Horizon Sensor (H/S) Inhibit Anomaly

A RACS H/S inhibit condition was noted during the POGO pass on Rev 67. This condition also existed during two data sampling periods prior to POGO. Performance prior and subsequent to this period was normal. During the inhibit condition the roll output remained steady while the pitch output tracked the vehicle pitch attitude indicating a one head (or channel) inhibit which was probably in the right channel. The most probable cause is thought to be a cracked solder joint or poor bond in an active component. This type problem could occur abruptly and heal itself just as abruptly.

An attempt was made in the SOLO flight to cause a recurrence of the inhibit anomaly by producing a partial temperature cycle but no inhibit was produced. Review of history, procedures and inspection methods have not revealed any areas that could have caused the observed anomaly.

Although not instigated by this anomaly, the design changes and the added burn-in time (continuous monitoring) on Block II were implemented to preclude the occurrence of this type anomaly on future vehicles. An additional 100 hours of burn-in has been conducted on the SV-6 Horizon Sensor.

2.2 REACTION CONTROL SYSTEM

2.2.1 Flight Summary

History of RCS propellant consumption and flight are shown graphically in Figure 2-1.

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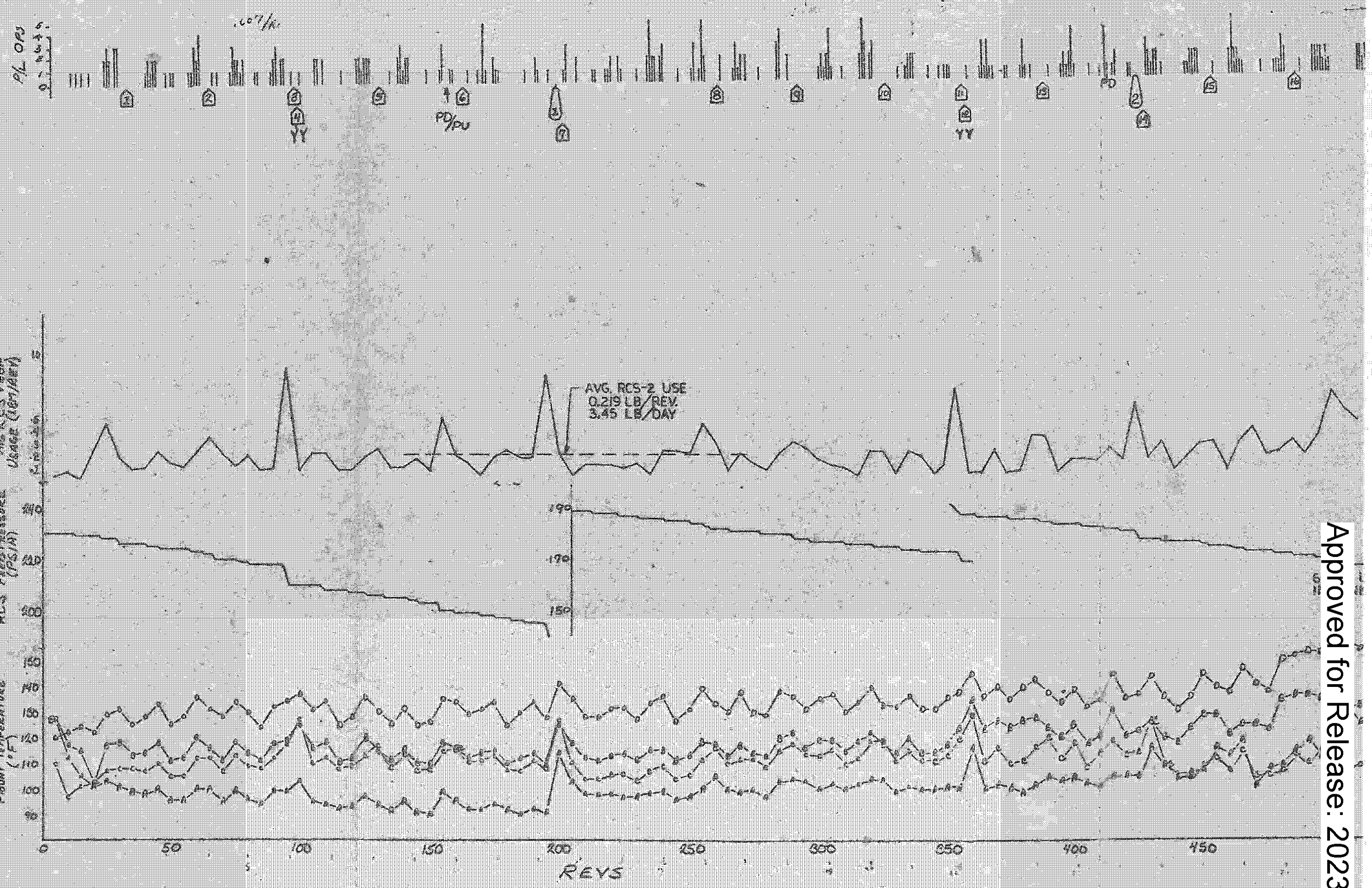
P/L OPS
.007/R
1
2
3
4
YY
5
6
PD/PU
1
7
8
9
10
11
12
YY
13
PD
2
14
15
16
AVG RCS PROP USAGE (LBM/REV)
AVG. RCS-2 USE
0.219 LB/REV.
3.45 LB/DAY
RCS FEED PRESSURE (PSIA)
240
220
200
190
170
150
MOUNT TEMPERATURE (°F)
150
140
130
120
110
100
90
0
50
100
150
200
250
300
350
400
450
REVS

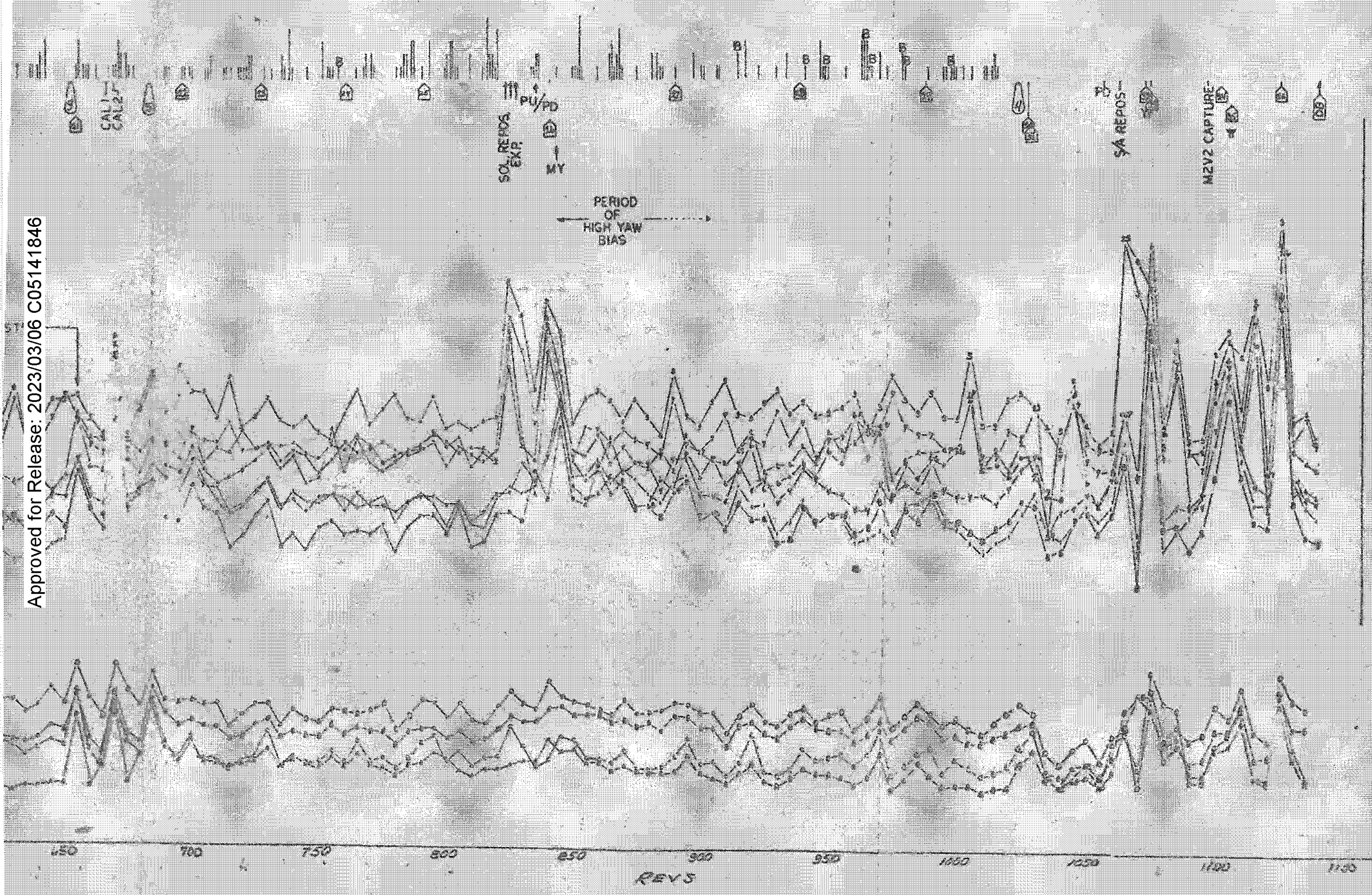

Figure 2-1 History of RCS Propellant Consumption

Satisfactory vehicle and rate control were provided by the RCS System during the 71 Day flight. Leakage developed in the standby system (RCS 2) as expected and control was switched to the primary system (RCS 1) on Day 32. No further leakage was detected throughout the remainder of the flight since non NVR propellant was supplied from the OAS Tank.

2.2.2 Propellant Consumption

RCS propellant consumption for the 71 day mission was computed to be 333 pounds. Propellant was consumed from RCS Tanks 3 and 4 until Day 32 when control was switched to RCS 1 which was fed directly from the OAS Tank. The standard leakage signatures (an abrupt mount temperature increase and excessive propellant consumption) were observed starting on Day 29. After switching to RCS 1, no abrupt temperature increases were noted in either the individual REA or the mount temperature monitors. The daily RCS propellant consumption does not provide an early leak detector as the ullage is too large on the OAS Tank to accurately measure the pressure change caused by a nominal 5.0 pound per day usage rate.

2.2.3 Thruster Performance

The thrust level was determined, prior to Day 32, by using gyro rate information. Results of the study is shown in Table 2-5 for the pitch thrusters. REA 7' consistently indicated a lower thrust than the others; however, the indicated thrust was well above the minimum 2.5 pounds specified.

After Day 32, the thruster performance of RCS 1 was determined from the thruster chamber pressures and from gyro data when available. Neither RCS 1 nor RCS 2 exhibited the thrust decay observed at Rocket Research during the Extended Life Thruster Evaluation Test (ELTET). Figure 2-2 is a plot of the chamber pressure tailoff times. The doubling of tailoff time was used as the onset of pulse shape distortion which in turn preceded the drop in thrust during the ELTET. As shown, tailoff times for the period after Rev 1100 doubled even though for these values the REA temperatures were high (in excess of 1000°F) which has the effect of shortening the tailoff times, but no change in calculated I_{Bit} or I_{sp} was observed.

Table 2-5
RCS2 THRUST LEVELS

Rev	154 (Pitch down)		154 (Pitch Up)		413	
Thrust	Act	Norm	Act	Norm	Act	Norm
2'	4.89	5.13	4.10	4.30	4.39	5.67
3'	5.05	5.30	5.94	6.23	4.39	5.67
Combined	9.94	10.43	10.05	10.54	8.79	11.36
6'	5.17	5.42	5.69	5.97	4.30	5.55
7'	3.69	3.87	4.02	4.21	3.18	4.11
Combined	8.86	9.29	9.71	10.19	7,49	9.68

Act — Actual chamber pressure and thrust

Norm — Actual values normalized to a feed pressure of 220 psia

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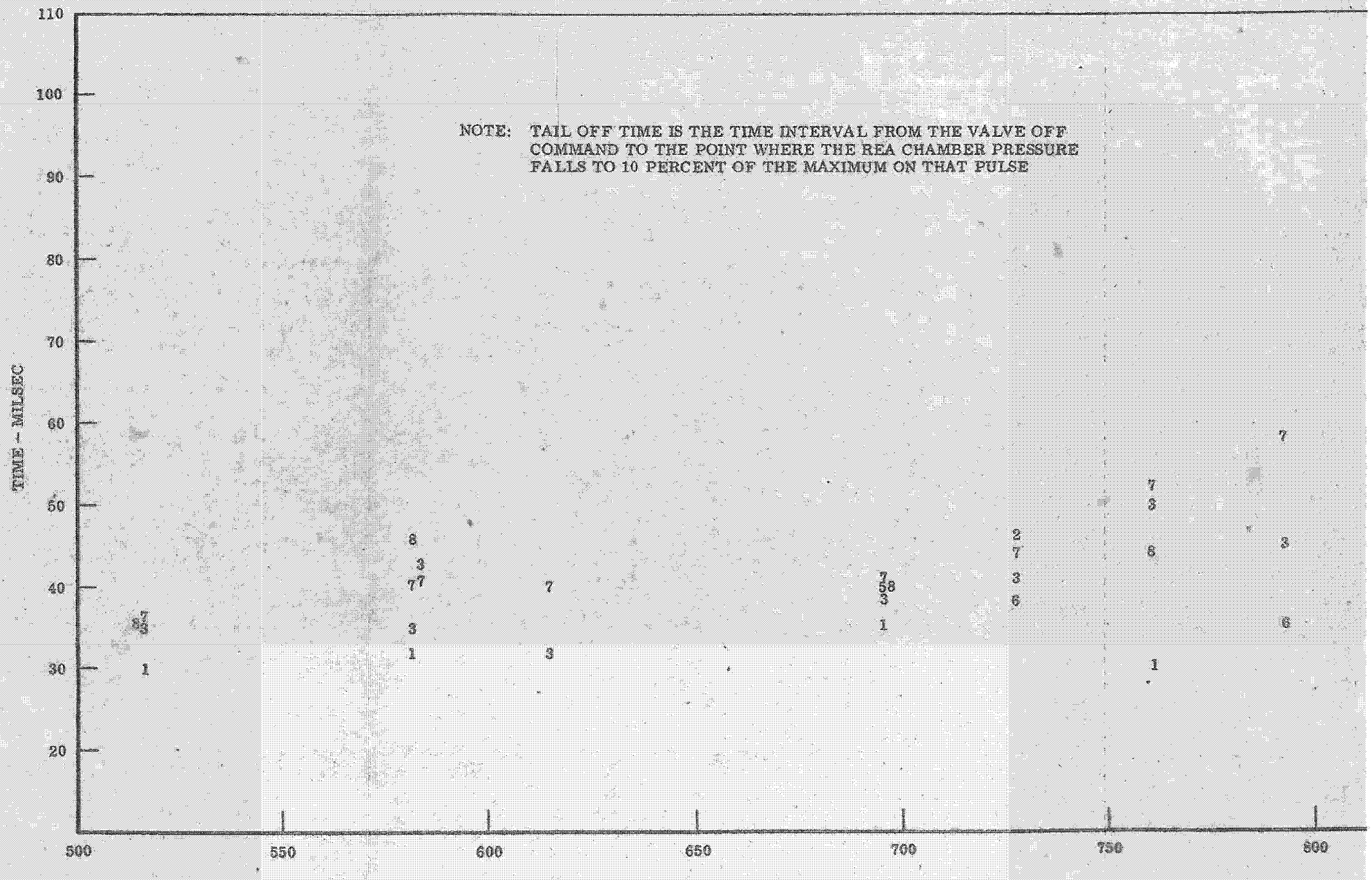

NOTE: TAIL OFF TIME IS THE TIME INTERVAL FROM THE VALVE OFF COMMAND TO THE POINT WHERE THE REA CHAMBER PRESSURE FALLS TO 10 PERCENT OF THE MAXIMUM ON THAT PULSE

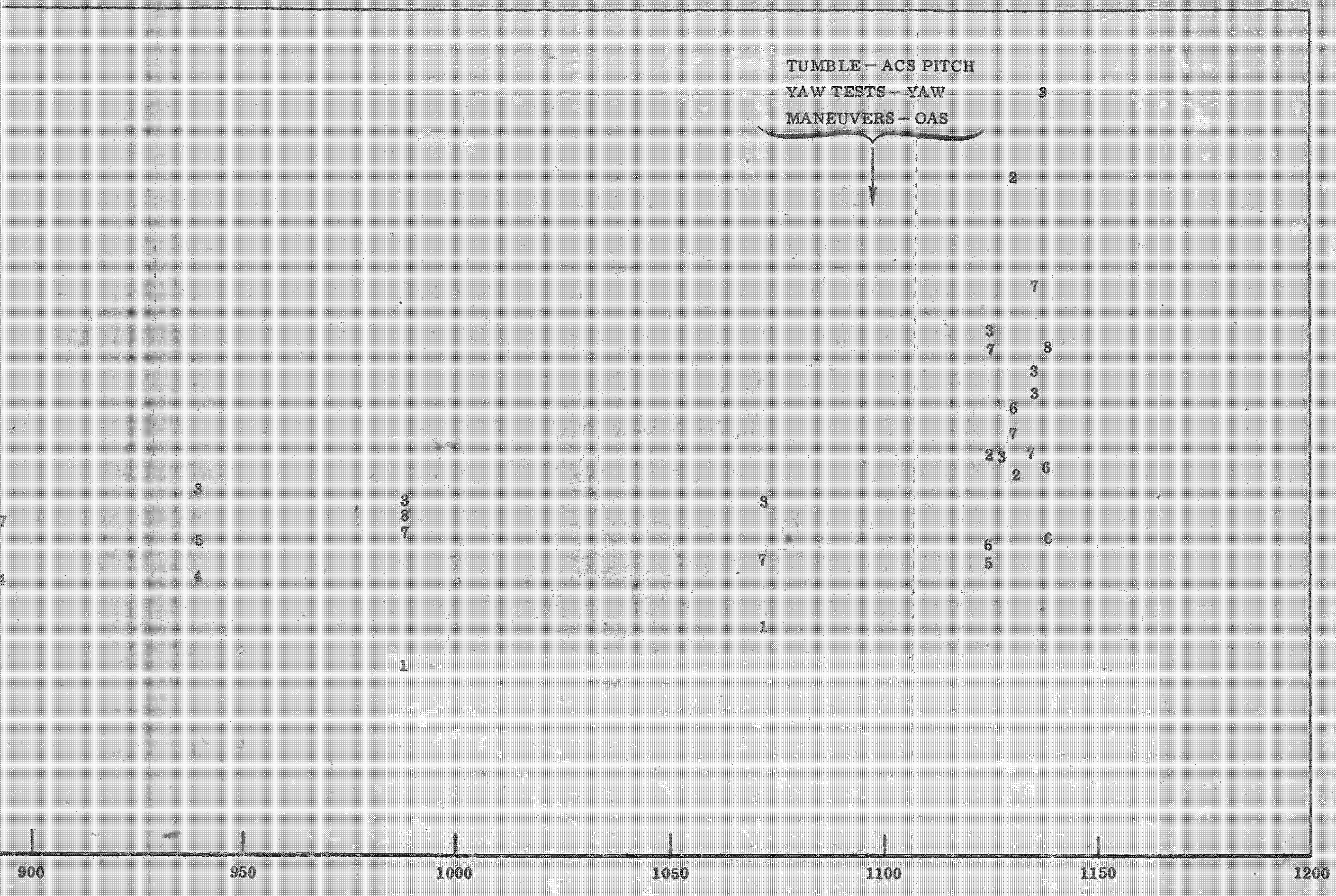

FIG. 2-2 TAIL OFF TIMES FOR RCS 1

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A comparison between the thrust obtained using gyro information and thrust determined using chamber pressure information is being made using data from this flight; however, the comparison is not complete at this time.

2.2.4 Conclusions

- Elimination of the use of the NVR fuel from the RCS tankage stopped the RCS valve leakage.
- Thrust degradation was not experienced on this flight as observed in ground tests; however, pulse shape changes were noted toward the end of mission.

Section 3

ORBIT ADJUST

3.1 ORBIT CONTROL

The Orbit Adjust System (OAS) was utilized 29 times during the active mission and 12 times during the SOLO phase.

The engine I_{sp} was slightly higher than for previous engines, but the OA firings were all normal and engine performance was well within specifications. The catalyst bed pressure drop exhibited a rapid decline and reached values lower than previously experienced on flight or test engines. This low ΔP and high chamber temperature were the prelude to suspected engine wash-out which occurred during ground testing, Therefore, to determine if this would occur a long out-of-plane burn was planned prior to SV-5 deboost during SOLO. This 190 second burn (curtailed in length due to data problems) and the subsequent shorter deboost burns discussed in Section 3.2 did not show any signs of wash-out. All ground and flight data to date indicates that washout is of no concern for the shorter drag make up burns under 100 seconds but only for the longer deboost burns of near 300 seconds or longer. The mechanism for wash-out is not well understood so an attempt is being made to correlate engine flow characteristics with flight performance to ascertain the controlling wash-out parameters. Additional engine injector flow tests are also being run.

3.2 DEBOOST

For the deboost phase of the mission, the OA engine was pulsed five times (155, 150, 150, 150, and 100 seconds) with an off-time of five seconds between pulses. Total firing duration was 705 seconds to achieve a planned negative velocity increment of 298 ft/sec. Engine operation was nominal. Pulse firings were employed to assure thrust integrity for each burn with engine wash-out.

Table 3-1
OAS PERFORMANCE

OA Firing No.	Rev No.	Impulse Delivered (lbf-sec)	Planned ΔV (ft/sec)	Achieved ΔV (ft/sec)	Percent Error ΔV
1	30	5249	7.89	8.04	+1.99
2	62	14923	22.43	22.90	+2.10
3	94	19897	29.97	30.63	+2.21
4	96	12319	18.85	19.04	+1.03
5	127	10299	15.65	15.92	+2.05
6	159	9764	14.85	15.18	+2.24
7	198	21494	35.25	36.20	+2.69
8	257	10654	17.71	18.02	+1.76
9	289	11407	18.94	19.35	+2.13
10	322	10436	17.53	17.76	+1.31
11	354	18662	31.09	31.83	+2.41
12	356	8847	14.77	15.16	+2.64
13	387	14363	23.82	24.66	+3.53
14	426	11902	22.01	22.36	+1.58
15	452	6251	11.48	11.79	+2.67
16	484	10219	18.78	19.29	+2.69
17	516	11215	20.69	21.25	+2.71
18	549	11445	21.24	21.75	+2.38

Table 3-1 Continued

OA Firing No.	Rev No.	Impulse Delivered (lbf-sec)	Planned ΔV (ft/sec)	Achieved ΔV (ft/sec)	Percent Error ΔV
19	581	11292	21.27	21.53	+1.23
20	614	8638	16.55	16.53	-0.17
21	653	19329	40.72	40.83	+0.26
22	695	9494	20.74	20.76	+0.06
23	717	11421	25.07	25.06	-0.02
24	760	9083	19.26	19.61	+1.83
25	792	12521	26.81	27.68	+3.23
26	841	21905	47.78	48.64	+1.79
27	890	12750	28.39	28.51	+0.41
28	938	13751	30.67	30.88	+0.70
29	987	17892	39.99	40.38	+0.98
30	1027	7277	18.15	18.49	+1.89
31	1027	7362	18.19	18.75	+3.09
32	1071	3313	8.65	8.47	-2.08
33	1073	8796	22.27	22.50	+1.01
34	1101	6589	16.81	16.92	+0.68
35	1105	32745	84.50	84.20	-0.35
36	1124	3561	9.27	9.55	+3.02
Deboost	1139	112445	-298.11	*	—

*Ephemeris data not available.

Section 4

TRACKING, TELEMETRY AND COMMAND (TT&C)

4.1 TRACKING

RTS COOK and POGO reported inability to achieve range lock on Revs 105 and 106, respectively. Range lock was achieved on Rev 107 at HULA and KODI but not at 110 GUAM or 111 POGO and BOSS. Configuration was SGLS1 and the RTS were using 0.1 radian mod index. When the uplink mod index was increased to 0.3 radian at POGO and BOSS on Rev 111, range lock was satisfactory. The anomaly was attributed to degradation of the turn-around ratio within the vehicle transponder which can be compensated for by increasing the mod index on the uplink provided that uplink commanding and downlink telemetry are not adversely affected. All RTS except HULA and COOK continued to use the 0.3 radian mod index on the uplink; HULA reported interference with uplink commanding with 0.3; therefore, HULA and COOK returned to the use of the 0.1 radian mod index. With this arrangement, the RTS were able to achieve range lock a sufficient number of times each day to satisfy STC requirements.

The RTS measured an approximate 8 db degradation in the vehicle transponder turnaround ratio. This is similar to that which occurred in ground testing and is attributed to a degraded potentiometer in the Baseband Assembly Unit of this type of transponder. A new type transponder will be used on SV-7, SV-9 and up. SV-6 and SV-8 will have one of each type.

4.2 TELEMETRY

4.2.1 General Performance

Telemetry system performance was satisfactory throughout the flight. Out of a total of 1136 active station contacts through Rev 1024, PCM Side 1 and SGLS Side 1 were operated during 1133 station contacts an estimated average time of 300 seconds per contact for a total on-time of 5665 minutes. PCM Side 2 and SGLS 2 were operated during Rev 9 KODI and Rev 18 POGO and HULA for an operating time of approximately 18 minutes with normal performance. (NOTE: refer to the SOLO report for a discussion of anomalous operation of SGLS 2 during the SOLO Phase.) In addition, operation of the PCM system during tape recording and operation of the Tape Recorders (T/R #1 and T/R #2) was normal throughout the flight.

4.2.2 Equipment Temperatures

The ranges of selected T&T equipment temperatures through Rev 1024 are summarized below:

		Temperature Range	
Monitor	Identification	Hi	Lo
H20	PCM Master Unit #1 Temp	102	60
H22	PCM Remote Unit #1A Temp	96	71
H24	PCM Remote Unit #2A Temp	92	66
H26	PCM Remote Unit #3A Temp	80	60
H80	Tape Recorder #1 Temp	91	68
H250	VCTS #1 Temp	102	73
H251	VCTS #2 Temp	84	70
H373	Time Word DC/DC Converter Temp	81	60
H383	Instrumentation Converter Temp	77	61
H432	PCM Remote Unit #4 Temp	91	71
H433	DIU Internal Temp	83	60

4.2.3 Instrumentation

The following comprises the list of anomalous instrumentation existing at liftoff:

ID No.	Description
B055	Primary REA #5 Chamber Temperature is open circuited and may read any voltage on telemetry.
A918 A924	Shroud temperature monitors are open circuited and may read any voltage on telemetry.
C391 C392	Solar Array Force Transducers are not connected and may read any voltage on telemetry.
C267	Charge Current Controller #4 setting of K1 operation is 40 to 110 millivolts (TM volts) higher than specification value at temperatures below 70°F, but there is no operational impact.

4.3 COMMAND

4.3.1 Uplink Operation

The vehicle SGLS command equipment was utilized to receive approximately 13.5 million bits with no vehicle problem indications.

4.3.2 GFE Command System

4.3.2.1 Extended Command System. The ECS responded satisfactorily in all command modes resulting in the loading of 170,180 SPCs in memory. Of these 170,180 SPCs loaded, 77,063 were output by both PMUs for decoder processing. The remainder were erased prior to their time label matches.

In loading the 170, 180 SPCs, a total of 239 command rejects occurred, as summarized below:

Rejects	HULA	COOK	BOSS	KODI	POGO	GUAM
Segment 1	74	0	0	0	0	0
Segment 2	17	1	3	1	0	0
Segment 3	70	1	23	3	0	15
Segment 4	5	6	5	13	0	2

The above rejects did not prevent proper loading of the ECS. The HULA rejects during segment 1 occurred after the RTS changed the uplink PRN ranging mod index from 0.1 radian to 0.3 radian (Ref Par 4.1).

4.3.2.1.1 ECS Clock Operation. The accuracy and stability of the ECS clock, as computed for each flight segment, are listed in the following table.

ECS Clock Performance

	Accuracy	Stability, Average 6 Hr Period
Segment 1	.0363 parts in 10^6	3.4 parts in 10^{10}
Segment 2	.0668 parts in 10^6	2.7 parts in 10^{10}
Segment 3	.0923 parts in 10^6	3.03 parts in 10^{10}
Segment 4	.1128 parts in 10^6	3.05 parts in 10^{10}

All of these values are well within system specifications.

4.3.2.2 Minimal Command Subsystem. The MCS responded correctly to all commanding.

4.3.2.3 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.

4.3.2.4 Command System Usage Summary Through Rev 1024.

System	Total Operating Time (hr)
ECS	1531
MCS	4.5
Remote Decoder	6.0
Backup Decoder	.05

4.3.3 375 MHz Receiver

The 375 MHz Receiver was powered during the entire mission with no anomalies.

4.3.4 Data Interface Unit

The Data Interface Unit performed satisfactorily throughout the flight.

Section 5
ELECTRICAL DISTRIBUTION AND POWER (EDAP)

5.1 SOLAR ARRAYS

Solar arrays were extended on Rev 1. Power output from each leg exceeded the specification value. Degradation from the initial output to end of the fourth segment was 7.4 percent. The solar array normally degrades from 3 to 5 percent during the first 30 days in flight and then levels off. Calculations showed a 4.8 percent degradation in the first 42 days which is within predictions. However, an additional 1.6 percent degradation was calculated for the next 3 days which is abnormal. The only activity occurring in this period was RV-5 drop. Since other drops do not show such a large decrease, it suggests that RV-5 is causing a greater than predicted degradation. This is further substantiated by a degradation of only 0.97 percent from Day 45 to Day 71 which included RV-4 drop.

5.2 MAIN BUS VOLTAGE

The Main Bus voltage varied from a low of 27.0 to a high of 31.4 volts. The allowable range was 25.5 to 33.0 volts. Low voltage data was obtained in the dark with a bus load of 70 amps. High voltage data was gathered during charge cycles.

5.3 POWER CAPABILITY AND USAGE

Power usage ranged from 270 to 390 amp-hours/day. This is within the 390 amp-hour/day capability. 390 amp-hours were used on Days 1 and 11. Excess capacity (K2 charge relay cutoffs) occurred on Rev 3 and essentially every rev thereafter except those with heavy payload operations.

5.4 TYPE 29 BATTERY PERFORMANCE

All Type 29 Batteries operated in a desirable environment (43°F to 49°F) and performed normally throughout the mission.

5.5 PYRO BATTERY PERFORMANCE

Pyro Battery 1 stabilized at 47°F thus minimizing self discharge during the mission. Thirty-seven days after launch the battery left the peroxide region. Lift-off capacity was calculated at 9.3 amp-hours. 1.4 amp-hours were used during 71 days of flight leaving 6.9 amp-hours. Cell degradation life still available was 37 days. Pyro Battery 2 followed the same pattern with the exception of leaving the peroxide operating region on Day 18. Thirty-four (34) days of cell life were still available at deboost on Day 71.

5.6 LIFEBOAT BATTERY PERFORMANCE

The Lifeboat II battery operated normally in a 49°F environment throughout the entire mission. A total of 76 amp-hours remained at the end of mission from an initial 343 amp-hours at launch. Remaining cell degradation life was 33 days.

Section 6
LIFEBOAT II

6.1 BAY 10 BATTERY INDUCED ERRORS

For this flight, two Type 29 batteries were installed in Bay 10 adjacent to the Lifeboat magnetometers in Bay 9. Ground tests indicated that this installation would introduce errors that would be significant but within the Lifeboat attitude specification. Since these errors are a function of the earth's magnetic field vector, it is difficult to show that Lifeboat meets specification in all cases; however, sufficient data was obtained to show that the attitude error is very probably within specification. The most significant errors are due to induced magnetism of the batteries. The errors due to the permanent magnetism of the batteries were -3, -6 and -2 mg for the Q, P and R magnetometers, respectively. The tests showed a -2 mg telemetry bias for the Q but none for the P and R magnetometers. It was also possible to determine the influence of the battery current variation which was shown to be of second order.

The Lifeboat attitude specifications are defined for both the RV recovery and the deboost modes for restricted latitudes and longitudes where the magnetic field is in the order of 500 mg. For other locations, the specification is related to the magnetic field; smaller fields allow a wider deadband. The test and computed test-deduced errors are shown in Table 6-1 together with the specified values.

6.2 YAW ATTITUDE DETERMINATION

Flight tests demonstrated the Q magnetometer capability to determine yaw attitude errors (in case of an ACS gyro malfunction) of 1 degree or more provided the magnetic field inclination angle is not large and a satisfactory calibration has been accomplished prior to the ACS failure. The restriction to the method is that the calibration must be for the same latitude and within ±5° of longitude for the point at which the yaw is to be

Table 6-1

LIFEBOAT ERRORS DURING RV RECOVERY AND DEBOOST

	Sensors		
	Q (Y Axis)	P (X Axis)	R (Z Axis)
Worst Case Errors (Flight Test)			
ΔMG(1)	16	14	9
Attitude in 500 mg Field (deg)	1.8	1.6	0.7
Actual Error During RV Recovery			
ΔMG(1)	1.9	12.6	N/A
Attitude (deg)	0.3	1.5	N/A
Max Allocated Error for Recovery (deg)	2.42	2.50	N/A
Predicted Error for Deboost			
ΔMG(1)	7	N/A	9
Attitude (deg) (300 to 400 mg field)	1.5 to 1	N/A	1.9 to 1.3
Max Allocated Error for Deboost (deg)	1.73	N/A	1.64

(1) ΔMG is the difference between the predicted magnetic field from DGMAP and the observed value.

determined. In the test this was done by spacing the tests approximately a week apart. Table 6-2 shows the test results derived from the test data shown in Fig. 6-1.

Table 6-2

YAW ATTITUDE ERROR DETERMINATION

Rev No.	ACS		Magnetometer	
	Roll (deg)	Yaw (deg)	Average $\Delta Q_{(mg)}$ from Average Baseline	Yaw (deg)
531	-.5	-1.3 to -1.5	-5	-1.3
612	-.2	-.6 to -.3	-1.5	-0.3
726	-.4	-1	-3	-0.8
839	-.5	-1.2 to -1.4	-5	-1.2
953	-.3	-0.8	-2.5	-.6

6.3 FUNCTIONAL HEALTH CHECK

On Rev 1097 the ACS was deactivated and Lifeboat was allowed to control the vehicle for 30 seconds. The Lifeboat control system performed normally, pitching down approximately 17 degrees and yawing approximately 13 degrees up to the time of Reset.

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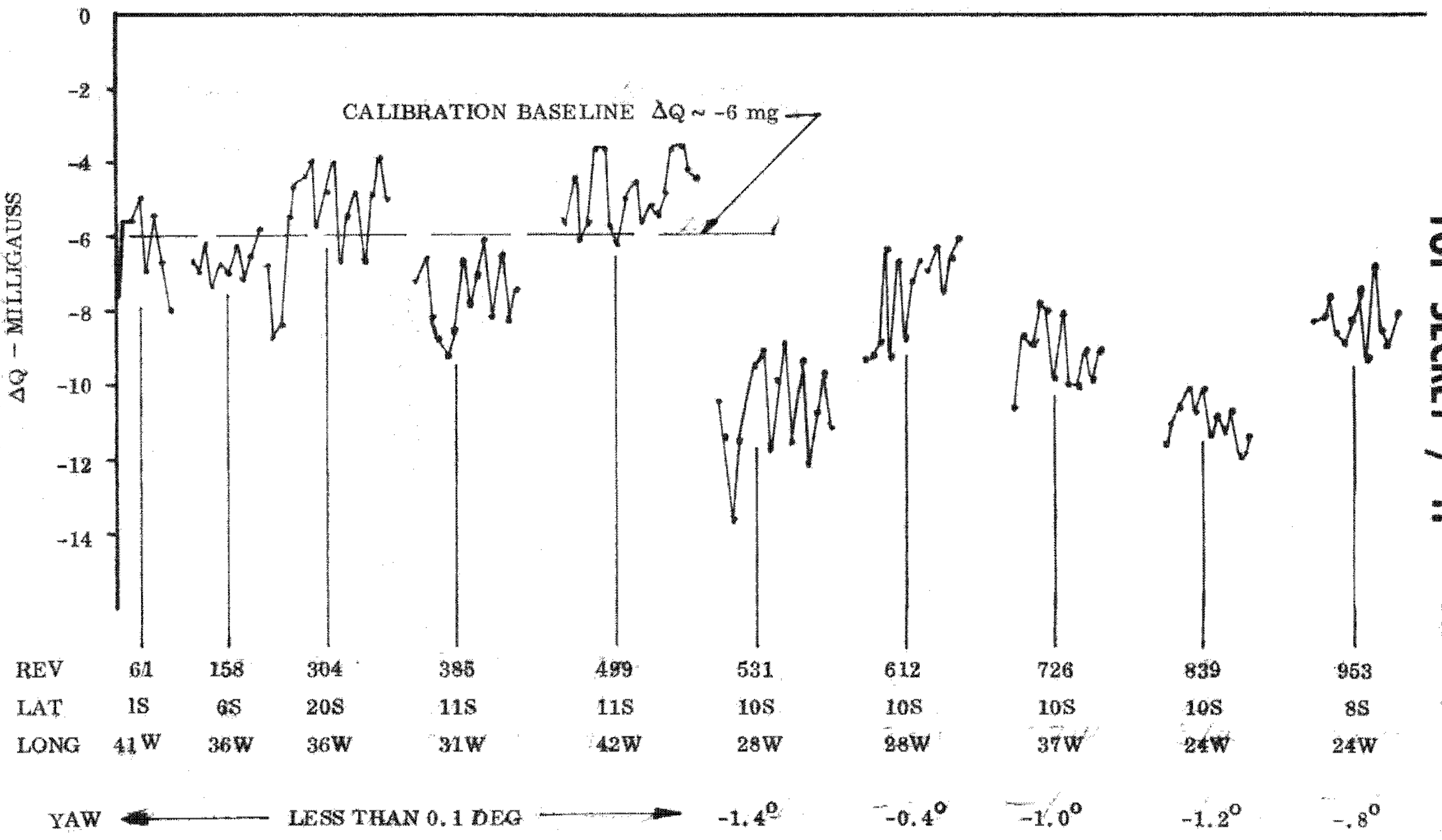

Figure 6-1 Yaw Effect on Q Magnetometer

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Section 7
SENSOR SYSTEM

7.1 COARSE FILM PATH

Both coarse film paths – supply, loopers, steerers, articulators and takeups – exhibited nominal operation throughout the mission except for a possible rubbing of the film during startup on one of the 10 operations performed between Revs 151 and 176 when the 5 ips rewind restriction was relaxed to 55 ips (48 ips was maximum used).

7.2 FINE FILM PATH

Both fine film paths performed nominally throughout the mission except for the possible indications of rubbing on one operation as described in paragraph 7.1.

7.3 COMMAND AND CONTROL

The command and control subsystem exhibited nominal operation throughout the mission in both stereo and mono modes. Adjustments of V_y and OOAA were made to compensate for the vehicle attitude errors which began on Rev 523. Post-flight photographic analysis showed that these adjustments were effective in eliminating almost all of a 20 to 30 line/mm resolution loss present without the adjustment, especially for narrow scan angles.

7.4 OPTICAL BAR PERFORMANCE

The optical bar performance of both cameras was nominal throughout the mission with the exception of an out-of-focus band near the center of the B-side film for all operations during Revs 875 through 965. At the time of this report no cause has been identified.

7.5 INSTRUMENTATION

This subsystem experienced two anomalies.

- An apparent failure in the Instrumentation System Command and Control Unit (ISCCU) about 500 seconds after lift-off which caused the loss of all thermal and pneumatics instrumentation with the exception of the film path chute pressure. Start of normal operation was delayed until Rev 11 when nature of the failure and status of the pneumatics system had been ascertained. An acceptable thermal environment was inferred from the SV T_{ref} temperature monitor point and pneumatics consumption was estimated on a use rate of 0.0240 lb N2/minute of pneumatics ON time.
- The TU 3 select discrete was lost on Rev 491 during Segment 3 but without any effect on operations. After the transfer the TU 4 select discrete indicated properly.

7.6 PNEUMATICS

Pneumatics system performance was nominal throughout the mission despite the loss of instrumentation described in paragraph 7.7. During SOLO the pneumatics system was run to depletion and the average use rate was determined as 0.0201 lb N2/minute as opposed to the assumed 0.0240.

Section 8
RECOVERY VEHICLES

8.1 SUMMARY

The recovery statistics are shown in Table 8-1 and Fig. 8-1. Performance of the RV subsystems is summarized in Table 8-2. Data indicate that all RV events (on-orbit, reentry and recovery) occurred as planned (except for a flashing recovery light during "reel-in" on RV-3) and the RV flights followed the predicted trajectories.

The payload on RV-2 was recovered in good condition. The outer wraps on RV-1, RV-3 and RV-4 were loose due to payload rotation after aerial retrieval induced shearing of the core pins. Aerial retrieval loads exceeding the core pin strength were anticipated.

All subsystems performed satisfactorily and met all mission requirements as shown in Table 8-2.

8.2 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 8-1 shows the entry conditions to be well within previously established entry boundaries. Also shown are the conditions at time of drogue chute deployment which are within the design envelope.

Table 8-1

RV RECOVERY SUMMARY

	RV-1	RV-2	RV-3	RV-4
RV Serial No.	24	23	22	21
Recovery Rev. No.	196	424	651	1024
Recovery Date	21 March 1973	4 April 1973	18 April 1973	11 May 1973
Payload Weight (lb) (A;B) (Measured wt from recovered RV)	A = 217.6 B = 218.4	A = 220.6 B = 220.4	A = 228.8 B = 231.2	A = 200.7 B = 207.3
Unbalance Percent	0.3	0.09	1.0	2.9
SV Orbit (hp x ha/ωp)*	86.02x144.93/ 126.81	85.69x146.33/ 131.18	85.95x143.91/ 122.66	86.50x149.10/ 129.12
SV Pitch Angle (deg)	-33.5	-37.5	-37.8	-37.2
Nominal PIP Latitude	29.00°N	23.50°N	22.00°N	26.00°N
Impact Location Error (EPPD vs Teapot Eval)				
Overshoot (nm)	8.7	5.2	1.52	
Undershoot (nm)				5.44
Crosstrack (nm)	2.7E	3.7E	.36W	.92E
Recovery (aerial)				
Altitude (ft)	11,000	7,700	14,200	10,300
Parachute Condition	No Damage	No Damage	Minor Cone Damage	Minor Cone Damage
Retrieval Pass	2	3	1	2
RC/Payload Condition	Good	Good	Good	Good

*hp = Altitude of Perigee (nm), ha = Altitude of Apogee (nm), ω_p = Arg. of Perigee (deg)

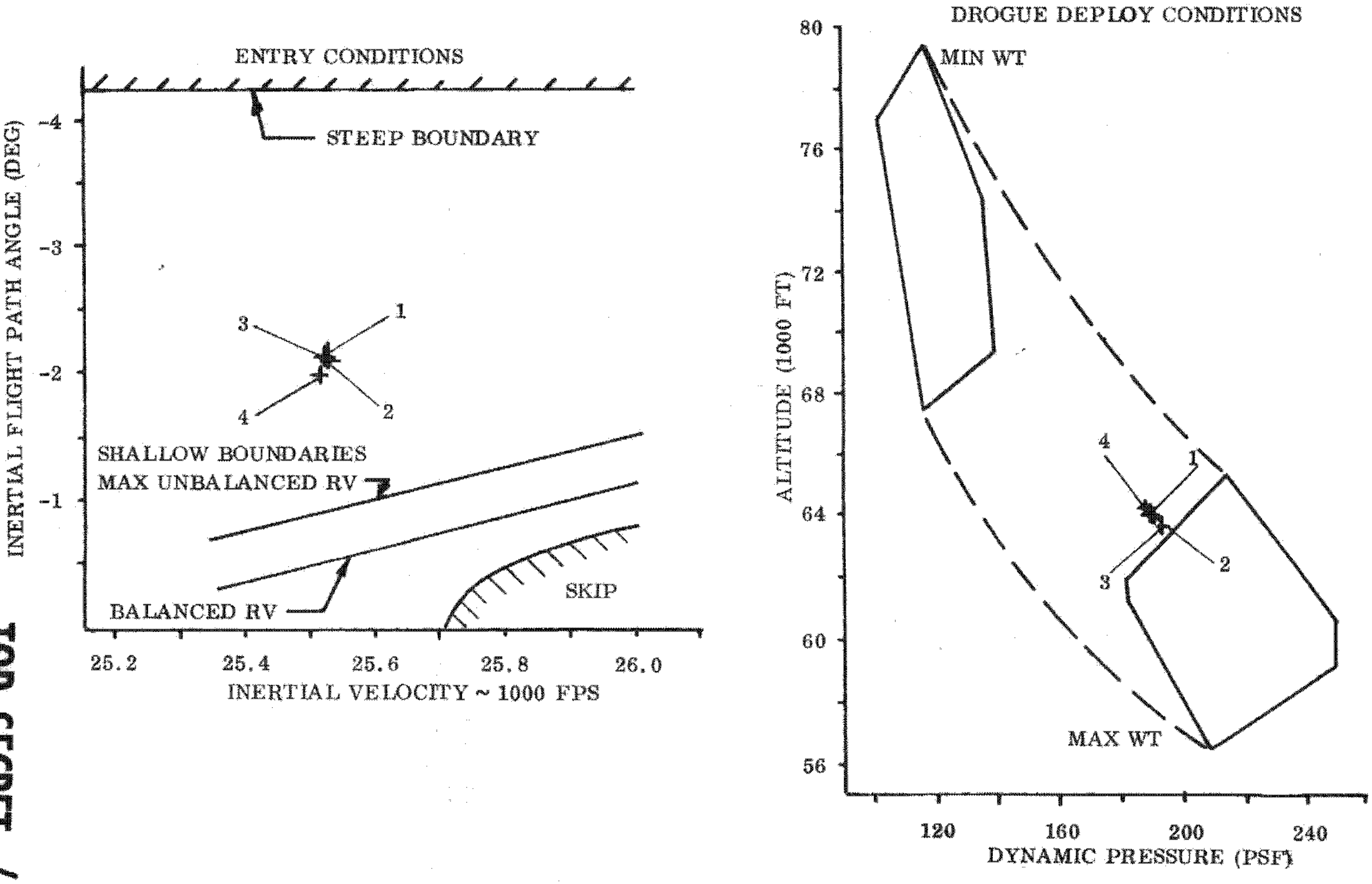

Figure 8-1 SV-4 Reentry Parameter Comparisons

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Table 8-2

RV SUBSYSTEM PERFORMANCE SUMMARY

RV Subsystem/Function	Performance Assessment
On-Orbit Thermal Protection	Normal • T_{PL} Container = $T_{ref-7^{o}F}^{+2^{o}F}$ • Power Usage (watts/RV) Maximum = 18 (first day in orbit) Stabilized = 7.5 (fifth day in orbit) Allowable = 20
Trim and Seal	Normal
Electrical Distribution & Power	Normal • All batteries activated • All voltages > 2.5 volts
Sequential Subsystem	Normal on RV-1, RV-2 and RV-4. On RV-3 while in tow the water sensor switch was inadvertently shorted by a piece of graphite cloth from the parachute cover or from metallic debris from propulsion truss jettison.
Pyro Subsystem	Normal • All primary and redundant pyrotechnics in each RV were verified by post-flight inspection to have functioned properly.
Structure	Normal
Spin Stabilization	Normal
Retro Motor	Normal
Tracking, Telemetry and Instrumentation	Normal
Head Shield	Normal
Base Thermal Protection	Normal
Recovery	Normal

8.3 REENTRY VEHICLE SUBSYSTEM PERFORMANCE

The only anomaly noted was the activation of the RV-3 recovery light, a component within the Sequential Subsystem, reported by the retrieval crew on board the recovery aircraft. Normally this light is activated during water recoveries by sea water in contact with one of four Water Sensor switches. Post-flight analysis and testing revealed no discrepancy in associated wire bundles, relays or switches; however, the anomaly was duplicated by shorting the Water Sensor switches with graphite cloth strands, and also with metallic debris from the propulsion truss separation. Openings of sufficient size to permit entrance of such debris exist in the aft thermal protection. A vented protective cap will be installed over the switches to preclude a recurrence.

(b)(1)
(b)(3)

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Section 10

SUBSATELLITE

There was no subsatellite flown on SV-5.

Section 11

STELLAR TERRAIN (ST) SUBSYSTEM

11.1 ST PERFORMANCE

The first ST camera system was flown on SV-5 and its operation and performance was highly satisfactory. The two anomalies involving the malfunction of the terrain thermal door and the tape stop switch together with a summary of the ST-RV performance follow. The Doppler Beacon System (DBS) which is mounted on the MCM is also discussed.

11.2 TERRAIN CAMERA THERMAL DOOR MALFUNCTION

The thermal door malfunctioned on Revs 8, 13, 39, 70, 90, 91, 665 and 668. when it did not open on command. Because the anomaly was intermittent it was necessary to continue the analysis through several revs. On Rev 16, the transfer was made to the the thermal door redundant electronics to eliminate the probability of a telemetry problem. Operations were successful until Rev 39 when the anomaly was observed with both servo electronics circuits. Based on ground tests, the anomaly was determined to be telemetry and operations were continued. With the exception of Rev 70, operations were normal up to Rev 90 when the telemetry indicated the doors were now not closing. The malfunction was then correlated with cold temperature conditions experienced at latitudes greater than 50 degrees north. Operations were restricted to latitudes less than 50 degrees north on Rev 100. Periodically this restriction was altered based on the change in solar elevation and increased to 63 degrees north by the end of the ST mission. The calibration procedure on Revs 665 and 668 required the camera to look skyward on the cold side of the orbit resulting in the coldest possible conditions and the doors did not open. The terrain thermal doors are being redesigned to eliminate this malfunction.

11.3 TAPE STOP SWITCH MALFUNCTION

The tape stop switch sets up the photographic sequence and provides an internal "OFF" command to the camera. Malfunction of this switch resulted in both stellar and terrain cameras transporting more frames than commanded and a random loss of photographic functions. The ST system was switched to the backup system on Rev 503. This mode has a separate tape stop switch but locks the camera system to a fixed set of operating parameters. The anomaly cost the mission of total of 31 frames.

11.4 ST-RV (RV-5) RECOVERY

The ST-RV was successfully recovered on Rev 683. Recovery statistics are shown in Table 11-1. 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 11-1. The miss distance between the PIP and EPPD was calculated to be 11.68 nm short and 1.46 nm west of the ground track. The capsule was affected by a 125 KTS jet stream and was blown 16 nm from the EPPD by a 105 KTS wind from 250 degrees.

The capsule was recovered at 12,400 ft on the first pass with no damage to the chute or capsule.

Table 11-1

ST-RV (RV-5) RECOVERY SUMMARY

Recovery Rev		683	
Date		20 April 1973	
Payload Weight (100%)		65.93 lb	
SV Recovery Orbit			
Perigee (nm)/Apogee (nm)/ Perigee Arg (deg)		86.3/152.0/129.1	
SV Pitch Angle (after yaw around) (deg)		-64.4	
	PIP	EPPD	Air Snatch
Latitude	16° 10.2'	16° 22'	16° 37'
Longitude	159° 23.4'	159° 23'	159° 03'
Altitude			12,400 ft

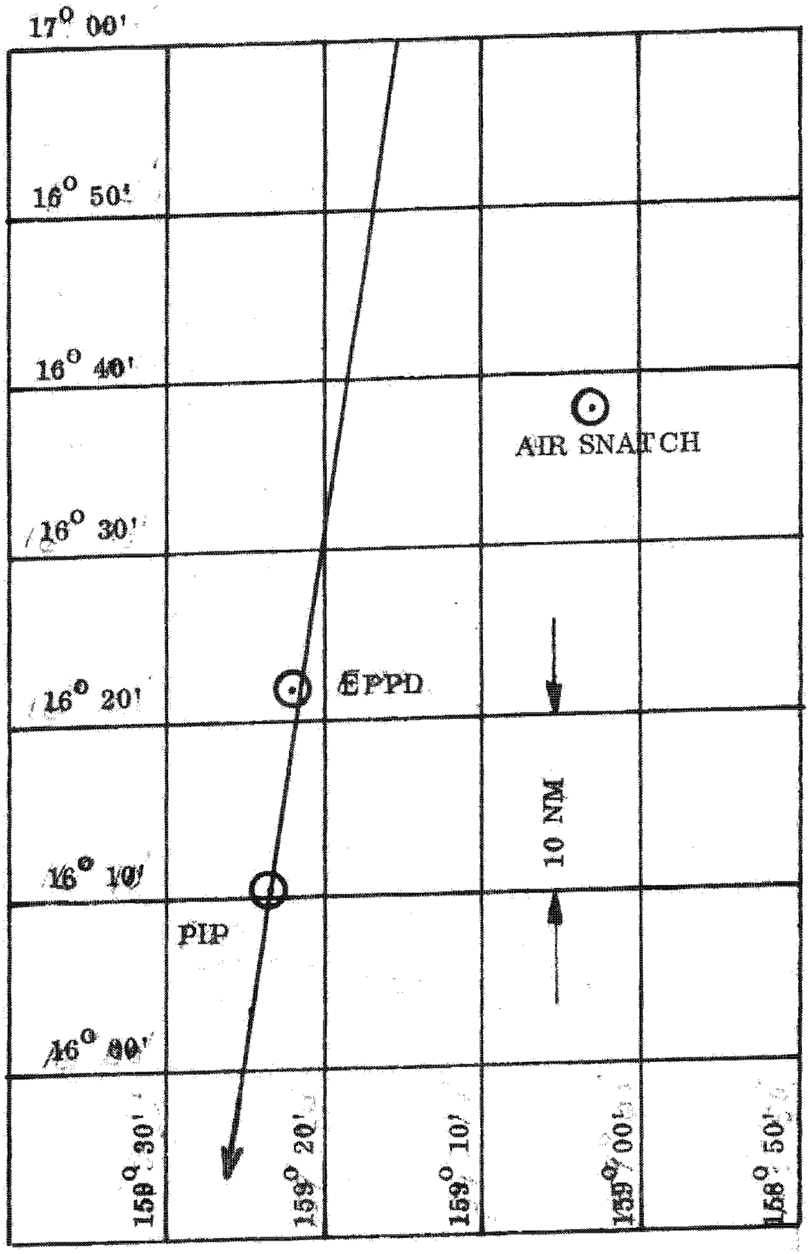

Fig. 11-1 ST-RV Recovery Locations

11.5 DOPPLER BEACON SYSTEM (DBS)

Although the antenna remained in the stowed attitude (90° from the deployed attitude) throughout the flight, the DBS satisfactorily performed all mission objectives. The antenna was not deployed as commanded due to thermal taping of the antenna overlapping the pin puller block assembly which was detected on photographs of the MCM on SV-5. This area and other possible interferences with the DBS will be closely followed on future vehicles.

Section 12
THERMAL CONTROL

12.1 FORWARD AND MID SECTIONS

The Forward and Mid Section structural temperature control is summarized in Table 12-1. The data indicates that the Forward and Mid Section thermal design provide good control of payload temperature levels. No design changes are forthcoming as a result of SV-5 flight performance.

12.2 ACTIVE THERMAL CONTROL

T_{Ref}, which represents the average Mid Section film path temperature, decreased from 71 to 63°F during the flight as shown in Fig. 12-1. This followed a gradual cooling of the Mid Section from 69 to 63°F. These temperatures are well within the allowable range of 47 to 93°F but are noted since this cooling had not been seen on previous vehicles. Changes in the solar constant during the flight could account for approximately 2°F or 30 percent of the temperature reduction. At present, no reason for the rest of the decrease has been found. No further action is contemplated. The temperatures will be studied again on future flights.

The RV heater zones which are actively controlled relative to T_{ref} were generally within 1°F of T_{ref} indicating adequate performance of the Active Thermal Control (ATC) System. Early in the mission, there was an anomalous behavior of ATC when an RV heater was not activated at the proper time. This anomaly is discussed in Section 12.4.

Table 12-1

FORWARD AND MID SECTION TEMPERATURE FOLLOWING INITIAL TRANSIENT

Parameter	Design Limits (^{o}F)	SV-5 Actuals
$\overline{T}_{fwd}$	47/93	69/75
$\overline{T}_{tca}$	48/92	67
$\overline{T}_{fwd} - \overline{T}_{tca}$	$<\|20\|$	2/8
$\overline{T}_{su}$	49/91	70
$\overline{T}_{su} - \overline{T}_{tca}$	6/-4	3

Definitions:

$\overline{T}_{fwd}$ – Orbit average radiation temperature of the Forward Section derived from the average bulkhead temperature

$\overline{T}_{tca}$ – Orbit average radiation temperature of the forward compartment structure in the Mid Section

$\overline{T}_{su}$ – Orbit average radiation temperature of the aft compartment structure in the Mid Section

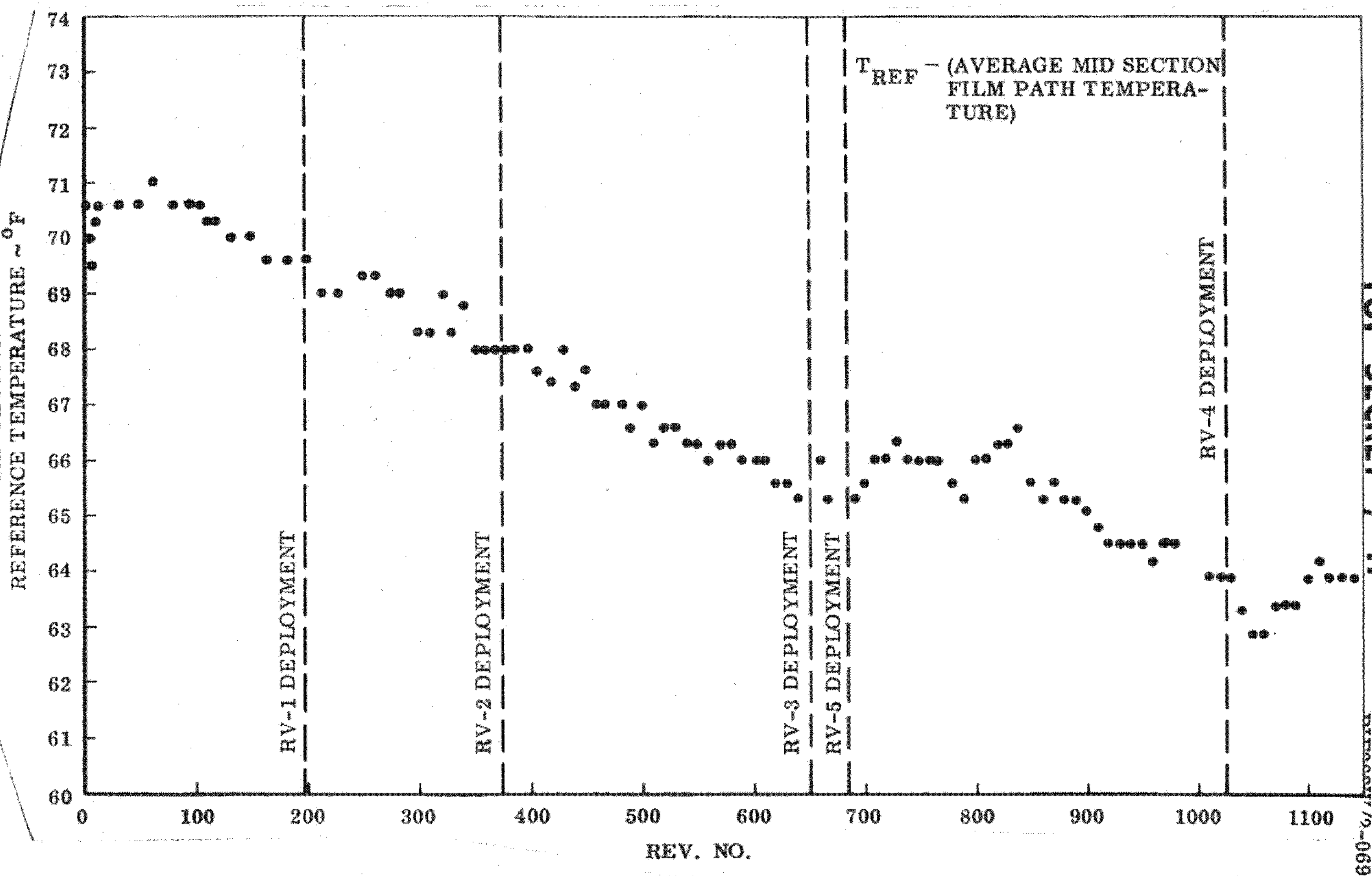

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Fig. 12-1 SV-5 Mid Section Temperature History

12.3 AFT SECTION

Acceptable Aft Section temperature control was maintained throughout the flight. All equipment temperatures remained within design limits as shown in Table 12-2.

The SV-5 Aft Section was configured as follows:

- Type 29 Batteries were located in Equipment Section (ES) bays 10 and 3.
- Battery bay doors as well as bays 11 and 2 doors were covered with Flexible Optical Solar Reflector (FOSR), replacing white silicone paint.
- Heat straps were installed in the ARM module and the ES bay 7 door was painted white in order to provide capability for dual ACS operation. This was first done on SV-4.
- A Block II IRA and Horizon Sensor were flown in the ARM.

Flight data indicates that battery and IRA temperatures were satisfactory, and that the battery bay and ARM designs performed as predicted.

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 by Fig. 12-2, which compares actual Equipment Section door temperatures with predictions of a Beta angle of -8 degrees. Solar absorptance (α_s) for the degraded FOSR was estimated to be 0.30 to 0.36, less than the $\alpha_s = 0.50$ assumed for the worst case.

12.4 THERMAL CONTROL ELECTRONICS ASSEMBLY (TCEA) ANOMALY

The TCEA compares the Mid Section temperature (C700) with the RV temperatures (C702, C703, C704 and C705). When the RV temperature is 0.3°F less than C700, the RV heaters come on until the RV is only 0.2°F less than C700. TM error and processing of these absolute temperatures is approximately 0.35°F.

Table 12-2
SV-5 AFT SECTION CRITICAL COMPONENT TEMPERATURES

Critical Component	Design Limits (°F)	SV-5 Actuals(2) (°F)
EDAP		
PDJB	-30/170	73/81
CCCs	-30/170	84/96
Batteries, Bay 3	35/70	42/49
Batteries, Bay 10	35/70	43/48
PDAs	-30/160	56/81
Solar Array Panels	-125/225	-76/148
ACS		
IRA	50/130	89/109
HSA Heads	0/130	68/89
FCEA	-30/160	—
OAS		
Tank	65/100	75/92
Quad Valve	35/200	110/120(1)
Catalyst Bed	—	129/161(1)
T&T		
Tape Recorders	20/130	64/87
Transmitters	-30/170	67/90
PCM Master	-30/170	63/82
PCM Remote, B2	-30/170	74/84
PCM Remote, B10	-30/170	60/75
Command		
PMU A	-40/145	73/76
PMU B	-40/145	81/85
Clock	-40/153	84/95
MCS	-40/149	44/50
RCS		
Tanks	40/140	71/88
Plumbing, Bay 12	35/140	75/94

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

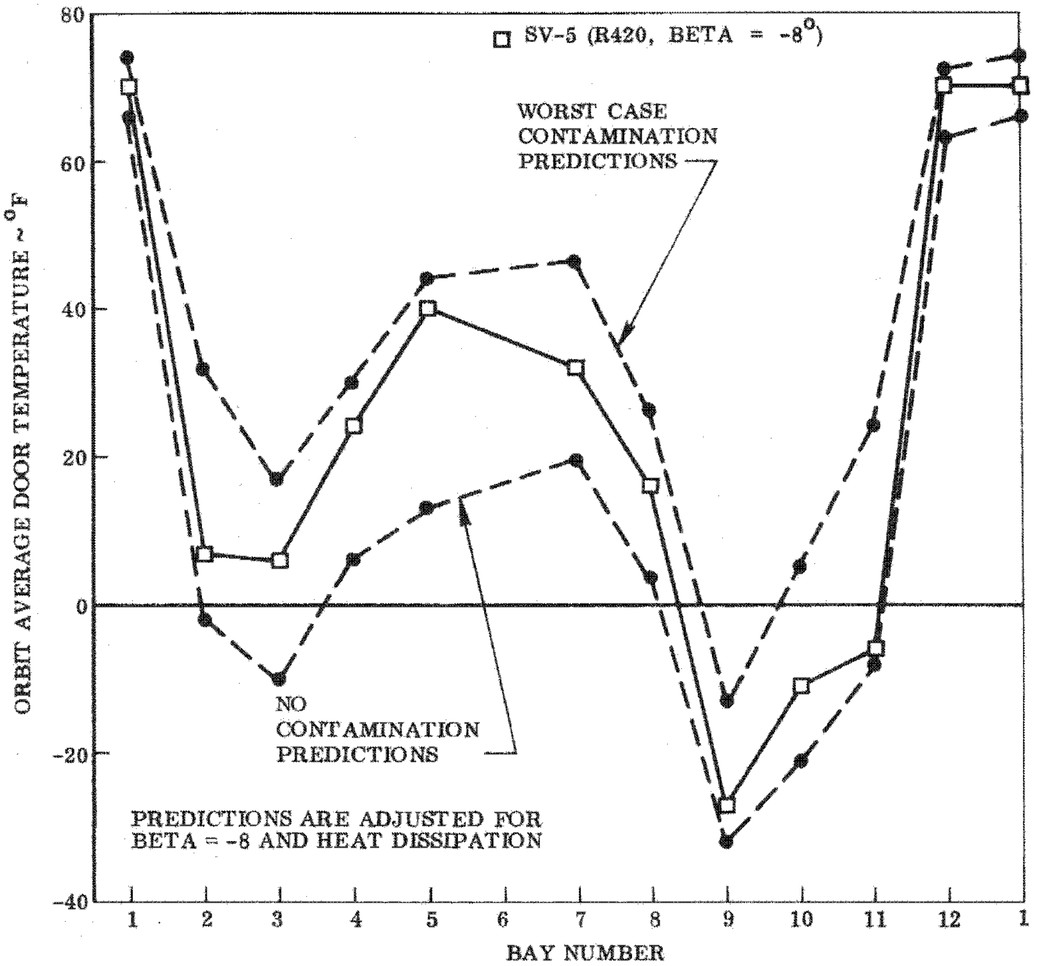

Fig. 12-2 SV-5 Equipment Door Temperatures

From launch through Rev 195, C700 was 0 to 0.7°F greater than the RVs which is normal. After the first RV drop (196K) the RV-4 (C705) temperature deviated by more than this amount as shown in Table 12-3 until Rev 207 after which it returned to normal. RV-4 heater status indicated off from 197P to 199G and from 204K to 3900 seconds before 207G. A similar failure was observed in the RV-4 TCEA control during the A-1 chamber test of SV-5. The unit was removed and the trouble isolated to the heater driver board. Analysis of the board resulted in the removal of an operational amplifier which subsequently was shown to have a gross seal leak which was thought to be the cause of the original failure. Because the problem repeated in flight it is now felt that the original failure was not corrected and the amplifier was not the cause. The most probable cause is either a bad bond in a semi-conductor device on the board or a bad solder connection. Corrective action taken was to subject TCEAs to more power on testing at the vehicle level (both primary and redundant sides) to obtain additional visibility and burn-in.

Table 12-3

TCEA TEMPERATURES

Rev/Sta	System Time	C700 Ref Temp	C705 Zone 4 Temp	ΔT
196H	82438	69.3	69.0	-0.3
197P	575	69.6	68.3	-1.3
197K	995	69.6	68.3	-1.3
198P	5820	69.6	67.6	-2.0
199P	10968	69.6	67.3	-2.3
199G	12272	69.6	68.6	-1.0
200B	15800	69.6	69.3	-0.3
201P	21648	69.6	69.3	-0.3
202C	26416	69.6	69.3	-0.3
203C	31653	69.6	69.3	-0.3
204K	37411	69.6	68.6	-1.0
205H	42156	69.6	67.6	-2.0
207G	52578	69.6	69.3	-0.3
208P	59294	69.6	69.0	-0.6
209P	64696	69.3	69.0	-0.3
210P	69918	69.3	69.0	-0.3
211P	75273	69.3	69.0	-0.3

Section 13
MASS PROPERTIES

The history of the SV mass properties throughout the flight are tabulated in Table 13-1.

Table 13-1
SV-5 MASS PROPERTIES

Description	Weight (lb)	Center of Gravity (inches)			Moment of Inertia (slug-ft^2)			Product of Inertia (slug-ft^2)		
		$\overline{X}$	$\overline{Y}$	$\overline{Z}$	I_x	I_y	I_z	I_{xy}	I_{xz}	I_{yz}
SV Launch Weight	23996	1974.2	0.21	4.20	6911	200202	199992	-509	100	40
Separation From Stage 2	21003	1985.9	0.26	4.82	4755	168702	168423	-490	425	39
Solar Arrays Deployed -18°	21003	1986.4	0.26	4.82	5911	169786	170607	-489	435	233
Prior to Drop 1	20641	1975.0	0.20	5.29	5876	174089	174920	-446	945	223
After Drop 1	19125	1998.6	0.22	4.33	5674	142464	143433	-431	-338	224
Prior to Drop 2	18646	1986.1	0.15	4.88	5646	144025	144993	-383	109	214
After Drop 2	17131	2007.7	0.17	3.77	5441	122532	123641	-373	-981	214
Prior to Drop 3	16762	1996.3	0.12	4.44	5437	123203	124292	-346	-608	207
After Drop 3	15213	2015.6	0.13	3.10	5222	109698	110939	-340	-1534	208
After Drop 5	14719	2025.2	0.14	3.86	5124	95202	96530	-331	-576	205
Prior to Drop 4	14165	2013.0	0.14	4.71	5138	93623	94920	-331	-415	205
After Drop 4	12669	2029.7	0.15	3.22	4931	86196	87637	-329	-1063	205
End Deboost	11787	2017.8	0.09	3.34	4908	81005	82455	-303	-1114	198

Section 14
STRUCTURE AND DYNAMICS

14.1 PRELAUNCH WINDS ALOFT LOADS ANALYSIS

Table 14-1 presents a chronological tabulation of the winds aloft computer runs for SV-5. The results are plotted on Fig. 14-1.

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 30 January 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 correct by letter (MMC 73-Y-30231) dated 5 February 1973.

14.2 SOLAR ARRAY

The erections and deployment time history for the left (-Y) solar array is shown in Fig. 14-2 and for the right (+Y) solar array in Fig. 14-3. It should be noted that the arrays were deployed at the first station pass, INDI. The arrays were fully deployed and erected by the next station, POGO, and they were then repositioned from +18 deg to 0 deg and then to -18 deg for maximum output at the flight beta angle of -7.8 deg. Deployment potentiometers have been added on the outboard solar panels which more accurately show the initial motion of the arrays (C-393 and C-394) and these are shown together with the potentiometers common to this and preceding vehicles.

Table 14-1
WINDS ALOFT ANALYSIS SUMMARY

	Balloon Release Time				
	T-30	T-12	T-6	T-3	T-0
	3800 Run at STC Time				
	T-24	T-8.5	T-3	T-1	–
SV Structural Loads:					
Bending Mom (% Limit Load)	73.2	67.9	62.9	61.2	66.7
Critical SV Station	1902	1902	1902	1902	1902
Elapsed Time (seconds)	46.8	48.8	50.8	50.7	54.1
Altitude (feet)	23,992	26,005	28,193	28,000	32,013
SRM Side Force:					
% Allowable	53.2	53.7	50.1	39.2	47.7
SRM No.	2	2	2	2	2
Pitch or Yaw	Yaw	Pitch	Pitch	Pitch	Pitch
TVC Usage for Control:					
Expended (% Allowable)	87.6	69.4	80.5	75.9	73.3
SRM No.	1	2	2	2	2
Expended (pounds)	2023.3	1604.3	1859.8	1632.0	1692.2
Vehicle Response					
Maximum αq (% allowable)	57.8	42.0	38.5	33.9	41.4
Maximum αq (deg-psf)	2191	1409	1176	1372	1789
Elapsed Time (seconds)	45.8	43.3	77.3	49.8	54.3
Altitude (feet)	23,005	20,427	65,076	27,007	32,227

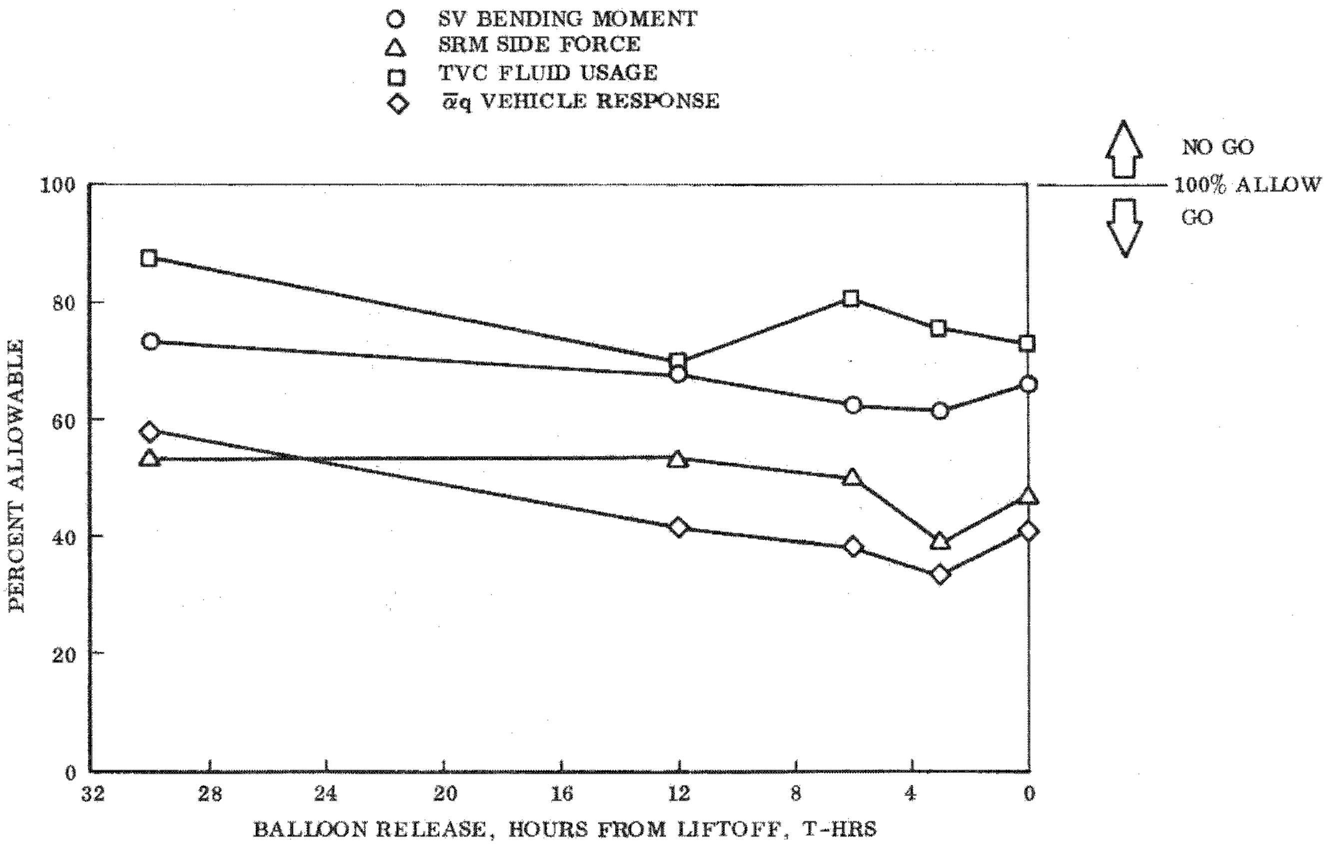

Fig. 14-1 Critical Launch Parameter Summary

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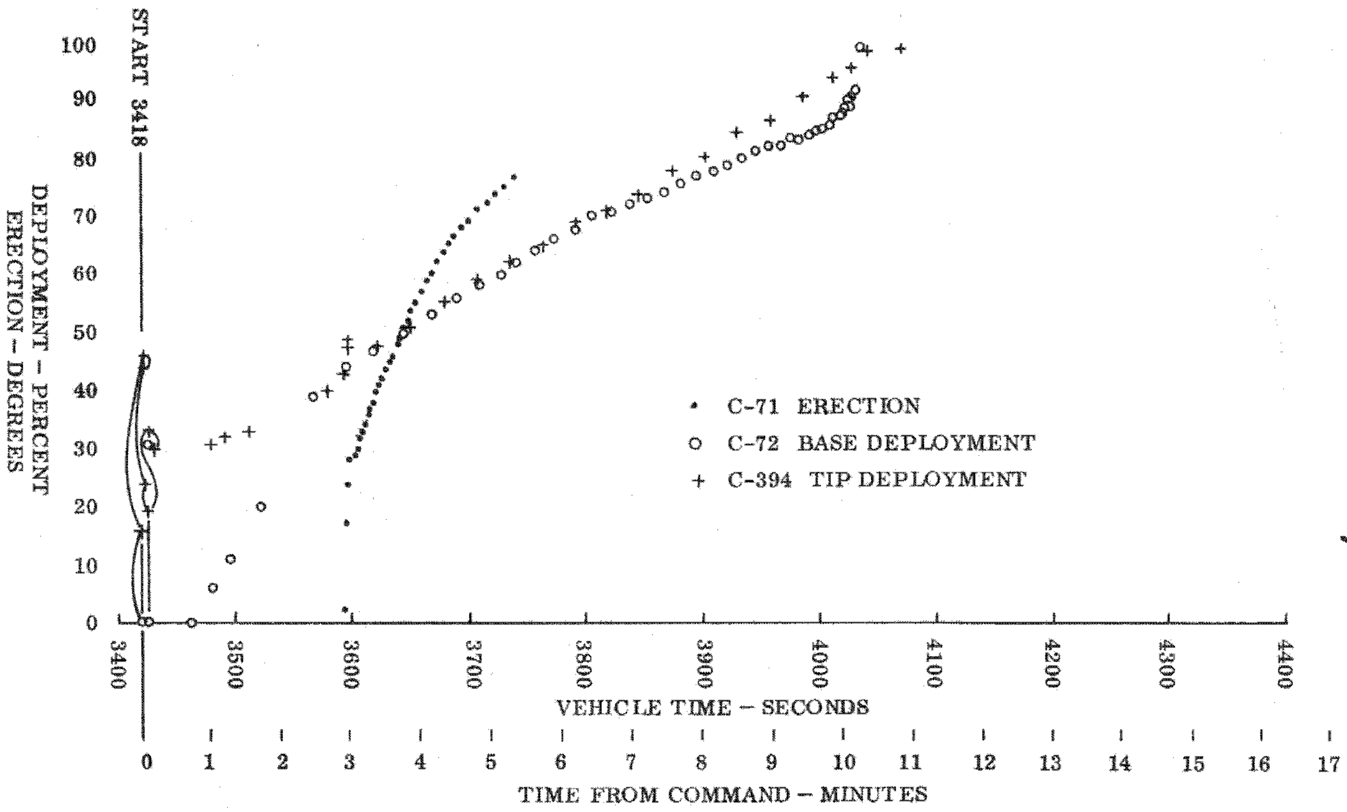

Fig. 14-2 Left-Hand Solar Array Erection and Deployment Time Histories

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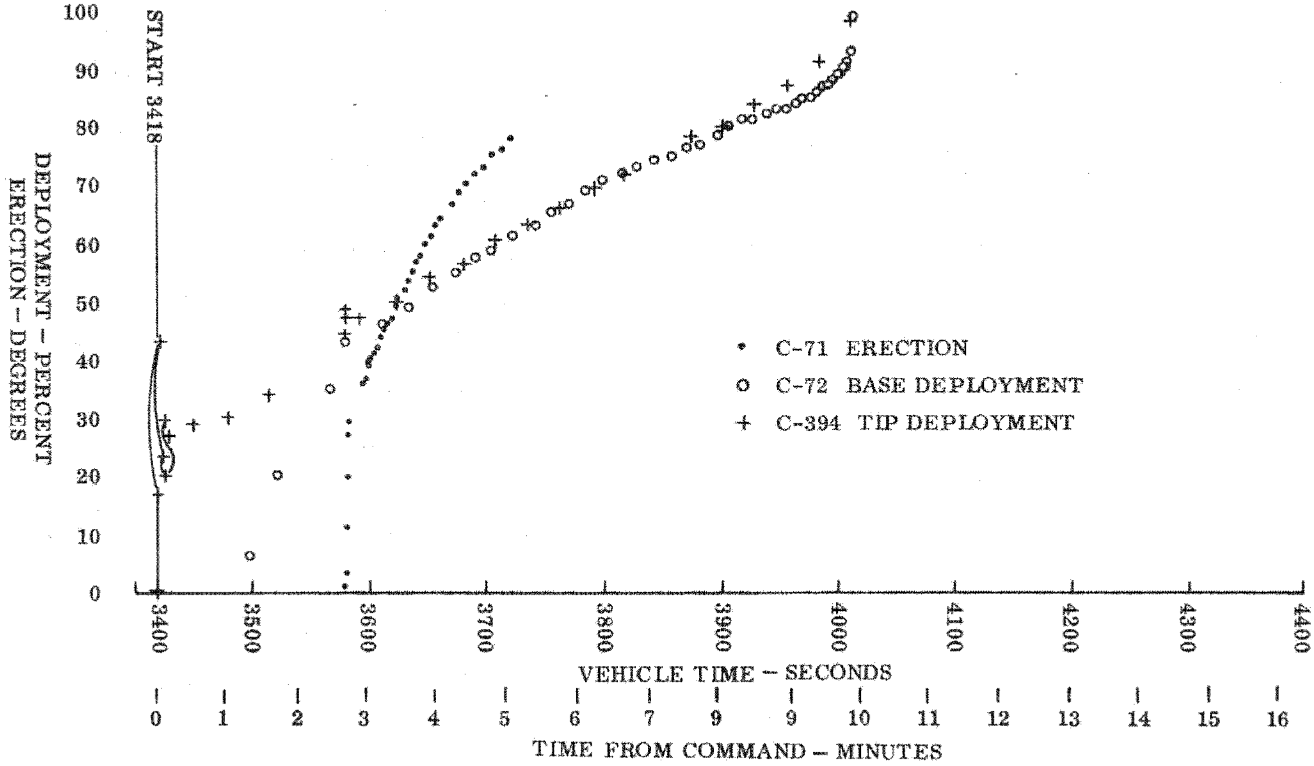

Fig. 14-3 Right-Hand Solar Array Erection and Deployment Time Histories

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14.3 SHROUD SEPARATION

Previous flights have indicated the shroud separates faster than predicted. The potentiometer end was relocated on SV-5 to more accurately measure the initial 10 deg of shroud rotation by measuring only 18 deg rather than the full rotation (approximately 60 deg) before separation. The measured initial rates are shown in Fig. 14-4 to be 5 deg/sec faster than accounted for in pre-flight analysis. Two possible contributors to this initial velocity are being investigated:

(1) Slight internal pressure remaining at shroud separation
(2) Thermal gradients

Effect of these energy contributers on the hinge loads is being studied. So far the loads associated with (1) fall within the structural capability.

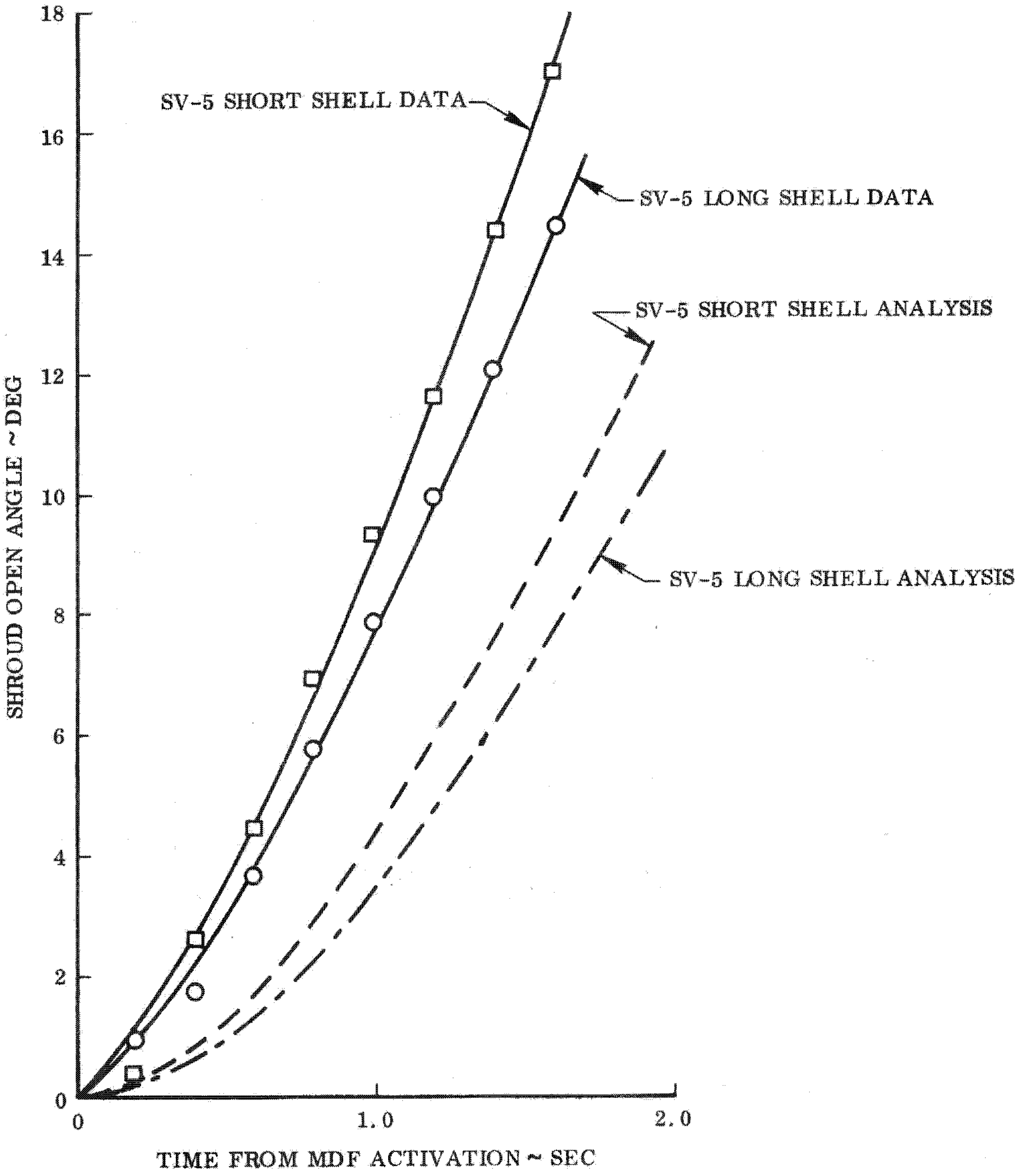

Fig. 14-4 Shroud Separation History

Section 15

SOFTWARE

There were no software problems which impacted flight objectives.